Status of Water Quality of River Yamuna at Nigambodh Ghat-a Major Cremation Ground in Delhi, India

Simerjit Kaur* and Pragati Mehra

*** Coressponding author: Assistant Professor, Dept. of Applied Sciences, Rayat-Bahra Institute of Engineering & Biotechnology, Mohali Campus (Punjab)**

Abstract

The present investigation was undertaken for the assessment of the water quality parameters, including pH, total dissolved solids (TDS), alkalinity, total hardness (TH), concentrations of nitrate, phosphate, dissolved oxygen (DO) and biological oxygen demand (BOD) from a point source of River Yamuna, namely Nigambodh Ghat, New Delhi during December, 2009. The Ghat is a major and the busiest cremation ground, situated on the bank of river Yamuna, flowing through the capital city of Delhi. Water quality analysis was also done for the samples collected two kilometer before the river enters the Ghat in order to compare the extent of pollution being caused at the site. In addition, the results obtained for various parameters for River Yamuna at Nigambodh Ghat, Delhi have been with Indian and international water standards to check for their suitability for variouspurposes.

Key Words: Water pollution, cremation activities, Total dissolved solids, DO, BOD.

Introduction

River Yamuna, the largest tributary of the River Ganga, is one of major and holy rivers in northern India. The source of Yamuna lies in the Yamunotri Glacier at a height 6,387 meter,

on the south western slopes of Banderpooch peaks, which lie in the Mussoorie range of Lower Himalayas, in the Uttarkashi district, Uttarakhand, north of Haridwar (Jain *et al*., 2007). It flows through the states of Uttar Pradesh, Uttarakhand, Himachal Pradesh, Haryana, Rajasthan, Madhya Pradesh andDelhi.

Although several studies on water quality of river Yamuna at various stretches have been carried out (Singh *et al*., 2008; Saini *et al*., 2009, Kaushik *et al*., 2009, Mandal *et al*., 2010) little attention has been given to the Nigambodh Ghat area. The Nigambodh Ghat is located on the banks of the Yamuna river coast in New Delhi, which is a major cremation ground in the city of Delhi. It is a platform designed for the cremation of bodies by members of the Hindu faith and Sikhs. It is believed that it was on this ghat during the Mahabharat era, Lord Brahma, Hindu God of Creation, had bathed and recovered his lost memory and sacred books and hence the name Nigambodh Ghat, literally realization of knowledge.It is also believed that the ghat was established by the eldest Pandava brother and the king of Indraprastha (the older name of Delhi), Yudhisthira. The Ghat is the oldest and the busiest burning ghats in Delhi with 50-60 pyres burning everyday. It consists of a series of bathing and ceremonial stepped piers leading to the waters of the river Yamuna. In addition, the ashes or the left overs or the unburnt flesh after burning the dead bodies are casted out or floated away in the river Yamuna in accordance with the Hindutradition.

Thus the present study has, therefore, been undertaken, to assess the water quality River Yamuna at Nigambodh Ghat, a major cremation ground in the city of Delhi. In this study, efforts have been made to collect water samples from the selected sites and to evaluate the levels of various parameters, viz. pH, total dissolved solids (TDS), alkalinity, total hardness (TH), concentrations of nitrate, phosphate, dissolved oxygen (DO), biological oxygen demand (BOD) which are indicators of the pollutants present in the water bodies. In addition, water samples were also collected and assessed two kilometer before the river enters theGhat

(Site A) and two kilometer away the river exits the Ghat (Site B), in order to compare how much pollution has been caused at the site of investigation i.e. the Nigambodh Ghat. Comparisons would also be made between the results obtained for various parameters being tested to assess the water quality of River Yamuna at the Nigambodh Ghat with that of various water standards. Till now, there has been no comprehensive report available on the assessment of water quality of River Yamuna at Nigambodh Ghat,Delhi.

Materials and Methods

Study Area: Nigambodh Ghat is situated at Ring Road, near Inter State Bus Terminus (ISBT), Kashmere Gate, Delhi. The location map of the Nigambodh Ghat, Delhi is presented in the Figure 1.

Water Sample Collection and Preservation: The water sample was collected from the bank of Nigambodh Ghat, Delhi (named as NBG) as well as from Site A & Site B during December, 2009. The water sampling was done in high grade plastic bottles (500 ml). The bottles were dipped into the river water and after being filled, they were capped tightly, inside the river water, itself. The sampling was done after wearing the surgical gloves, to avoid any infection.

Sampling bottles were kept in ice-box at 4^0C till they were transported to laboratory for experimentations.

In addition, for comparative analysis, samples were also collected two kilometer before (named Site A) the river enters the Nigambodh Ghat in the same way as done for NBG.

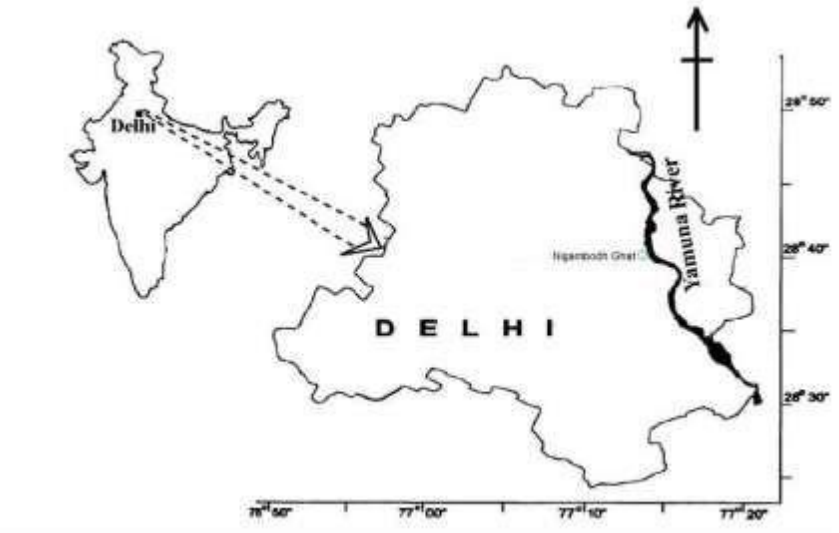

Fig.1. Map showing the location of the selected study spot - Nigambodh Ghat, Delhi.

3. EXPERIMENTAL

Water Analysis: Physiochemical and biological parameters were analyzed by using techniques given by APHA, 2000.

A. pH: The measurement of pH was done using pHmeter.

B. Total dissolved solids (TDS): TDS of the water samples was determined indirectly from EC by using the followingformulae:

TDS (mg/l) = 0.64 X EC X1000

C. Alkalinity: To 20.0 ml of water sample in a titration flask, added 2.0 drops of phenolphthalein indicator and titrated it against 0.1 N HCl solution till the pink color disappears. Recorded the volume reading as 'A' ml (this gives the phenolphthalein alkalinity). To the same solution, added 2-3 drops of methyl orange indicator and titrated it against 0.1N HCl solution, until the color changes from light yellow to red. Volume of acid used in titration with methyl orange as indicated was recorded as 'B'ml.

Total volume of the acid used = (A+B) ml.

Total alkalinity was calculated using the formulae:

Total Alkalinity (as $CaCO_3$) = N_2 X V_2 X equivalent weight of $CaCO_{3X}$ 1000/ V_1

Where, $N_{2=}$ Normality of titrant (HCl) used

V_2 = Total volume of acid used (A+B) ml

$V_{1=}$ Volume of the sample taken (in ml)

D. Total hardness (TH): TH was estimated by EDTA titration method using the following chemicals: standard calcium solution, NH_3 buffer solution (added 16.9 g of NH_4Cl to 143 ml of NH_4OH, made the final volume to 250 ml using distilled water), 0.01 M EDTA solution (Dissolved 3.723 g of EDTA disodium salt to distilled water, made the volume to 1 litre), Erichrome Black T (EBT) indicator (Dissolved 0.5 g of EBT in 100 ml of 80% ethyl alcohol). Standardization of EDTA solution with standard $CaCO_3$ solution: To 10.0 ml of standard calcium solution, added 2.0 ml of ammonia buffer solution. Added 4-5 drops of EBT indicator, wine red color appeared. Titrated it against EDTA solution till wine red color changed to blue. Recorded the volume of EDTA used to be taken as equivalent to $CaCO_3$. Titration of test samples: To 10.0 ml of water sample taken in a titration flask, added 2.0 ml of buffer solution. Added 4-5 drops of EBT indicator, wine red color appeared. Titrated it against EDTA solution till wine red color changed to blue. Recorded the volume of EDTA solutionused.

TH was calculated using the following formulae:

TH = AXBX1000/V

Where, V= Volume of sample taken(ml)

A = Volume of EDTA used (ml) for titrating sample

B = mg of $CaCO_3$ equivalent to ml of 0.01 M EDTA titrant used in standard calcium solution titration. (1ml of 0.01 M EDTA = 1 mg of $CaCO_3$)

E. Nitrate content: Nitrate content of the water samples were estimated spectrophotometerically, using the followingchemicals:

Standard nitrate solution: Dissolved 0.7218 gram of KNO_3 in 1L of distilled water. Prepared standard solutions of 0.0, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9 and 1.0 concentrations.

To the 50.0 ml of clear sample, added 1.0 ml of 1N HCl solution, shake thoroughly and poured into cuvettes. Absorbance for each sample taken using the spectrophotometer at Abs = 220 nm. Obtained the nitrate concentration in the water samples from the calibration curve prepared by taking a range of standard nitrate solutions.

F. Phosphate content: Phosphate content of the water samples were estimated spectrophotometerically, taking into account the followingchemicals:

Standard phospahte solution: Added 0.438 gram KH_2PO_4 in 100 ml of distilled water. Prepared standard solutions of 0.0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8 and 2.0 concentrations.

Ammonium molybdate solution: Diluted 2.5 grams of molybdate in 15 ml distilled water. Diluted 28.0 ml of concentrated sulphuric acid with distilled water to make the volume 40.0 ml. Both the solutions were mixed and the final volume was made 100.00 ml with distilled water.

Stannous chloride solution: Added 2.5 gram of $SnCl_2$ and 10.0 ml of concentrated HCl to distilled water. Made the final volume to 100.0 ml using distilled water.

Added 2.0 ml of Ammonium molybdate and 5.0 drops of stannous chloride distilled water to prepare blank. It was added to each standard solution. Blue color appeared. Spectro-photometric reading of each standard solution taken at Abs 690 nm, within 5-10 minutes duration because the blue color which appeared due to formation of complex of unknown concentrations starts fading after 12 minutes. Prepared standard curve between concentrations of standard solutions and absorbance obtained for each standard. Absorbance for the samples

taken and from the standard curve, the phosphate concentration of the water samples were estimated by checking their absorbance in the standard graph.

G. Dissolved oxygen (DO): DO was measured by titration method taking into account the following chemicals: $MnSO_4$ solution (dissolved 100.0 grams of $MnSO_4$ in previously boiled distilled water, made the volume upto 200.0 ml), 0.025N sodium thiosulphate solution (dissolved 6.205 grams of $Na_2S_2O_3$ in distilled water, made the volume to 1.0L by adding distilled water), alkaline iodide solution (dissolved 100.0grams of KOH and 50.0 grams of KI in200.0mlofpreviouslyboiledwater),starchindicator(dissolved100.0gramsofstarchin 100.0 ml of warm distilled water), potassium fluoride solution, concentrated sulphuric acid.

To the water sample filled BOD bottles, added 2.0ml of KF solution, 2.0 ml of $MnSO_4$ solution and 2.0 ml of alkaline KI. Shake the bottles and allow the precipitates to settle. Added 2.0ml of concentrated sulphuric acid, shake well to dissolve the precipitates. Transferred the contents of the bottles into titration flasks, added few drops of starch indicator to the flask till blue color appears. Titrated the solution against $Na_2S_2O_3$ solution until blue colordisappears.

DO was calculated using the following formulae:

$$DO\ (mg/L) = 8X1000XNXV'/V$$

Where, V = Volume of the sample taken in ml

V'= Volume of titrant used inml

N = Normality of the titrant

H. Biological oxygen demand (BOD): BOD involves the measuring differences in oxygen concentration in the water samples before and after incubating it, using the following chemicals: $MnSO_4$ solution (dissolved 100.0grams of $MnSO_4$ in previously boiled distilled water, made the volume upto 200.0 ml), 0.025N sodium thiosulphate solution(dissolved 6.205gramsof$Na_2S_2O_3$indistilledwaterandmadethevolumeto1.0Lbyaddingdistilled

water), alkaline iodide solution (dissolved 100.0grams of KOH and 50.0 grams of KI in 200.0 ml of previously boiled water), starch indicator (dissolved 100.0grams of starch in 100.0 ml of warm distilled water), potassium fluoride solution, concentrated sulphuricacid.

Collected water samples in two different BOD bottles. From the first bottle, determined initial DO. Incubated second bottle at 27^0C for 3 days, after which the DO was determined using the previously usedprocedure.

BOD was calculated using the following formulae:

BOD (mg/L) = D1-D2

Where, D1= Initial DO (mg/L) of the first sample i.e. beforeincubation

D2= Initial DO (mg/L) of the second sample i.e. after 3 days of incubation

Results and Discussion

When comparison was done among various parameters studied at NBG, Site A & Site B, it has been found out that pH, TDS, alkalinity, Total hardness, nitrate, phosphate, BOD have shown significant ($p<0.05$) increase in their concentration beyond acceptable range at NBG & Site B (Table1).

Table 1: Comparative analysis of various parameters (Mean±SD) at NBG, Site A & Site B

S.No.	Parameters	Site A	NBG	Site B
1	pH	6.1±0.02	6.70±0.02	6.92±0.03
2	TDS (mg/l)	990±11.2	1012.5±12.5	1262.5±12.9
3	Alkalinity(mg/l $CaCO_3$)	975±10.5	1012.5±11.5	1100.0±11.0
4	TH(mg/l)	530±5.1	680.0±7.2	540.0±7.8
5	Nitrate(mg/l)	0.062±0.01	0.144±0.03	0.178±0.05
6	Phosphate(mg/l)	0.059±0.02	0.164±0.05	0.184±0.07
7	DO(mg/l)	8.8±0.07	7.2±0.03	15.4±0.05
8	BOD(mg/l)	15.3±1.2	43.2±1.9	19.6±1.5

The water was nearly neutral in at NBG & Site B. The observed pH values were what would be expected of normal river water. The water at Site A was more acidic than it was at NBG.

Water with high alkalinity is considered to cause scaling in plumbing. Water containing TDS concentrations below 1000 mg/litre is usually acceptable to consumers, although acceptability may vary according to circumstances. TDS showed considerable variations at NBG. However, the presence of high levels of TDS at NBG & Site B may be objectionable to consumers owing to the resulting taste and to excessive scaling in water pipes, heaters, boilers, and household appliances. Nitrate and phosphate are responsible for 'eutrophication' their increasing concentration is worrisome. It has been found out that nitrate & phosphate have shown remarkable increase in its concentration at Nigambodh ghat (NBG) and at Site B. DO level varied significantly showing lowest value at nigambodh ghat & highest ($p<0.05$) at Site B simply represents that these activities consume dissolve oxygen present in water. The increase in the concentration of BOD indicates the large amount of organic matter present in this site. The increase inthese

parameters at NBG may be attributed to various anthropogenic activities and ashes left behind after cremation on thissite.

Conclusion

These investigations clearly indicate that main reason for the deterioration of water quality at Nigambodh Ghat, is ashes or unburnt flesh that add extra organic matter, phosphate & other ceremonial materials in to the river site. The increased TDS, Alkalanity, TH, BOD & decreased DO level have resulted from above factors. Though water condition at Nigambodh Ghat is worrisome but it can be improved by educating the people not to carry out such activities that deteriorate water quality.

Acknowledgement: Author is grateful to Head, department of biotechnology, Post Graduate College, sector-11 for providing all the laboratory facilities forexperimentation.

References

1. APHA. Standard methods for the examination of water and waste water(2000).

2. S. K. Jain, P.K. Agarwal, and V.P. Singh. *Hydrology and water resources of India-Volume 57 of Water science and technology library*. (2007) pp.344–354.

3. J. Singh, D.K. Agarwal and S. Panwar. Seasonal variations in different physico-chemical characteristics of Yamuna river water quality in proposed Lakhwar hydropower project influence area. *International Journal of Applied Environmental Sciences* . (2008) pp 107-117.

4. P. Saini, A. Kumar and J.N. Shrivastava. Influence of untreated and bacterial-treated Yamuna water on the plant growth of *Zea mays* L. *African Journal of Biotechnology*. (2009): 4149-4153.

5. A. Kaushik,, A. Kansal, M. Santosh, S. Kumari, and C.P. Kaushik. Heavy metal pollution of river Yamuna in the industrially developing state of Haryana. *India J. Environ. Health*. (2001):164-168.

6. P. Mandal, R. Upadhyay and A. Hasan. Seasonal and spatial variation of Yamuna River water quality in Delhi, India. *Environ Monit Assess.* (2010):661-670.