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Water quality of River Yamuna – Delhi stretch

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ABSTRACT

River Yamuna has been extensively studied with regard to physical and chemical characteristics. It originates from the Yamunotri Glacier at a height 6,387 metres. Earlier the waters of the Yamuna were distinguishable as "clear blue", as compared to the silt-laden yellow of the Ganges. However, due to high density population growth and rapid industrialization today Yamuna is one of the most polluted rivers in India, especially around New Delhi, the capital of India, which dumps about 58% of its treated or partially treated waste into the river. The paper presents pollutional aspects of river Yamuna at Delhi (Capital of India). 9 locations were selected and samples were collected on monthly basis from June 2011 to June 2012 during the entire stretch of Yamuna River in Delhi. Parameters studied were Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and pH. Results shows that despite of all efforts pollution load is still increasing making water unfit for consumption.

Keywords: Yamuna, Pollution, Biochemcal Oxygen Demand, Chemical Oxygen Demand, Dissolved Oxygen.

1. Introduction

As a part of timeless civilization, the river Yamuna, other than being a traditional water source is also a cultural icon and is worshipped as a goddess in Indian Culture. Many temple towns are situated along its bank that have their characters based on the river. The river Yamuna, a major tributary of river Ganges, originates from the Yamunotri glacier near Banderpoonch peaks in the Mussourie range of the lower Himalayas at an elevation of about 6387 meters above mean sea level in district Uttarkashi (Uttranchal). It enters Delhi near Palla village after traversing a route of about 224 Km. The river is again tapped at Wazirabad through a barrage for drinking water supply to Delhi. Generally, no water is allowed to flow beyond Wazirabad barrage in dry season, as the available water is not adequate to fulfill the demand of water supply of Delhi. Whatever water flows in the downstream of Wazirabad barrage is the untreated or partially treated domestic and industrial wastewater. After 22 km downstream of Wazirabad barrage there is another barrage, Okhla barrage, through which Yamuna water is diverted into Agra Canal for irrigation. No water is allowed to flow through barrage during dry season. Whatever water flows in the river beyond Okhla barrage is contributed through domestic and industrial wastewater generated from East Delhi, Noida and Sahibabad and joins the river through Shahdara drain (*CWC, 2009*). Based on the water

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quality, the entire Yamuna river stretches may be segregated into five distinguished stretches i.e. Himalayan stretch, upper stretch, Delhi stretch, mixed stretch and diluted stretch (*CPCB, 2006-07*). The 22-km stretch of the Yamuna, which is barely 2 per cent of the length of the river basin, continues to contribute over 80 per cent of the pollution load in the entire stretch of the river. There is also no water in the river for virtually nine months (*CSE, 2009*). Given that the waters of the Yamuna are visibly black with filth, and stinking badly, no tests are really needed to verify its quality or health. The river is a repelling sight full of foul smelling water with load of pollutants floating and gases oozing out (*Jain P., 2009*).

1.1 Sources of Pollution of River Yamuna

The main sources of pollution in NCT are

1. Increasing density of human population on the bank of river
2. Industrial wastewaters
3. Immersion of idols
4. Dumping of garbage into drains
5. Domestic sewage
6. Cattle bathing and agricultural runoffs.

1.2 Yamuna water Quality status

The criteria for a healthy river are

1. Dissolved Oxygen: At least 5 mg/l
2. Biochemical Oxygen Demand: About 3 mg/l

Indian River water qualities have been categorized in five classes as shown in table 1.

Table 1: Indian river water qualities

Designated-Best-Use	Class of water	Criteria
Drinking Water Source without conventional treatment but after disinfection	A	Total Coliforms Organism MPN/100ml shall be 0 or less pH between 6.5 and 8.5 Dissolved Oxygen : 6mg/l or more Biochemical Oxygen Demand 5 days 20°C : mg/l or less
Outdoor bathing (Organized)	B	Total Coliforms Organism MPN/100ml shall be 00 or less pH between 6.5 and 8.5 Dissolved Oxygen : 5mg/l or more Biochemical Oxygen Demand 5 days 20°C : 3mg/l or less

Drinking water source after conventional treatment and disinfection	C	Total Coliforms Organism MPN/100ml shall be 000 or less pH between 6 to 9 Dissolved Oxygen 4mg/l or more Biochemical Oxygen Demand 5 days 20°C : mg/l or less
Propagation of Wild life and Fisheries	D	pH between 6.5 to 8.5 Dissolved Oxygen : 4mg/l or more Free Ammonia (as N) : 1.2 mg/l or less
Irrigation, Industrial Cooling, Controlled Waste disposal	E	pH between 6.0 to 8.5 Electrical Conductivity at 25°C micro mhos/cm Max.2250 Sodium absorption Ratio Max. 26 Boron Max. 2mg/l Below E- Not Meeting A, B, C, D & E Criteria

With reference to the above talbe Yamuna River belongs to Class E (Mishra, 2010).

2. Material and methods

Grab sampling method was adopted and analysis was carried out as recommended by APHA (*APHA, 1995*). Samples were collected on monthly basis for a period of 13 months from June 2011 to June 2012 during the entire stretch of river Yamuna from nine different locations as shown in Fig.1 for this study.

3. Result and Discussion

The sample analysis shows the deteoration of the river at various locations. BOD is a measure of the amount of oxygen that bacteria will consume while decomposing organic matter under aerobic conditions. The variation in the water quality parameters were observed during the entire study. The BOD level in river at the studied location found exceeding the permissible limit of 2 mg/l (Table 1) except river at Palla where BOD level found normal, beyond that the BOD level starts increasing due to falling out of drains in river Yamuna. The list of 22 drains falling in Yamuna River has been listed in table 2.

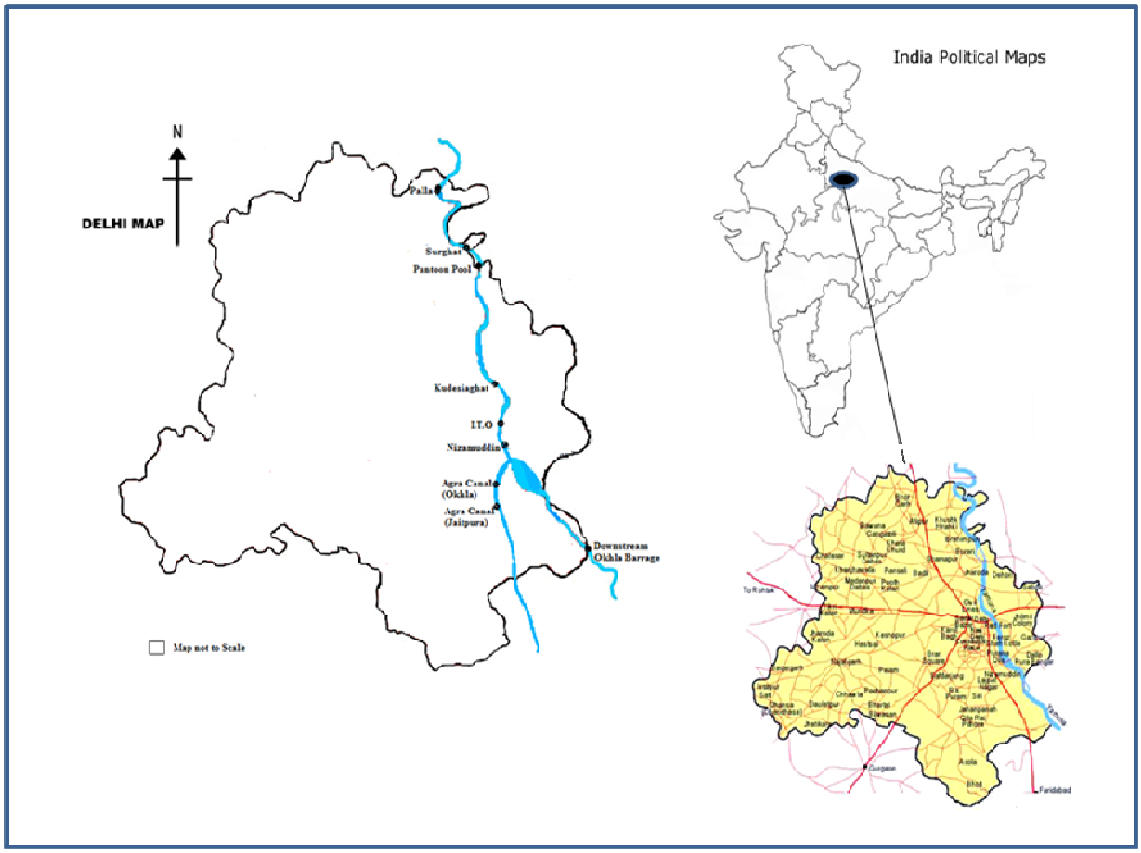

Figure1: Image showing the map of the study area

Table 2: List of drains out falling into River Yamuna (DPCC)

UPSTREAM	DOWNSTREAM
Najafgarh Drain	Barapulla Drain
Metcalfe House Drain	Maharani Bagh Drain
Khyber Pass Drain	Kalkaji Drain
Sweeper Colony Drain	Sarita Vihar Drain
Magazine Road Drain	Tekhand Drain
ISBT Drain	Tughlakabad Drain
Tonga Stand Drain	LPG Bottling Plant Drain
Civil Mill Drain	Sarita Vihar Bridge Drain
Power house Drain	Shahadra Drain
SN Home Drain	Sahibabad Drain
Drain No.14	Indrapuri Drain

BOD level was found to be highest at Pantoon Pool reaching 145mg/l in May 2012. Variation in BOD level at studied sites is shown in figure 2.

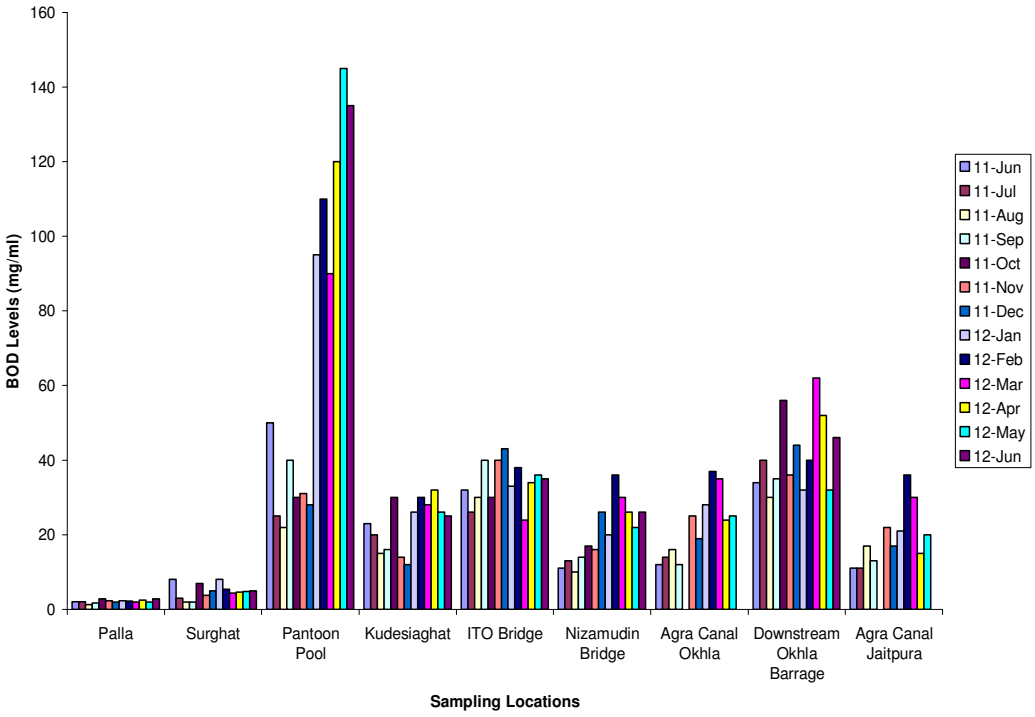

Figure 2: Longitudinal profile of BOD in Yamuna River in Delhi (DPCC)

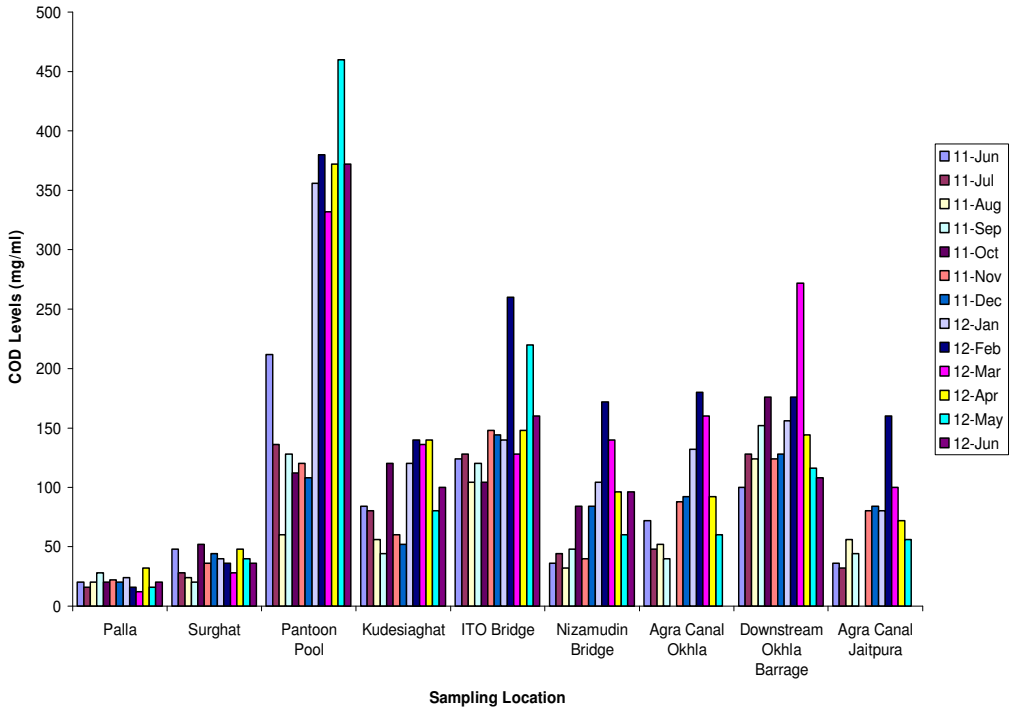

Figure 3: Longitudinal profile of COD in Yamuna River in Delhi

The Chemical Oxygen Demand is used as a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant (*APHA*, *1995*). COD test gives a relatively quick estimation as compared to the BOD test which normally takes 3 days. Increased COD level is an indicator of organic and inorganic pollution. COD levels at Palla & Surghat found to be below 50mg/l (Figure 3). Pantoon Pool shows highest COD level reaching 460 mg/l in May 2012. COD found to be exceeding the permissible limit at all the sampling locations except Palla & Surghat. Delhi for most of the year at all the studied locations sees DO levels falling to around zero except Palla & Surghat. This is true even during monsoon. This indicates a complete failure of pollution control measures. The DO levels in river at the studied locations are shown in Fig.4.

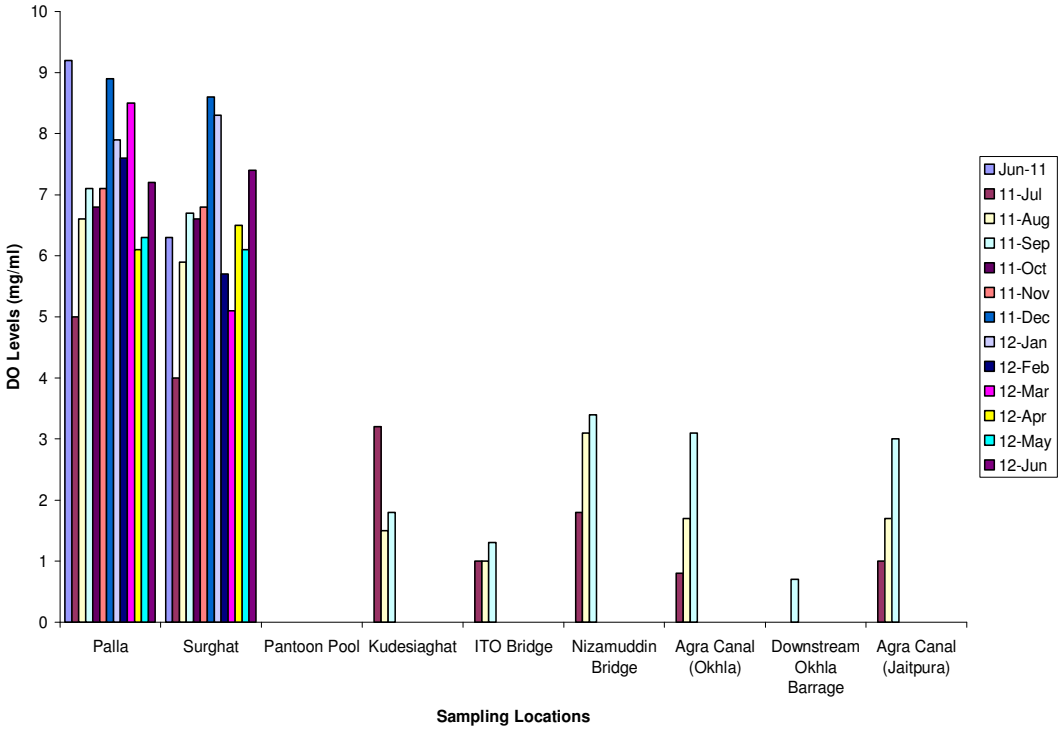

Figure 4: Longitudinal profile of DO in Yamuna River in Delhi

pH is very important parameter as rise in pH increases the solubility of toxic chemicals which can prove harmful to aquatic fauna. The natural pH range of a river is largely determined by the geology and soils of the area, for example limestone areas will result in rivers and streams having naturally higher pH levels and peat areas will have naturally low pH levels. Carbon dioxide from the atmosphere can also affect the pH of a river; when it mixes with the water it increases its acidity. Low pH levels (below optimal) can result in fish kills by stressing their systems causing physical damage, which in turn can make them more vulnerable to disease, similarly high pH particularly in combination with high water temperature, can increase the amount of unionized ammonia which is highly toxic to fish (*River H_2O* Quality Graphs. http://www.marlborough.govt.nz Environment/ Rivers-and Wetlands/River-Water-Quality /Quality.aspx). Most rivers have a neutral pH of 6.5 – 8.5 (*Kumar et al, 2010*) .pH values at Palla and Surghat ranges from 6.3 – 8.4 and 7.4 – 8.2 respectively. The pH profiles of all the locations studied were shown in table 3.

Table 3: pH profile of Yamuna River at Delhi

Sampling Locations	2011							2012					
	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
Palla	8.1	8.2	8.1	7.8	7.6	7.6	8.6	7.7	8.4	8.1	8.3	6.3	7.4
Surghat	7.4	8.1	8	8.1	7.6	7.5	8.7	8	9	7.8	7.8	8	8.2
Pantoon Pool	7.8	7.4	7.5	7.5	8	8	7.9	7.6	7.6	7.5	8.1	7.9	7.9
Kudesiaghat	8	7.5	7.8	7.8	7.4	7.4	7.8	7.9	7.6	7.5	8.2	7.8	7.8
ITO Bridge	7.3	7.4	7.6	7.6	7	7.2	7.7	8.4	7.5	7.6	8.2	7.2	7.8
Nizamuddn Bridge	7.7	8	7.7	7.6	7.1	7.1	7.7	7.7	7.7	7.7	8.2	7.6	7.9
Agra Canal Okhla	7.6	7.2	8.1	8.1	No Flow	8	7.9	7.6	7.6	7.9	8	7.9	No Flow
D/S Okhla Barrage	7.7	7.5	7.4	7.7	7.6	7.8	7.7	7.6	7.6	7.9	8.2	7.8	7.9
Agra Canal Jaitpura	7.9	7.1	8.1	8	No Flow	7.9	7.9	7.8	7.7	8	7.9	8	No Flow

4. Conclusion

The present study on nine different sampling locations in Delhi represents that despite of the continuous efforts to minimize the pollution; pollution load is increasing which is deteriorating the water quality of river Yamuna. Domestic wastewater, agricultural runoffs, mass bathing, offering of religious materials, clay idols, etc. increases the pollution in water. Due to presence of large number of towns and cities along the bank of the river Yamuna which uses the river for dumping of wastes makes the condition of the river even worst. Now it has become imperative to identify viable remedial methods for cleaning the river Yamuna. For this we need to develop awareness among people regarding the consequences of river pollution. People should be taught various methods to reduce increasing pollution load. In Delhi, state government has formed 10 feet high wire barricades along all Yamuna bridge under the Yamuna Action Plan 1 with signboard messages to prevent people from tossing things into the Yamuna. NGO's print Media and electronic media can be used for creating awareness among the masses.

Few methods that can prevent deterioration of water quality include

1. Wastewater can be recycled through effective technologies and can be reused for various purposes.
2. Improvement in sewage system can prevent the seepage of sewerage water into rivers.
3. Farmers should use bio-fertilizers instead of fertilizers and pesticides.
4. Efforts should be made to prevent the loss of plantation along the banks of the river as it will help in preventing soil erosion.
5. Formulation of strict rules and regulations and their effective implementation to control the pollution in river.

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