Yamuna River Water Pollution-A Review

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Abstract:
This paper reviews the impact of industrial pollution on Yamuna River based on studies over the past few years. It Engenders from Yamunotri glaciers in the lower Himalayas at an elevation of approximately 6387 meters. River can be divided into five segments on the foundation of hydrological and ecological situation. The river is contaminated by both point and non-point sources, where National Capital Territory (NCT) – Delhi is the main Helper, followed by Agra and Mathura. The Delhi segment is the most polluted as the river gets severely affected by the impediments of industrialization, urbanization and agricultural advances. In addition to municipal sewage, a large number of diverse industries like pulp and paper, steel plants, chemicals, rubber, sugar, tannery, glass, engineering, plastics, and food processing directly Release their wastes into it. There 22 industrial units in Haryana, 42 units in Delhi and 17 units in Uttar Pradesh which were found to be directly discharging and polluting the Yamuna River. This is due to discharge of environmental pollutants or effluents into water bodies without treatment. Water pollution affects the whole biosphere, including not only the individual species but also their natural biological denomination. It results in the death of much of the aquatic life inhabitant inside the defective water body. Pollution levels in the Yamuna River have arise. Average Biochemical Oxygen Demand (BOD) and Dissolved Oxygen (DO) levels at this point are 1.2 mg/l and 11.7 mg/l respectively. In order to restore the quality of river, the Government of India (GOI) initiated the Yamuna Action Plan (YAP) in the 1993 and later YAPII in the year 2004 and YAPIII (CPCB, 2006-07).

Keywords: Yamuna River, water quality, Dissolved Oxygen, BOD, COD, Organic Matter, Industrialization, Water pollution, Himalayan Segment, Delhi Segment, Treatment, Aquatic life, India.

I. INTRODUCTION

1. The Yamuna River:

The River Yamuna is the largest influent of river Ganga, originates from the Yamunotri glacier, in the Himalayan Mountains. 6387m above mean sea level (msl), at the Banderpooch peak in the Uttarkashi district in the Himalaya of Uttarakhand. The catchment of the river extends to states of Uttar Pradesh, Himachal Pradesh, Haryana, Rajasthan and Madhya Pradesh and the entire union territory of Delhi. Engender from Himalayas its total length is 1,376 km covering a catchment area of 366, 220 km² (Fig. 2). The main tributaries joining the river include Hindon, Chambal, Sind, Betwa and Ken (Jain et al., 2004). The annual flow of the river is about 10,000 cumecs. The annual usage is 4400 cumecs, irrigation accounting for 96% of this (MoEF, 1994). It is not just like another river but it has a major religious and cultural significance.

The river not only provides a livelihood for denomination living in the basin but also offers a life support to agricultural, industrial and urban sectors and is the main source of drinking water for most of the towns along its course. More than 70% of drinking water supply of Delhi is abstracted from river Yamuna (CPCB, 1996., Upadhyay et al., 2010). An estimated 57 million people are dependent on the water of the Yamuna River.

In view of the rapid development of urban population, industrialization and inadequate infrastructure, the river water quality across the country has been found to be deteriorating alarmingly. The industrial towns all along the river, discharges significant amounts of wastes into the river. In lower stretch, the Yamuna becomes a drain, receiving mainly agriculture, industrial and domestic effluents (Ali et al., 2001) According to CPCB (2000) there were approximately 359 industrial units out of which 22 industrial units in Haryana, 42 units in Delhi and 17 units in Uttar Pradesh which were found to be directly discharging and polluting the river. These industries include paper, sugar, chemical, leather, distillery, pharmaceuticals, power etc. It has several large and industrial cities on its banks like Yamunanagar, Sonepat, Panipat, Delhi, Agra and Mathura (Fig. 1).

The categories of industries discharging wastewater into Yamuna river includes Pulp & paper, Sugar, tannery, steel plants Distilleries, Textiles, Leather, Chemical, Pharmaceuticals, rubber, glass, Oil Refineries, Thermal Power Plants, food etc. (CPCB, 2006).

Due to extensive anthropogenic pressure the river Yamuna is rapidly deteriorating into a sewage drain. Delhi alone discharges its treated and untreated domestic and industrial wastes through small or large drains. 95% of the Yamuna pollution at Delhi is resulted due to discharge of wastewaters through seven major drains viz; Najafgarh, Yamunapur, Sen Nursing Home, Barathpula, Maharani Bag, Kalkaji and Tuglakabad. In Delhi the Yamuna River is so polluted that beyond Okhala, it hardly supports any form of life. Not only the organic matter and nutrients, but several pesticides and heavy metals have also been found at alarming level in the river (Aggrawal, 1993).
II. SEGMENTS

Table 1. Major Water Quality Levels and Segments of the Yamuna River

<table>
<thead>
<tr>
<th>No.</th>
<th>Segment</th>
<th>Reach</th>
<th>Length (Km)</th>
<th>Water Quality Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Himalayan Segment</td>
<td>From origin to Tajewala Barrage</td>
<td>172km</td>
<td>BOD (0.3 mg/L), COD, TDS and DO (6-10 mg/L) &amp; more or less no pollutants.</td>
</tr>
<tr>
<td>2</td>
<td>The Upper Segment</td>
<td>From Tajewala Barrage to Wazirabad Barrage</td>
<td>224Km</td>
<td>BOD (1-3 mg/L), COD and DO (10-7 mg/L).</td>
</tr>
<tr>
<td>3</td>
<td>The Delhi Segment</td>
<td>Wazirabad Barrage to Okhla Barrage</td>
<td>22Km</td>
<td>BOD (3-25 mg/L), COD and DO (7-1 mg/L) values of the river water are seriously bad.</td>
</tr>
<tr>
<td>4</td>
<td>The Eutrophicated Segment</td>
<td>Okhla Barrage to Chambal Confluence</td>
<td>490km</td>
<td>BOD: 18-6 mg/L, DO: 1-12 mg/L.</td>
</tr>
<tr>
<td>5</td>
<td>The Diluted Segment</td>
<td>Chambal Confluence to The Ganga Confluence</td>
<td>468Km</td>
<td>BOD: 13-1 mg/L, DO: 11-7 mg/L.</td>
</tr>
</tbody>
</table>

Source: CPCB 2009

1. The Delhi Yamuna Water Statement
The Delhi Segment is the poorest segment of all in the entire journey of Yamuna which contributes in making the river “the second most polluted river of India”. This can be seen from the following table prepared by the Yamuna Action Plan:

Table 2.

<table>
<thead>
<tr>
<th>Sewage Generated</th>
<th>Total Sewage (L)</th>
<th>Sewage Treated (L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily</td>
<td>2871 million</td>
<td>1478</td>
</tr>
<tr>
<td>TDS</td>
<td>Quantity (mg/L)</td>
<td>Permissible Limit (mg/L)</td>
</tr>
<tr>
<td>1000-10,000</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>BOD</td>
<td>Quantity (mg/L)</td>
<td>Permissible LIMIT (mg/L)</td>
</tr>
<tr>
<td>15-30</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>COD</td>
<td>Quantity (mg/L)</td>
<td>Permissible Limit (mg/L)</td>
</tr>
<tr>
<td>3-155</td>
<td>1-50</td>
<td></td>
</tr>
<tr>
<td>Coliform Level</td>
<td>Quantity (mg/L)</td>
<td>Permissible Limit (mg/L)</td>
</tr>
<tr>
<td>11.8 Crore per 100 ml of water</td>
<td>5000 per 100 ml of water</td>
<td></td>
</tr>
<tr>
<td>DO</td>
<td>Quantity (mg/L)</td>
<td>Permissible Limit (mg/L)</td>
</tr>
<tr>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Required Drinking Water</td>
<td>Total Required (curses)</td>
<td>Available Quantity (curses)</td>
</tr>
<tr>
<td>1480</td>
<td>1221</td>
<td></td>
</tr>
<tr>
<td>Forest Cover</td>
<td>Existing (%)</td>
<td>Required (%)</td>
</tr>
<tr>
<td>24.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
III. REVIEW OF THE LITERATURE

1. It is widely observed that population pressure contributes to the dilapidation and depletion of important natural resources in developing countries. Growing rural populations and rising subsistence demands have resulted in the decline of ecosystems.
2. According to ecologists, the acute resource scarcities faced in the developing countries today is because people in world’s poorest regions face acute scarcities relative to their numbers that they are so poor. On the contrary, economists believe, people there experience scarcities, because they are poor. A natural response to the former by the latter is that people come first and therefore current poverty should matter the most. However there are two problems with the above made statement. First, future will eventually become the present. Secondly, extreme poverty is frequently associated with a degraded environment.
3. But, in developing countries, the negative part of the link seems to be applicable. The reasons for degradation of water quality, in this case ranging from, the ever increasing population, and industrialisation to institutional failure.
4. Since 1994 in India, enormous quantities of polluted water have continued to flow in or around urban settlements. It is also influenced by the problems imparted by industrialization, urbanization and rapid agricultural developments similar to other riverine system. The Third World Centre for Water Management has estimated that less than 10 per cent of wastewater generated in the country is now properly collected, properly treated and then discharged to rivers and lakes in an environmentally safe manner (Report on government of NCT of Delhi, 2005).
5. One such river is Yamuna, one of the major freshwater sources of India. The total length of Yamuna from its origin near Yamunotri to its confluence with Ganga River at Allahabad is 1376 kilometre and the total basin area of the river accounting to 366223 km sq., which covers part of geographical area in the states of Uttaranchal, Uttar Pradesh, Himachal Pradesh, Haryana, Rajasthan, and Madhya Pradesh & NCT – Delhi. These urban centres draw fresh river water for various activities. In return, almost the entire wastewater generated by these centres is disposed into the river. This is one of the prime reasons for dilapidation of Yamuna River water quality from urban agglomeration of Delhi up to Chambal River confluence (CPCB report, November 2006).
6. About 85% of the total pollution in the river is contributed by domestic sources. The domestic pollution is the major source of pollution in Yamuna River, mainly caused by the urban centres. The intensity of impact of domestic pollution on river therefore depends on the efficiency of the wastewater digest system, type and length of the waste transportation system. If wastewater gets more retention time within urban premises before reaching to receiving water bodies, in such case the pollution load will reduce due to biodegradation and settling. In addition, there are numerous unauthorized colonies which exist in various urban centres. Due to non-availability of sewerage system in these colonies, the night soil is collected, transported and dumped either in drains, tributaries or directly into river without any treatment.
7. The condition of river deteriorates further due to the abstraction of significant amount of river water (for domestic and irrigation purposes, both amounting to nearly 92 per cent of the river water), leaving almost no fresh water in the river, which is essential to maintain the assimilation capacity of the river. (CPCB report, November 2006)
8. To keep up with the tide of the times, and prevent further degradation of water quality, the Government of India (GoI) decided to take up water quality restoration measures named as Yamuna Action Plan (YAP) under the mega project of the Ganga Action Plan (GAP) phase – II.
9. A lot of studies have empirically analysed the link between water quality (taken as a measure of environmental degradation), population, industrialization and institutions. Even though, Goldar and Banerjee (2004) have attempted to assess the impact of informal regulation of water pollution on water quality in Indian rivers and for this purpose, an Ordered Probit Model is estimated for 106 monitoring points on 10 important rivers for five years, 19951999. But, none of the studies have so far attempted to study this link using a simultaneous equation modelling (SEM), especially in the case of Yamuna. This study effort to do so, for 9 districts on 1 important river, Yamuna for 3 years, 2001, 2006 and 2010.

IV. POLLUTION IN THE YAMUNA RIVER AND ITS MAJOR SOURCES

The Yamuna River is one of the most contaminated rivers of India (CPCB 2010; Misra, A.K.,2010). Untreated or partially treated domestic sewage, industrial effluents and agricultural effluents are the major contributors of pollution in the river. The cities alongside the Yamuna River release loads of contaminants in it. Due to its religious, cultural, social and economic significance the Yamuna River flows in the hearts of many Indians, but unfortunately like many other riverine systems of the country, it too is affected by the setbacks of industrialization, urbanization and rapid agricultural developments (Maheshwari et al., 2011). In his study C.K. Jain (2004) reported that due to industrialisation in the towns along the Yamuna River basin, all the industrial effluent find its way into it. He also reported that the tributaries of the Yamuna River also transferred their pollution load into it. Water is consumed for different activities which generate a lot of wastewater causing dilapidation of water quality of Yamuna River. Various point and non-point sources contribute to the contamination of the Yamuna River.

Point sources
Point sources are organized sources of pollution with measurable pollution load (CPCB 2008). These sources include surface drains carrying municipal sewage or industrial wastes; sewage pumping stations etc.

Domestic pollution
Domestic pollution accounts for 85% of the pollution in the Yamuna River and is sourced to the major cities along the river (CPCB 2010). These cities include Delhi, Ghaziabad, Mathura-Vrindavan, Agra, Etawah, Panipat, Sonepat and Allahabad. The domestic waste majorly comprises of organic matter and microorganisms, salts, detergents, nutrients, oil and grease and others.

Industrial pollution
A number of towns along the Yamuna River have numerous industries that discharge their waste water into the Yamuna. According to the CPCB (2009) report, the industries include
textile, chemical, sugar, paper and pulp, Leather, thermal power, fertilizers, pharmaceuticals, oil refineries, food industries, etc. were set up in many cities in the Yamuna basin. Many of these have poor environment management systems and discharge untreated or partially treated waste water containing toxic and organic effluents into the river, thus contributing to the degradation of water quality.

Non-point sources
Non-point sources are the numerous diffused and unspecified sources of pollution and are non-measurable as the amount of pollution generated by each source is less. These include the organic matter, residues of plants, topsoil, microbes, toxicants etc. (CPCB 2009). Such sources are influenced by the land-use patterns in the overall watershed and include sources from both, the natural processes and the anthropogenic inputs (Ritchie, Zimba and Everitt, 2003). The chief non-point pollution sources are: Agricultural runoffs, Dumping of solid waste, dead bodies, animal carcasses etc. Immersion of idols made of Plaster of Paris, ashes and floral offerings, Pollution due to in-stream use of water, such as bathing, washing, cattle wading and open defecation.

V. STRATEGIES AND POLICIES TO REDUCE POLLUTION

1. Proper Management and Treatment Procedures Delhi has 17 drains discharging all the sewage directly into the river. Delhi has 6 Water treatment plants around its territory with different capacities as:

<table>
<thead>
<tr>
<th>Water Treatment Plant</th>
<th>Capacity(MGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chandrawal (Northeast Delhi)</td>
<td>103</td>
</tr>
<tr>
<td>Wazirabad (North Delhi)</td>
<td>132</td>
</tr>
<tr>
<td>Haiderpur I &amp; II(Northwest &amp; South Delhi)</td>
<td>225</td>
</tr>
<tr>
<td>Nangloi I &amp; II(South &amp; West Delhi)</td>
<td>40</td>
</tr>
<tr>
<td>Bhagirathi(East Delhi)</td>
<td>105</td>
</tr>
<tr>
<td>Sonia Vihar (East Delhi)</td>
<td>140</td>
</tr>
</tbody>
</table>

As per the report of Delhi Jal Board (DJB) in 2010, the treatment plants aren’t fully used to their capacities. Also, some machines used are very old. DJB should make plans making the system more efficient by using the plants to their optimum capacity, build new plants, develop or import new treatment technology. Along with that, smaller units can be set up along the 17 drains to reduce the discharge near the spot only specially the Najafgarh Drain, which passes from North-west to North Delhi.

2. Checking on Agricultural and Industrial Waste Different bodies like the Ministry of Water and Sanitation, Government of Delhi should adopt some measures to check on the increasing pollution by industries and agriculture fields. Proper disposal techniques should be thought of and implemented.

3. Laws and Legislation As per the new law policy of the Government of Delhi, headed under Chief Minister Mr. Arvind Kejriwal, barriers and embankments have been placed or imposed on bridges and banks along Yamuna to reduce the dumping of waste directly into the river. Special fines and penalties have been decided and implemented for such activities. Along with that on auspicious occasions like Ganesh Visarjan, Chatth Puja, Diwali, etc special provisions are made to prevent the river from pollution as now only biodegradable effigies can be dumped in the river. Policemen and guards are kept on duty to check this and other unwanted activities.

Along with this, the Central Government has set a special drive to clean Yamuna and other rivers. This is regarding the waterway policy introduced by Mr. Nitin Gadkari, Minister of roads and transportation, in the year 2016 with the first one being between Delhi and Agra.

a) FUTURE NEEDS:
As per directions by the Hon’ble Supreme Court of India, minimum water flow of 10 m3/sec should be maintained throughout River Yamuna (Paliwal et al., 2007). The standard given by (CPCB) for discharge of treated effluent into water body in terms of BOD and COD are 30 mg/l and 250 mg/l respectively. After spending Rs. 1187.54 – 1443.84 cr (CSE, 2005) in YAP the BOD load from the NCT has increased from 117 tons/day in 1982, 211 tons/day in 1998 (CPCB, 1999-2000), 231.2 tons/day in 2003 (CPCB, 2003) to 260 tons/day in 2004 (CPCB, 2004). Thus to maintain the water quality of river within the stipulated criteria of bathing class B, nearly 10 times dilution of the fully treated municipal wastewater is required. For controlling industrial pollution in River Yamuna some preventive measures are given below:

- Industries should have effluent treatment plants so that industrial wastes do not find the way to river without treatment. There should be regulatory guidelines for operation and maintenance of ETPs.
- Treated and untreated effluent should be separated, and recycling and reuse of treated waste water should be encouraged.
- Systems and procedures need to be strengthened to ensure accurate measurement of both the quantity of treated effluent being discharged as well as its quality with reference to the prescribed parameters.
- Prevention of Yamuna River pollution cannot be achieved without people's participation. Therefore it's important to create awareness among the people regarding the way river pollution is occurring and its related consequences. People should be taught various means to be adopted to reduce the increasing pollution levels in the river.
- Steps should be taken from not putting the industrial waste into the river as most of the industries are on the banks of Yamuna.
- A water abstraction control policy is required to check and control over maximum and wasteful use of river water in industries.
- Water conservation practices through information, education and communication should be implemented with the help of community participation. In order for investments under YAP- I, YAP-II to be effective for the pollution control of Yamuna.
River, industrial effluents should be controlled according to the relevant effluent standards established by CPCB.

1. Afforestation As per the Delhi Master Plan 2021, to develop a world-class city, by Delhi Development Authority, the cleanliness of Yamuna is important. Funds are raised for new projects to be undertaken for the protection of the rivers such as afforestation, tourism and recreational activities.

2. Awareness Through Mass Media Along with that a separate Mission „Nirmal Yamuna” (NYM) has been initiated under which plans to make Yamuna clean and healthy by 2019. Under this, a program me named “YAMUNA AARTI” is organized every evening at Qudsiaghat to aware people about Yamuna’s importance and lost treasures and making them realized about the river. No diyas, garlands are allowed to be dumped in the river at the time of AARTI which is not the case in GANGA AARTI in Varanasi, Haridwar and Rishikesh. This is done to reduce the floating waste in the river. The government has also taken help from different NGOs for spreading awareness among people and raising funds. Fund are also provided under the Swatchch Bharat Mission (SWA, a Central Government initiative for a clean and healthy India) Special toilets are decided to be built under SWA and NYM so as to prevent defecation in the river.

VI. CONCLUSION

The pollution study of Yamuna shows us the truth about how it has been neglected over the years. Delhi, the capital of the country, boasts to be a developed or a high-tech city but we have seen the horrible conditions of Yamuna there by the water analysis. The various reasons have been discussed above and the various measures and policies have also been mentioned. But nothing is going to change if we do not change. The careful, diligent control of discharges to rivers will go a long way towards restoring and preserving the good quality of water. The blame game can no longer be played & individual steps need to be taken for the good future of Yamuna. If Yamuna has a good future, then our future generations will have a good & prosperous world.

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