Journal of Advances in Science and Technology

Vol. VII, Issue No. XIII, May-2014, ISSN 2230-9659

AN ANALYSIS OF WATER QUALITY EVALUATION OF RIVER YAMUNA, WITH RESPECT TO PRIMARY AND BIOLOGICAL WATER QUALITY CRITERIA

AN INTERNATIONALLY INDEXED PEER REVIEWED & REFEREED JOURNAL

www.ignited.in

Journal of Advances in Science and Technology
Vol. VII, Issue No. XIII, May-2014, ISSN 2230-9659

An Analysis of Water Quality Evaluation of River Yamuna, With Respect To Primary and Biological Water Quality Criteria

Charu Vashishtha

Research Scholar, Sainath University, Ranchi, Jharkhand

Abstract – Clean to slight pollution in biological water quality was observed in River Yamuna at Yamunotri and Hanuman chetti, in terms Biological Water Quality Criteria. River Yamuna was moderately polluted from Okhla Barrage to Allahabad throughout the year. At Etawah, the water quality became severely polluted during summer season. Water quality of River Yamuna at Yamunotri, meets the Primary Water Quality Criteria in terms of pH of 8.1, DO of 7.8 mg/l, BOD of <2 mg/l and Total Coliform count of <2 MPN/100 ml used for drinking water without conventional treatment but after disinfection Class A and Outdoor bathing Class B and Class 'C' and drinking water source after conventional treatment. Average Total Coliform counts of 24775 – 66357500 MPN/100 ml did not meet the criteria of Total Coliform counts of 5000 MPN/100ml for drinking water source with conventional treatment followed by disinfection(Class 'C') in River Yamuna at downstream Yamunotri. Free Ammonia levels of 1.4-6.6 mg/l were unsuitable for propagation of wildlife, fisheries under Class 'D' in River Yamuna from Okhla Barrage to Etawah. Entire stretch of River Yamuna was found to meet the desired criteria for irrigation, industrial cooling and controlled waste disposal (Class 'E') in terms of conductivity levels of 83-1087 µmhos/cm.

The flow of the Yamuna River varies significantly during monsoon and non-monsoon seasons. The river constitutes maximum flow i.e. around 80% of the total annual flow during monsoon period. During non-monsoon period the Yamuna cannot be designated as a continuous river but segregated into four independent segments due to the presence of three barrages from where almost the entire water is being diverted for various human activities. The river water is used for both abstractive and in stream uses. Irrigation is the important use of Yamuna Water followed by domestic water supply, industrial and other uses.

The ground water quality of adjoining areas of river Yamuna in Delhi has been assessed to see the suitability of ground water for irrigation and domestic applications. Thirty eight ground water samples from shallow and deep wells were collected each during pre-monsoon and post monsoon seasons in the month of June and November 2000 respectively. Various physicochemical, trace elements and bacteriological parameters have been determined. The data was analyzed with reference to BIS and WHO standards, ionic relationships were studied, hydro chemical facies were determined and water types identified. The study has clearly indicated higher concentration of total dissolved solids, electrical conductivity, nitrate, sulphate and sodium. The presence of total colifoims indicates bacterial contamination in ground water. The presence of heavy metals in ground water though recorded in many samples butthese were not significantly higher. The water quality standards have been violated for TDS, nitrate, sulphate and sodium at few places.

----------♦----------

INTRODUCTION

Water is one of the essential requirements of life. In the modern age it also plays a significant role in various economic activities. It is also one of the most exploited natural resources. Most of the fresh water bodies all over the world are getting polluted due to domestic waste, sewage, industrial waste, agricultural and religious activities like idol immersion (Vyas et al., 2007). River Yamuna, the main source of water supply to national capital-Delhi, plays a crucial role in its growth (Goel et al.). Total length of the River Yamuna from its origin near Yamunotri to its confluence with Ganga River at Allahabad is 1376 kilometer. The total basin area of the river is 366223 km2 which covers part of geographical area in the states of Uttaranchal, Uttar Pradesh, Himachal Pradesh, Haryana, Rajasthan, Madhya Pradesh & NCT – Delhi (CPCB,2006). The 22 km stretch in Delhi, once described as the life line of the city, today has

become one of the dirtiest rivers in the country (Mishra, 2010). Idol immersion is one cause of water pollution in the river Yamuna as it is widely worshipped by devotees in India.

In India, since ages, there has been a strong interrelationship between religion, customs, rituals and divine rivers. These pious rivers are worshiped right from the time any person takes birth to its death, the entire rituals and ceremonies are associated with these rivers (Singh, 2009). The immersion of idol of Lord Durga during Navratris festival is a major source of contamination and sedimentation to the lake water.

Water is an essential and vital component for our life support system. In tropica!
regions ground water plays an important role with context to fluctuating and increasing contamination of surface water resources. Ground water has unique features, which render it particularly suitable for public water supply. It has excellent natural quality, usually free from pathogens, colour and turbidity and can be consumed directly without treatment. Ground water is widely distributed and can be frequently developed incrementally at points near the water demand, thus avoiding the need for large-scale storage, treatment and distribution system. It is particularly important as it accounts for about 88% safe drinking water in rural areas, where population is widely dispersed and the infrastructure needed for treatment and transportation of surface water does not exist. Ground water plays an important role in agriculture, for both watering of crops and for irrigation of dry season crops. It is estimated that about 45% of irrigation water requirement is met from ground water sources. Industrial demands for ground water are also high, as many of the qualities which make ground water a preferred source of potable water (low TDS, low turbidity, absence of pathogens) are also important in use of ground water in various industries.

BACKGROUND

River Yamuna's most threatened section is perhaps the Delhi section – when it enters Wazirabad and leaves Okhla. The massive scale of construction works for improving storage of water or improving land connectivity causes a series of impacts both in the immediate time and extends over a long duration. Over the years, physical development in the form of Bridges and Barrages has taken place along this stretch resulting in transformations of different nature – surface level transformations, drainage modification etc. When a number of them come across a river the health of the river could be jeopardized along with host of unmitigated environmental and social impacts on the banks and the flood plains. The shrinking of active flood plains of River Yamuna over the years lessens the scope of recharge and sub-surface flows which could further deteriorate the river character – meaning the flow regulation, lessening of dilution capacities would thus lead to higher pollution loads, which could be attributed to the construction activities.

MATERIALS AND METHODS

A number of religious activities take place every year, which affect the water quality of upper and lower lakes. The festival of Durga idol immersion is observed once a year. Durga immersion, though it is not celebrated in Delhi at a large scale but its celebration in some pockets have led to heavy pollution in Delhi stretch of river Yamuna (CPCB, 2006). Thirteen sites were selected in the Delhi stretch where the immersion activity is done.

The water samples was collected from surface layer from the site of idol immersion at different intervals i.e. pre immersion, during immersion and post immersion. Pre idol immersion samples were collected three days before the commencement of the immersion activities. During idol immersion samples were collected during the immersion activities. Post idol immersion samples were collected two days after the completion of immersion activities. The samples were subjected to various physio-chemical analysis and were analyzed according to standard methods (APHA, 1995). The parameters namely pH, BOD, COD, DO, and TSS were analyzed. Figure 4 shows the map of the selected sites.

STUDY AREA

Tlie NCT of Delhi occupies ail area of 1483 km^2 covering six administrative blocks,
namely, Alipur, Kanjhawala, Najafgarh, Mehrauli, city and Shahdara (Fig. 1). Delhi generates about 2600 MLD of sewage against installed capacity of 1270 MLD of sewage treatment. The balance untreated sewage alongwilh significant quantity of partially treated sewage is discharged into river Yamuna every day. The river receives sewage .and industrial wastes through twenty two drains, which join river Yamuna between Wazirabad and Okhla. Thus Delhi is the largest contributor of pollution to river Yamuna receiving almost 80% of pollution load through these drains.

The water requirement of NCT of Delhi constitutes mainly for the drinking water
supply of its growing population. The water supply resources in Delhi are continuously under severe pressure due to ever increasing population and industrial activities. The metropolitan city became a major centre of commerce, industry and education after independence. The growth of government departments and office complexes has contributed to the city growth. Civic amenities have not kept
pace with increasing urbanisation. The unabated immigration of population has compounded the problems, resulting in flouting of land use regulations and restriction and deterioration of green cover.

The population pressure on Delhi metropolitan city is ever growing. As per 1991
census, the population of Delhi was 94.2 lakhs, which is projected to reach 141 lakhs in the year 2001 (Fig. 3). Besides, a floating population of 3 to 4 lakhs per day is recurring feature at Delhi. According to recent survey, more than 50% ofDelhi's population lives in about 1304 unauthorised colonies, 1080 Jhuggi Jhonpari clusters, 44 resettlement colonies and 209 rural villages. The total number of vehicles have increased phenomenally in order to meet the transportation demand of population from 2.35 lakhs in 1975 to 26.29 lakh in 1996 and is expected to touch a figure of 60
lakhs in 2011. The master plan 2001 for Delhi suggests the water consumption norm of 364 litres per capita/day (lpcd) as detailed in Table.

S.No.	Water Use	Consumption (lpcd)
1.	Domestic	226
2.	Industrial, commercial and community requirement based on 45000 litres per hectare per day	47
3.	Fire protection based on 1% of total demand	04
4.	Garden based on 67 litres par day	35
5.	For floating population and special uses	52
	Total	364

Table: Details of water consumption

RESULTS AND DISCUSSION

The flow velocity of River Yamuna varies from Yamunotri to Allahabad with respect to Altitudinal variation ranging from 3291 msl to 74 msl (Table 3). River Yamuna is not a continuous river especially during about 9 dry months a year. As a result there are three independent segments of river i.e. river stretch downstream of Hathnikund Barrage to Wazirabad Barrage in between Haryana and Delhi state, downstream of Wazirabad Barrage to Okhla Barrage in Delhi state.

Flow velocity in River Yamuna from Yamunotri to Allahabad, was measured during November 2009, May 2010, November 2010 and again in May 2011. Maximum flow velocity of 1.66 m/s was recorded in River Yamuna at Wazirabad during May 2011. This abrupt increase in flow velocity was due to release Minimum flow velocity was observed in upper segment (0.055 m/s) and there was no flow velocity in River Yamuna in Delhi segment at Okhla barrage during October –November, 2009. 1.25 m/s flow velocity was observed at Etawah during November 2009, Hanumanchetti during November 2010 and at Lakhwar Dam during May 2011. Minimum flow velocity was observed at Dakpatthar, Wazirabad and Okhla Barrage mainly due to impact of barrages.

The issues related with water quality of River Yamuna due to regulated flow which has transformed the river into various segments in dry seasons. Intermittent release of water from barrages due to unpredictable rainfall cause significant change in the water quality at downstream reaches of barrage. Flow regulation in upper segment of River Yamuna was affected both in terms of quality and quantity, which has resulted into Moderate (Class ‘C’) to Heavy Pollution (Class ‘D’) at downstream Tajewala Barrage to Kalanur during winter of 2004 whereas at the same location, the water quality improved to Class C during 2009, 2010, 2011.

Aquatic organisms are affected by pH because most of their metabolic activities are pH dependent. Optimal pH range for sustainable aquatic life is pH 6.5-8.2. pH of an aquatic system is an important indicator of the water quality and the extent pollution in the watershed areas (Kumar et al., 2011). The pH values were within the permissible level set by GPCB and CPCB i.e. 6.5 to 8.5, varying between 8.40 in the pre winter of 2010 to 7.70 in post winter of 2011.

Conductivity itself is not a human or aquatic health concern, but because it is easily measured, it can serve as an indicator of other water quality problems. If the conductivity of a stream suddenly increases, it indicates that there is a source of dissolved ions in the vicinity.

In water, total dissolved solids are composed mainly of carbonates, bicarbonates, chlorides, phosphates and nitrates of calcium, magnesium, sodium, potassium and manganese, organic matter, salt and other particles (Mahananda, 2010). At high flows, the TDS values tend to be diluted by surface runoff and for most rivers there are an inverse correlation between discharge rate and TDS.

Designated Base Use	Class of Water	
Drinking water source without conventional treatment but after disinfection.	A	1. Total Coliform organism MPN/100ml. shall be 50 or less. 2. pH between 6.5 and 8.5. 3. Dissolved Oxygen 6 mg/l or more. 4. Biochemical Oxygen Demand 5 days 20 ^{0}C 2 mg/l or less.
Outdoor bathing (Organized)	B	1. Total Coliform organism MPN/100ml.shall be 500 or less. 2. pH between 6.5 and 8.5. 3. Dissolved Oxygen 5 mg/l or more. 4. Biochemical Oxygen Demand 5 days 20 ^{0}C 3 mg/l or less.
Drinking Water Sources after conventional treatment	C	1. Total Coliform organism MPN/100ml.shall be 5000 or less. 2. pH between 6 and 9. 3. Dissolved Oxygen 4 mg/l or more. 4. Biochemical Oxygen Demand 5 days 20 ^{0}C 3 mg/l or less.
Propagation of Wild Life Fisheries.	D	1. pH between 6.5 and 9.5. 2. Dissolved Oxygen 4 mg/l or more. 3. Free Ammonia (as N) 1.2 mg/l or less.
Irrigation, Industrial Cooling Controlled Waste.	E	1. pH between 6.5 and 9.5. 2. Electrical Conductivity at 25-mg/cm max. 2250. 3. Sodium absorption ratio Max. 26. 4. Boron Max 2 mg/l.

Table : Primary Water Quality Criteria

WATER QUALITY STATUS OF YAMUNA RIVER

The water quality of River Yamuna in terms of organic pollution had been quite good from origin till Palla as evident. Though, there was a gradual increase in BOD from river stretch between origin to upstream Delhi. However, the average BOD values have been well below the designated best use criteria in this stretch. The BOD level increased significantly afterwards and average BOD values were not confirming the standard till the confluence of river Chambal.

Bio-chemical Oxygen Demand (BOD) - The BOD level in the Yamuna from its origin till Palla has been observed generally between in the rage of 1-3 mg/l with annual average not exceeding 3 mg/l. This is due to the fact that there is no significant wastewater outfall in the river and adequate fresh water available in this river stretch. However, the BOD concentration rises beyond the desired standard i.e. from 3.0 mg/l to 6.0 mg/l between Kalanaur to Palla. This may be either due to accidental discharges of wastewater from urban agglomerations located upstream to these locations or due to human / animal activities in the river e.g. washing, defecation etc.

Chemical Oxygen Demand (COD) - It has been observed that besides the wastewater discharges that Yamuna River receives at various places, excessive presence of algal mass (due to Eutrophication) also contributes significantly to COD. Upto Palla the COD was in the range of 1 - 49 mg/l. The COD was observed lowest at places located either in hilly stretch or near foothill. From Lakhwar dam till Kalanaur the annual average of COD was never exceeded 10 mg/l and was in the range of 2-10 mg/l. At Sonepat and Palla the annual average of COD was 9-17 mg/l. The pH in the entire Yamuna stretch varied from 6.11 (Yamunotri) to 9.39 (Bateshwar). The pH in the Yamuna River has remained within prescribed limit. Slightly low pH at Yamunotri might be due to presence of various sulphur springs that joins the river.

CONCLUSION

River Yamuna, the largest tributary of River Ganga, travels a distance of 1376 Km, from its origin at Yamunotri at an elevation of 3291msl to its confluence with River Ganga at Allahabad at an elevation of 74 msl. During its travel, flow velocity of River Yamuna varies from 0.0 to maximum of 1.66 m/s. The minimum water temperature of 4.0 0C was observed at Yamunotri and maximum of 40 0C was observed at Agra. The biological water quality of River Yamuna showed clean (Class 'A') to slightly polluted (Class 'B') at Yamunotri and Hanumanchetti. Water quality at this location can be used for drinking and bathing purposes throughout the year. The moderate pollution of (Class 'C') was observed in water quality of River Yamuna was from Okhla Barrage to Allahabad throughout the year.

The water quality of Mini River is deteriorating due to anthropogenic activities like, industrial use of water and discharge into the river without any pretreatment. In post winter the pollution load is more prominent as compared to other seasons. The validity of the results obtained from Mini River indicated the correlation found between the variables. The obtained BOD value (also crossed the permissible limit of GPCB) showed the contamination of water indicates decline in DO of the water; which affects the sustainable life of plant and animals into the river stream.

Central Pollution Control Board has formulated a comprehensive set of guidelines on the practice of idol immersion in lakes, rivers and seas (CPCB, Guidelines for Idol Immersion, 2006). These guidelines delineate and specify the role of the state pollution control boards in conducting water quality assessments of water bodies and classifying them on the basis of certain physio-chemical parameters. These guidelines if followed and acted upon can help in bringing tremendous change in the water quality of river post idol immersion. Some alternatives that can prevent the further deterioration of the river during immersion period:

REFERENCE

- Abida, B. & Harikrishna, (2008), Study on the Quality of Water in Some Streams of Cauvery River, Journal of Chemistry, 5(2), pp 377-384.
- APHA, (1998), Standard Methods for Examination of Water and Wastewater, 20th Edn., American Public Health Association, Washington, DC, New York.
- Bhatt, L.R., Lacoul, P., Lekhak, H.D. & Jha, P.K., (1999), Physicochemical characteristics and phytoplankton of Taudha Lake Kathmandu, Pollution Research. 18 (14), pp 353-358.

- CPCB: Application of artificial substratum for bio-assessment of water bodies. Laboratory Analytical Technique Series, 13, Central Pollution Control Board Delhi, 1998-99.
- CPCB: Scheme for Zoning and Classification of Indian Rivers, Estuaries and Coastal Waters (Part One: Sweat Water) Assessment and Development Study of River Basin Series 3 Central Pollution Control Board, Delhi, 1978-79.
- Dhote S., Varghese B., Mishra S.M., (2001), Impact of idol immersion on water quality of twin lakes of Bhopal. Indian journal environmental protection. 21, pp 998- 1005.
- Gupta, S. K., Choudhary, G. C. and Agarwal, H. P. (1991o), Heavy metal pollution in water of Varanasi, Proc. All India Environ. Cong., New Delhi, Dec. 1991.
- Handa, B. K. (1994), Ground water contamination in India, Proc. Regional Workshop on Environmental Aspects of Ground Water Development, Kurukshetra, pp. 1-1 to 1- 33.
- Handa, B. K.. (1983), Occurrence and distribution of trace elements in natural water of Utlar Pradesh, proc. CGWB Seminar on Assessment, Development and Management of Ground Water Resources, New Delhi, pp. 293-304.
- Hasan, M. Z. (1986), Heavy metals in aquatic environment, J. Indian Water Works Association, XVHI, 155-159.
- Jain, C. K. and Bhatia, K. K. S. (1987), Physico-chemical Analysis of Water and Wastewater, User's Manual, UM-26, National Institute of Hydrology, Roorkee.
- Mishra Anil Kumar., (2010), A river about to Die: Yamuna, Journal of water resource and protection, 2, pp 489-500.
- Qureshi S, Akolkar P, Garg JK. Suitability Assessment of the River Yamuna in upper stretch for bathing purposes. International Journal of Current Research 2012; 4(03):27-30.
- Singh J., (2009), Sacredly polluting rivers, International research journal, II(9-10),