*International Research Journal of Environment Sciences*_____ ISSN 2319–1414
Vol. **4(2),** 58-63, February **(2015)** *Int. Res. J. Environment Sci.*

Understanding the Chemical Metamorphosis of Yamuna River due to Pollution load and Human use

Sandeep Sharma K[1] and Mamta Sharma Chhabra[2*]
[1]Department of Chemistry, Rajdhani College, University of Delhi, New delhi-110015, INDIA
[2]Department of Chemistry, Kirori Mal College, University of Delhi, Delhi-110007, INDIA

Available online at: www.isca.in, www.isca.me
Received 19th December 2014, revised 15th January 2015, accepted 14th February 2015

Abstract

In the lower Himalayas, at an altitude of roughly 6000 m, glacier Yamunotri is the point of origin of the sacred river Yamuna. Yamuna passes through certain areas of the states of seven states viz., Uttarakand, Uttar Pradesh, Haryana, Rajasthan, Madhya Pradesh, Himachal Pradesh and NCT–Delhi. This surface water is widely used for irrigation, domestic water supply, industrial etc. It has been subjected to over abuse, both in volume and quality. Before entering Delhi, it crosses Uttarakhand, Himachal Pradesh and Haryana. It enters Delhi near Wazirabad (Delhi) and covers a 48 km stretch in Delhi before inflowing the state of Uttar Pradesh. Although two other major industrial cities Yamuna Nagar and Panipat of Haryana state are located close to the river prior to its entering Delhi yet its appearance changes drastically due to mindless discharge of waste water from the drains. So much alarming is the level of pollution that at certain stretches in Delhi, the dissolved oxygen (DO) has fallen to zero. Given that a large number of inhabitants are dependent on the river, it is of significance to understand its chemical metamorphosis and preserve its water quality.

Keywords: Pollution; chemical metamorphosis; dissolved oxygen (DO); biological oxygen demand (BOD); heavy metal ions.

Introduction

River Yamuna is one of the most holy yet most contaminated rivers of the India. Yamuna has been classified into five partson the grounds of hydrological and environmental situations. These are Himalayan Section, Upper Section, Delhi Sectio, Eutriphicated Section and Diluted Section[1]. The segments and cities along Yamuna are depicted in figure-1 and 2

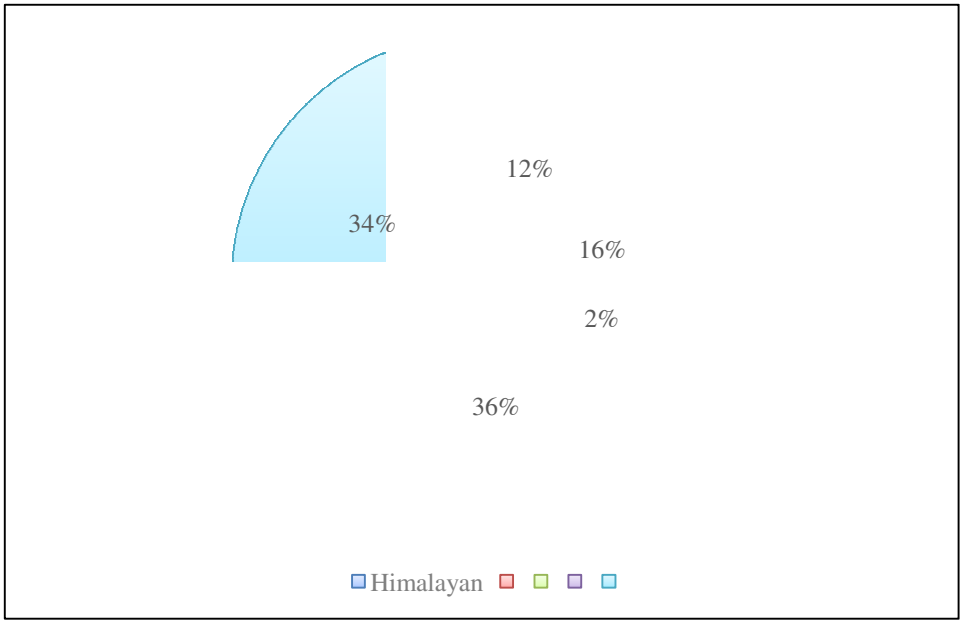

Figure-1
Approximate lengths (km) of different sections of River Yamuna

The only segment which fulfills the condition of the river water quality standards is the initial segment (Himalayan segment). The emission of unprocessed domestic and industrial wastes have badly deteriorated the quality of Yamuna in the other segments and currently it comes under the category E, thereby regarded as appropriate only for water sports and industrial purposes. The likelihood for sub aquatic life and domestic resource is completely out of question. Major indicators are low levels of Dissolved Oxygen (DO) and elevated levels of Biochemical oxygen demand (BOD). In general, the acceptable least amount of DO to upkeep a large populace of numerous fishes is from 4 to 5 mg/l. When the Dissolved Oxygen (DO) is less than 3 mg/l, even the robust fishes die. Since DO levels are critical to fish, due to high pollution load, mass death of fishes is reported every year. Dissolved Oxygen has fallen from an already low of 0.3 to 0.0 mg/L between 1996 and 2010 in the Delhi segment. Biochemical oxygen demand (BOD) load has increased from 25 mg/L to 34.5 mg/L in 2008 in the same area where as the acceptable levels is less than or equal to 5 mg/L. The Yamuna has become a small rivulet with untreated noxious industrial wastes, sewage and other poisonous stuffs. There is uncritical need to take rigorous and stern actions to assuage these pollution levels and protectthesick river[2]. It has been observed that DO concentration was very low and due to increase amount of waste water it cannot be fixed without taking improved management based on experimental and theoretical research the simulated results[3,4].

Point and non-point sources of pollution: Point and non-point sources contaminate the river.NCT is the main providing source of polluting substances trailed by Agra and Mathura. The section between Chambal River and Wazirabad confluence is disparagingly unclean and almost 20km of Delhi stretch is the extremelypolluted[5] (Water Quality Status of Yamuna River (1999-2005)).

Point sources of pollution: These are specified and localized causes of pollution. The point sources of pollution may be divided into two categories: Domestic Pollution and Industrial Pollution.

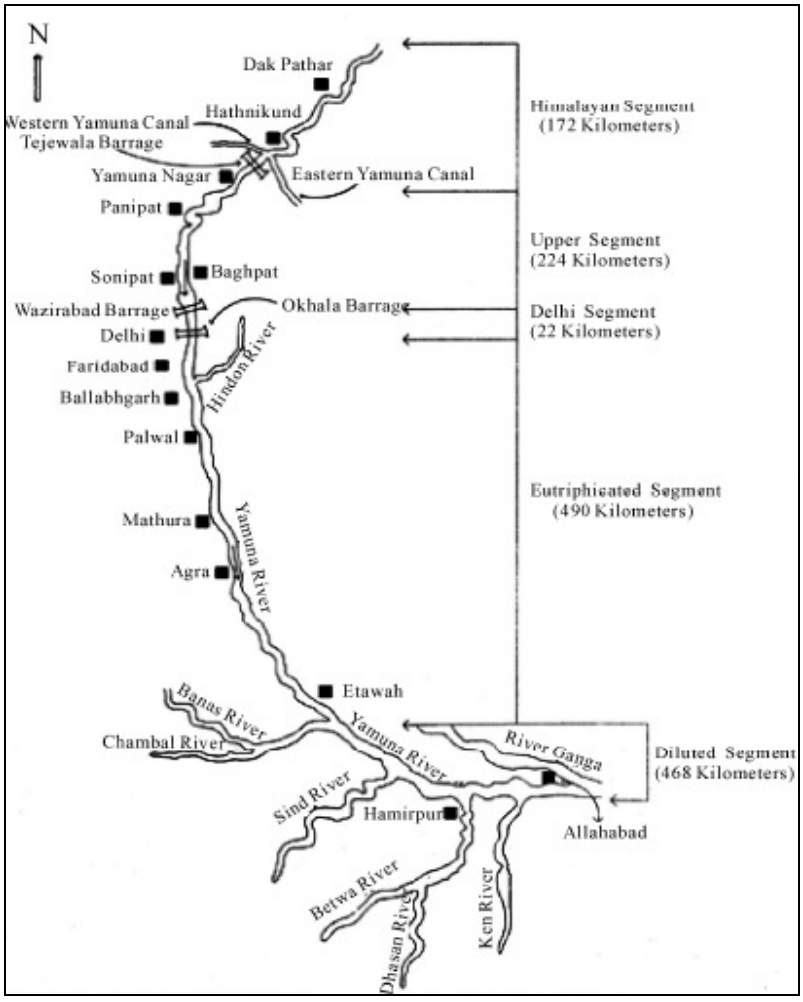

Figure-2
Major cities along River Yamuna[1,4]

Domestic Pollution: The domestic sources cause maximum pollution in Yamuna estimated to be roughly 85% of the total pollution. These mainly include the dumping of waste by urban centers like Panipat, Sonepat, Delhi, Ghaziabad, Mathura-Vrindavan, Agra, Etawah and Allahabad. The severity of impact of domestic pollution on river depends on the effectiveness of the wastewater collection system, type and stretch of the waste carriage system. If there is more holding time of waste water within urban sites before reaching the Yamuna and other water bodies, the pollution levels would become less due to settling and biodegradation. The domestic waste is mainly constituted of organic matters and micro-organisms. Apart from this total salts, detergents, grease etc. also contribute to this type of pollution. Waste generated from abundant unauthorized colonies existing in various urban centers with no sewerage system, is transported and discarded either in gutters, streams or straight into river untreated. A survey done by Central Pollution Control Board (CPCB), estimated that a major fraction (0.23) of the entire wastewater produced is contributed by Delhi among Class I cities. These are the cities with population of more than 100,000 people. More bewilderingly, this in turn is around fraction of 0.45 of the total waste caused by Class I and II cities taken together. Yamuna becomes more toxic with the dumping of the untreated domestic wastewater when the concentration of ammonia ranges to 0.4 mg/L or more[5].

Industrial Pollution: Post-independence, swift industrial development occurred across the Yamuna river basin. There are huge number of industrial clusters at various places including Indore, Gwalior, Kota, Khetri, Panipat, Yamuna Nagar, Nagda, Delhi, Baghpat, Sonepat, Ghaziabad, NOIDA, Mathura Faridabad and other places. These different industries discharging wastewater into Yamuna river comprises of Distilleries, Pulp, Sugar, Weaving, Oil Refineries, Chemical, Drugs, Thermal Power Plants, foodstuff industries etc. It is mandatory for these industries to treat the waste generated in order to achieve recommended criteria before throwing effluent into the environment for the acquiescence to the environment laws. This aspect is ignored in most of the cases. Yamuna River has become murky river and river of sadness to the areas around with special reference to Mathura, Delhi, and Agra. The color of Yamuna River is awfully dark, it looks virtually like a gutter in NCT, as most of the manufacturing and other engineering units are situated on its bank and at one time used to junk and throw the unprocessed wastes into the Yamuna. The River water remains immobile for nearly three-fourth time of a year. There are unchecked and unrestricted numbers of industries, throwing huge amount of unprocessed effluents in Yamuna prevailing in Faridabad, Delhi, Agra and Mathura. According to Central Pollution Control Board (CPCB) survey, approximately 350 industrial units that throw their wastes in Yamuna of which more than forty are in Delhi[5] (Water Quality Status of Yamuna River (1999-2005)).

Non point or diffused of Pollution: The non-point sources are unnamed, plentiful and impact of each is of less implication this is contrary to the point source. Nevertheless, in blend the subsequent impact is substantial. This pollution is not confined in the catchment area of the Yamuna but regularly transported or and sometimes rarely by discharge, and surface water during rains. The pollutants initiated from these non-point sources include heavy metals in upper layer of soil, nutrients/fertilizers, plant residues, organic chemicals, organic matter etc. The other important non-point pollution sources contributing to river Yamuna are: Agricultural remains, Fertilizer and Pesticides, Animal husbandry, Dumping of Garbage and Dead bodies, Immersion of Idols, Bathing and clothes washing, Cattle wading, Open defecation.

Current Status of Yamuna Water Quality

Degradation due to pollution has substantially decreased the ability of wetlands to provide enough amounts and also the water fulfilling the minimum standards. The constant dilapidation of wetlands, and more specifically the continued decline in water standards and quality, will result in further deterioration of human health especially for people in developing countries who are more vulnerable[6,7]. This also affects aquatic life. The physicochemical parameters of water bodies like freshwater pond can be significantly changed by anthropogenic activities such as numerous farming practices and natural dynamics which subsequently disturb the water quality and quantity, biodiversity, capacity of the land to produce and even commotion in the of environmental equilibrium operating there[8-10]. Chemical Metamorphosis of river water quality can be evaluated by the biochemical studies and analysis of different chemicals present. A healthy river should have minimum 5 mg/L of DO which is essential for the existence of aquatic life and about 3 mg/L of BOD. However the microorganisms that cause diseases can be characterized by Fecal Coliforms counts, should be less than 500 per 100 mL of water. In accordance with the water qualities, river waters have been classified in five classes[11]: Class A: In this category, the water of the river is acceptable for drinking after addition of disinfectant e.g. bleaching powder or chlorine. Class B: In this class of river water one can take bath only. Class C: In this category, the river water is appropriate for consumption only after apt treatment i.e., removal of physical substances such as plastic, paper etc. Class D: The river water in this class is appropriate only for aquatic and Class E: The water of the river is right only for manufacturing units' purposes, irrigation, etc.

River Yamuna fits into class E[12]. Swift urbanization and agricultural growth in Yamuna basin has primarily as well as secondarily affected the Yamuna water quality. Yamuna has six barrages which block the river flow and design the flowing situation. Usually most of the slush gets dumped at upstream of the barrages. These solid toxic substances that have settled, moves to downstream along with rapid and abrupt discharge of water from the barrages thereby increasing the river contamination. Central Pollution Control Board (CPCB) carries out regular checking and investigation of Water quality of Yamuna River since 1977.

Dissolved Oxygen (DO) DO decreases with increase in temperature[13]. Thus the fishes are not able to survive at elevated temperature (figure-3). Dissolved Oxygen level in Yamuna from its origin to Palla is found within safe limits but away from that it starts depleting. After Wazirabad the DO level starts declining drastically and most of times the DO level touches duck at different Delhi downstream sites; it may be due to Shahdara drain and Hindon River discharging discarded water at these sites.

Biological Oxygen Demand (BOD) quantifies the amount of oxygen consumed by creatures in the river and other water bodies to decay the organic matter obtained by the industrial wastes. Higher value of BOD specifies that the level of dissolved oxygen is dipping, thereby endangering the river's aquatic species and biodiversity. It is triggered by the occurrence of elevated level of nitrate levels and organic toxins in water body. There are fluctuations in the Biological Oxygen Demand level in Yamuna from Yamunotri to Palla in Delhi segment between 1 to 3 mg/L. After Palla, wastewater drains fall into Yamuna. The BOD level is between 3 and 51 mg/L from Nizamuddin Bridge to Agra downstream. Figure 4, 5 and 6 displays the average BOD and DO levels in Yamuna River at diverse locations from 1996 to 2010[14]. (Water quality criteria, (2012))

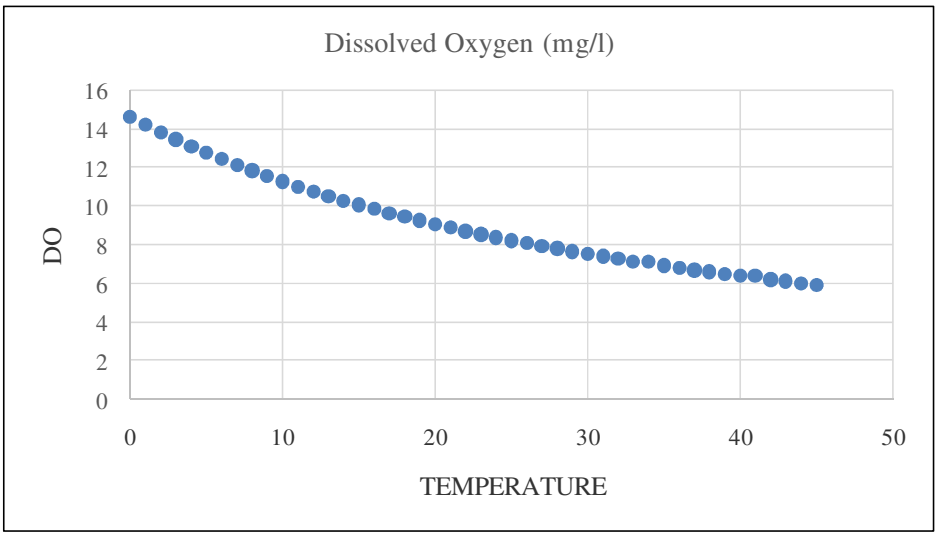

Figure-3
Variation of DO with temperature

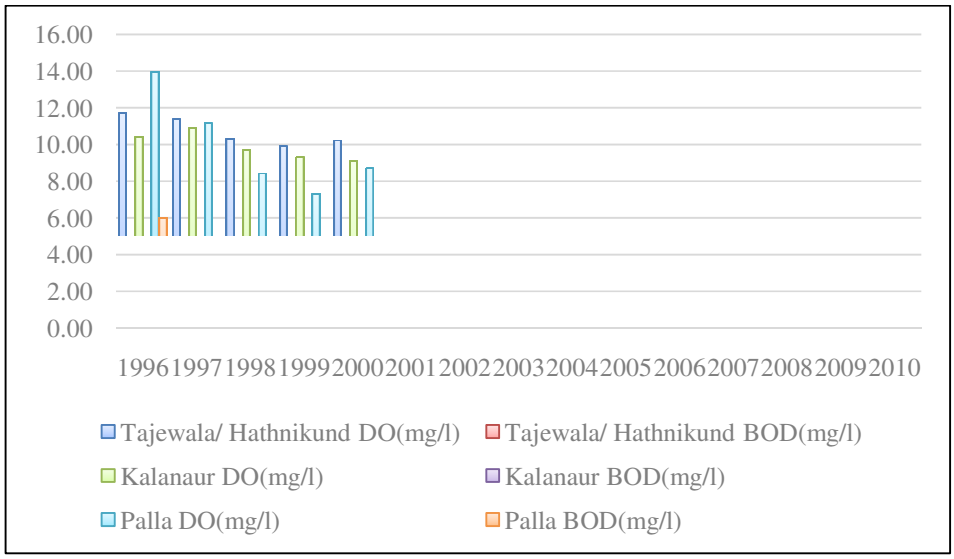

Figure-4
BOD and DO at different locations in Haryana from 1997 to 2010

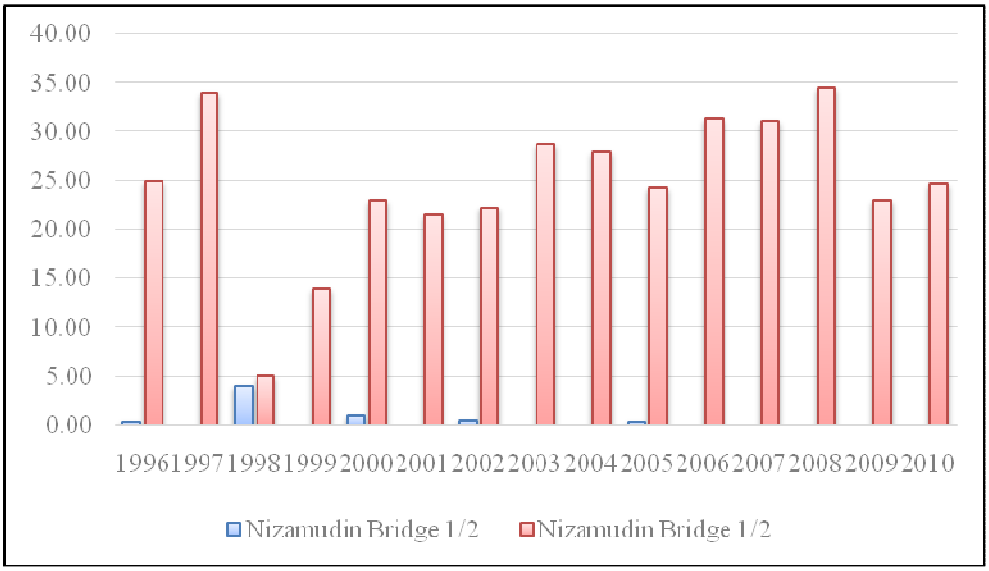

Figure-5
BOD and DO at Nizamudin Bridge in Delhi from 1997 to 2010

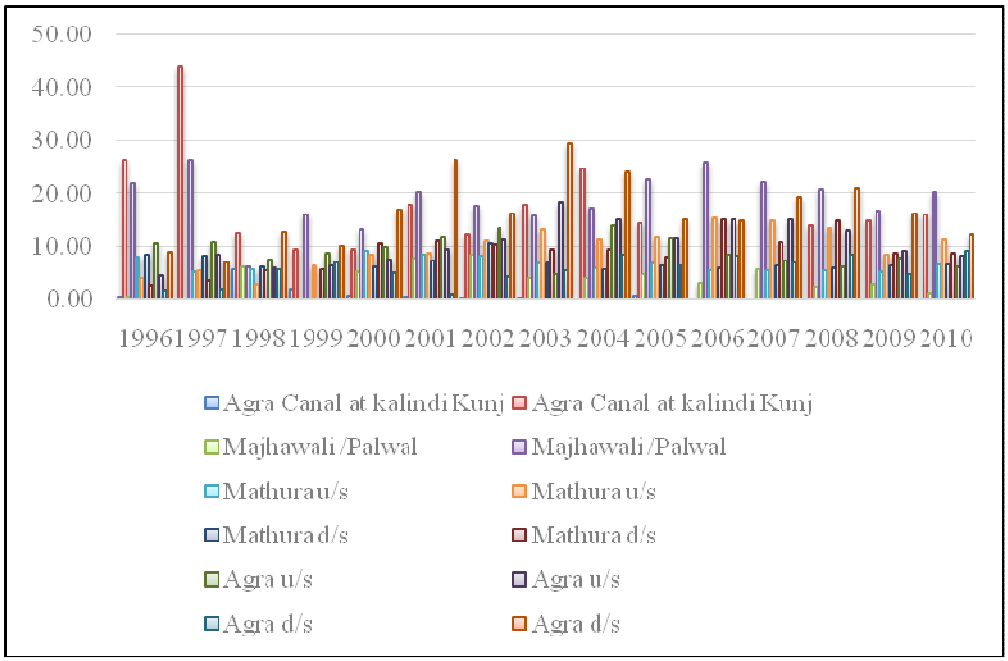

Figure-6(a)
BOD and DO at different locations in Uttar Pradesh from 1997 to 2010

Conclusion

The desired quality refurbishment of River Yamuna at diverse sites is a very multifaceted striving. Yamuna River pollution cannot be lessened simply by launching more sewage treatment plants and diversion of waste water drains. Certain procedures and approaches that can prevent worsening of water quality can be adopted. It has been observed that DO concentration was very low and due to increase amount of waste water it cannot be fixed without taking improved management. Wastewater can be salvaged by recycling through effective tools and expertise and can be reused for several purposes like irrigation. Use of bio-fertilizers should be promoted. More cultivation along Yamuna would check soil pollution. Environmental laws should be implemented with sternness. There should be upgrading in sewage system can avoid the leakage and leaching of dirty water into water bodies.

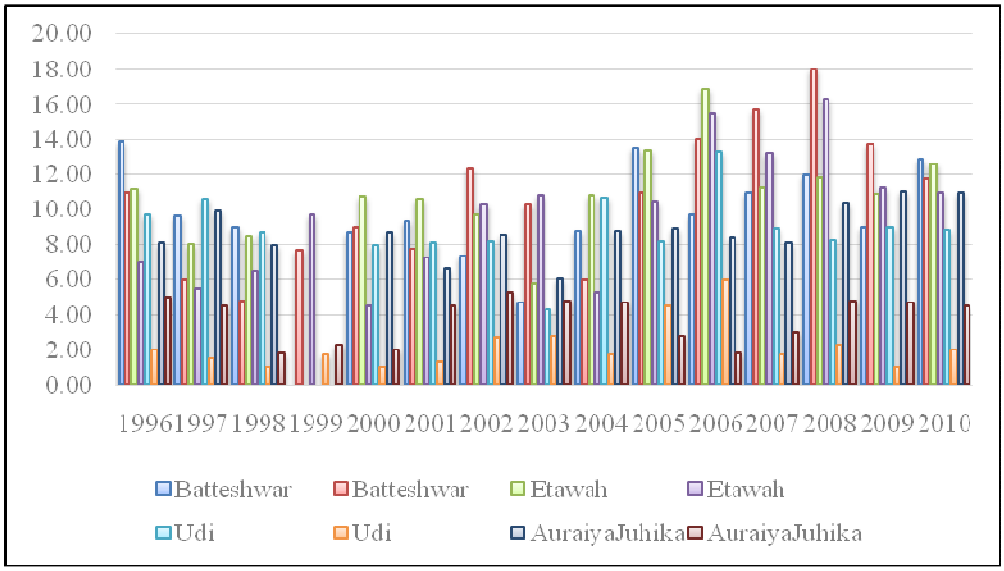

Figure-6(b)
BOD and DO at different locations in Uttar Pradesh from 1997 to 2010

References

1. Misra AK, A River about to Die: Yamuna, *J. Water Resource and Protection*, **2,** 489-500 (**2010**) (doi:10.4236/jwarp.2010.25056 Published Online May 2010)
2. Jain P., Sick Yamuna, Sick Delhi, Searching a correlation, *Peace Institute Charitable Trust,* **(2009)**
3. Hossain M.A., Sujaul I.M. and Nasly M.A., Application of QUAL2Kw for water quality modeling in the Tunggak River, Kuantan Pahang, Malaysia, *Res. J. Recent Sci.,* ISSN 2277-2502, **3(6),** 6-14 **(2014)**
4. http://www.washalliance.org/wp-content/uploads/2013/10/The-Yamuna-River-Life-and-Death-of-a-Principal-Waterway-Policy-Paper-00032014a.pdf, **(2013)**
5. Water Quality Status of Yamuna River, Assessment and Development of River Basin Series, **(1999-2005)** available at ADSORBS/41/2006- 7 CPCB, http://www.cpcb. nic.in/newitems/11.pdf, accessed during December, **(2012)**
6. http://edugreen.teri.res.in/explore/maps/water.htm, **(2014)**
7. Mushini V.S.R., Vaddi D.R. and Bethapudi S.A.A., Assessment of Quality of Drinking Water at Srikurmam in Srikakulam District, Andhra Pradesh, India, *I. Res. J. Environment Sci.,* **1(2)**, 13-20 **(2012)**
8. Vincy M.V., Brilliant Rajan and Pradeep Kumar A.P., Water Quality Assessment of a Tropical Wetland Ecosystem with Special Reference to Backwater Tourism, Kerala, South India, *International Research Journal of Environment Sciences,* ISSN 2319–1414 , **1(5),** 62-68 **(2012)**
9. Pathak Neelam B. and Mankodi P.C., Hydrological status of Danteshwar pond, Vadodara, Gujarat, India, *Int. Res. J. Environment Sci.,* ISSN 2319–1414, **2(1),** 43-48 **(2013)**
10. Patil Shilpa G., Chonde Sonal G., Jadhav Aasawari S. and Raut Prakash D., Impact of Physico-Chemical Characteristics of Shivaji University lakes on Phytoplankton Communities, Kolhapur, India, *Res J. Recent Sci.,* ISSN 2277-2502, **1(2),** 56-60 **(2012)**
11. Parikh Ankita N. and Mankodi P.C., Limnology of Sama Pond, Vadodara City, Gujarat, *Res. J. Recent Sci.*, **1(1),** 16-21 **(2012)**
12. Hindu, Delhi reduces Yamuna to a sewage drain, New Delhi, **(2002)** http://www.hinduonnet.com/thehindu/2002/06/25/stories/2002062506380400.htm, **(2002)**
13. http://water.epa.gov/type/rsl/monitoring/vms52.cfm, **(2014)**
14. Water quality criteria, Available at http://www.cpcb.nic.in/Water_Quality_Criteria, php, accessed on 22nd November, **(2012)**
15. http://edugreen.teri.res.in/explore/maps/water.htm,**(2014)**