

Urbanisation and Environmental Degradation: A Geographical Perspective on Yamuna River Pollution in NCT Delhi

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Abstract:

The Yamuna flowing into the National Capital Territory (NCT) of Delhi is a typical case of river degradation caused by sewage, untreated/partially treated effluents discharge, poor environmental flow, and poor enforcement. The current research paper synthesizes and analyses recent technical reports of river Yamuna: (1) to quantify the water-quality issue (DO, BOD, FO (faecal coliform) and other indicators) at inter-state entry/exit point and in major drains; (2) to study the role of environmental flow and drain tapping; and (3) to offer prioritized, actionable interventions to improve the situation in the short and medium term.

Significant study results include; DO (Dissolve Oxygen) is sufficient at the point of entry (Palla) but declines to near zero at the point of drainage (Asgarpur), BOD and faecal coliforms are orders of magnitude higher than bathing and environmental standards at most of the sites in NCT, and few drains (particularly Najafgarh, Shahdara and Barapullah) hold the bulk of the pollutant load. We recommend a progressive programme of controlling pollution of the river Yamuna at Delhi NCT.

Keywords: Yamuna, river pollution, NCT Delhi, BOD, DO, Faecal Coliform, STP compliance, drains, environmental flow.

1. INTRODUCTION

The Yamuna River is very polluted with 22 km in the state of Delhi contributing 80 percent of the total pollution in spite of the fact that it is only 2 percent of the overall length. Each day, Delhi discharges 200 MGD of untreated sewage in the river which poses a threat to aquatic life and domestic water supply. Sewage is treated only 50 percent with 55 percent of industrial waste worked on (Vyas et al. 2022).

The quality of water of Yamuna River in the Delhi stretch has considerably deteriorated owing to the large quantities of various contaminants. It indicates that the major causes of the pollution in the Yamuna are the discharges by industries and poor sewage treatment (Trisal et al. 2008). In the Delhi parts, which have been hard hit by urbanization, industry, and agricultural runoff the study observed significant variations in water quality indicators (Rout C. 2017).

Population increase, poor infrastructure, and institutional disintegration have placed a lot of pressure on fast-growing megacities. The Yamuna via Delhi is a perfect example; to the river, the dissolved oxygen (DO) levels are acceptable, but quickly become much worse as it flows through the city; caused mostly by sewage and municipal/ industrial discharges through the drains into the river. Judicial oversight and multi agency plans were not new; however, limited improvements have only been measurable through years of sustained improvements.

The empirical context of restatement of the problem and intervention design is provided by two recent, comprehensive, authoritative documents: (a) the report to the National Green Tribunal by the Central Pollution Control Board of the water-quality monitoring and trends of River Yamuna, and the

compliance status of STPs at Inter-State Locations, along with desilting, e-flow study and upgradation of STPs ([https://nationalgreen.tribunal.nic.in/Data/Central Pollution Control Board/ 2023](https://nationalgreen.tribunal.nic.in/Data/Central%20Pollution%20Control%20Board/2023)), and (b) the Government of NCT of The two reports have been utilized in this paper as the major sources of data and the interpretation of their data in structured research format has been used to (i) describe the extent and spatial distribution of pollution in NCT Delhi, (ii) measure the infrastructural and operational deficiencies, and (iii) have an evidence-based, step-by-step remediation and research agenda.

Research questions.

What are the space and time distributions of DO, BOD and faecal coliform at inter-state entry/exit points and the Delhi stretch of the Yamuna?

What are the most significant sources of drains and pollution that cause the greatest load of pollutants in Delhi?

2. STUDY AREA

This paper is based on the Yamuna stretch, which passes through the NCT of Delhi, specifically the stretch between Palla (where it enters Haryana) and Asgarpur/Agra Canal (where it enters the Uttar Pradesh/Agra Canal system). The most important locations to carry out monitoring and outfall in the reports are Palla, Wazirabad, ISBT (Qudsia Ghat) and ITO/ITO barrage area, Nizamuddin bridge, Okhla barrage and Asgarpur. Big drains that empty in this stretch, Najafgarh, Shahdara, Barapullah, Delhi gate(power house drain), ISTB/ Mori gate, Sen Nursing homes drain, and others, are specifically taken into account.

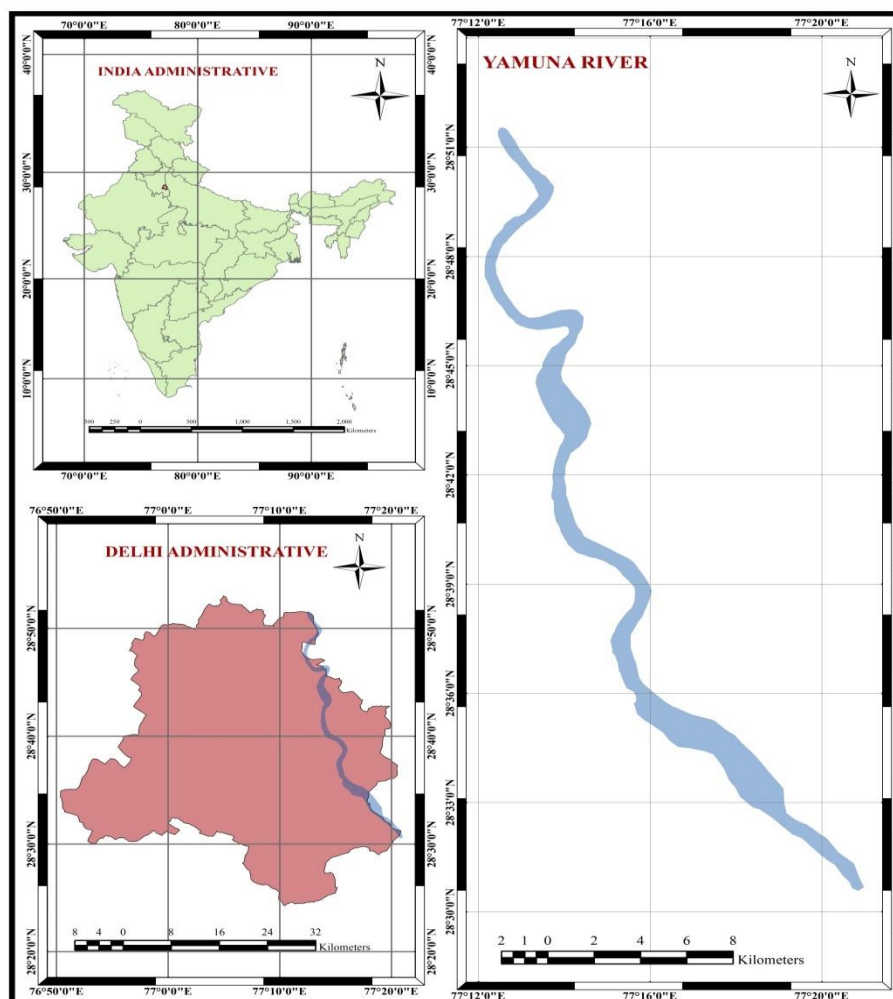


Figure 1.1 the Study Area Map

3. METHODOLOGY

Data Sources: The current research paper is based directly on two official documents; (1) CPCB (2023) Report on Water Quality of River Yamuna at Inter-State Locations, Drains and Compliance Status of STPs in Delhi (prepared on behalf of NGT), (2) Progress in Rejuvenation of River Yamuna Report (Jan 2025) Dept. of Environment, Govt. of NCT Delhi (2025).

Data collection: The research has reviewed the report of CPCB and the NCT Delhi progress report of 2019-2024 data series, sampling tables, trend charts and project status matrices systematically. The important tables utilized are; inter-state water quality Tables, drain monitoring tables, STP compliance tables, DPCC monthly reports, and CPCB summary. The paper concentrated on three main river health indicators employed by the NGT and reporting agencies, including Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD) and Faecal Coliform (FC). Drains and CETP performance was characterized by additional supporting parameters (COD, TSS and selected heavy metals).

Data analysis: With the trend charts and min-max ranges that have been given in the reports, we were able to spot hotspots and the major contributing drains. The trend analysis of the reports (2018-2024) was applied to identify either the deteriorating or improving trends. According to the load shares of drains pollutants in the reports, the study ranked interventions based on immediate action to reduce the environmental impacts.

4. RESULTS AND DISCUSSIONS

4.1 Inter-state entry and exit water quality

Results sampled by CPCB contrast strongly between Palla (entry to Delhi) and Asgarpur (exit from Delhi): BOD 16 mg/L at Palla and 94mg/L at Asgarpur; faecal coliform 17×10^3 MPN/100 mL at Palla and 46×10^5 MPN/100 mL at Asgarpur. These one day results are in line with longer term results in which DO is only meeting criteria near the entry point and collapsing downstream; BOD and FC are much above bathing and environmental standards.

The quality of water is measured by the use of biological Oxygen Demand (BOD) since it is the amount of oxygen bacteria required to break down organic material. The river should have a maximum percentage of 3 mg/l of BOD. At the point of entry, Yamuna has a BOD of 4mg/L at Palla, Delhi. The concentration rises to 6 mg/l at Wazirabad and then dramatically increases to 51mg/l and 66mg/l at the ISBT Bridge and ITO Bridge respectively. (DPCC, 2024)

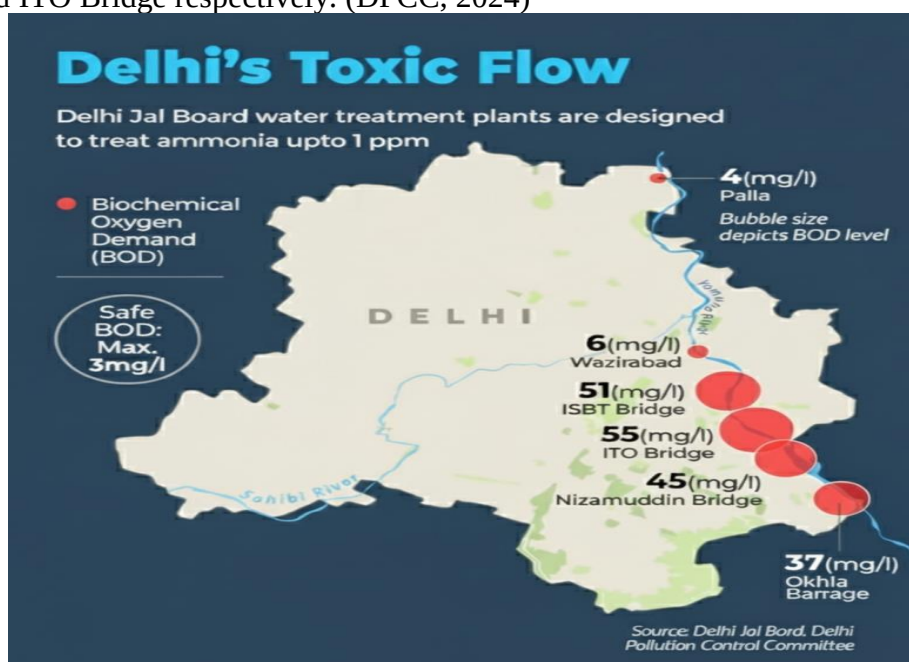


Figure 1.2 Delhi's Toxic Flow (Source: Delhi Jal Board DPCC, 2024)

Pollution Trends (2019–2022).

In Palla (Delhi entry) Dissolved oxygen (DO) at ranged approximately 3.9 to 17.1mg/L in 2019-2022 with declines in some years and biological oxygen demand (BOD) often exceeded the 3 mg/L bathing standard with Minimum of 40 to 100 MPN/100 mL faecal coliforms had an alarming increasing trend with highs of tens of millions MPN/100 mL in 2022. In Asgarpur (Delhi exit), the DO levels were almost zero during the monitored times, the minimum values were approximately 0.2-0.3 mg/L; BOD was extremely high (8-127 mcg/L), the faecal coliforms were very high (tens of thousands up to millions of MPN/100 mL). This implies a great amount of pollution burden in the city and insufficient in-stream treatment or dilution.

The severity of degradation between Palla and Asgarpur shows that the river is being turned into intolerable conditions of gross pollution by the time it is leaving Delhi. The trend blames local discharges of drains and insufficient treatment/ dilution within the city of Delhi as the main culprits.

4.2 Major contributor Drains:

In the CPCB report, there were 24 drains that are released into/near Yamuna system in Delhi (16 between Wazirabad and Okhla, 3 below Okhla, and others into Agra/Gurgaon canals). The NCT progress report mentions 22 large drains that are discharging in the Yamuna and it follows the tapping of these drains.

Najafgarh Drain: this drain was many times found to be the largest in volume and BOD load. The trend analysis indicates increased minimum and maximum values of BOD/COD/TSS at Najafgarh during 2018- 2022.

Shahdara Drain: The drain accommodates domestic and industrial wastewater, trend charts indicate that the concentrations are high.

There are also Drains which carry substantial loads, such as Barapullah Drain, Delhi Gate (Power House) Drain, ISBT/Mori Gate Drain, Sen Nursing Home Drain and others.

The pollutant load is volumetric and a concentration based one; few high flow drains with high levels of pollutants give high levels of total BOD/COD and FC loads. Addressing these drains would bring in the greatest reduction in loading to the Yamuna in the short term.

4.3 Capacity of Sewage Treatment Infrastructure.

The estimated sewage generation in Delhi, as reported by CPCB, is 3,491 MLD and an installed treatment capacity (35 operational STPs at 20 locations) of 2,874 MLD with a treatment capacity deficit of 618 MLD and a treatment gap (flows not treated) is approximately 900 MLD.

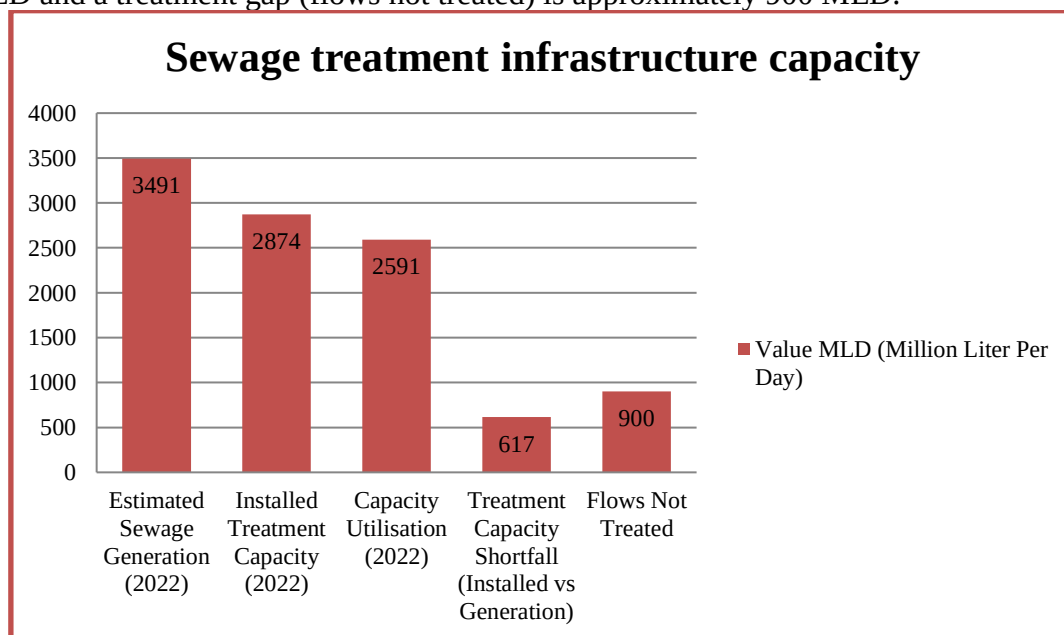


Figure 1.3 Sewage treatment infrastructure capacities in Delhi

4.4 Environmental flow (e-flow)

The NMCG/NIH study (Hathnikund to Okhla) recommends an e-flow of **23 cumecs** during lean season (May) to achieve significant dilution benefits (this is the recommended minimum to reduce BOD in the stretch). The present release from Hathnikund at the time of the progress report was about **10 cumecs**, implying a **gap of 13 cumecs**. Under the NIH scenario, raising e-flow from 10 to 23 cumecs would reduce modeled BOD from 25 mg/L to 12 mg/L, but to achieve bathing standard $BOD \leq 3$ mg/L the river would need an impractically large e-flow 390 cumecs.

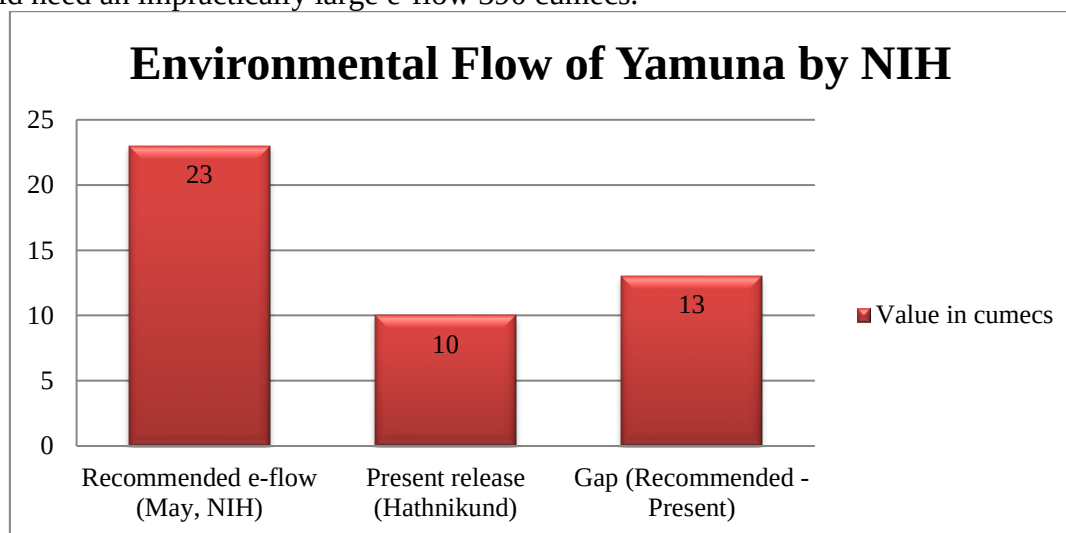


Figure 1.4 Environmental Flow of Yamuna River at Delhi By Recommended NIH

E-flow increase to 23 cumecs would materially improve water quality but would not, alone, restore bathing quality so treatment and source control are necessary in parallel. Achieving larger e-flows requires inter-state water-sharing decisions, dam/canal projects and political negotiation and a water sharing agreement.

5. RECOMMENDATIONS

Immediate actions

Install makeshift pumping and transport treatment facilities to harvest and treat most loaded flows (Najafgarh, Shahdara, Barapullah) as permanent tapping is expedited. These emergency practices have the ability to mitigate short-time pollutant release during lean season. Implement sewage control laws, prohibit sewage disposal in the sewerage and use surveillance and sanctions. Sewage dumping is a contributor that is emphasised on in NGT/CPCB material. Introduce a publicly accessible dashboard on a weekly basis with DO/BOD/FC in major stations and make them more responsible.

Short-term structural & institutional interventions.

Make Najafgarh, Shahdara and Barapullah a priority; make sure that land is allotted and that obstacles that hamper the construction of STP are removed. Progress doc gives physical-progress position which should be applied to fast-track completion. Focus on high load areas and routes that serve large drains to connect to sewer connections; the 1799 unauthorized colonies that are fast tracking their connection in the NCT plan will decrease direct dumping.

Increase CETP capacity and monitoring; make sure that industrial clusters are discharged into a zero load or on-site pretreated. The progress report indicates that the variations in the utilization of CETP have to be handled.

Strategic and policy actions.

Rigid E-flow deal as suggested by NIH. Schedule inter-state technical and political negotiations to achieve the recommended 23 cumecs lean-season release identified operational steps (pilot releases, monitoring) of the operation.

Strict polluter-pays enforcement, environmental compensation levied in cases where necessary and revenues used to fund operations and maintenance. Protect and restore floodplains and wetland as buffer, polish and biodiversity good; this resonated with a Tribunal recommendation, and is consistent with long-term resilience.

6. CONCLUSION

The facts represented at CPCB by the NGT report and the NCT Delhi progress document tells a dismal yet realistic story. Although the Yamuna enters Delhi with a fairly manageable DO levels at Palla, a high concentration of drains and long-term deficits of treatment turns it into a very contaminated, virtually lifeless river by the time it flows out of the Asgarpur. The technical way to go is obvious and multi-faceted: (i) vigorously implement and enforce current STP capacity; (ii) intercept and treat the most heavily loaded drains; (iii) increase and modernise treatment (STPs/DSTPs/CETPs), and ensure Operations and Maintenance pathways and (iv) achieve meaningful improvements in environmental flows (NIH-recommended 23 cumecs) by a concerted inter-state effort. The fastest returns are provided by institutional responsibility, open monitoring panels, rigid pollutant-pays schemes, and emergency actions (temporary pumping/mobile treatment) that must be taken immediately. Bringing sustainable recovery takes not only technical investments but also governance reform; reports examined herein offer both the empirical base and blueprint to the challenge that is now implementation with strong oversight.

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