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Research article

ACCELERALTED PHOSPHATE & NITRATE LEVEL: FACTORS TO BLAME FOR 'EUTROPHICATION' IN YAMUNA RIVER, DELHI, INDIA

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ABSTRACT: The study reflected the nitrate & phosphate level at ten preferred spots to assess the eutrophic level of River Yamuna, Delhi, in summer & monsoon season. Results have shown that phosphate & nitrate concentration was found to be increased during Monsoon season at all the sampling sites. The discharge of domestic and industrial wastes into the Yamuna River has caused huge pollution loads of nitrate & phosphate & has accelerated the process of 'eutriphication' in Yamuna River, Delhi. The physico-chemical characteristics, trophic status and pollution studies of Yamuna River intensively studied for summer & monsoon season 2011. Phosphates varied from 0.029 - 0.245 mgl $^{-1}$ during summers and from 0.038-0.256 mgl $^{-1}$ in monsoon. Likewise, nitrate concentration was higher during summers (1.38 – 2.9 mgl $^{-1}$) in comparison to winter season (1.51 – 3.1 mgl $^{-1}$). Studies have shown that nitrates & phosphates are in sufficient quantities for the growth of algal blooms in both the seasons. The algal blooms compete with aquatic plants for light for photosynthesis, thus deplete the oxygen for aquatic life. Moreover, these algal blooms also release some toxic chemicals which kill fish and other aquatic life, making the water body stink. They may also be added into the water bodies during water treatment, during laundering (as phosphates are major constituents of many commercially available cleansing materials), during agricultural run-off (as parts of many fertilizers). Monitoring of water quality is the first step that can lead to management and conservation of aquatic ecosystems. Hence, in the present study, an attempt was made to study the physico-chemical parameters especially phosphate and nitrate of Yamuna River flowing through Delhi NCR to arrive at certain conclusions on the structural and functional aspects of the river and to suggest ways and means for its conservation.
Key Words: Yamuna River, Water pollution, Nitrate, Phosphate, Eutrophication.

INTRODUCTION

India is facing a serious problem of natural resource scarcity, especially that of water in view of population growth and economic development. Water is a prime natural resource, a basic human need and a precious national asset and hence its use needs appropriate planning, development and management. However, studies related to ecology and environment are often perceived as 'anti-development' and detrimental to the overall growth and welfare of human beings and are viewed with suspicion and generally considered as nuisance. The trophic status of a water body depends on the locality and its topography. Of all renewable resources of planet, water has the unique place. It is essential for sustaining all forms of life, food production, economic development and for general well being. Due to tremendous development of industry and agriculture, the water ecosystem has become perceptibly altered in several respects in recent years and as such they are exposed to all local disturbances regardless of where they occur [13].

The increasing industrialization, urbanization and developmental activities, to cope up the population explosion have brought inevitable water crisis. The health of rivers and their biological diversity are directly related to health of almost every component of the ecosystem [9]. In freshwater bodies, nutrients play a major role as their excesses lead to eutrophication. Phosphorus and nitrogen are nutrients that are essential for aquatic plant and algae growth. Most waters naturally contain enough of these nutrients to support native aquatic life. However, an over-abundance of these nutrients can over-stimulate plant and algae growth such that they create water quality problems. Excessive macrophytic vegetation is indicative of the eutrophication status of any water body. Monitoring of water quality is the first step that can lead to management and conservation of aquatic ecosystems. It is also true that the management of any aquatic ecosystem is aimed to the conservation of its habitat by suitably maintaining the physico-chemical quality of water within acceptable levels.

Industrial wastes and domestic sewage are the major urban sources of nutrient overload, responsible for 50% of the total amount of phosphorus unloaded into lakes from human settlements [12]. Approximately 15% of the Indian population contributes phosphorus-containing wastewater effluents to rivers and lakes, resulting in eutrophication. Other sources that contribute to cultural eutrophication include the use of fertilizers, faulty septic systems, and erosion into the lake. Industrial agriculture, with its reliance on phosphate-rich fertilizers, is the primary source of excess phosphorus responsible for degrading rivers and lakes [4]. The routine application of chemical fertilizers and phosphorus-laden manure has resulted in the gradual accumulation of phosphorus in soil, which washes into lakes of the watershed where it is applied. On a global basis, researchers have demonstrated a strong correlation between total phosphorus inputs and algal biomass in lakes (Anderson *et al.,* 2002). Since 1950, phosphorus inputs to the environment have been in - creasing as the use of phosphate-containing fertilizer, manure, and laundry detergent has become more common [8]. Consequently, humans release 75% more phosphorus to the soil than would be naturally deposited by weathering of rock [3]. Even increases in minute amounts of the nutrient can stimulate tremendous growth and productivity [1]. According to an estimate, 400 grams of phosphates could potentially induce an algal bloom to the extent of 350 tons [10].
Therefore, these studies were initiated to monitor the nitrate & phosphate level in Yamuna River, Delhi to keep a check on 'eutrophic' conditions. In identifying sources of eutrophication, studies have observed a strong relationship between algal biomass and nutrient loading, with phosphorus being the primary limiting nutrient in freshwater bodies.

MATERIALS AND METHODS

Location of study area

Yamuna River, one of the most important Rivers of Indogangetic plains, originates from Yamnotri glacier near Banderpuch peaks of lower Himalayas (38° 59° 78° 27°) in the Mussorie range at an elevation of about 6320 meter above mean sea level in the Uttarkashi district of Uttarpradesh. It is the sub-basin of the Ganga river system. Out of the total catchment's area of 861404 sq km of the Ganga basin, the Yamuna River and its catchment together contribute to a total of 345848 sq. km area which 40.14% of total Ganga River Basin (CPCB, 1980-81; CPCB, 1982-83). The river water is used for both abstractive and in stream uses like irrigation, domestic water supply, industrial etc. It has been subjected to over exploitation, both in quantity and quality. Given that a large population is dependent on the river, it is of significance to preserve its water quality. The river is polluted by both point and non-point sources, where National Capital Territory (NCT) – Delhi is the major contributor, followed by Agra and Mathura. Approximately, 85% of the total pollution is from domestic source. 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° 4' N and 77° 2' E. It is also located within the basin of River Yamuna. The objective of this study is to assess the nitrate & phosphate content in summer & monsoon season to analyze the seasonal variability between these two parameters. The water quality analysis has been carried out for different samples in winter as well as summer season by selecting 10 sites (Fig.1) given below:

S1: Wazirabad Barrage, New Delhi (Entry point of Delhi)
S2: 2 Km away from Wazirabad Barrage (Sonia Vihar)
S3: 4 Km away from Wazirabad Barrage (Yamuna Vihar)
S4: 6 Km away from Wazirabad Barrage (Mukundpur)
S5: 8 Km away from Wazirabad Barrage (Burari Chauk)
S6: Okhla Barrage, New Delhi (Exit point of Delhi)
S7: 2 Km away from Okhla Barrage (Kalindikunj)
S8: 4 Km away from Okhla Barrage (Bakhtawarpur)
S9: 6 Km away from Okhla Barrage (Swarnim Vihar)
S10: 8 Km away from Okhla Barrage (Badshahpur)

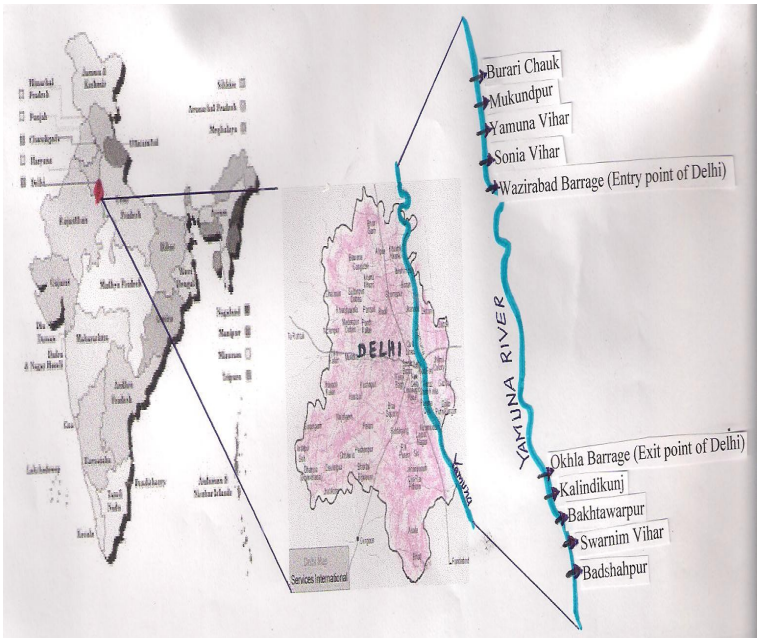

Fig.1: Location of study area

Sampling

The water samples were collected in triplicates from ten selected sites of Yamuna River flowing through Delhi region during April, 2010 to March, 2011. The high grade plastic bottles (500 ml) were dipped into the river water and after being filled, they were capped tightly, inside the river water, itself. Sampling bottles were kept in ice-box at 4^0C till they were transported to laboratory for experimentations.

Water Analysis

Phosphate &Nitrate content of the water samples was estimated by spectrophotometerically. Methodology is same as described by Kaur & Mehra, 2011.

RESULTS AND DISCUSSION

It is clear from Fig.2 that phosphate concentration was in the range of 0.029-0.245 mg/l during summer season whereas during winter, it was in the range of 0.038 & 0.256 mg/l. Phosphate concentration at S6 (Okhla barrage) is significantly ($p<0.005$) high in comparison to S1 (Wazirabad barrage) due to industrial activities. Also, all the sites have shown elevated phosphate concentration in monsoon season in comparison to summer season. Sites S5, S6, S7 & S8 have elevated phosphate concentration both during summer season & monsoon season. Elevated phosphate level in monsoon may be due to agricultural run-off from adjacent fields.

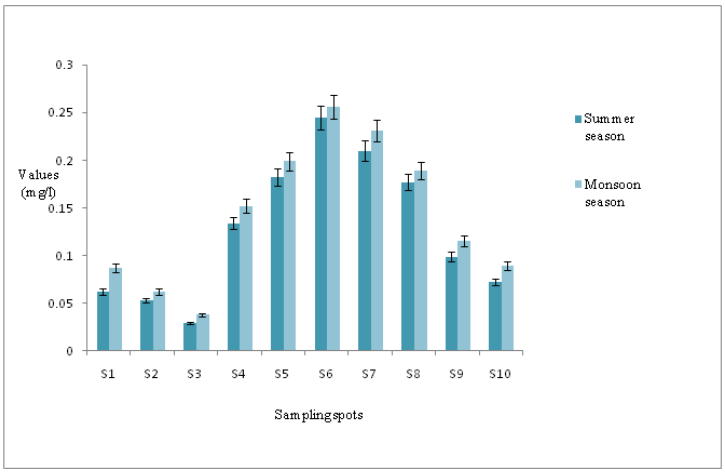

Fig.2: Phosphate concentration at selected points covering a stretch of 20Km around Wazirabad & Okhla barrage of Yamuna River, Delhi.

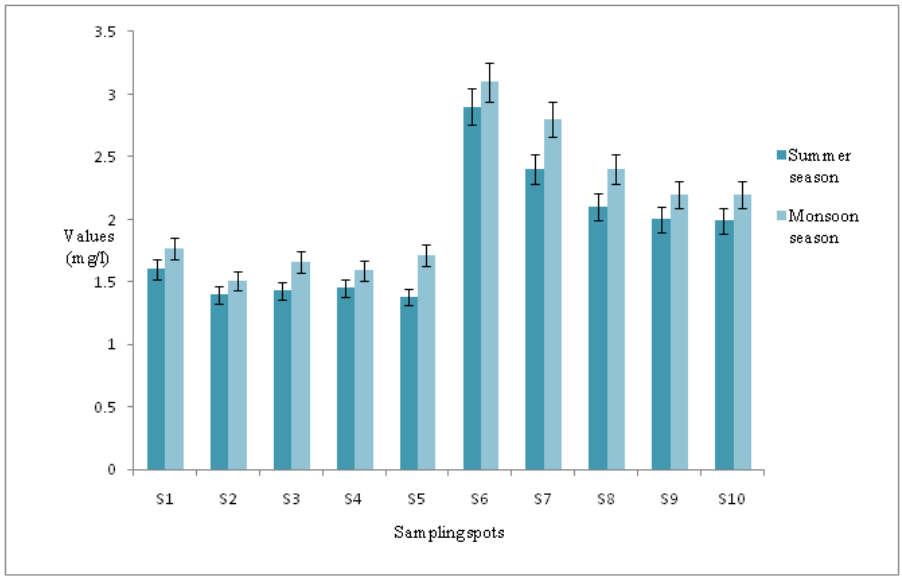

Fig.3: Nitrate concentration at selected points covering a stretch of 20Km around Wazirabad & Okhla barrage of Yamuna River, Delhi.

Nitrate concentration is also quite high in monsoon season in comparison to summer season.
Nitrate concentration fluctuated from 1.38-2.9mg/l during summer season whereas it varied from 1.51-2.8 mg/l during winter (Fig.3). Almost all the sites have shown significantly high ($p<0.05$) nitrate concentration in both the seasons. These findings are in accordance with [7]. Sudden rise in nitrate concentration at S6 (Okhla barrage) may be attributed to livestock's or agricultural farms located around the River at Okhla barrage. S7, S8, S9 & S10 have also shown significantly ($p<0.05$) high nitrate concentration.
It has been found out that nitrate & phosphate have shown remarkable increase in its concentration at S6 (Okhla barrage) in both the seasons. High concentration of these parameters had derived from anthropogenic sources like untreated domestic sewage, agricultural watershed & storm water containing nitrogenous compounds and sometimes increased nitrate content may also be caused by acid rain and exhaust gases [6].

CONCLUSION

Human-induced eutrophication has heavily degraded freshwater systems worldwide by reducing water quality and altering ecosystem structure and function. Population growth, industrialization and excessive use of fertilizers have resulted in disproportionate amounts of phosphorus in lakes stimulating plant and algae overgrowth. A solution to eutrophication, especially in developing countries is urgent since nutrient accumulation renders controlling eutrophication more difficult over time. Eutrophication into the water bodies makes the water bodies unfit for drinking and interferes with fishing and navigation. Steps should be taken to treat waste water before discharging them into the water bodies. Bacterial multiplication should be stimulated in order to reduce the amount of nutrients solublised in water. Method should be followed to check recycle of nutrients in the water bodies through harvest and removal of algal blooms upon their death or decomposition. In addition dissolved phosphates should be removed from water bodies using various techniques such as precipitation. New and innovative technologies have to be developed to limit phosphorus content in soil and runoff. At present, governments should implement more effective policies to regulate the industrial and agricultural sectors to reduce activities that contribute to eutrophication. It will be important to acquire the cooperation and understanding of these sectors to take greater measures to limit their nutrient loading.

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