Acta Ciencia Indica, Vol. XLVI-C, No. 2 to 4, 117 (2020)

ASSESSMENT OF POLLUTION LOADCAUSED BY SEWAGE IN RIVER YAMUNA AT DELHI STRETCH

V. HIMA JWALA

Scientist-B, Bioscience Laboratory, Central Pollution Control Board, Delhi

DR. P. BHRAMAJI RAO

Director & Professor, Department of Environmental Science, Acharya Nagarjuna University, Guntur

DR. P.K. BEHERA

Scientist-E & Divisional Head of Bioscience Laboratory, Central Pollution Control Board, Delhi

RECEIVED : 9 June, 2021

Most of the rivers in India are not polluted at their source while environment/ecological flow in the plains many rivers got polluted because of run-off from agricultural land, discharge of industrial effluents, and domestic sewage. Almost all the storm water drains converted to sewage carrying drains due to poor network system.River Yamuna is polluted by pesticides and fertilisers as it enters Haryana but significant pollution occurs in Delhi stretch due to improper proper sewage disposal system where water carrying sewage is discharged into open drains, from where it finds its way to the river. Though Delhi constitutes only 2% of the catchment area, it is responsible for 70% of the pollution load of the river.

The two major causes of pollution in the river Yamuna of Delhi stretch is absence of ecological river flow (triggering the pollution load) and dumping of sewage, industrial wastes into drains. In order to address the second issue following are recommendations to be taken by Government :–

1. Stoppage of sewage flow into storm water drains and all sewage to be diverted to flow only to STPs for proper treatment.
2. To direct all the new housing constructions/ colonies/societies for commissioning of Decentralized Sewage Treatment System (DTS) to treat their entire generated sewage.
3. To adopt ‘Polluters Pay Principle’ for Operation & Maintenance of the treatment plant.

PCM0210145

4. To Promote DSTS for appropriate treatment, recycling, reuse or disposal of the treated wastewater.

Key words: ecological flow, sewage, Decentralized Sewage Treatment System (DTS), Polluters Pay Principle.

INTRODUCTION

India is a land where many sacred rivers portrays culture and traditions. River Yamuna is one of holy river and it is the sixth longest river in India and the largest tributary of River Ganga originated from the Yamunotri glacier (Saptrishi Kund) near Bander punch peaks (38° 59' N 78°27' E) in the Mussoorie range of the lower Himalayas at an elevation of about 6320 meter above mean sea level in Uttarakashi district of Uttaranchal (CPCB, 2006). The total length of the Yamuna River from its origin Saptrishi Kund to its confluence with Ganga at Allahabad is 1376km traversing through seven states. People from all over the country visit various stretches of river Yamuna to take holy dip to purge away their sins.

All the water of the river Yamuna is held by dams built over it and this water is being diverted for drinking, irrigation and power generation. The first intervention in the flow of Yamuna is 200 kilometres upstream from Delhi at Dak Pathar, near Dehradun in Uttarakhand. Here at Uttarakhand-Himachal Pradesh border, almost all the water of the river Yamuna is diverted into a huge water channel known as Shakti Canal where diverted water is used to generate electricity, almost river Yamuna river is left as a dry patch except during the monsoon, resulting in the death of the riverine ecology.

During dry season, about 160 cusecs of environmental flow is allowed to flow in the river downstream to Tajewala barrage and in some stretches it remains dry between Tajewala & Delhi (Rajat Mittal and Mubeen Beg, 2013). The river regains water because of ground water accrual, contributions of feeding canal through Som nadi (seasonal stream) upstream of Kalanaur and through drain no.8 upstream of Palla. It enters Delhi near Palla village after traversing a route of about 224 km. Almost all the water of river Yamuna has been sucked out for power generation, irrigation and drinking before reaching Delhi with less flow. In Delhi, river Yamuna turned into drain, loosed its sustainability and became unfit for drinking, irrigation or any industrial purpose due to uncontrolled flow of untreated sewage and the discharge of industrial effluents, as reported in the "Delhi Human Development Report", 2013. It covered 22km at Delhi stretch *i.e.* entry point at Wazirabad barrage and exit point at Okhla barrage and considered as most polluted stretch.

SEGMENTATION OF YAMUNA RIVER:

The Water flow characteristics of Yamuna River changes significantly from monsoon to non-monsoon seasons. This change in water flow along with the construction of various barrages hampers the continuous flow of the river. Thus, in dry season (almost 9 months), the river becomes segmented in four distinguished independent segments as given **Table 1 & Fig. 1**.

Table 1: Classification of various segments of Yamuna River (Prashant, 2016)

River Segments	Segment Area	Approx. Segment Length
Himalayan Segments	From Origin to Tajewala Barrage	172 km
Upper Segment	Tajewala Barrage to Wazirabad	224 km
Delhi Segment	Wazirabad Barrage to Okhla Barrage	22 km
Eutrophicated Segment	Okhla Barrage to Chambal Confluence	490 km
Diluted Segment	Chambal Confluence to Ganga Confluence	468 km

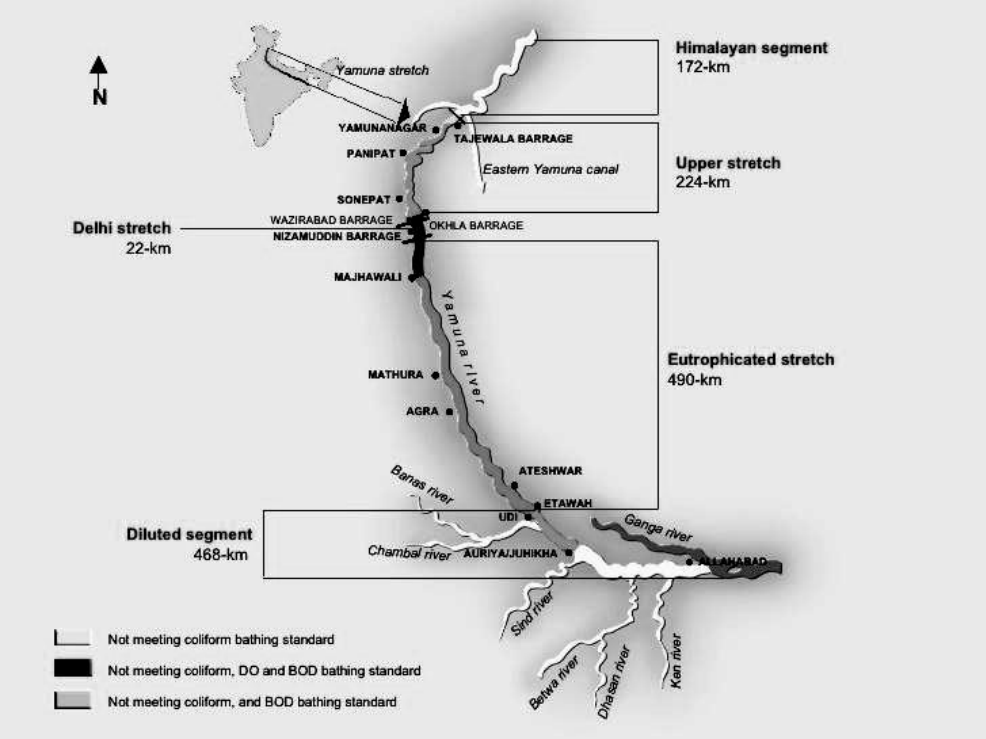

Fig 1:Segments of Yamuna River

The major root cause of pollution in river Yamuna is sewage about 79% of pollution load is contributed by sewage in 22 kilometres stretch of Delhi & Delhi NCR (2% of total 1400km long river Yamuna) between Wazirabad and Okhla (Taskeena Hassan, 2017). River Yamuna receives sewage of treated and untreated water from 23 drains of Delhi and also from Western Jamuna Canal (WJC) and Upper Ganga Canal via Najafgarh Drain.

MANAGEMENT OF SEWAGE IN DELHI

Wastewater(sewage) inflow in the river Yamuna is major source of pollution, which is governed by population, water supply, sewerage network &collection, efficiency of the relevant infrastructure, inadequate treatment, etc. It is estimated 45% of Delhi city lacks proper drainage facility and sewage disposal (Simar Singh, September 2017) which alone contributes approx. 1100 million litres per day of sewage being dumped without any treatment in the River Yamuna along its entire course. During the study period (2017-2019), an average 4000MLD of sewage being generated per day of which about 2815MLD of sewage is being channelized to Sewage Treatment Plants (STPs) to treat in Sewage Treatment Plants (STPs). There is a large gap between generation and treatment in Delhi itself. Under Yamuna Action Plan, though several STPs have been installed along the river course but, the river quality of the river is not yet improved as the treatment capacity is neither adequate nor effectively utilized. (A.Upadhyay, 2013)

Main issues related to sewage management are:

- STPs capacity is inadequate as compared to the generated sewage.
- STPs are in general practically not meeting their compliance.
- Under capacity running of most of the STPs due to lack of sewer connections.
- Improper drainage system.

Delhi collects sewage through drainage system and it is divided into six drainage zones viz. (i) Keshopur Zone, (ii) Rithala-Rohini Zone, (iii) Okhla Zone, (iv) Coronation Pillar Zone, (v) Trans Yamuna (Shahdara) Zone, and (vi) Outer Delhi Zone (CPCB CUPS, 2005). The Najafgarh drain basin area, the largest drain basin lies mainly in Zones (i), (ii), (iv) & (vi). As of study period 2017-19 about40 STPs were commissioned in 17 localities under Yamuna Action Plan having the total sewage treatment capacity 2815 MLD, however, actual treatment is only 1937 MLD due to improper functioning of STPs. A location map of sewerage facility including location of Sewage Treatment Plants and trunk sewer line is given in Fig. 2.

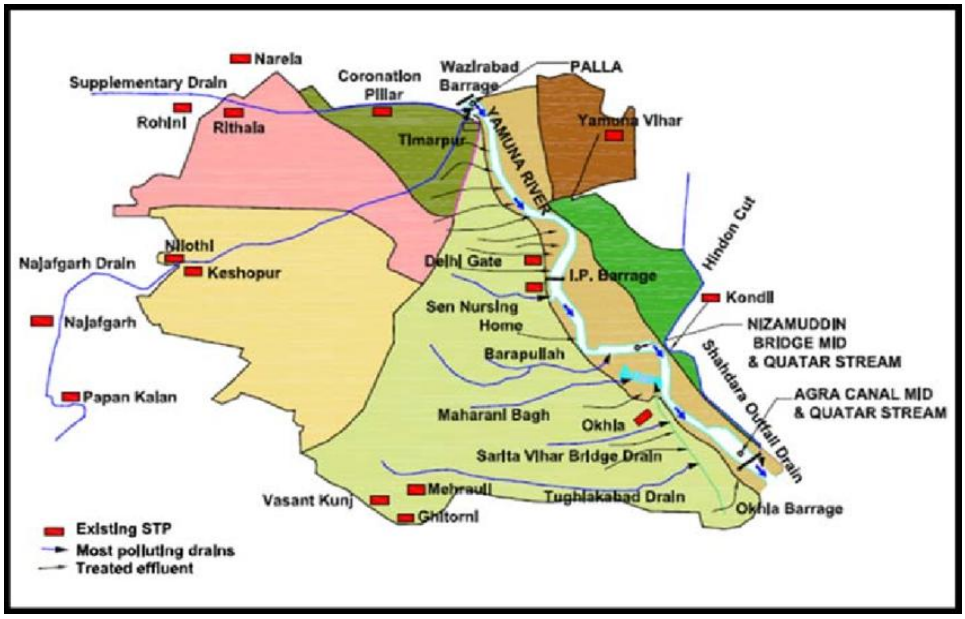

Fig. 2: Delhi STPs location map

QUANTITATIVE AND QUALITATIVE ASSESSMENT OF POLLUTION LOAD OF DRAINS IN RIVER YAMUNA:

The Yamuna river and Agra Canal receives pollution through 23 drains, out of which 20 drains join Yamuna River and rest joins Agra/Gurgaon canal. These are severely polluted in Delhi area carrying treated/untreated sewage. The flow and BOD load of these 23 drains is presented in Table. 2 for three consecutive years *i.e.* 2016, 2017 & 2018. The average percentage flow by each 23 drains into the river Yamuna/Agra Canal during 2016, 2017 & 2018 is given in **Fig 3** and also percentage contribution of these drains in terms of BOD load is presented in **Fig 4**. A line diagram showing various disposal points of drains alongwith discharge and pollution load is presented in Figure 5.

Table 2: Annual Average flow (MLD) and BOD load (TPD) of drains

S. No	Name of Drain	2016		2017		2018	
		Flow (MLD)	BOD Load (TPD)	Flow (MLD)	BOD Load (TPD)	Flow (MLD)	BOD Load (TPD)
1.	Najafgarh Drain	2026.08	23.45	2042.3	132.55	2066.7	101.29
2.	Shahdara Drain	426.82	42.48	513.9	41.26	473.5	38.95

3.	Old Agra Canal Near Kalindi Kunj	491.62	17.11	480.3	36.00	405.2	34.89
4.	Old Agra Canal At Okhla	279.07	5.77	240.9	5.57	187.5	4.27
5.	Barapulla Drain	83.81	6.43	136.3	10.30	151.2	9.06
6.	Tuglakabad Drain	114.05	11.93	88.9	9.12	45.8	3.25
7.	Delhi Gate (Power House) Drain	74.30	5.88	84.8	6.26	47.5	3.31
8.	Sen Nursing Home Drain	66.53	7.19	64.4	9.45	41.0	5.29
9.	Abu Fazal Drain	38.02	1.22	50.9	1.54	35.0	1.08
10.	ISBT + Mori Gate Drain	47.52	2.52	45.2	2.89	51.0	3.06
11.	SaritaVihar Drain	59.62	9.93	40.8	9.90	26.0	6.02
12.	Maharani Bagh Drain	23.33	1.68	26.5	3.03	24.2	2.43
13.	Jaitpur Drain	11.23	1.80	16.6	2.28	23.3	3.39
14.	Molar Bandh Drain	8.64	1.06	14.0	1.98	19.0	2.07
15.	Kailash Nagar Drain	9.50	2.15	11.9	3.15	7.8	2.82
16.	Tonga Stand Drain	12.09	1.17	11.4	1.75	7.8	1.18
17.	Shastri Park Drain	4.32	0.06	7.6	0.84	4.3	0.46
18.	Drain No.14	3.46	0.04	7.3	0.13	4.3	0.05
19.	Magzine Road Drain	11.23	1.07	7.1	0.54	6.0	0.44*
20.	Civil Mill Drain	6.91	0.34	6.3	0.50	8.6	0.57
21.	Metcalf House Drain	6.912	0.19	6.1	0.20	4.3	0.12
22.	Sweeper Colony Drain	6.91	0.08	6.0	0.16	6.0	0.18
23.	Khyber Pass Drain	4.32	0.37	1.3	0.03	NF	NF

Note: NF refers to No Flow

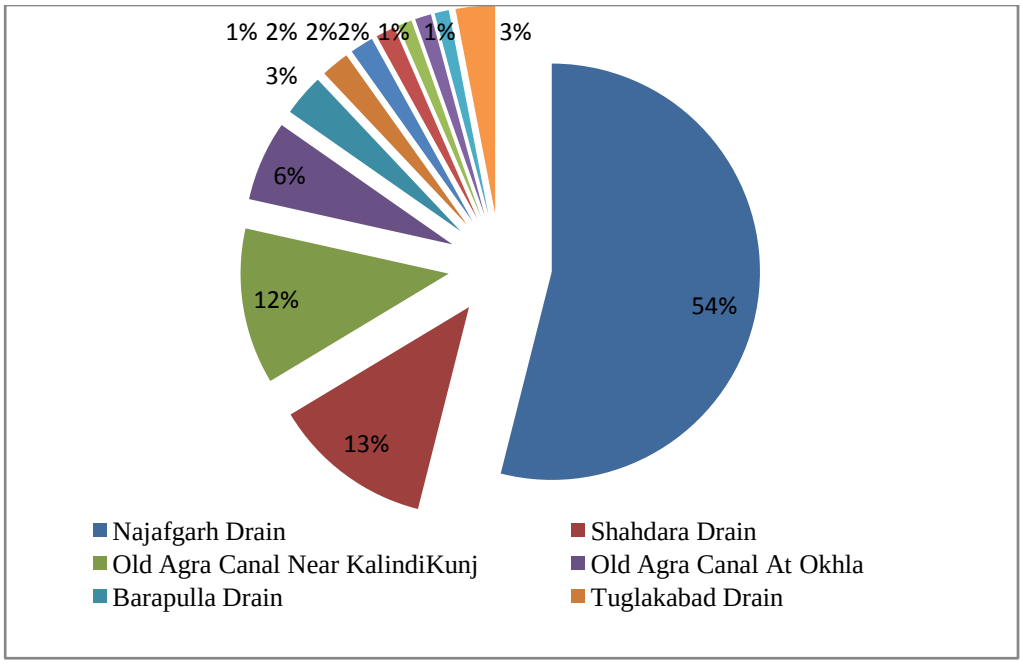

Fig.3 : Average % Quantification of drains in river Yamuna (2016-2018) in terms of Flow, MLD

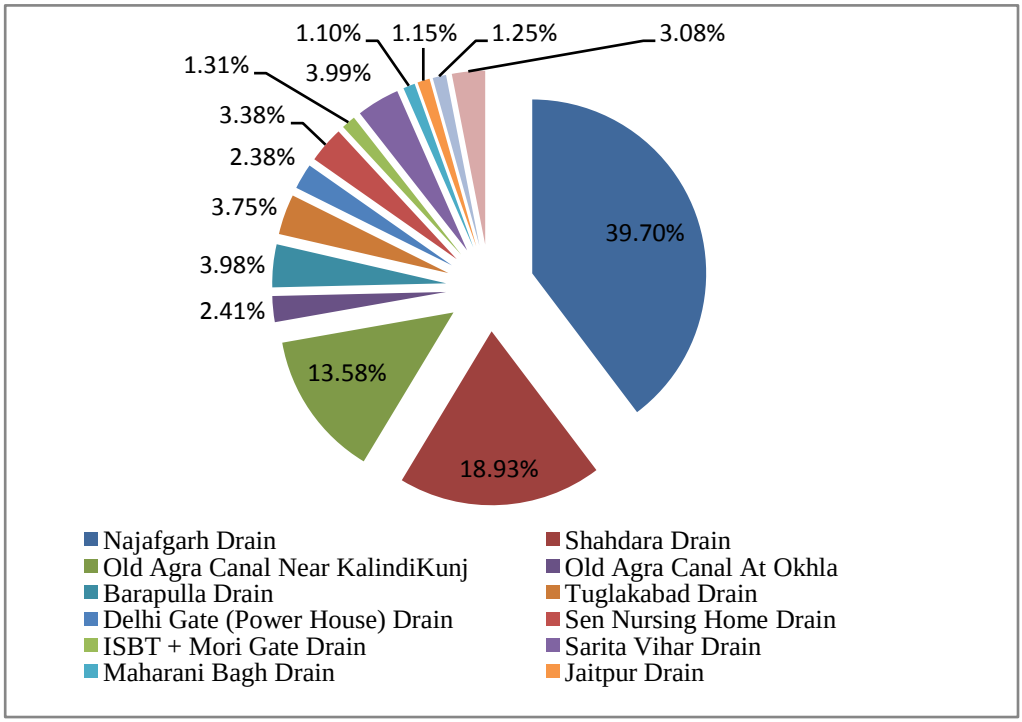

Fig.4 : Average % of Quantification of drains in river Yamuna (2016-2018) in terms of BOD load,TPD

The Fig. 3 & Fig. 4 indicates that major contribution of flow & BOD load is from Najafgarh drain, Shahdara drain, Agra Canal drain and Barapulla drains. Out of 23 drains flow into the river Yamuna, Najafgarh drain (including Supplementary drain), Delhi Gate drain, Sen Nursing Home drain, Barapulla, Tughlakabad and Shahdara drain contribute about 93.5 % of hydraulic load (Volume of Water) and 88.1 % of organic load (amount of organic matter) while the remaining drains contribute about 6.5 % of hydraulic load and 11.9% of BOD load (based on assessment for the year 2016-18).

ASSESSMENT OF POLLUTION LOAD OF RIVER YAMUNA IN DELHI STRETCH:

An attempt been made to check and assess the pollution load in river Yamuna at Delhi stretch at 5 locations i.e. Palla (U/s of Wazirabad barrage), Nizamuddin Bridge, Okhala at Kalindi Kunj (Okhla U/s) and Okhala D/s for three consecutive years – 2016, 2017 & 2018. The average of annual data for water quality parameters is presented in the Table : 3.

Table 3 : Average annual data of drains for water quality parameters

Source	Year	Parameters					
		DO	NH_3-N	COD	BOD	TC	FC
Palla	2016	8.6	3.9	15.2	3.9	13426	6960
	2017	7.6	0.9	10.4	2.5	18975	5498
	2018	7.4	1.1	16.1	2.9	143342	81062
Nizamuddin Bridge	2016	1.0	16.0	77.3	26.6	4884917	2601083
	2017	1.3	16.4	58.7	20.2	14214167	10153750
	2018	2.4	18.3	76.7	20.8	6893333	5167250
Agra Canal at Kalindi Kunj	2016	0.9	15.5	71.8	20.4	3216667	2012583
	2017	1.2	13.0	53.3	16.9	2842727	2262727
	2018	2.2	10.7	61.2	14.6	2446667	1152333
Okhla Downstream	2016	0.9	29.6	128.6	38.0	19834167	11825000
	2017	1.3	19.7	87.8	36.0	7410167	4309050
	2018	2.2	21.3	104	29.0	22340833	6837500
Agra Canal at Badarpur	2016	0.8	18.9	82.2	24.2	6460833	3310833
	2017	1.2	14.7	69.3	25.9	5352000	2016000
	2018	1.9	15.0	69	18	16055833	2203333
Note:	*Parameters of DO, NH3-N, TKN, COD & BOD are expressed in mg/l* *Parameters of TC, FC & FS are expressed in MPN/100ml*						

In Delhi stretch the water quality trend of the river Yamuna from Palla to downstream of Okhla barrage at 4 locations *i.e.* Palla, Nizamuddin Bridge, Okhla at KalindiKunj (Okhla U/s) Okhla D/s and Agra Canal at Badarpurwas studied during the year 2016-2018 in terms of Dissolved Oxygen (DO) & Bio-chemical Oxygen Demand (BOD). The values of DO reflects that the level was well above the prescribed limit in the range from 7-8 however, significant depletion even below 2.4 was observed from Nizamuddin barrage and remained critical forrest of the river stretch. BOD at Palla generally meets the prescribed standards in the range of 1 – 4 mg/l while at Okhla D/s BOD valuewas found well above the limit even above 38 mg/l. Free ammonia (NH_3) which is a criteria parameter was found exceeding the prescribed limit of 1.2 mg/l except Palla. Increasing trend of Total Coliform(TC), Fecal Coliform(FC) and Fecal Streptococci (FS) values clearly indicates the contribution of sewage in river Yamuna.

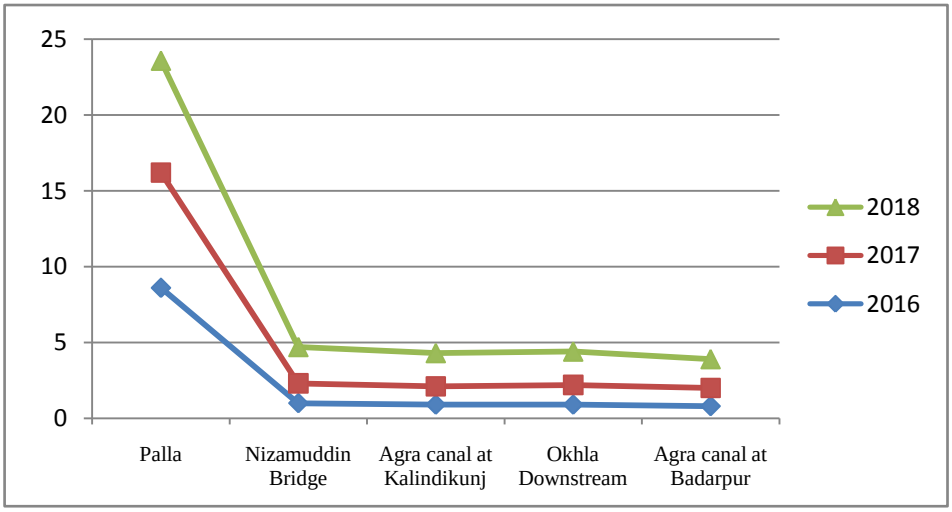

Fig. 5: Water Quality of River Yamuna in terms of DO, mg/l

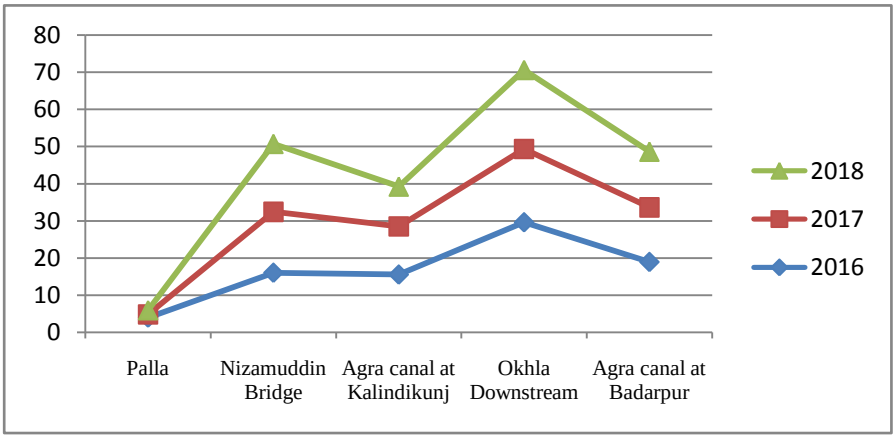

Fig. 6: Water Quality of River Yamuna in terms of Ammonical Nitrogen, mg/l

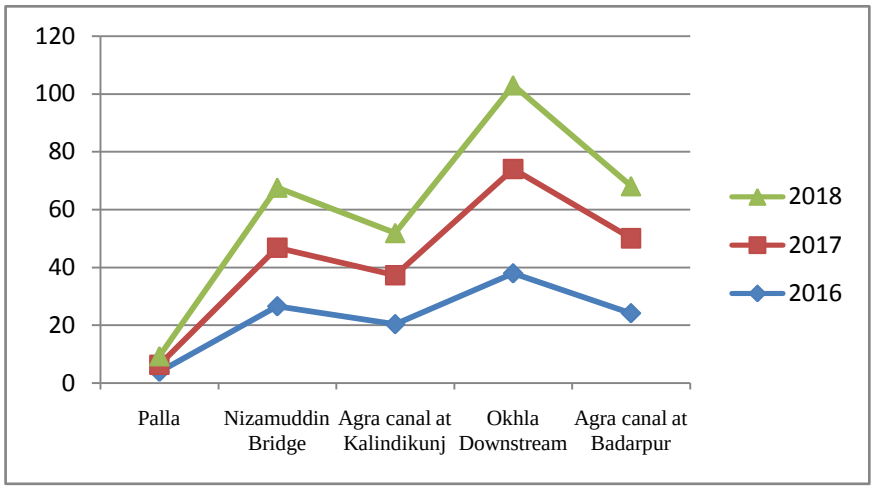

Fig. 7: Water Quality of River Yamuna in terms of BOD, mg/l

The Fig.5 depicts DO depletion in water quality of river Yamuna from Palla to Agra canal posing significant impact on aquatic life. Fig. 6 & Fig. 7 depicts increasing trend of Ammonical Nitrogen level and BOD levels (Organic matter) indicating sewage contribution contaminating river water quality of Yamuna at Delhi stretch (from Palla to Okhla Downstream), this is the reason, after Okhla downstream river Yamuna stretch is called Eutrophication segment. Also direct discharge of domestic sewage into the river without treatment is major threat to water quality of river Yamuna

RECOMMENDATIONS:

During the study Sewage (untreated/partially treated) is the significant contributor of pollution load of river Yamuna in Delhi stretch. During the study year (2017-19), it is observed that approx. 4000 mld of sewage being generated in Delhi, however, the actual treatment is of only 1936.8 mld, which is a huge gap between generation and available treatment.

In view of the critical problem of increasing contamination of surface water due to untreated or inadequately treated wastewaters and the unsatisfactory performance of the Sewage Treatment Plants in handling the problem following are recommendations need to be adopted:

1. Mass awareness and public participation needs to be promoted for commissioning of Decentralized Sewage Treatment System (DSTS) by all the new housing constructions/colonies/societies.

2. Promoting DSTS for appropriate treatment, recycling, reuse or disposal of the wastewater generated by them.
3. 'Polluters Pay Principle' should be adopted for O & M of the treatment plant.
4. Reuse of treated wastewater should be encouraged for recharging the groundwater table or should be used at household level for flushing, gardening etc.
5. Resource recovery like energy should be part of technology to make the system sustainable.
6. The DSTS proposals should be cleared by the municipal and pollution control authorities who would also be responsible for monitoring after commissioning of the system.
7. Consent to establish to be made mandatory for new townships or residential colonies.
8. The government should provide immediate rebate in property/house tax for those participating in DTS in order to promote DTS.
9. STP standard i.e. reference to BOD value should be less than 5 ppm.

River bed may be used for treatment of floating matter etc.

CONCLUSION :

The deteriorated river quality of Yamuna at Delhi stretch (22km) significantly due to dumping of high organic load of sewage and industrial wastewater, found not fit to any class (A to E) of designated best use of CPCB's Water Quality Criteria.

River Yamuna requires environmental flow for pollution assimilation that's why sewage contamination seems more aggravate(significant) in Delhi stretch. However, this quantity of water for maintaining the ecological flow is really a great challenge because of other priority uses of water such as drinking and irrigation.

This paper is the part of study wherein pollution load assessment of river Yamuna was carried out and identified sewage is major contributor for contamination of river Yamuna especially at Delhi stretch (22km from Wazirabad barrage to Okhla barrage). In continuation of the study survey was conducted on adoption of upgraded technologies for treatment of sewage upto tertiary level.

ACKNOWLEDGEMENT

Authors are thankful to CPCB for providing help to carry out the study.

REFERENCES

1. Rajat Mittal and Mubeen Beg,: Morphometric Study on River Yamuna: A Review : *Journal of Civil Engineering and Environmental Technology* (2013).
2. CPCB : Ecological Characterization of the River Yamunain Tajewala to Wazirabad stretch (2006).
3. A.Upadhyay, :Water management and public participation : Case studies from river Yamuna (2013).
4. Simar Singh, September :Banega Swasth India "Why untreated sewage continues to be dumped into the Yamuna" (2017**)**.
5. Prashant, Shubham Saurab, Shubham Saxena, Shantanu Choudhary, Snehil Mishra: March : "Excruciating Pain of River Yamuna": *International Journal of Advanced Research in Science and Engineering* (2016).
6. Dr. R.C.Trivedi, Dr. S.Agrawal, 2005. Control of Urban Pollution Series: CUPS/57/2004-05, Central Pollution Control Board, *Report on Status of Sewerage and Sewage Treatment Plants in Delhi* (2004-05).
7. Taskeena Hassan*, Saltanat Parveen, Bilal Nabi Bhat and Uzma Ahmad, : *Seasonal Variations in Water Quality Parameters of River Yamuna, India* (2017).

❑