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POLLUTION LOAD INTO RIVER YAMUNA THROUGH BURIA NALA AT FARIDABAD DISTRICT OF HARYANA

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ABSTRACT
The present research study was carried out to examine the contribution of pollution load by Buria Nala itself into surface water of river Yamuna in Faridabad district by studying organic parameters over two different seasons named pre-monsoon season and post-monsoon season for a period of one year May 2016 to April 2017. The results clearly showed a remarkable variation at all the four sites across both the seasons which indicated that water is poorly affected due to the whole time disposal of huge amounts of industrial waste discharged from many small, medium and large scales industries water through Buria Nala, directly into the river, without any treatment. Based on the observations and results, this study concluded that the river is extremely polluted in Pre-monsoon season followed by Post-monsoon season.

Key words: Faridabad, Yamuna, Buria Nala, Pollution, Organic parameter and WQI.

1. INTRODUCTION

Among five basic elements for our survival, water is most required precious natural resource **[1]** which is essential to sustain the life on planet earth **[2]**. Though 80% of planet earth's surface is enclosed by water, the supply of fresh-water has progressively more become a restrictive issue because of several reasons **[3].** The speedy expansion of industrialization, urban development and exploding demography are the major once. Anthropogenic actions like sand mining, discarding of untreated toxic waste and harmful metal chelates released from different industries resulted in decline of water excellence rendering severe environmental troubles **[2].** Enormous loads of wastes from several industries, household sewage and farming practices find their mode into water bodies, resulting in big scale worsening of the quality of water body**.** In present days, superiority of water is an immense concern for environmentalists as well as for the general public in each part of the globe **[4].** Rising pollution in water results not only decline the water quality, but also terrorize human fitness and the stability of water's eco- systems, communal richness and economic growth **[5]. C**haracteristics of water excellence of aquatic surroundings arise from a large amount of physico-chemical and biological relations **[6].** Organic characteristics are very important water quality monitoring parameters which provides information on the productivity of water resource, type of water treatment process to be adopted and permit better understanding of the ability of populations of organisms to survive in them **[7].** Prime purpose of the present work was to estimate the contamination level of Buria Nala which directly discharged into Yamuna river and determine the seasonal variation in river water to assess the degree of organic parameters contamination at Faridabad stretch. A number of researchers like **[8-10]** have made a study on similar aspects.

MATERIALS AND METHODS

2.1 S*tudy area*

Faridabad District is a hub of many small, medium scales and large scales industries ranked 9th position of biggest industrial city in Asia **[11-12].** Buria Nala is the research area selected for the present study which is located in Faridabad district of Haryana, falling in between 28˚ 22' 59.96" (N-latitudes) and 77˚29'11.66" (E-longitudes)**.** It is approximately 21 km downstream from Okhla Barrage in New Delhi. Buria Nala is the most polluted industrial drain in Faridabad city which starts from sector 45 and sector 46 of Faridabad city and drained off into the Yamuna river near Manjhawali, Mozzamabad Majre Shekhpur village and Akbarpur village. River Yamuna is the major lotic system which continuous flows from north direction to south (Figure 1) and bordered this district from east direction **[13].**

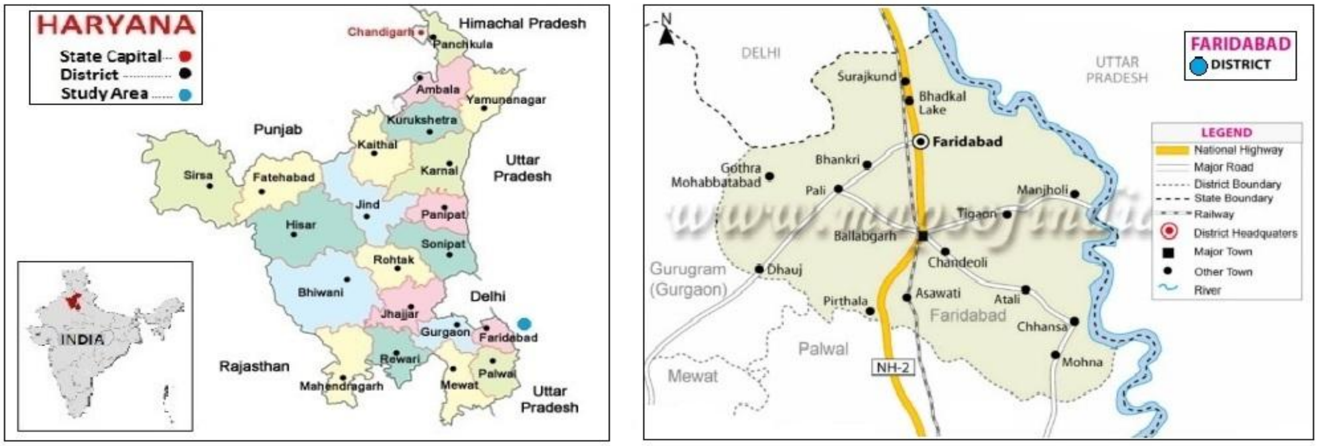

Figure 1: Location of the study area

2.2 *Water sample collection:*

Figure 2: Location of sampling sites

For the present study area (Buria Nala), total 20 samples were grabbed in Pre-monsoon and Post-monsoon season. Four sampling points i.e. site 1, site 2, site 3 and site 4 (Figure 2) were chosen and water samples grabbed from these sampling locations were coded as sample A for site 1, sample B for site 2, sample C for site 3 and sample D for site 4, whereas Sample A collected from site 1 denotes Drain sample; sample B from site 2 denotes confluence point of Yamuna river and Buria Nala (drain effluents); samples C from site 3 denotes 50 metres upstream from site 2 and samples D from site 4 denotes 50 metres downstream from sampling site 2.

2.3 ***Research methodology***

The water samples grabbed were analyzed and tested in the water laboratory as per the given standard procedure adopted by APHA*, 2012 **[14]**. Polyethylene bottles (1 litre) were used for water sample collection. Prior to the sampling, dilute acid was used to clean all these bottles, then followed by the distilled water and then dried up well. Before collection of the water samples, the water sample bottles were washed (3 times) with the water to be grabbed. Organic parameters analyzed in this study included temperature, pH, BOD (biochemical oxygen demand), COD and dissolved oxygen. Among all these mentioned parameters, pH, temperature and DO were assessed without delay at the water sampling sites using standard

equipment **[8].** Description of organic parameters, their instrumentation and analytical methods used, permissible limit with recommended agency WHO (World Health Organization) are given in table 1. All the organic parameters for this analysis were calculated in mg/l **[15].**
[*APHA- American Public Health Association]

2.4 ***Statistical Analysis***
SPSS 20 version was used to compute the correlation between selected organic parameters. Micro-Soft Excel was used to quantify the minimum, maximum, mean value and standard deviation (SD) of the data of grabbed samples of Drain effluent and surface water of Yamuna in Faridabad stretch to measure the variations in both seasons.

2. RESULTS AND DISCUSSION

Table 1. List of organic parameters with their analytical methods and water quality standards with recommended agency [16-17]

Parameters	Instruments	Method Used	Standard	Recommended agency
pH	Digital meter	Digital pH Meter	6.5-8.5	WHO
Temperature	Glass mercury thermometer	-	-	-
Dissolved Oxygen	Titration Instrument	Winkler Iodometric	>5	WHO
Biochemical Oxygen Demand	Titration Instrument	Winkler Azide method, incubated for 5 days at 20 ˚C	<6	WHO
Chemical Oxygen Demand	Titration Instrument	Closed Reflux Method	<10	WHO

Table 2. Statistical analysis of organic parameters of water samples collected from the study area in Pre-monsoon season

Parameters →		pH	Temp.	DO	BOD	COD
Site 1	Min.	6.3	35.9	0.6	12.4	520.0
	Max.	7.2	40.4	1.4	15.6	680.0
	Mean ± SD	6.8±0.64	38.2±3.18	1.0±0.57	14.0±2.26	600.0±113.1
Site 2	Min.	6.8	35.7	1.1	11.9	488.0
	Max.	7.3	40.0	1.8	15.2	664.0
	Mean ± SD	7.1±0.35	37.9±3.04	1.5±0.49	13.6±2.33	576.0±124.5
Site 3	Min.	8.3	35.6	3.8	7.2	112.0
	Max.	8.5	39.8	4.2	8.7	128.0
	Mean ± SD	8.4±0.14	37.7±2.97	4.0±0.28	8.0±1.06	120.0±11.3
Site 4	Min.	7.5	35.4	1.4	10.6	464.0
	Max.	8.1	39.6	2.0	15.1	632.0
	Mean ± SD	7.8±0.42	37.5±2.97	1.7±0.42	12.9±3.18	548.0±118.8

Table 3. Statistical analysis of organic parameters of water samples collected from the study area in Post-monsoon season

Parameters →		pH	Temp.	DO	BOD	COD
Site 1	Min.	7.7	17.8	2.0	6.4	312.0
	Max.	8.2	34.2	3.3	9.5	480.0
	Mean ± SD	8.0±0.25	27.8±8.75	2.8±0.70	7.6±1.69	402.7±84.8
Site 2	Min.	7.9	17.1	2.8	5.1	288.0
	Max.	8.6	34.0	5.5	8.6	456.0
	Mean ± SD	8.2±0.38	27.2±8.94	4.1±1.35	6.7±1.76	376.0±84.3
Site 3	Min.	8.6	16.1	5.2	1.1	48.0
	Max.	8.9	29.8	9.1	4.8	72.0
	Mean ± SD	8.7±0.15	24.9±7.66	7.0±1.96	2.6±1.97	58.7±12.2
Site 4	Min.	7.9	16.6	3.8	4.8	272.0
	Max.	8.5	29.7	6.1	8.2	424.0
	Mean ± SD	8.2±0.30	25.0±7.27	4.8±1.17	6.3±1.73	352.0±76.3

The seasonal variation of organic parameters measured in Buria Nala and Yamuna River has been given in Table 2-3.

pH

The pH is influenced by the reaction of CO_2 and the occurrence of inorganic and organic solutes in water body. Any variation in pH is due to the alteration of other physical and chemical water quality parameters **[18].** The value of pH varies from 6.8±0.64 to 8.4±0.14 in pre-monsoon and 8.0±0.25 to 8.7±0.15 in post-monsoon depicted in table 2-3. The maximum pH was recorded 8.4 at site 3 and minimum pH was found 6.8 at site 1 in pre-monsoon however in post-monsoon maximum pH was recorded 8.7 at sampling site 3 and the minimum pH was 8.0 at sampling site 1 (figure 3). According to the WHO prescribed limit for pH value (6.5-8.5) mentioned in table 1, all the water sampling sites were found alkaline except site 3 post-monsoon.

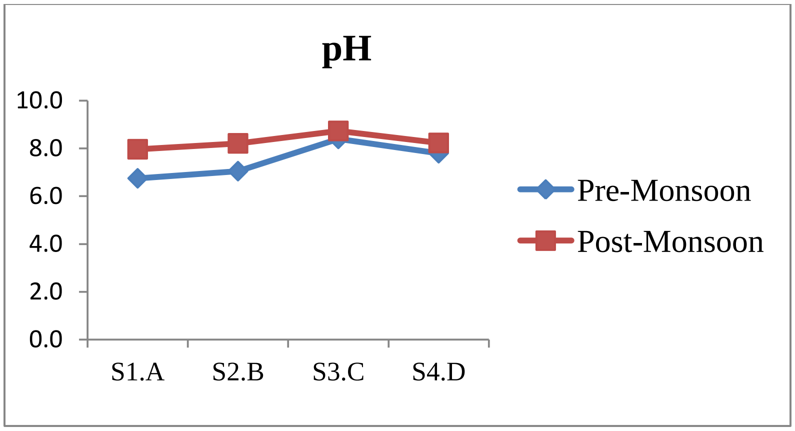

Figure 3. pH difference in pre-monsoon and post-monsoon seasons

Temperature

Temperature is a vital physical distinctiveness of aquatic systems. As temperature of water ascends, the photosynthesis process also rises, thus providing plenty amount of many nutrients **[19] [16].** Temperature is an imperative biologically significant aspect, which significantly take part in the metabolic actions of the life form and determine the physico-chemical property of water body **[20].** The temperature of research area varies from 37.5±2.97 ˚C to 38.2±3.18 ˚C in pre-monsoon season and from 24.9±7.66 ˚C to 27.8±8.75 ˚C in post-monsoon (table 2-3). The maximum temperature was recorded 38.2 ˚C at sampling site 1 and minimum temperature was 37.5 ˚C at sampling site 4 in pre-monsoon while in post-monsoon maximum temperature was recorded 27.8 ˚C at sampling site 1 and minimum temperature was 24.9 ˚C at sampling site 3 (figure 4).

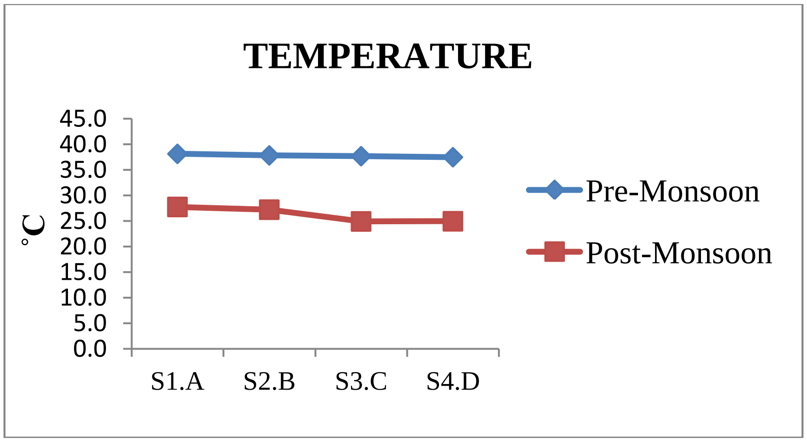

Figure 4. Variation in temperature in pre-monsoon and post-monsoon seasons

Dissolved Oxygen

Dissolved oxygen is an essential factor that reveals the physical and biological progression existing in the water body and helpful in finding out whether the biological modifications are carried out by anaerobic or aerobic (oxygen needed) organisms. Oxygen's concentration present in water either dissolved from the atmospheric air or produced by photosynthetic organisms. Generally, oxygen present in water body is reduced due to increase in temperature respiration of biota, breakdown of organic substances, industrial wastes and inorganic toxic matter **[21-22]**. The quantity of dissolved oxygen present in river varies from 1.0±0.57 mg/l to 4.0±0.28 mg/l in pre-monsoon season and from 2.8±0.70 mg/l to 7.0±1.96 mg/l (post-monsoon) mentioned in table 2-3. Maximum DO was measured 4.0 mg/l at sampling site 3 and minimum DO was recorded 1.0 mg/l at sampling site 1 in pre-monsoon whereas in post-monsoon season maximum DO was recorded (7.0 mg/l) at sampling site 3 and minimum DO was found 2.8 mg/l at sampling site 1 (figure 5). As per the WHO prescribed limit for DO (>5) presented in table 1, except at site 3 in post-monsoon, rest all the water sampling locations were found below the limit in both the seasons which were found inappropriate for fish survival. At site 3 in post-monsoon season good amount of oxygen was recorded because of increase in volume of river's water due to raining that result in enhancement of quality at this site.

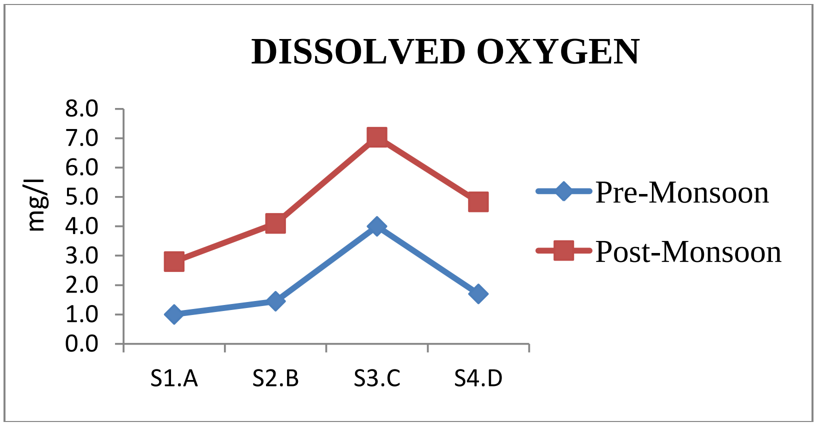

Figure 5. Dissolved oxygen variation in pre-monsoon and post-monsoon seasons

Biochemical Oxygen Demand

BOD is an important factor i.e. measure of the O_2 (oxygen) in the water that is required by the aerobic organisms **[23].**The concentration of BOD present in grabbed samples of water were ranged from 8.0±1.06 mg/l to 14.0±2.26 mg/l in pre-monsoon and 2.6±1.97 mg/l to 7.6±1.69 mg/l in post-monsoon (table 2-3). Maximum BOD was obtained 14.0 mg/l at sampling site 1 and minimum BOD was measured 8.0 mg/l at sampling site 3 in pre-monsoon whereas in post-monsoon maximum BOD was found 7.6 mg/l at sampling site 1 and minimum BOD was recorded 2.6 mg/l at sampling site 3 (figure 6). At all the sampling sites, biochemical oxygen demand was found above the limit according to the WHO permissible limit (<6) mentioned in table 1, except at site 3 in post-monsoon.

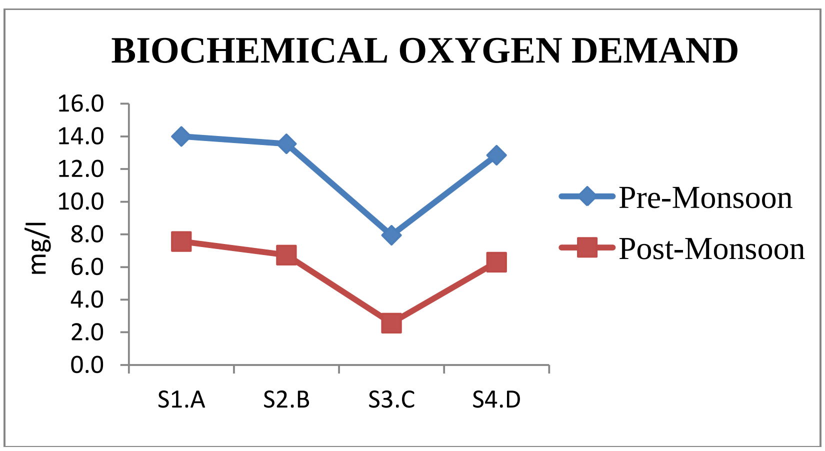

Figure 6. Biochemical oxygen demand (BOD) variation in pre-monsoon and post-monsoon seasons

Chemical oxygen demand

COD determines the O_2 (oxygen) necessary for chemically oxidation of biological (organic) substances. The values of COD express the concentration of dissolved oxidisable organic substances as well as the non-biodegradable materials exist in water [24]. The COD detected in collected water samples were found in the range from 120.0±11.3 mg/l to 600.0±113.1 mg/l in pre-monsoon season and 58.7±12.2 mg/l to 402.7±84.8 mg/l in post-monsoon (table 2-3). The value of COD recorded maximum (600.0 mg/l) at sampling site 1 and minimum COD was found (120.0 mg/l) at site 3 in pre-monsoon however, in post-monsoon season maximum COD was detected 402.7 mg/l at site 1 and minimum COD was recorded 58.7 mg/l at site 3 (figure 7). According to the WHO prescribed limit mentioned (table 1), overall COD were found above the limit in both the seasons at all the sampling sites.

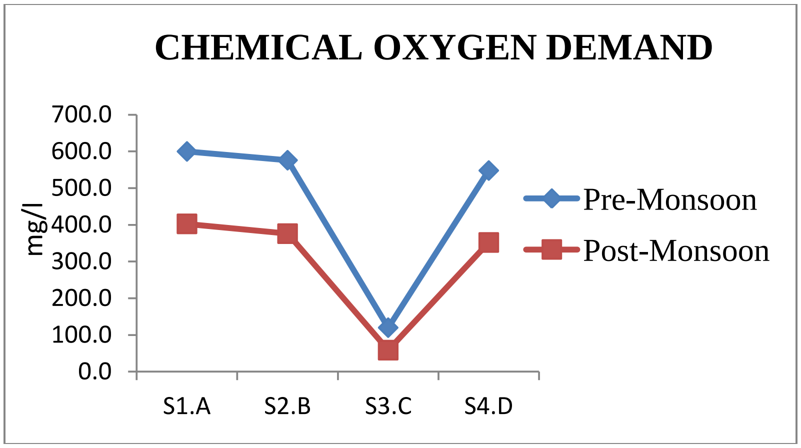

Figure 7. Chemical oxygen demand (COD) variation in pre-monsoon and post-monsoon seasons

Correlation Matrix

The Pearson correlation coefficients (r) between the two variables were calculated in a way to specify the nature, character and the basis of the polluting materials **[25].**

Table 4: Correlation coefficient matrix of organic parameters of water samples in pre-monsoon.

Variables	Temp.	pH	DO	BOD	COD
Temp.	1	-.259	-.306	.566	.343
pH		1	.847**	-.732*	-.783*
DO			1	-.939**	-.985**
BOD				1	.962**
COD					1

**. Correlation is significant at the 0.01 level.

*. Correlation is significant at the 0.05 level.

Table 5: Correlation coefficient matrix of organic parameters of water samples in post-monsoon.

Variables	Temp.	pH	DO	BOD	COD
Temp.	1	-.096	-.610*	.544	.443
pH		1	.695*	-.808**	-.782**
DO			1	-.945**	-.857**
BOD				1	.921**
COD					1

**. Correlation is significant at the 0.01 level.

*. Correlation is significant at the 0.05 level.

In this present research work total 5 variables were computed using SPSS 20 version software and the overall correlation (r) among the organic parameters of water samples at all the 4 sites in both pre and post monsoon are as follows: pH showed significantly positive correlation with dissolved oxygen (0.01 level) in pre-monsoon and 0.05 level in post-monsoon and correlated negatively with BOD (Biological oxygen demand) and COD at 0.05 level in pre-monsoon and 0.01 level in post-monsoon; DO significantly negative correlated with BOD (Biological oxygen demand) and COD at 0.01 level in both seasons; BOD showed significantly positive correlation with COD at 0.01 level in both pre-monsoon and in post-monsoon.

CONCLUSIONS

This research study provide ground information about the pollution level and assist us to recognize the existing condition of toxic wastes load and its impact on biological life of Yamuna river through Buria Nala which is an industrial drain, at Faridabad city. This study revealed healthier water quality before entry of industrial drain into the river and represented remarkable variation and badly affected the superiority of river water during and after meeting of this drain. In spite of presence of STPs, found very poor quality of river's water which adversely disturbing the life and ecosystem of river Yamuna. The chief sources of worsening of water quality were due to the higher anthropogenic activities and release of sewage from many production units. The minimization of pollution load and increase in the excellence of the river's water could be only possible by restrict the discharge of raw waste water from housing and industrial establishments and the recycling and re-use of wastewater after treatment in spite of directly release into the river without any prior and proper treatment. This study also suggests that there is a necessary and urgent requirement of regular periodic monitoring and detailed water quality supervision of Yamuna River.

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