



Research Paper

WATER QUALITY STATUS OF RIVER YAMUNA IN DELHI WITH REFERENCE TO PRESENCE OF HEAVY METALS: A REVIEW

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Yamuna is the major tributary of River Ganges serving almost 57 million people across its travelling length in India. Apart from being mythologically associated with the Hindus, it caters to diverse needs of the people across such as power generation, domestic water supply, irrigation, fish farming and more. With such great dependence on its waters, the after effects are many. Increasing pollution of the river has been alarming since quite a long time in India. Over the last few years, the water quality of Yamuna has deteriorated despite huge expenditure and efforts put by the government. One of the potent effects of the polluted water is occurrence of heavy metals. Which are harmful and toxic at high concentrations affecting aquatic animals as well as human life. The article reviews the present status of Yamuna and describes the major studies across this topic. Emphasis has been laid on the waters entering Delhi region and the control exerted by the Government. The water quality of Yamuna at the point of its entry into Delhi fits to water quality standards in terms of Dissolved Oxygen (DO) and Bio-chemical Oxygen Demand (BOD). However, during its exit, the water quality becomes unfit for any purpose.

Keywords: Dissolved oxygen (DO), Biochemical Oxygen Demand (BOD), Yamuna River, Heavy Metals

INTRODUCTION

River Yamuna originates from Yamunotri glacier in Himalayas and is the largest tributary of River Ganges in India. Of its total travelling length of about 1380 km, it crosses many states such as Himachal Pradesh, Uttar Pradesh, Uttarakhand, Haryana and Delhi. Almost 57 million people depend on this river for various needs. Mythologically, Yamuna has a great significance

as far as Indian population is concerned. In Hindu Mythology, it is worshipped as goddess Yamuna and it is believed that bathing in waters of Yamuna eradicates all the sins. Table 1 shows the area covered by Yamuna in various states. The total catchment basin of the Yamuna River is 3,66,223 sq.km which is 42.5% of the Total Ganga basin area and around 11% of the total landmass of the country.

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Table 1: Catchment Area of River Yamuna

Name of the State	Total Catchment Area in Yamuna (sq.km)
UP (including Uttaranchal)	74208
Himachal Pradesh	5799
Haryana	21265
Rajasthan	102883
Madhya Pradesh	14028
Delhi	1485
Source: CWC	

USES OF YAMUNA WATER

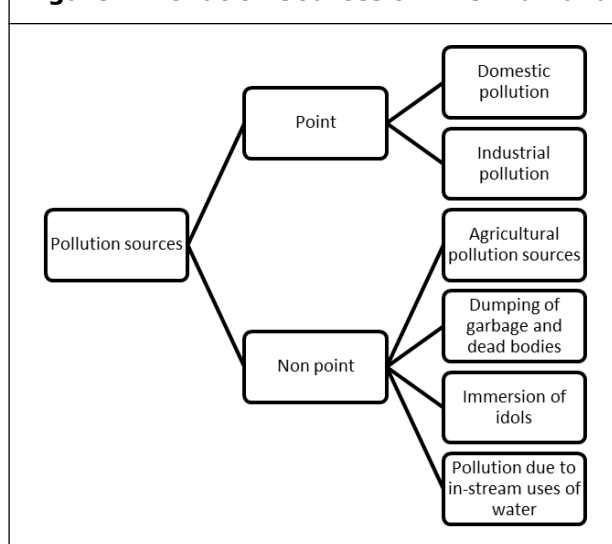
Even today, water stands as one of the most essential requirements of life. We cannot think our livelihood without water. Yamuna waters contribute a lot to sustaining our lives in every manner. Some of the uses of its waters are as follows:

- Areas like Delhi, Mathura, Agra and Allahabad use the Yamuna water for domestic water supplies. In Delhi, at a specific location i.e. Wazirabad, the entire water is diverted specifically for domestic supplies.
- Almost 93% of Yamuna water is used for the purpose of irrigation with the help of four irrigation canals which are Western Yamuna canal, Eastern Yamuna canal, Agra canal & Gurgaon canal.
- The Yamuna basin also has huge potential to generate hydropower & currently almost 400 MW of hydropower is being channeled through this basin.
- River Yamuna provides a large scope of farming for fish and other aquatic animals.
- Waters of Yamuna are also used for bathing as depicted by Hindu mythology and also for

washing clothes and utensils by nearby community.

- Moreover, it is estimated that about 70% of the total cattle population in the Yamuna basin uses flowing water of river and canals for bathing.

With such a high dependence on its waters, this river surely is one of the biggest areas of concern as far as environmental impacts are concerned. The river is one of the most polluted rivers in the world. Figure 1 shows the pollution sources.

Figure 1: Pollution Sources of River Yamuna

WATER QUALITY OF RIVER YAMUNA

Water quality of a river is assessed and categorized with reference to its use:

- Raw water fit for drinking purposes
- Raw water fit for bathing purposes
- Raw water fit for agricultural use

The categorization of water for its different uses is based on three parameters

- Dissolved Oxygen (DO)

b) Bio-Chemical Oxygen Demand (BOD)

c) Total Coli form (TC)

Under the Water (Prevention and Control of Pollution) Act, 1974, the Central Government constituted the Central Pollution Control Board (CPCB) and the State Government constituted similar State Pollution Control Boards (SPCB). In Delhi, the executing agency delegated for the construction and maintenance of sewage treatment plants, sewage pumping stations and trunk sewers and for treatment of domestic sewage is the Delhi Jal Board (DJB).

THE SEWAGE SYSTEM IN DELHI

The DJB has 30 STPs at 17 locations in the NCT of Delhi and 5600 kms long sewerage lines. This includes 28 main trunk sewers of a total length of 130km. For sewage management, Delhi is divided into five drainage zones of Okhla, Keshopur, Rithala-Rohini, Coronation and Shahdara. Also, there are newly sewered areas of Pappan Kalan (Dwarka), Vasant Kunj, Sarita Vihar and Narela. (Measures to Control Water Pollution in River Yamuna in Delhi, 2005).

The main source of pollution of the river Yamuna is the domestic and industrial sewage generated within the National Capital Territory (NCT) of Delhi. Despite over ten years of efforts on formation of sewage treatment infrastructure,

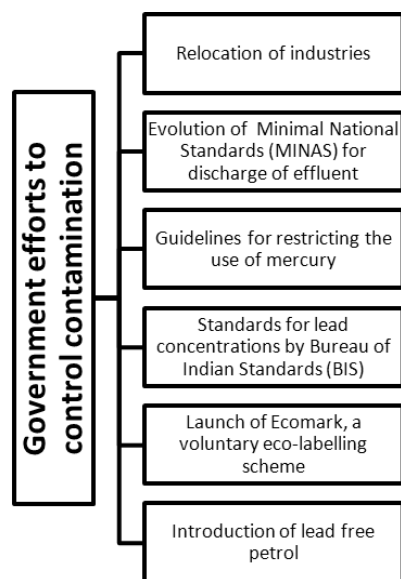
the quality of water at the point where the river leaves Delhi has extremely deteriorated with large quantities of untreated sewage falling into the river. The water quality of Yamuna at the point of its entry into Delhi fits to water quality standards in terms of Dissolved Oxygen (DO) and Bio-chemical Oxygen Demand (BOD). However, at the point of its exit from Delhi, the water quality of the river is unfit for any purpose.

THE IMPACT

Over the last few years, the water quality of Yamuna has deteriorated despite huge expenditure and efforts put by the government. There has been a substantial decline observed in the BOD and DO parameters as well as the Coli form count, which has also deteriorated exponentially. According to the report, published by RITES in 2004, free ammonia which is toxic to fish and micro-organisms was present far above the acceptable levels. The concentration of heavy metals like copper, lead, nickel, zinc and mercury were far in excess of the limits prescribed by the Environment Pollution Act. Also, by the time Yamuna leaves Delhi at Okhla, the water wanes far below the 'bathing standards' and is considered practically unfit for any use. Another effect was observed in sickness of soil where the capacity of the soil to retain oxygen required for biological decomposition is reduced

Table 2: Parameter of Water Quality for Bathing Standard

Parameter	Prescribed standard
Dissolved Oxygen (DO)	Not less than 5 mg per liter
Bio Chemical Oxygen Demand (BOD)	Not more than 3 mg per liter
Total Coli form (TC)	Not more than 500 per 100 ml
Source: Report on Government of NCT of Delhi of 2005	

Figure 2: Government Efforts to Control Contamination

Source: TERI

hindering decomposition of organic matter. Presence of heavy metals has also had a huge impact on the vegetables cultivated in the particular area. Vegetables grown in areas like Yamuna Pushta, Okhla, Najafgarh, etc. were found to have a significantly higher level of contamination of zinc, lead and cadmium.

ROLE OF HEAVY METALS

In simple words, heavy metals are chemical elements that have high density and are toxic at some specific concentrations. They are capable of entering our bodies via food, water or air. Their toxicity can be justified by a phenomenon known as bioaccumulation. These heavy metals tend to accumulate inside the human body and they are stored faster than they are broken down. Living organisms require different amounts of heavy metals. For e.g.: Fe, Cu, Mn, Mg, Mb, Zn are required by humans. However, high levels of such metals are damaging to the organism. On the contrary, heavy metals such as Hg and Pb are

the ones that have no known benefits on humans and their accumulation leads to major ailments.

As described above, heavy metals are toxic to the human body at certain concentrations. Therefore, they have huge impacts as far as humans are concerned. These heavy metals are required in trace amounts by our body, but as their concentration increases, the toxicity associated with them also increases. These heavy metals affect humans by upsetting our cellular enzymes. They tend to remove the nutrients and bind their receptor sites. This in turn has huge effect on our nerves, digestion, hormones and our immune function. They also lead to decline in mental and cognitive health of a person.

PRESENCE OF HEAVY METALS IN YAMUNA

Till date, numerous studies have been conducted for testing the presence of heavy metals in river Yamuna. This review article will summarize few of the studies to give an idea in totality about the heavy metals in Yamuna waters and their potent effects.

In a study for determination of heavy metals in fish species (Sen *et al.*, 2011), characterization of heavy metals in fish elucidated that the concentrations of Ca, K, Mg, Na and P were too high as compared with other metal and were not in the maximum permissible level set by World Health Organization (WHO). As a result of ecological stress created by humans on the aquatic environment, the pollution levels have significantly increased. Industrial discharge, release of organic material into water, house waste etc. have caused a reduction in oxygen level and are a major reason for eutrophication. Consequently, high algal growth leads to depletion

or killing of fish in the water. As a major component of sea food, fish serve to be an important part of human diet and consequently, studies on elucidating the presence of heavy metals holds a lot of importance.

Another research conducted by TERI (Yamuna, the poisoned river, 2012), showed moderate levels of toxic metals in the water at several locations. The samples were taken across various locations around Yamuna in Delhi and Haryana. The study also emphasized on the effect of heavy metals on the vegetables growing on the river banks as well as on the population dependent on river water.

The Central Pollution Control Board (CPCB) of Ministry of Environment and Forests also conducted a long term study (Water Quality Status of Yamuna River, 2006) from 1999-2005 focusing on in depth analysis of river Yamuna, its pollution sources, findings between 1999-2005 by CPCB, bacteriological contamination, effect of micro pollutants and BOD load. The report also suggested significant steps to be taken for abatement of pollution in Yamuna. The suggestions were summarized Figure 3.

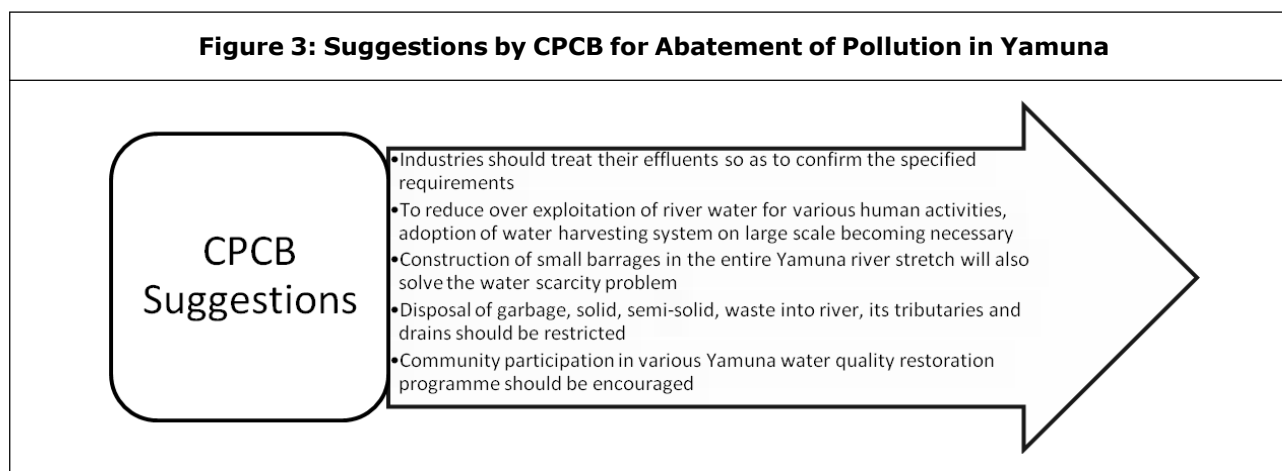
Another study (Sehgal *et al.*, 2012) focused exclusively on Heavy metal contamination in the Delhi segment of Yamuna basin. Starting from Wazirabad barrage till the Okhla barrage, 13 sites were chosen and concentration of heavy metals in water as well as soil was reported across. Key findings of the study were:

- Average heavy metal concentration at different locations in the river water varied in the order of Fe>Cr>Mn>Zn>Pb>Cu>Ni>Hg>As>Cd
- The average heavy metal concentration at different locations in soil varied in the order of Fe>Mn>Zn>Cr>Pb>Ni>Hg>Cu>As>Cd

CONCLUSION

Tremendous efforts have been put up by the Indian Government to prevent alarming levels of pollution in the river Yamuna. Despite such efforts, the pollution is increasing drastically and is affecting life, cattle and aquatic species. The main source of pollution of the river Yamuna is the domestic and industrial sewage due to which the quality of water at the point where the river leaves Delhi has worsened. The water quality of the river is unfit for any purpose.

Figure 3: Suggestions by CPCB for Abatement of Pollution in Yamuna



The long term consequences of high pollutions levels are significant and are not limited to humans. The heavy metals tend to bioaccumulate in the body of humans as well as fish. The effects are seen on our nervous system, digestive system, endocrine system and immune function. Following the CPCB suggestions could help us prevent the pollution. This is important as Yamuna is a national concern.

We do suggest some preventive measures recommended by TERI (Yamuna, the poisoned river, 2012), for the abatement of Yamuna pollution. To monitor the levels of heavy metals, a set of guideline values and regulations must be developed. These shall ensure monitoring of heavy metals in soil, water, and farm yield. The population staying beside the river banks shall be paid attention to by regular bio monitoring. The government should be involved in developing technologies which aim at reduction in release of heavy metal. Lastly, efforts should also be made on increasing awareness in people on effects of

obstinate pollutants on our environment as well as human life.

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