Monitoring & Assessment of Water Quality of Najafgarh Drain & Its Sub-Drains

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Abstract: ***Any metropolitan city has a major issue with wastewater production, management and treatment. Drinking water supplies in the Delhi NCR are very restricted and largely depend on agreements with the surrounding states, resulting in ongoing political conflicts. Untreated wastewater regularly comes in from the surrounding populous areas and industrial sectors consequently; the quality of water flowing in the drains has become significantly decreased over time. It not only has an adverse effect on the Yamuna River's aquatic habitat, but it also has a detrimental impact on the health of the human population residing near the drain area. Sewerage pollution is a key contributor to the rise of water-borne diseases such as typhoid, dysentery, diarrhea, and other illnesses in the city. Even after the treatment of wastewater, several contaminants persist in the wastewater. Irrigation with wastewater may pollute the soil, making it available for plants to uptake and giving a pathway through the food chain, as well as having biological effects on soil fauna and flora after long-term use. The poorly treated wastewater may have acute or cumulative effects. Acute effects from wastewater are frequently caused by high concentrations of ammonia, chlorine, heavy metals, and organic pollutants, to mitigate these harmful impacts on society, treatment of wastewater should be done before discharging it into any water body.***

Keywords: Water pollution; Yamuna River; Wastewater treatment; Aquatic habitats; Najafgarh drain

1. Introduction

Sewerage and drainage systems in most Indian cities are extremely poor because sewerage systems are designed to carry a limited amount of wastewater in a given amount of time while a large portion of the population lives in a small area adjacent to a sewerage network. As a result, a significant amount of wastewater bypasses the current sewerage system, producing stagnation in metropolitan areas by providing breeding habitats for disease-carrying vectors. There is no sewerage infrastructure in many areas due to which a huge quantity of wastewater falls into rivers, which serve as the primary source of municipal water for the majority of the municipalities. Every consumer is presumed to have been exposed to unknown levels of pollutants in their water across time due to inadequate wastewater management. Almost 80% of the water used for household purposes is returned as wastewater. Untreated wastewater is usually released, which either sinks into the ground as a potential groundwater contaminant or is released into the natural sewage system, polluting populations downstream. The increasing concentration of pollutants in receiving surface water causes cumulative effects, which are only noticeable when a specific limit of contaminants is exceeded. The studies also revealed that uncontrolled/unregulated wastewater discharges, mostly from domestic sources, are the prime reason for the worsening of Yamuna River water quality in Delhi.

Delhi is located between 28°24′17″ and 28°53′00″ North Latitude and 76°50′24″ and 77°20′37″ of East Longitude. It is surrounded by Ghaziabad (UP) in the east, Rohtak in the west, Sonipat in the north and Gurugram in the south, because it is the country's capital, the city has direct contact with the central government, which provides certain additional benefits in the form of specific financial help and subsidies. The city is a key distribution center for trade and business in north India, with the greatest concentration of contemporary small-scale industry. In the previous several decades, Delhi's population has exploded. Studying the effects of wastewater on people and species in metro areas will aid in identifying holes in the current sewerage system. Mitigating wastewater issues will immediately aid in lowering pollution, achieving sustainability, and conserving resources.

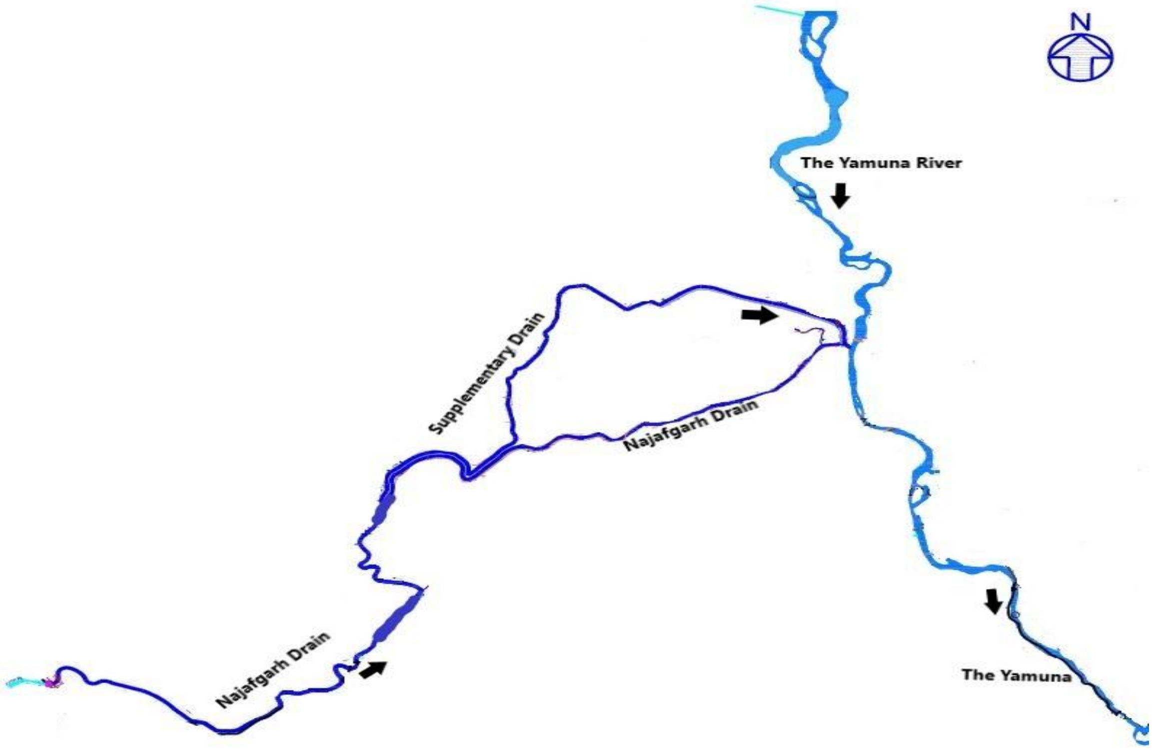

Figure 1: Showing Najafgarh & Supplementary Drains of Delhi

The city's wastewater is collected by an underground sewage network and transferred to sewerage treatment facilities (STPs), with the remainder flowing into the Yamuna River through drains. There are 24 drains in Delhi that are falling in the Yamuna River of which three are the major drains: Najafgarh drain, Supplementary drain and Shahadra drain.

In the National Capital Territory (NCT) of Delhi, the Najafgarh drain is the longest drain covering an area of 977.26 square kilometers. The Najafgarh drain accounts for almost 60% of all wastewater produced in Delhi. Several drains in the Delhi NCR region generate the majority of this wastewater, which has a significant influence on the area's surface water and groundwater systems. Heavy metal pollutants such as copper, iron, manganese, and lead were found in high concentrations in the Najafgarh drain water. Wastewater has a greater negative influence on groundwater. The industrial and household waste discharge, which is mostly conveyed by this drain, has a significant impact on groundwater pollution.

From Haryana, the Najafgarh drain reaches the southwest portion of Delhi. It runs for 57.48 kilometers before entering the Yamuna River downstream of the Wazirabad barrage. The drain conveys floodwater, wastewater, and surface runoff from Haryana and Delhi at its early stage via the southwest district of the National Capital Territory of Delhi. Roughly 30.90 km of the 57.48 km stretch of the drain runs through the southwest district of the National Capital Territory (NCT) of Delhi, from Dhansa to Kakraula. The study's goal was to assess the water quality of the Najafgarh drain at some specific inlet points in order to contribute to research on wastewater treatment and management in the Delhi NCR. The research also intends to give design infrastructure that may address the issue of natural resource deterioration while also reducing the negative impacts on those who live near the drain.

2. Literature Review

According to reports, the Najafgarh drain water is highly contaminated with heavy metals like iron, lead, manganese, and copper. Even more severely, this effluent has an effect on the groundwater system. Groundwater is significantly contaminated by domestic and industrial effluents, which are mostly transported by this drain (Shekhar et, al., 2013).

Leakages of nearly 40% in the outdated water delivery system further restrict the amount of water that is available to the consumers. The system is further weakened by the daytime public network's frequent variations in water pressure. The "siphon-effect," which occurs when polluted wastewater enters the freshwater system as a result of a drop in pressure, has an impact on freshwater lines, which frequently are located close to drains (Krafft et, al., 2003).

95 percent of the wastewater produced worldwide is discharged untreated into the environment. Only 5% of the world's wastewater is effectively treated using "standard" sanitation facilities; these facilities are primarily found in developed nations. As a result, the majority of people on earth are still susceptible to diseases spread by contaminated water, and the quality of water supplies has drastically declined, especially in developing nations (Ujang et, al., 2006).

One of the main contributors to the contamination of surface and groundwater is industrial and municipal solid waste. The abundance of heavy metals makes the water that is readily available in many areas of the country unfit for human consumption. Due to water shortages and precipitation runoff, the issue gets worse throughout the summer. One of the serious health issues is the heavy element, metal ion, and hazardous microbe contamination of drinking and domestic water supplies (Gupta, 2009).

The advantages of better wastewater management are being undermined by the rapid rate of population increase and unchecked sewerage discharge into urban water bodies and drains. The severity of the environmental imbalance is such that even agricultural usage of the Yamuna River's water is prohibited. According to research on the Yamuna River undertaken by the Ministry of Water Resources, there is no simple solution to the complicated situation of conserving the optimum level of water quality in the Yamuna (Delhi Jal Board, 2014).

The majority of nitrate that enters groundwater comes from anthropogenic sources like improperly collected, transported, treated, and disposed of urban waste, atmospheric nitrous oxide deposition linked to the combustion of coal, petrol, and gas, land application of animal manure at farms, and application of fertilizers to agricultural crops and gardens. The primary source of Delhi's high nitrate levels appears to be uncollected urban trash, including sewage and garbage. As a result, proper waste management is crucial to keeping Delhi's groundwater free of nitrates and safe for drinking. To manage the garbage effectively, there ought to be sufficient infrastructure, resources, and labor (Kumar, L).

The Yamuna River in Delhi is so contaminated that it rarely supports any life from outside Okhla. Not only have many pesticides and heavy metals been discovered in the river at dangerously high levels, but also organic materials and nutrients. Significant volumes of wastewater are discharged into the river from the industrial areas situated along the river (Ali et al.2001).

The industrial belt is primarily located along the Yamuna in the state's northeast. The quality of the river's water is impacted by the wastes from industrial companies, agricultural runoff, and urban drains containing municipal sewage (Khaiwal et, al., 2003).

In rivers like the Yamuna, which has been susceptible to anthropogenic contamination for many years, the situation is more serious. According to reports, 80 percent of the nation's urban sewage is dumped into rivers like the Yamuna, many of which are too dirty for people to safely bath in them (Upadhyay et, al., 2010).

3. Materials and Methods

The samples were taken in accordance with Indian Standard 3025 (PART 1) -1987. Wastewater samples were taken at three separate locations: 1. Upstream in relation to the inlet point; 2. The inlet point itself; 3. Downstream in relation to the inlet point. Samples were obtained at a depth of 0.6m and in the middle of the water flow. For sample collection, 5-liter polyethylene bottles were used. To prevent contamination, bottles were thoroughly cleansed with HCL and distilled water. With the use of relevant meters, temperature and dissolved oxygen were measured on-site.

A Cup Type Water Current Meter was used to calculate the discharge and the velocity of the flowing water. Samples were collected to test the various waste parameters i.e., Biochemical oxygen demand (BOD^3) at 27 degrees Celsius, nitrate by UV spectrophotometer (410nm), dissolved oxygen (DO), pH, conductivity, and total suspended particles (TSS). In 50ml Tarson Tubes, separate samples for biological parameters testing, such as Faecal Coliform and Total Coliform, were collected.

Table 1: Showing Parameters & Methods used for Analysis

Test Parameter	Test Method
pH	IS: 3025 (Part 11) –1983 (RA 2012)
Volume Discharge	IS 1192: 1981
Turbidity	IS: 3025 (Part -10) - 1984 (RA 2012)
Conductivity	IS: 3025 (Part 14) –1984 (RA 2013)
Dissolved Oxygen	IS: 3025 (Part 38) – 1989 (RA 2014)
Total suspended Solids	IS: 3025 (Part 15) – 1984 (RA 2014)
BOD 3 Days at 27 Degree Celsius	IS: 3025 (Part 44) – 1993 (RA 2014)
Nitrate	IS: 3025 (Part 34) – 1988 (RA 2014)
Total Phosphorus	APHA, 22nd Edition 4500-P(B&C) 2012
Fecal Coliform	APHA, 22nd Edition
Total Coliform	APHA, 22nd Edition

The three sampling points were selected on the basis of the size and pollution load of the sub-drains due to some unauthorized industries in their area. There were three sampling locations: Mungashpur Drain (L/B), Kanhaiya Nagar Drain and Najafgarh drain outfall into Yamuna River.

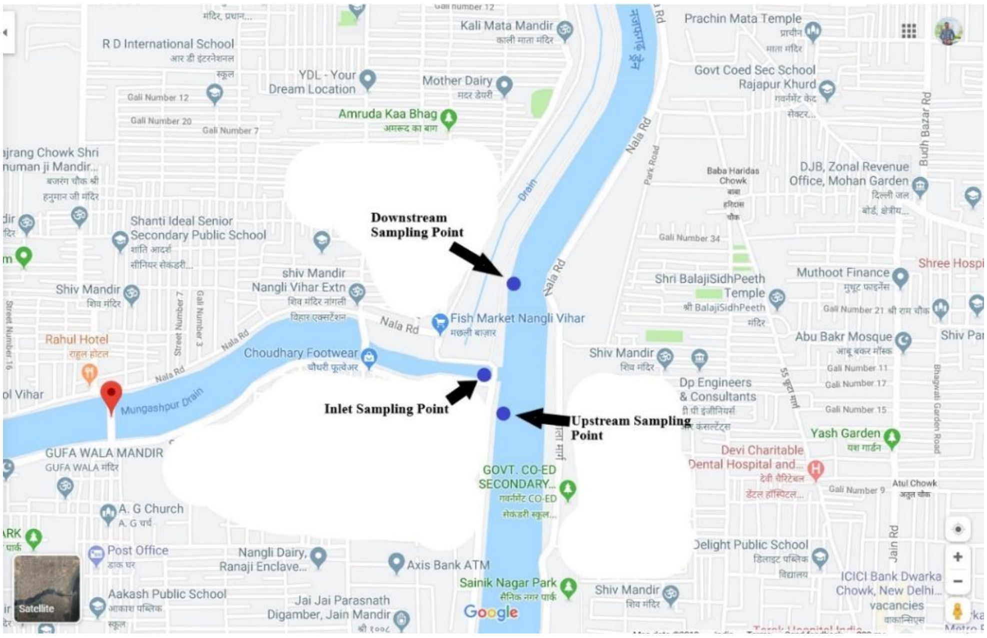

Figure 2: Below image showing sampling points at Mungashpur Drain L/B

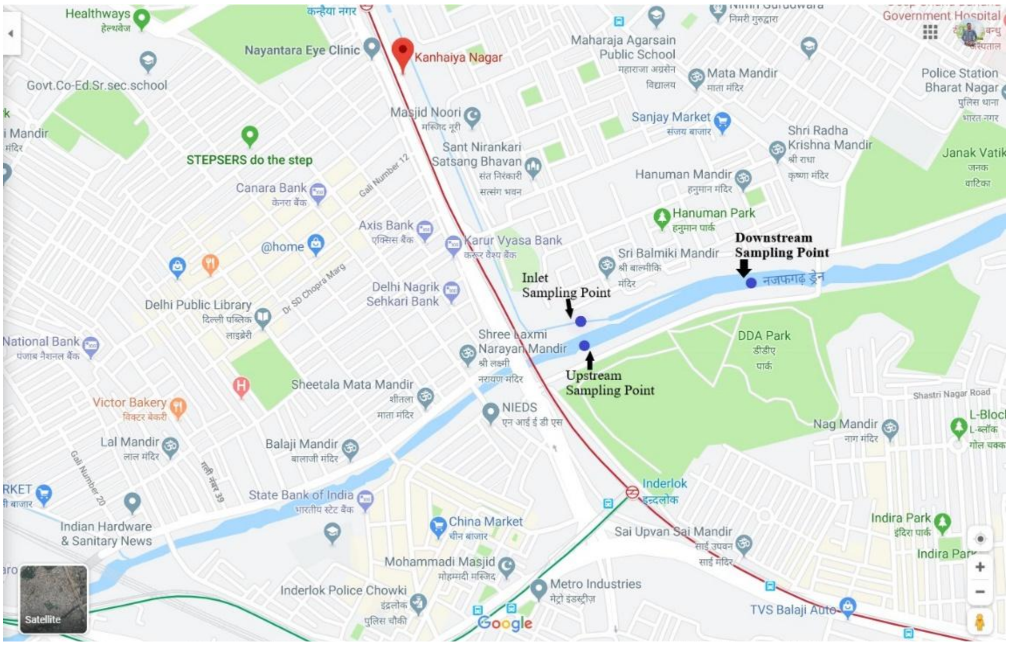

Figure 3: Showing sampling points at Kanhaiya Nagar Drain

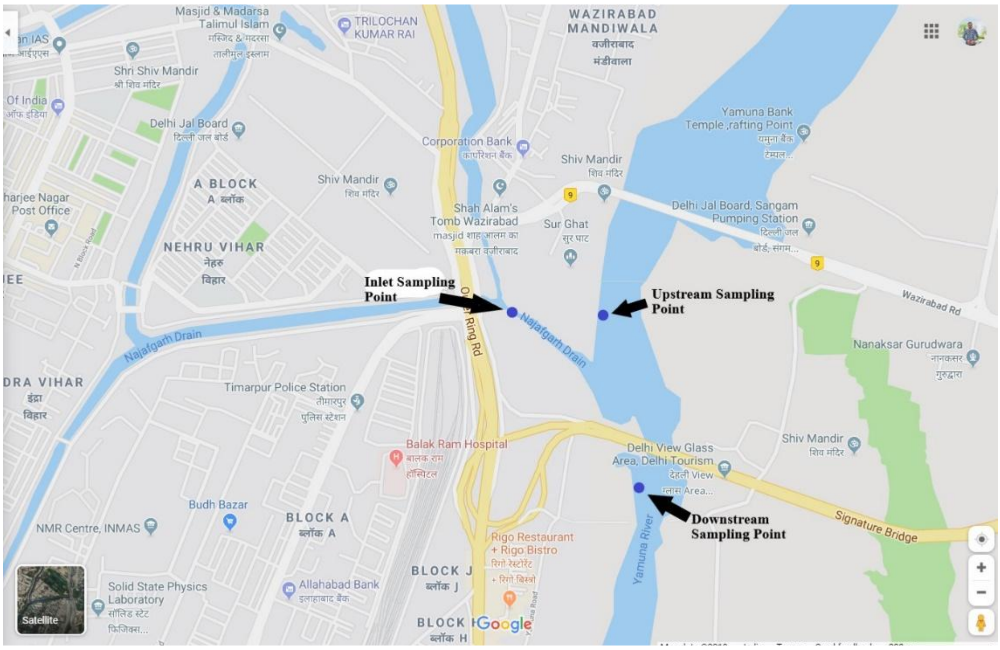

Figure 4: Showing sampling Points at Najafgarh Drain outfall in Yamuna River

4. Results & Discussion

A total of 24 drains from various parts of the city flow into the Yamuna River. One of the largest drains is the Najafgarh drain. The Najafgarh drain flows northwest for 57 kilometers and finishes in the Yamuna River. On its route to the Yamuna River, it splits into two drains. The major drain is Najafgarh, while the secondary drain is Supplementary. The Supplementary Drain runs for 37 kilometers until rejoining the main drain right before entering the Yamuna River. Najafgarh drain has been divided into two civil divisions CD-I and CD-II. Both drains carry the sewage burden of Delhi via more than 150 inlets on their journey to the Yamuna River. On the day of sampling, the entrance points at Dhansa showed a 14.21 Cusec inflow, and the water quality was as good as compared to any other river. The Yamuna River's outflow was 2004.79 Cusec, and the water quality is as bad as no one can imagine.

Results obtained from different parameters are discussed below:

Table 2: Showing results of Mungashpur Drain

	pH	Volume Discharge (cusec)	Turbidity (NTU)	Conductivity (µS/cm)	Dissolved Oxygen (mg/l)	Total Suspended Solids (mg/l)	BOD (mg/l)	Nitrate (mg/l)	Total Phosphorus (mg/l)
Up stream	7.02	331.55	71.50	2821	1.2	80	67.21	24.40	38.80
Inlet	7.80	2.41	80.20	5430	0.7	102	51.70	1.52	26.50
Down stream	7.20	334.50	77.60	3110	0.8	95	59.10	23.90	32.48

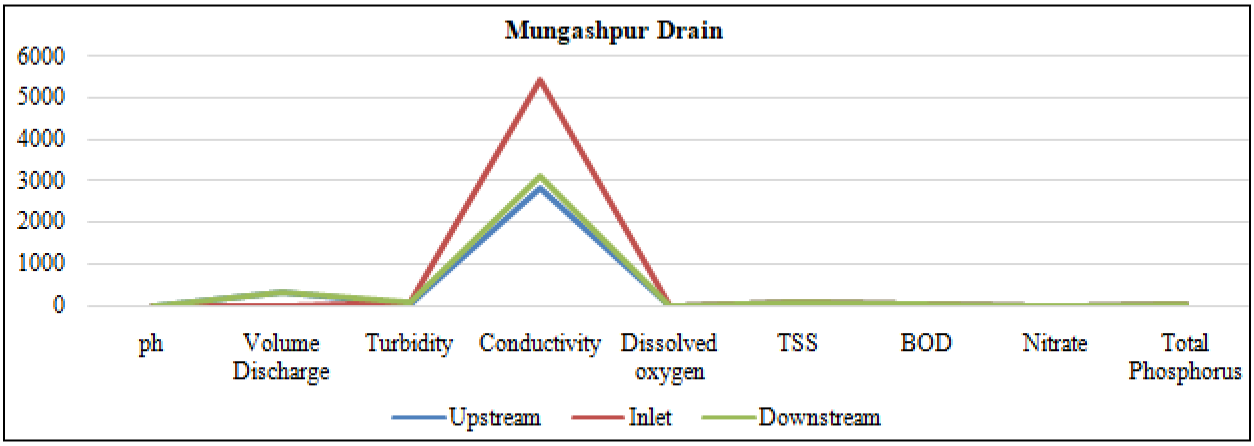

Figure 5: Showing graphical representation of Mungashpur drain results

Table 3: Showing results of Kanhaiya Nagar Drain

	pH	Volume Discharge (cusec)	Turbidity (NTU)	Conductivity (µS/cm)	Dissolved Oxygen (mg/l)	Total Suspended Solids (mg/l)	BOD (mg/l)	Nitrate (mg/l)	Total Phosphorus (mg/l)
Up stream	6.92	537.62	56.50	2610	0.5	58.10	57.50	15.70	14.57
Inlet	4.10	2.29	137.0	2302	2.0	1772.50	71.35	1.82	10.50
Down stream	7.01	542.10	67.0	2615	1.4	149.90	68.0	12.65	12.40

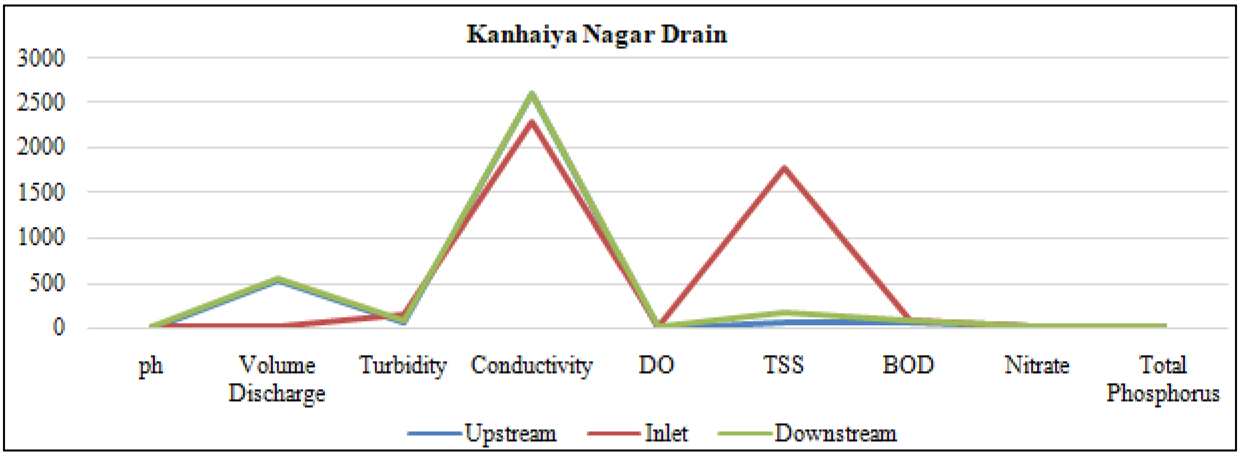

Figure 6: Showing graphical representation of Kanhaiya Nagar drain results

Table 4: Showing results of Najafgarh Drain Outfall

	pH	Volume Discharge (cusec)	Turbidity (NTU)	Conductivity (µS/cm)	Dissolved Oxygen (mg/l)	Total Suspended Solids (mg/l)	BOD (mg/l)	Nitrate (mg/l)	Total Phosphorus (mg/l)
Up stream	6.89	--	33.50	874	1.5	46.00	12.07	0.08	5.52
Inlet	6.95	2004.79	143.00	1758	0.3	168.00	54.40	17.36	54.57
Down stream	7.08	--	99.60	2109	0.7	134.00	45.33	0.50	26.95

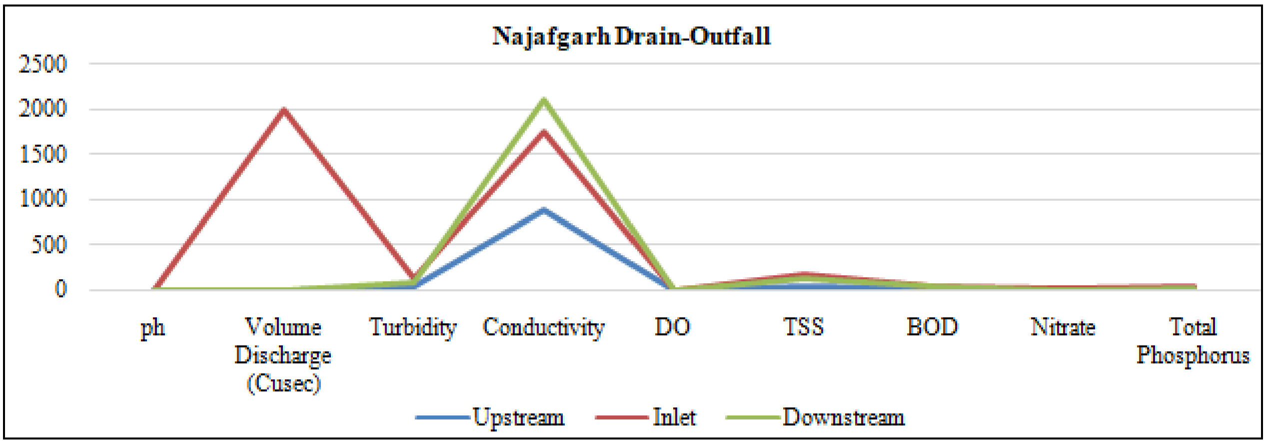

Figure 7: Showing graphical representation of Najafgarh drain-outfall in Yamuna results

Based on the foregoing findings, we may conclude that the lowest pH value reported at 4.10 at Kanhaiya Nagar Inlet Point is due to industrial discharge, and the other fact could be that water bodies with a high rate of respiration and decomposition result in low pH owing to carbon dioxide. The highest pH is 7.80 at the Mungashpur drain, according to the research. pH discharge limits range from 5.5 to 9.0. pH can have a negative impact on marine organisms, reducing their biogenic capacity and making fish more susceptible to parasites and infections. Fish's appetite, growth, and tolerance to hazardous substances are all affected by acidic water. (Mustafa et. al., 2004)

Turbidity is caused by suspended silt, clay, fine organic, and inorganic particles in the wastewater. As sewage concentration rises, turbidity rises as well (Harshit, 2014).

Human health may be harmed by suspended material that is not filtered away. Heavy hazardous metals like mercury and cadmium may be added to water with high turbidity. Turbidity may potentially impair aquatic creatures by limiting food availability and interfering with fish gill function. The maximum turbidity was 143 NTU at the Najafgarh drain outfall inlet, while the lowest was 56.50 NTU upstream at the Kanhaiya Nagar drain.

The capacity of water to carry electricity is known as conductivity. The quantity of conductivity is determined by the ion concentration. The conductivity increases as the number of dissolved salts/ions increases. If the conductivity level changes rapidly, aquatic creatures will not have enough time to adjust and will perish. During sampling, the maximum conductivity was 5430 µS/cm at the Mungashpur drain inlet and the lowest was 2302 µS/cm at the Kanhaiya Nagar inlet.

The highest BOD reading was 71.35 mg/l at the inlet Kanhaiya Nagar drain, while the lowest reading was 51.70 mg/l at the inlet mungashpur drain. The presence of organic stuff and microbes digesting the waste is generally indicated by BOD. BOD is a measure of the water's quality in terms of DO. DO lowers when BOD rises.

Nitrate is mostly utilized in fertilizer production. Because of the excessive use of manure and animal excreta, nitrate may reach the surface as well as the groundwater. Nitrosomonas bacteria may also generate nitrate chemically in pipes if the water includes nitrate or if the drinking water has a low DO level. The addition of nitrate is also aided by chlorination. Nitrate levels in drinking water are particularly dangerous to babies and pregnant women. Methemoglobinemia is caused by nitrate (Chen, 1996).

Phosphorus is a necessary nutrient for all living things. Detergents, food items, meat, and human and animal wastes all contribute to its presence in the water. Excess phosphates may contribute to algal bloom, and excess algal bloom may cause aquatic creatures to lose oxygen (US, EPA 2005). The greatest phosphate concentration was 54.57 mg/l at the inlet of the Najafgarh drain outfall, while the lowest was 10.50 mg/l at the inlet of the Kanhaiya Nagar drain.

Water quality is constantly threatened by biological creatures. In comparison to other bacteria, E. coli (Escherichia coli) and fecal coliform are detected in considerable proportions. All warm-blooded animals and humans have them in their feces. Their presence in water implies that it contains germs and should not be consumed. Human or animal excreta cause most illnesses that might pollute water supplies. At all sample sites, the Fecal coliform/Total coliform ratio was > 1600 MPN, according to the research.

Initiatives by the government to address water contamination and the water crisis

The followings are some initiatives by the government to mitigate water pollution:

- The Delhi government constructed a natural STP in the Bawana Industrial area in July 2018. The facility cleans sewage water passing via the Ghoba drain using natural materials (pebbles and aquatic plants). Every day, around 1 MLD of sewage is processed. Surprisingly, BOD has decreased from 300 mg/l to 30-35 mg/l, and other pollutants like TSS and ammoniacal nitrogen have also decreased significantly. The maximum BOD level should not exceed 20 mg/l, according to the current CPCB rules, while the former Delhi Jal board STPs had a BOD limit of 30 mg/l. For a healthier and more sustainable future, natural treatments must be used (HT Times, Feb 2019).
- The Ministry of Urban Development and Poverty Alleviation (Delhi Division), Government of India, has made rainwater harvesting obligatory for plot sizes of 100 square meters and higher by a modification or addition to the construction by-laws. All structures with a minimum discharge of 10,000 liters per day and above are included in the notice (GWRMC, 2019).
- During festivals like Ganesh Chaturthi, Durga Puja, and Saraswati Puja, it is customary to immerse idols in water sources such as sewers and rivers. The idols are formed of harmful substances that affect water quality due to high BOD and chemical concentrations such as zinc, mercury, and chromium. To address this issue, the government has issued a stern regulation prohibiting the disposal of any puja material, oil, or food into drains. Anyone who disobeys the directives faces a monetary penalty of Rs. 5000.

STPs and CETPs in Delhi

The city's population is growing at an alarming pace. The biggest factor affecting water quality and quantity is population growth. The Delhi Jal Board (DJB) provides around 900 MGD (Million Gallon per Day) of potable water to Delhi residents. Delhi generates 3268 million liters (MLD) of sewage per day, though only about 2083 MLD gets treated, despite a treatment capacity of 2756 MLD. The city has 41 sewage treatment facilities spread out over 22 distinct sites, with 32 of them operational. Total sewage treatment capacity is now 2029 MLD, compared to 2775 MLD installed capacity. About 350 MTD sludge is produced by these units. Many sewage treatment plants are not operating at optimum efficiency, and their reporting and response systems are poor. (ENVIS Centre)

The CETP (common effluent treatment plant) idea was developed to provide wastewater treatment at a cheaper unit cost than separate enterprises, and these plants are regulated by environmental regulators. In Delhi, 14 CETPs process about 59.3 MLD of wastewater output (CSIR-CBRI, March 2019).

If the wastewater from these cities and villages can be collected and treated naturally, such as through wetland-based biotreatment, there are hundreds of villages and towns in India. This water may be put to agricultural use. As a consequence of rising urbanization (now about 30%) and anticipated to reach 50% by 2050 (Mckinsey, 2010), municipal wastewater production will also rise. According to a CPCB analysis, wastewater production from Class I and Class II cities will reach 100,000 MLD by 2050. (CPCB, 2010).

5. Conclusions

India's surface and groundwater are diminishing on a daily basis, and a major percentage of its water is utilized for agriculture. There is a way to get around this difficulty.

It is true that wastewater drains serve as a breeding ground for novel germs that are becoming more resistant to medications. The government should launch a program to cover drains and increase the number of operational STPs (sewage treatment plants). Every drain should have an STP installed, and the discharge should be monitored according to the BIS permitted limits. Preventing contamination of water bodies and enforcing the "polluter pays concept" are the greatest ways to guarantee water quality. Improvements to current schemes as well as the development of novel wastewater treatment systems. By estimating future water demand, you may prevent contamination of both surface and groundwater resources. For sustainable living, water recycling and reuse should be performed on a large scale. Several small-scale enterprises are compounding the problem by discharging wastewater containing chemicals and other harmful substances. It's a complicated issue that can't be solved without social participation.

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