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ORIGINAL ARTICLE

Study of seasonal variations between coliforms and biochemical oxygen demand (BOD) in Hindon River: a statistical approach

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ABSTRACT

Ghaziabad also known as gateway of Uttar Pradesh India, has its boundary adjacent to Delhi. It is one of the highly populated districts, with major source of water from Hindon river. Since Ghaziabad is home to many industries which discharge their waste into the river which has become highly polluted. Another major problem is the dumpage of sewage waste into the river resulting in high Fecal Coliforms. The aim of our study was to statistically analyse the data of water samples collected from April 2017 to April 2018, to find out the effect of seasonal variation of different parameters under study ie DO, BOD, Other forms of Coliform and Fecal Coliform. All parameters were analysed with standard methods as stated by APHA. No DO was reported in any season, levels of BOD, Fecal Coliforms and Other forms of coliforms were found too high, compared to the standards stated by UPPCB. Correlation Matrix and Regression Analysis found an approximately similar correlation between BOD and Fecal Coliform in summer and rainy season, but totally different results were obtained in winter season. Our study is one of the first approaches to judge the level of correlation between BOD and Coliforms for summer, rainy and winter season. The study highlights the major problem associated with industrial, sewage and other forms of waste being dumped in the river without any treatment which leads to oxygen depletion, a major requirement for survival of aquatic life in water. Since BOD levels partly reflect the degree of organic pollution associated with fecal sources in this river system, it is of great significance to observe the relationships of coliforms and BOD levels. The study in itself suggests that faecal coliform and total coliform vs BOD can be used as pollution indicator for further research work on water pollution.

Keywords: Ghaziabad, Hindon River, DO, BOD, fecal Coliform, Human Impact.

1. INTRODUCTION

River Hindon originates in the lower Himalayas in Saharanpur district and flows 260 km through 6 districts including Muzaffarnagr, Meerut, Baghpat, Ghaziabad and Gautambudh Nagar, until its confluence with the Yamuna. Recently NITI Aayog released a report warning that 21 cities , including Delhi will run out of groundwater by 2020, affecting 100million people. It is a major source of concern with increasing water demand with growing population. Rivers in India are the major source of water but many research works are proving that their pollution level in all forms are increasing day by day [1][2]. The area under study comprises the district of Ghaziabad, situated in Uttar Pradesh. River Hindon flows through this region downstream Kulsera. Ghaziabad has been selected for study work because in this region industries have developed at a very fast pace and are likely to grow in near future. Also Ghaziabad is home to large population finding employment in the district.

Hindon river is a major source of water to the highly populated western Uttar Pradesh. Rapid urbanisation in the territory of Ghaziabad has also placed pressure on the rivers water quality in this region [3]. Discharge of toxic wastes, suspended solids, coloured wastes, sewage, agricultural wastes , detergents being used for washing purposes , dairy waste water etc are also the major causes of worsening the river conditions [4].

Increase in urban population of Ghaziabad can be attributed to the influx of people to the city for their bread and butter. Till date, little attention has been paid on the river water quality in the industrialised city of Ghaziabad, Uttar Pradesh from the point of view of Coliforms especially fecal and their dependence on BOD. Although several studies on the impact of industrialization and urbanization on river water quality has been carried out in the past [5][6][7][8].

Rapid industrialization and disposal of sewage waste from nearby colonies is making the river unfit for not only drinking purposes but also vegetation, washing etc. The main aim of the study was to assess the impact of urban and industrial waste in river water during summer season, rainy season and winter season from April 2017 to April 2018.

Draining of sewage waste in the river water is major cause of the BOD levels and coliforms especially fecal being too high. Pollution of river bodies with coliforms especially fecal is major cause of concern as it results in growing of diseases in the area. Growing of public colonies near the river can be attributed as a cause of faecal coliforms being so high in the river. The high level of BOD can be attributed to discharge of industrial effluents from large number of pulp and paper mills, distilleries and sugar mills. The river does not have a perennial source at its origin leading to non-availability of fresh water. That was also one of the major reasons for DO (Dissolved Oxygen) levels being found nil in the river over a period of April 2017 to April 2018.The river receives the municipal sewage as well as industrial effluents from the township of Muzzaffar Nagar and adjoining areas. High fecal coliform (fecal bacteria that show presence of waterborne diseases) levels and low water quality for rivers increase the chance of waterborne diseases. Fecal coliform can lead to diseases such as typhoid fever, Traveler's diarrhea, and Asiatic cholera [9].

In addition, the wastes from several small units such as textile factory, sugar factory, land dries etc also transfer their waste into hindon river. As a natural resource of water, rivers need to maintain low levels of fecal coliform and high-water quality. After comprehensive literature review it has been found that no work has been reported on the application of multivariate techniques on water quality parameters of coliforms and BOD level correlation in river Hindon. It was against this background that this study is conducted which can facilitate the withdrawal of possible sources of water quality variations and pollution. The increase in BOD levels in natural water bodies might greatly affect the populations and survival of indicator bacteria's. It is therefore of interest to observe the relationships of TCs (Total Coliforms), FCs, (Fecal Coliforms) and BOD (Biochemical Oxygen Demand) in the aquatic environment. Although some workers have noted a direct relationship between the TC (Total Coliform) population and BOD in polluted river and estuary waters Schuettpelz [10], Aisxi et. al [11] detailed information available on this subject is limited. Water pollution indicating parameters of Hindon river as per our study were higher than the prescribed limit by the Uttar Pradesh Pollution Control Board, i.e. UPPCB. To define the resource water quality many researchers treated water quality parameters individually by describing the seasonal variability and their causes It is a very difficult and laborious task to regularly monitor all the parameters even if adequate manpower and laboratory facilities are available. Because of this reason, statistical correlation was found to be an easier and simpler approach, this method has been developed using mathematical relationship for comparison of physicochemical parameters. The statistical analysis was performed using standard methods.

Statistical studies have been carried out by calculating correlation coefficients between different parameters DO, BOD, TCs, and FCs applied for checking significance. The correlation among different parameters will be true when the value of correlation coefficient (r) is high and approaching one. Correlation, the relationship between two variables, is closely related to prediction. The value of correlation should lie between -1 and +1. The greater the association between variables, the more accurately we can predict the outcome of events.The regression analysis was used to establish the nature of the relationships between the variables and thereby provides the mechanism for prediction or forecasting.

On account of these outfalls of municipal and industrial wastes into the river, the water is subjected to varying degrees of pollution leading to depletion of oxygen. This study highlights the interrelationship of human activities and river water quality making the study significant and interesting to assess the pollution load discharges in Hindon river. The present study would be a step towards understanding the nature of pollutants and their impact on water quality.

2. METHODLOGY

Study area:

Ghaziabad is situated in the middle of Ganga-Yamuna region and is one the fastest growing industrial city of the state. The upper part of the river basin is in the area of Saharanpur district which has a large number of industries related to paper, milk products, distillery and small-scale cottage industries pertaining to electroplating, paper board, chemicals, textile and rubber, etc. The waste effluents generated from these industries are released either directly on the lowlands or into the tributaries of River Hindon. Much of these wastes contaminate the receiving water, especially in the stretches immediately downstream of their outfalls. The main effluent discharge in the upper part of the river system is from the Star Paper Mill, Saharanpur. The river has two major drains in Saharanpur, i.e. Nagdev nala and Dhamola nala, which join the Hindon near the village of Ghogreki and Sadhauli Hariya, respectively. The municipal wastewater generated from the Saharanpur city is discharged to Hindon River through Dhamola nala. There is no wastewater treatment system in the city. The wastes from several small units such as textile factory, sugar factory, cigarette factory, cardboard factory and laundries etc. also transfer their wastes to the Hindon through the Dhamola nala. The industrial effluent from the Cooperative Distillery also joins the river in this stretch. After Saharanpur region this river enters in Muzaffarnagar District area where it meets with Kali River which carries the municipal and industrial wastes of Muzaffarnagar district and joins the Hindon near the village of Atali. The Krishni River, receiving wastes from a sugar mill and distillery, joins the Hindon near the village of Barnawa, local drains from villages and the distribution of Biological Oxygen Demand (BOD) at all the stations is not the same. Keeping the objective of our study in mind Ghaziabad, downstream kulsera was chosen from where water samples were collected throughout the year from April 2017 to April 2018 Table 1 gives the GPS location of the sample site. The climate of the region is moderate subtropical monsoon type. The average annual rainfall is about 1000 mm, major part of which is received during the monsoon period (July to September). The daily maximum temperature varies from 10 to 43°C and minimum temperature varies from 4.6 to 29.2°C.

Table 1: GPS location and description of sampling site of Hindon River

Sampling Station	GPS Location	Description
Ghaziabad	Latitude $28^{0}66'91''$ Longitude $77^{0}45'37''$	Ghaziabad: Down Stream Kulsera

Sample Collection:

Sampling was done from April 2017 to April 2018 from Ghaziabad, Downstream Kulsera. The water samples were collected in sterile capped containers by following method as described by APHA. (American Public Health Association (APHA) [12]. To avoid contamination disposable gloves washed with HCl 1N were worn during sampling. The water samples were preserved by acidifying with concentrated nitric acid to $pH < 2$ and stored in polythene bottles. Sampling bottles were kept in airtight large plastic ice cold containers at 4^0C and were transported to laboratory within 6hrs of their collection for the further processing. Based on the reconnaissance survey, keeping in view the objective of the study, easy approachability in all seasons, mixing and other physical characteristics of the water body, confluence of tributaries and pollution load from important towns and industries near Ghaziabad were noted.

ANALYSIS:

Water samples were analysed for DO (Dissolved Oxygen), BOD (Biochemical Oxygen Demand), Feacal Coliform and Total Coliform by following the methods as described by APHA (1998). Detailed methodologies are given in Table 2. DO is fixed at sites and air and water temperatures were also recorded.

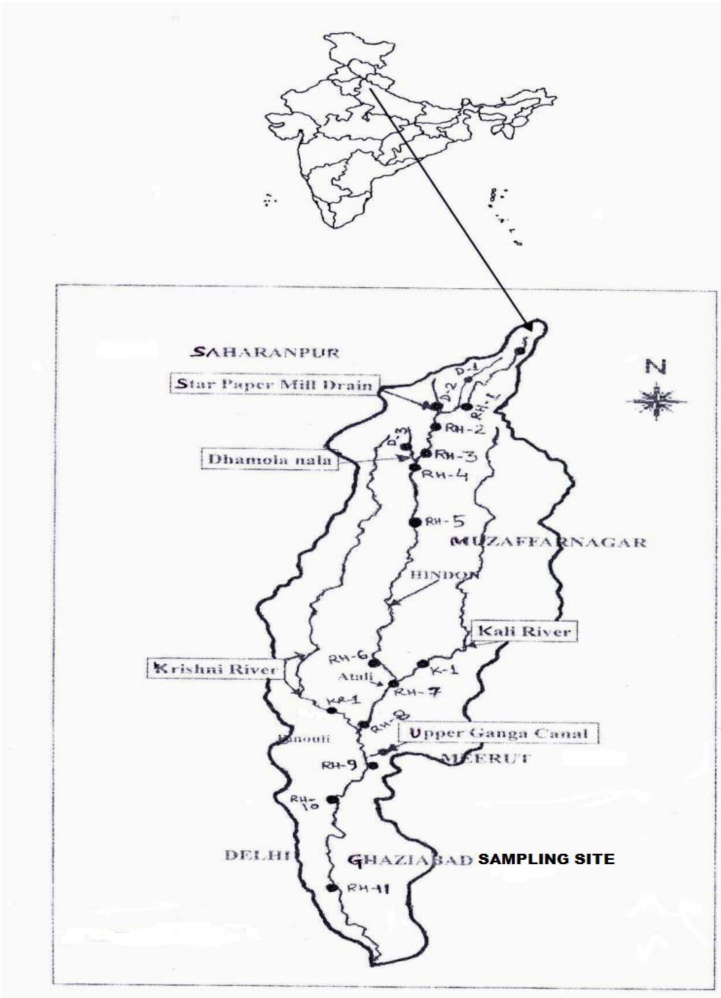

Figure 1 : Location Map of Sampling Site

Table 2: Water quality parameters, units and analytical methods used for Hindon River

Parameters	Abbreviations	Units	Analytical Methods	Instruments
Dissolved Oxygen	DO	mg/lt	Titrimetric	Titration Assembly
Biochemical Oxygen Demand	BOD	mg/lt	5 – day incubation, 20^0C	BOD incubator and titration assembly
Fecal Coliform	FC	mpn/100ml	Multiple Tube Fermentation technique	Tubes
Other Coliform	OC	mpn/100ml	Multiple Tube Fermentation technique	Tubes

Table 3: Primary Water Quality Criteria For Designated – Best Use Classes Prescribed by Uttar Pradesh Pollution Control Board

Classification	Category	Tolerance Limit
Drinking Water Source without conventional treatment but after disinfections	A	1. Total Coliform Organism MPN/100 ml shall be 50 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 6mg/l or more 4. Biochemical oxygen demand 5 days 20^{o}C 2mg/l or less
Outdoor Bathing (Organized)	B	1. Total Coliforms Organism MPN/100 ml shall be 500 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 5mg/l or more 4. Biochemical Oxygen Demand 5 days 20^{o}C 3mg/l or less
Drinking Water source after conventional treatment and disinfections	C	1. Total Coliforms Organism MPN/100 ml shall be 5000 or less 2. pH between 6.5 and 8.5 3. Dissolved Oxygen 4mg/l or more 4. Biochemical Oxygen Demand 5 days 20^{o}C 3mg/l or less
Propagation of Wild Life and Fisheries	D	1. pH between 6.5 and 8.5 2. Dissolved Oxygen 4mg/l or more 3. Free Ammonia (as N)1.2 mg/l or less
Irrigation Industrial Cooling, Controlled waste disposal	E	1. pH between 6.0 and 8.5 2. Electrical Conductivity at 25^{o}C micro mhos/cm Max. 2250 3. Sodium absorption ratio Max. 26 4. Boron Max. 2 mg/l

Source: http://www.uppcb.com/river_quality.htm

Statistical Analysis:
Corelation matrix was done between BOD and OCs and FCs for the different seasons of the year summer, rainy and winter. Regression analysis was done and regression plots were plotted showing the relation between BOD and other forms of coliforms. Plots were generated showing the results of the analysis.

3. RESULTS AND DISCUSSION

The higher values of BOD observed at this station indicates a high degree of organic pollution in this stretch of the river. The dumping of sewage waste with growing population and washing waste adds to the high concentration of coliform in the river, which is responsible for nil DO (Dissolved Oxygen), along with increase in BOD, in this stretch of river.

Dissolved oxygen (DO) is one of the most important water quality parameters used for assessing the quality of the water for survival of the aquatic life. None of the three seasons showed any Dissolved Oxygen (DO) throughout the year, major reason being Hindon river lacking free flowing water. The quality of the water in terms of DO content is always of primary importance because at the waste discharge points in river, the DO is required for aerobic oxidation of the wastes [13] Because the river Hindon flows through the sugarcane belt of western Uttar Pradesh and many factories allegedly dump the untreated chemical effluents into the river. Not only do the effluents directly affect the biodiversity within the rivers, but also leads to lowered levels of dissolved oxygen. In fact, the situation now is that DO levels are being reported nil throughout all seasons. When DO drops below 4 or 5 mg/L, the forms of life that can survive begins to reduce. Depletion of Dissolved oxygen due to release of high organic load and trace organic pollutants are other issues of concern. In fact, the DO levels being nil shows complete anaerobic condition in river water making it impossible for survival of aquatic life throughout the whole year (April 2017 to April 2018). This indicates that the wastewater generated from the industries and municipal wastes is only flowing in the river.

Biochemical oxygen demand (BOD) BOD is the measure of the amount of oxygen required by microorganisms to degrade organic matter and is the indicative of organic pollutants in the water. Naturally bacteria utilize organic matter during respiration and remove oxygen from the water [14].

BOD values at sampling site ranges from 32mg/lt in the month of July 2017 to 120 mg/lt in the month of May 2017, rest of the values lie in-between this range. With a mean value of 66.441 and standard deviation of 20.031. The BOD levels are very high compared to what is prescribed by CPCB for survival of aquatic life. (Table 3). The BOD results show that Hindon River water is not suitable for even drinking, washing or agricultural purposes.

Such high levels of BOD at Ghaziabad could be because of dumping of municipal wastes from nearby colonies. High value of BOD suggests that oxygen present in the water is consumed by the aerobic bacteria which makes fish and other aquatic species difficult to survive.

The high B.O.D values are good indicators of organic pollution level in the water organic pollutants such as sewage and food wastes have high nutrient levels. These nutrients attract bacteria and other microbes. As these microbes digest the nutrients and digest oxygen within the water column it reduces the level of oxygen available for other aquatic microorganisms. The more organic matter there is (e.g., in sewage and polluted bodies of water), the greater the BOD; and the greater the BOD, the lower the amount of dissolved oxygen available for aquatic animals. One of the main reasons for treating wastewater prior to its discharge into a water resource is to lower its BOD—i.e., reduce its need of oxygen and thereby lessen its demand from the streams, lakes, rivers, or estuaries into which it is released. Discharge of municipal wastes from Budhana drain and kali river into the river Hindon is also major cause of nil DO and high BOD. As more organic matter enters a stream, the BOD levels will rise. Organic matter may include woody debris; dead plants and animals, animal manure; effluents from pulp and paper mills, feedlots, and food-processing plants etc.

Feacal Coliform: A fecal coliform is a facultative anaerobic, rod-shaped, gram-negative, non-sporulating bacterium. The presence of Fecal Coliform in water may indicate contamination of the water by human sewage or animal droppings which could contain other bacteria, viruses, or disease-causing organisms. Standard value of fecal coliform by WHO is 1000 MPN per 100ml of water. The coliform bacteria have the following advantages for use as an indicator organism coliform are constantly found in the human intestine in large numbers, the coliform organism is easy to isolate and enumerate in the laboratory, and coliforms are normally not pathogenic and are easy to handle. Fecal coliforms exhibit all the characteristics of total coliforms, but are more specific in that they are normally present only in fecal material. If it is accepted that the coliform bacteria are of fecal origin are more representative of potential pathogens, then separation of the fecal and nonfecal coliform groups is justified. Most researchers have concluded that fecal coliforms rather than total coliforms are more realistic indicators of sewage pollution [10].

Fecal coliform test is considered indicative of dangerous contamination from all warm-blooded animals. Fecal coliforms may enter surface water by a number of ways, from contaminated soil runoff from storm water, from vegetation, washing water from cities, or from direct sewage pollution by man or animals. The best application for fecal coliform detection is in stream pollution studies, wastewater treatment systems, determination of bathing water quality, and other recreational use criteria

Fecal coliforms at Ghaziabad lie in the range of 11,0000mpn/100ml to 150000mpn/100ml with a mean value of 131538.46 and a Standard Deviation of 12142.31. No doubt the levels are alarmingly high. Giving proof of dumpage of human waste through sewage directly in the river. Efforts should be made that instead of dumping the sewage waste directly in the river some sort of treatment plant should be there which reduces the waste before it gets dumped. A simpler way out could be the use of chlorine and other disinfectant chemicals. Such materials to some extent help in killing the fecal coliform and disease bacteria. Also, these materials are cheap and easily available. Such high levels of fecal coliforms require higher levels of chlorine, because they are a great threat to aquatic life and growth of disease-causing bacteria.

Total Coliform: Total coliforms include bacteria that are found in the soil, in water that has been influenced by surface water, and in human or animal waste. If coliform bacteria are present in drinking water, the risk of contracting a water-borne illness is increased. Although total coliforms can come from sources other than fecal matter, a positive total coliform sample should be considered an indication of pollution. At site under study the total coliforms range from 240000mpn/ml to 360000mpn/ml. Once again, a very alarming figure there by showing that not only is Ghaziabad site having sewage waste dumped in high quantity but also other form forms of bacterial waste which are origin of many diseases being dumped in the river.

Water Quality Index (WQI) indicates the overall quality of water based on the values of various parameters. The mean WQI values obtained from our study indicated that Hindon river water quality is highly unsatisfactory throughout the year. The results indicate that the water is unfit for human consumption in any for and steps must be taken to reduce pollution.

STATISTICAL RESULTS

Correlation matrix between different parameters for different seasons of the year is presented in Table 4(a), 5(a), 6(a).

In summer season an average correlation was observed between BOD and OCs (42%) while a weak correlation was observed between BOD and FCs (8%). The correlation matrix for rainy season Table 5(a) showed a positive correlation between BOD and other forms of coliforms (46%). Indicating that BOD in rainy season is dependent positively on other forms of coliforms. While winter season Table 6(a) showed an above average correlation between BOD and OCs (54%) and a very strong and positive correlation between BOD and FCs (90%). The reason for such a strong correlation can be due to lack of sunlight in winter months because of which coliforms must be getting accumulated more. Lack of sunlight could also be held responsible for growth of bacteria. It could be attributed to the fact that in winter due to scarcity of sunlight more growth of coliform bacteria takes place. Lack of sunlight also slows the process of photosynthesis. Also other reason for this highly positive correlation could be dumping of large amount of sewage waste in the river from nearby localities etc.[15].

Table 4 : (Data Summer Season)

Month	Year	DO mg/lt	BOD mg/lt	Other forms of Coliform(mpn/100ml)	Feacal Coliform (mpn/100ml)	Total Coliform (mpn/ml)
April	2017	0	52	130000	150000	280000
June	2017	0	75.6	130000	110000	240000
July	2017	0	32	130000	120000	250000
April	2018	0	70	170000	140000	310000
	Mean	**0**	**57.4**	**140000**	**130000**	**270000**
	SD		19.70042	20000	18257.42	31622.78

Table 4(a) COORELATION MATRIX

Corelation Matrix Summer Season

	DO mg/lt	*BOD mg/lt*	*Other forms of Coliform(mpn/100ml)*	*Feacal Coliform (mpn/100ml)*	*Total Coliform (mpn/ml)*
DO mg/lt	1				
BOD mg/lt		1			
Other forms of Coliform(mpn/100ml)		**0.42639**	1		
Feacal Coliform (mpn/100ml)		**-0.08526**	0.365148372	1	
Total Coliform (mpn/ml)		0.22045	0.843274043	0.808290377	1

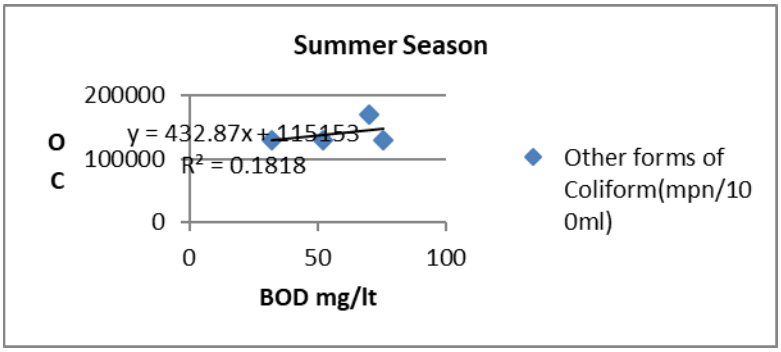

FIGURE 2(a) Regression Plots between Other Coliforms and BOD in Summer Season

Table 5 (Data Rainy Season)

Month	year	DO mg/lt	BOD mg/lt	Other forms of Coliform(mpn/100ml)	Feacal Coliform (mpn/100ml)	Total Coliform (mpn/ml)
July	2017	0	32	130000	120000	250000
August	2017	0	56.4	130000	130000	260000
September	2017	0	67.8	200000	120000	320000
October	2017	0	70.8	220000	140000	360000
	Mean	**0**	**56.75**	**170000**	**127500**	**297500**
	SD		17.62	46904.16	9574.271	51881.27

TABLE 5(a)

Coorelation Matrix (Rainy Season)

	DO mg/lt	*BOD mg/lt*	*Other forms of Coliform(mpn/100ml)*	*Feacal Coliform (mpn/100ml)*	*Total Coliform (mpn/ml)*
DO mg/lt	1				
BOD mg/lt		1			
Other forms of Coliform(mpn/100ml)		**0.46343**	1		
Feacal Coliform (mpn/100ml)		**0.0171**	0.573050913	1	
Total Coliform (mpn/ml)		0.40109	0.983576014	0.711557855	1

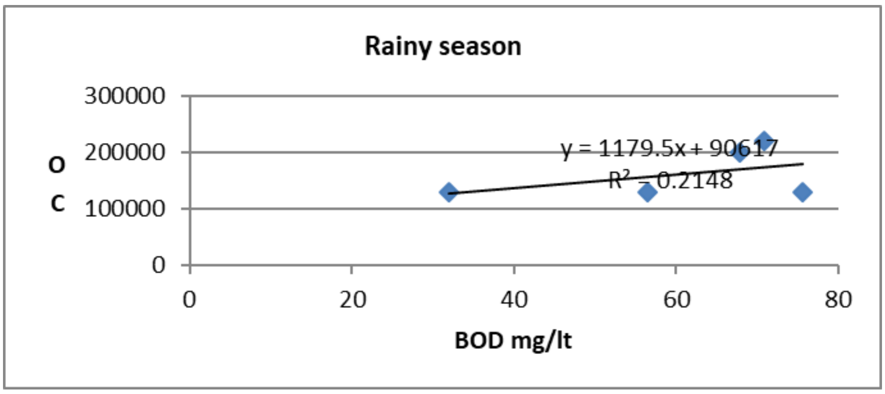

FIGURE 2(b) Regression Plot between Other Coliforms and BOD in Rainy Season

TABLE 6 (DATA WINTER SEASON)

Month	Year	DO mg/lt	BOD mg/lt	Other forms of Coliform(mpn/100ml)	Feacal Coliform (mpn/100ml)	Total Coliform (mpn/ml)
November	2017	0	60.6	180000	130000	310000
December	2017	0	54.6	160000	120000	280000
January	2018	0	78	140000	150000	290000
February	2018	0	62	140000	140000	280000
March	2018	0	64	160000	130000	290000
	Mean		**63.84**	**156000**	**134000**	**290000**
	SD		8.657251	16733.2	11401.75	12247.45

TABLE 6(a)

Coorelation Matrix Winter season

	DO mg/lt	*BOD mg/lt*	*Other forms of Coliform(mpn/100ml)*	*Feacal Coliform (mpn/100ml)*	*Total Coliform (mpn/ml)*
DO mg/lt	1				
BOD mg/lt		1			
Other forms of Coliform(mpn/100ml)		**-0.53706**	1		
Feacal Coliform (mpn/100ml)		**0.90469**	-0.68138514	1	
Total Coliform (mpn/ml)		0.10846	0.731925055	0	1

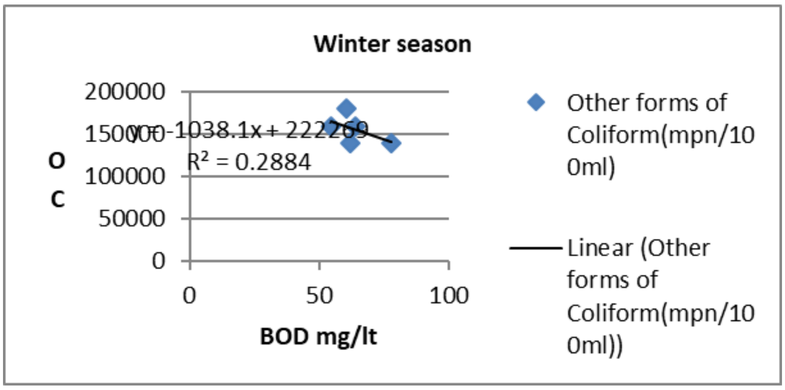

FIGURE 2(c) Regression plot between Other Coliforms and BOD in Winter Season

The most interesting observation is that only in winter season a strong correlation is observed between fecal coliform and BOD levels while summer and rainy season show a very weak or negative correlation.

The **regession analysis** also shows approximately same results. R^2 is a statistical measure of how close the data are to the fitted regression line. It is also known as coefficient of determination. A high R^2 of 80% and above indicates the values as good correlated. As per the regression analysis value of R^2 for summer (0.18) and rainy season (0.21) are very much less than less than 1 showing a weak correlation. For winter season the results are highly positive with R^2 value close to 1 approximately 0.83.

REGRESSION PLOTS: For summer season the regression plot between BOD and fecal coliform Figure 2(a) shows a very weak correlation while for BOD and other forms of coliforms it shows a bit strong correlation.

For rainy season Figure 2(b) BOD shows a weak relation with other forms of coliforms while a nil coorelation with fecal coliforms. For rainy winter season a very strong correlation is observed between BOD and fecal coliform. For winter season Figure 2(c) the results on the whole showed a good relation between BOD and fecal coliform.in winter season. It could be attributed to the fact that in winter due to scarcity of sunlight more growth of coliform bacteria takes place. Lack of sunlight slows the process of photosynthesis. This should be taken as an alarming situation for the authorities by imposing some sort of strict laws or fine for all causes that are contributing to dumping of sewage waste in the river here be it growth of civilization nearby, washing waste dumping or industrial waste dumping.

CONCLUSION

Oxygen that is available in the water is being consumed by bacteria of coliforms leading to the inability of fish and other aquatic organisms to survive in the river. The high value of BOD from April 2017 to April 2018 suggest that oxygen present in the water is consumed by the aerobic bacteria which makes fish and other aquatic species too difficult to survive.

The high BOD value is good indicator of organic pollution level in the water. River Hindon is also subjected to a varying degree of pollution caused by numerous untreated and/or partially treated waste inputs of municipal and industrial effluents. Hence, water quality modelling is necessary to estimate downstream DO deficit in fact nil in all stretches. Our report gives disturbing figures of faecal coliform contamination of river reaching a high of ***150000 MPN/100ml*** as against prescribed maximum limit of ***2,500MPN/100ml***. The human settlement and waste disposal along the route of hindon river and its tributary has been affecting the self-purification of the river system.

As stated by the recent report of NITI (National Institution for Transforming India) Aayog India is facing worst water crisis in history, The water crisis will get worse, as the country's water demand is projected to be twice the available supply by 2030.The assessment of the water quality of river Hindon indicates that the river is not meeting the criteria with respect to Dissolved Oxygen, BOD, Total Coliform and Faecal Coliform. The Dissolved Oxygen has been found to be nil in all seasons. The high level of BOD can be attributed to discharge of industrial effluents from number of electroplating and tannery units. River Hindon receives the municipal a well as industrial effluents from the township of Saharanpur, Muzaffarnagar, Shamli, Meerut and Baghpat and Gautam Buddhnagar. The water is not fit even for irrigation purposes as the source water is grossly polluted.

The purpose of this study was to assess the DO, BOD levels and its correlation with faecal coliforms and other forms of coliforms in Hindon river at Ghaziabad city, India. Results indicated relatively higher levels of BOD, and coliforms. It indicates that the river is highly polluted with sewage discharge waste at Ghaziabad is too high.

Since the river is a major tributary of the Yamuna River, it is essential that remediation of Hindon River contamination is included as a priority within the existing Yamuna River Action Plan. Such remediation needs to allocate sufficient fund and be implemented within a clearly defined and appropriate timescale accuracy at different location in the Hindon river. The present study would be a step towards understanding the nature of pollutants and their impact on the quality of water. As recent reports state that the national capital may soon get its own version of Singapore NEWater, essentially sewage treated to make it potable. In this scheme water from a sewage treatment plant will be released into the Yamuna, right from where the river enters the city. Downstream, it will be lifted and send to a water treatment plant for further treatment. This treated water will be supplied to the delhi people. Such plan can also be implemented at sites dumping waste directly in Hindon river.

Further studies on the relationships between river water quality and destroying of bacteria present in coliforms is needed.

Conflict of interest
No conflict of interest influenced in this research.

Authors Contribution
Author collected the data, after understanding the statistical analysis attending workshops on same, analysed the data and discussed the results with experts of the field.

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