

# COMPARATIVE PHYSICO-CHEMICAL ANALYSIS OF YAMUNA RIVER, DELHI, AT OKHLA BARRAGE IN PRE- MONSOON & POST-MONSOON SEASON

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## ABSTRACT

*Various physico-chemical parameters include turbidity, DO, BOD, COD, sulphates, hardness, calcium, magnesium & chlorides were analyzed during pre- monsoon and post-monsoon seasons to determine the water quality of the Yamuna River at Delhi. During these investigations, it has been found out that the quality of river water has deteriorated due to the continuous discharge of municipal and industrial effluents from various drains. Most of the parameters have shown significant increase in their concentration in the post-monsoon season. The main reason for the pollution in the Yamuna River in post-monsoon season is due to surface run-off of municipal, agricultural waste and industrial effluents during rainy days that increase the turbidity as well as other parameters afterwards. Therefore, water supply from the Yamuna River should be treated properly before supplying for domestic purpose.*

**Key Words:** *Pre-monsoon, Post-monsoon, Hardness, water pollution, DO, BOD, COD*

## INTRODUCTION

The Yamuna River originates from the Yamunotri glacier, 6,387 meters above mean sea level (msl), at the Banderpoonch peak in the Uttarkashi district of Uttar Pradesh. The river flows 1,367 km from here to its confluence with the Ganga at Allahabad. The annual flow of the river is about 10,000 cumecs. The

Delhi segment comprises the 22 km that the river traverses in Delhi from the Wazirabad barrage to the Okhla barrage. Delhi is a large city of approximately 1465 sq km area in the north central region of India. Its geographic position is  $28^{\circ} 4' N$  and  $77^{\circ} 2' E$ . It is also located within the basin of River Yamuna.

An estimated 57 million people are dependent on the waters of the Yamuna River. It is the main source of drinking water for most of the towns along its course. The water quality of the Yamuna River deteriorates almost the moment it reaches the plains. The agricultural belt of Haryana, and the industrial towns all along the river, discharge significant amounts of wastes into the river. However, throughout its course through Haryana and Delhi, the Yamuna becomes a drain, receiving agricultural runoffs containing pesticides and fertilizers as well as industrial and domestic effluents. With several towns and cities discharging their untreated or partially treated wastes into the river, the water quality deteriorates constantly. The Yamuna River with all its pesticide residues and industrial effluents is the source for more than 70 percent of Delhi's water supply. But the available water treatment facilities are not capable of removing the pesticide traces and heavy metals (Banerji and Martin, 1997).

The preservation and maintenance of our natural water resources is a very difficult task due to rapid growth of population and increased industrial activities. The quality of water resources is deteriorating day by day due to the continuous addition of undesirable chemicals (L.vovich, 1979). Potential of toxic metals in Yamuna River at Delhi has also studied by Jain *et al.* the other hand, the demand for safe water is increasing continuously due to the increase in population, living standards and industrialization. It warrants immediate attention for the enhancement of the water quality of the river. The improvement of the water quality of this segment cannot be delayed any further, especially because there exist an abstraction point at the Okhla water works which supplies 27,000 kiloliters of drinking water daily to about 3,000,000 people of Delhi (C. K. Jain, 1993). The health and welfare of these people is intimately connected with the quality of drinking water. Many researchers have already studied physico-chemical parameters of various rivers (Indu. V. Nair *et al*; 2011., Suratman *et al*; Trivedi *et al*; 2000., Pande & Sharma, 1998).

In the present study, the pollution potential of different parameters has been examined in the pre- and post-monsoon seasons.

## MATERIALS AND METHODS

### Sampling Site

Samples were collected during the pre-monsoon (May, 2009) and post-monsoon (October, 2009) seasons from Okhla Barrage (S1), two kilometers away from Okhla Barrage(S2) & four kilometers away from Okhla Barrage(S3).

The sample bottles were soaked in 10 percent  $\text{HNO}_3$  for 24 h and rinsed several times with double distilled water prior to use. Samples were collected by dipping the polyethylene bottles in to the river. Bottles were tightly closed inside the water to avoid any changes in the dissolved oxygen level. All the samples were stored in refrigeration for further investigations.

All glass wares and other containers were thoroughly cleaned and finally rinsed with de-ionized water several times prior to use.

All the chemicals and reagents used were of analytical grade and were procured from Merck, India.

### Methodology

Various parameters were analyzed by using techniques given by APHA, 2000. Data obtained were statistically analyzed at 5% level of significance by using one way ANOVA.

**Estimation of Turbidity:** Turbidity can be measured using several methods. The easiest and least expensive method is through the employment of a Secchi disk. A Secchi disk is an 8-inch diameter disk with alternating black and white quadrants that is lowered into the water column until it can no longer be seen from the surface. The point at which the disk disappears is a function of the lake turbidity. A turbidity tube, or T-tube, can be used as an alternative to lowering a Secchi disk through the water

column. The T-tube is a plastic tube with a small-scale Secchi disk pattern at its base. Water samples can be poured into the tube and the clarity of the bottom disk can be used to reveal turbidity.

**Estimation of Dissolved oxygen (DO):** DO was measured by titration method taking into account the following chemicals: MnSO<sub>4</sub> solution (dissolved 100.0 grams of MnSO<sub>4</sub> in previously boiled distilled water, made the volume upto 200.0 ml), 0.025N sodium thiosulphate solution (dissolved 6.205 grams of Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> 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 in 200.0 ml of previously boiled water), starch indicator (dissolved 100.0 grams of starch in 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<sub>4</sub> 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<sub>2</sub>S<sub>2</sub>O<sub>3</sub> solution until blue color disappears.

DO was calculated using the following formulae:

$$DO \text{ (mg/L)} = 8 \times 1000 \times N \times V' / V$$

Where,

V = Volume of the sample taken in ml

V' = Volume of titrant used in ml

N = Normality of the titrant

**Estimation of 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<sub>4</sub> solution (dissolved 100.0grams of MnSO<sub>4</sub> in previously boiled distilled water, made the volume

up to 200.0 ml), 0.025N sodium thiosulphate solution (dissolved 6.205 grams of  $\text{Na}_2\text{S}_2\text{O}_3$  in distilled water and made the volume to 1.0L by adding distilled 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 sulphuric acid.

Water samples were collected in two different BOD bottles. From the first bottle, initial DO was determined. Incubated second bottle at  $27^\circ\text{C}$  for 3 days, after which the DO was determined using the previously used procedure.

incubation BOD was calculated using the following formulae:

$$\text{BOD (mg/L)} = \text{D1} - \text{D2}$$

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

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

Chemical Oxygen Demand (COD): COD gives the measure of oxygen consumed during the oxidation of the oxidizable organic matter present in a water sample. The following chemicals were used to determine the COD of a water sample:

0.1N  $\text{K}_2\text{Cr}_2\text{O}_7$  solution (dissolved 3.67grams of  $\text{K}_2\text{Cr}_2\text{O}_7$  to 1L of distilled water), 2M sulphuric acid (dissolved 10.8 concentrated sulphuric acid to 1L of distilled water), 0.1M sodium thiosulphate solution (dissolved 15.811grams of sodium thiosulphate to 2L of distilled water), KI solution (dissolved 20grams of KI in 100ml of distilled water), 1% starch solution (dissolved 1.0grams of starch to 100ml of distilled water).

50.0ml of distilled water and 50.0 ml of water samples taken in two conical flasks, separately. To each flask, poured 5.0 ml of  $\text{K}_2\text{Cr}_2\text{O}_7$  solution, incubated the flasks at  $100^\circ\text{C}$  for an hour. After cooling for 10

minutes, added 5.0ml of KI solution and 10.0ml of sulphuric acid solution to each flask. Added 1.0ml of starch solution to each flask till blue color developed. Titrated the solutions in the flask against 0.01M sodium thiosulphate solution, till blue color disappears completely.

COD was calculated using the following formulae:

$$\text{COD (mg/L)} = 8 \times C \times (V_B - V_A) / V_S$$

Where,

C = Concentration of titrant (ml)

$V_A$  = Volume of titrant used for control (ml)

$V_B$  = Volume of titrant used for water samples (ml)

$V_S$  = Volume of water samples taken (ml)

**Estimation of sulphate:** Sulphate concentration was estimated by nephelometer.

Standard solution of sulphate of concentrations 0,4,8,12,16,20,24,28,32 and 40 were prepared using standard stock solutions. While preparing these solution, 10ml of NaCl-HCl reagent and 20ml glycerol-ethanol were added to each of the standards and made the final volume to 10ml. added BaCl<sub>2</sub> in sufficient quantity so that all the sulphate got precipitated out. After precipitation, samples were stirred on magnetic stirrer for 3 minutes of get turbidity. In the similar manner, 10ml NaCl-HCl, 20ml glycerol-ethanol were added to 10ml water sample. Sulphate concentration standard curve an multiplying the readingly with proper dilution factors.

**Estimation of Total Hardness (TH):** Estimation of total hardness (TH) is a measure of calcium and magnesium is expressed in terms of ppm was estimated by EDTA titration method given below:

1. Standardization of EDTA solution with standard CaCo<sub>3</sub> solution.

2. Titration of test samples: Take 10ml of sample in titration flask and 2ml of buffer solution, 4-5 drops of EBT indicator were added to it. Wine red colour appeared. Titrated it with EDTA solution till wine red colour changed to blue. Recorded the volume of EDTA solutions used.

General calculations:

$$\text{Total hardness} = A \times B \times 1000/V$$

Where,

V = volume of sample taken (ml)

A = volume of EDTA used

B = mg of  $\text{CaCO}_3$ , equivalent to ml of 0.01m EDTA titrant.

(1ml of 0.01m EDTA = 1mg of  $\text{CaCO}_3$ )

**Estimation of Calcium:** To 50ml of the sample added 1ml of 1N NaOH and a pinch of Pattern and Reader's reagent. Titrated it against EDTA till the colour changed from pink to blue. Noted down the volume of EDTA used.

General calculation:

$$\text{Ca (mg/l)} = AXB \ 400.8/V$$

$$\text{Calcium hardness (mgCaCO}_3) = AXBX1000/V$$

Where,

A= volume of EDTA used

B= mg of  $\text{CaCO}_3$  equivalent to 1 ml of 0.01 m EDTA titrant. Standard EDTA titrant 0.01m is equivalent to 400.8ug

V= volume of the sample taken (ml)

**Estimation of Magnesium:** Mg was estimated by estimating total hardness and calcium hardness.

Therefore, Mg can be calculated easily by simple calculation from total hardness and calcium hardness as follows:

$$\text{Mg (mg/l)} = (\text{Total hardness} - \text{Calcium hardness}) \times 0.243$$

**Estimation of Chloride:** Chloride content was estimated by organometric titration method.

To 25ml of the water sample were added 2-3 drops of  $\text{K}_2\text{CrO}_4$  indicator. Then  $\text{AgNO}_3$  in the burette was titrated against the  $\text{K}_2\text{CrO}_4$  till brick red colour appeared. Recorded the volume of  $\text{AgNO}_3$  used.

General calculation:

$$\text{Chloride content (mg/l)} = N_2 \times V_2 \times 35.5 \times 1000 / V_1$$

Where,

$N_2$  = normality of standard  $\text{AgNO}_3$  solution

$V_2$  = Volume of  $\text{AgNO}_3$  used

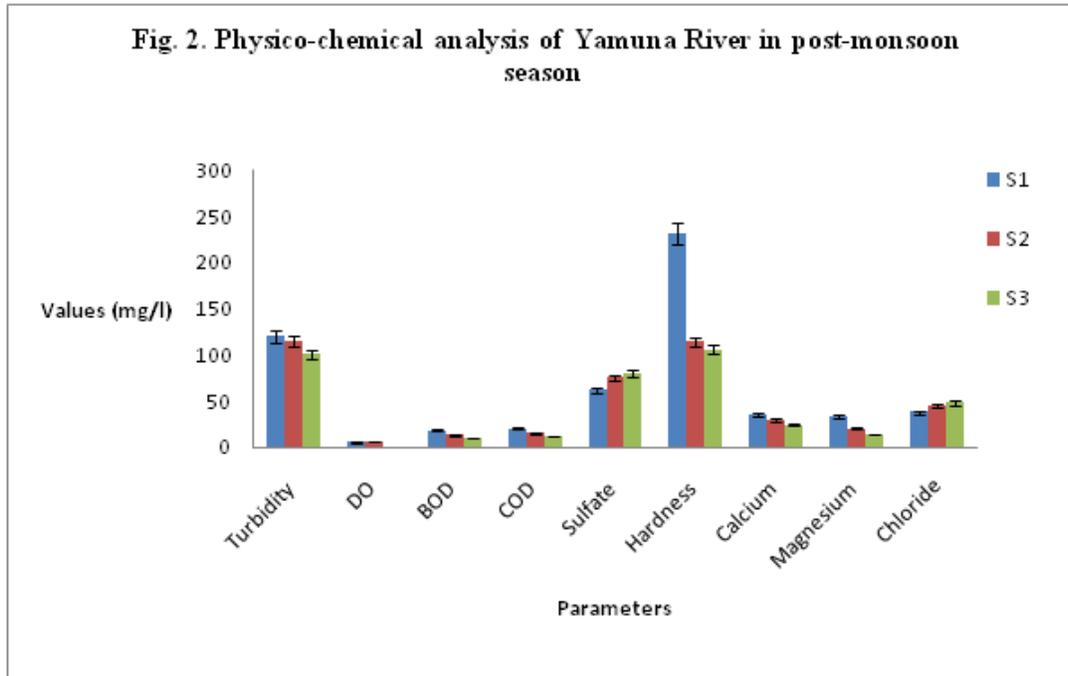
$V_1$  = volume of sample taken

### III. RESULT AND DISCUSSION

While comparing various parameters in pre-monsoon & post-monsoon season, data obtained have shown significant variation at ( $P < 0.05$ ) level.

Figure 1.

Figure 2.



The turbidity is important in aquatic systems as it can alter light intensities through the water column, thus potentially affecting rates of photosynthesis and the distribution of organisms within the water

column. Turbidity can be caused by high concentrations of biota such as phytoplankton, or by loading of abiotic matter such as sediments. If water appears muddy, its turbidity has reached at least 100 NTU (UW Extension). In present investigations, water has shown turbidity of 120 NTU in the post-monsoon season that is beyond the permissible limits (Fig. 2). DO is found to be increased in the post-monsoon season while in the pre-monsoon season it has low value (Fig.1). This may be due to addition of more water during rainy season. Certain DO levels have to be maintained in the rivers for the aquatic life.

BOD & COD at determine the organic as well as inorganic content in the water have also increased in the post-monsoon season. High concentration of BOD & COD is due to heavy sediments, organic matter and industrial pollutants added in during rainy days. Similar results were also found by Pande & Sharma, 1998. Ca, Mg, sulphate & Chloride concentration has shown significant increase in post-monsoon season. The sulphate concentration was higher in both seasons but tremendous increase in post-monsoon season. This may be due to surface run-off from the mineral rocks during rainy season. The investigation has shown that Yamuna water is hard in nature as hardness has crossed permissible limits in post-monsoon season.

In general, the concentration of pollutants was found higher in post-monsoon season. The different ions show different trends depending upon the discharge of different effluent drains. The contents of metal ions were higher during post-monsoon season. This may be due to flushing out of the effluent discharge from various industrial units through surface runoff. Therefore, the use of the Yamuna water for domestic supply is not safe without the proper treatment of water.

## CONCLUSION

The balance of untreated sewage, along with a significant quantity of partially treated sewage, is discharged into the Yamuna River every day. The river receives sewage and industrial wastes through various drains, which join the Yamuna River between Wazirabad and Okhla. It is clear from the results that in post-monsoon season, various parameters have shown significant variations in their concentration.

Therefore, in order to preserve the quality of river water, effluent discharge from various industries should be treated to an adequate extent. However, detailed studies need to be carried out to confirm this observation.

**Acknowledgement:** Authors are thankful to Head, department of biotechnology, Post Graduate College, sector-11 for providing all the support for testing.

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