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Comparative study of primary productivity in Yamuna River canal of different parts of Yamunanagar Haryana, India

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ABSTRACT

The present study discusses the primary productivity in the middle course of Yamuna River canal in Yamunanagar of Haryana, India by investigating different physico-chemical parameters like pH, temperature, TDS and DO with the help of water testing kit. The light and dark bottle technique was used to measure primary production. For estimating the primary productivity, various physico-chemical parameters is to be analysed and its study play a vital role in interpreting the health of aquatic water body. Three sampling locations were established along the course of the river at the average distance of 15 kms. starting from Dadupur head then at Yamuna Nagar and at last Radaur in March, 2015. Wide variations were observed in Temperature (15.9-16.8°C), pH (7.98-8.14), TDS (143-173 ppm), Dissolved Oxygen (7.64-8.56 mg/l), GPP (107.81-170.31 mgCm^{-3}water.hour^{-1}), NPP (25.31-120.42 mgC m^{-3}water.hour^{-1}). The overall average values for the GPP and NPP in Yamuna River canal, based on the data of all the three stations were 142.46 mgC m^{-3}water.hour^{-1} GPP & 55.59 mgC m^{-3}water.hour^{-1} NPP. The main focus of the study was to estimate the Net Primary Productivity in Yamuna River canal at various regions for analysing the water quality and find the pollution level due to increased anthropogenic activities in the region as the canal water utilizes for drinking, irrigation, industrial and several domestic purposes.

KEY WORDS: PRIMARY PRODUCTIVITY, GROSS PRIMARY PRODUCTIVITY, NET PRIMARY PRODUCTIVITY, COMMUNITY RESPIRATION

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INTRODUCTION

Haryana, unlike its neighbouring states, have no web of rivers. Ghagger, Saraswati, Markanda, Tangri and Yamuna are the main rivers flowing through the state, out of which Yamuna is perennial (Vats *et al.*, 2011). The most essential and prime necessity for performing life supporting activities is water (Gupta *et al.*, 2013). The most important freshwater resource is rivers on which most of the developmental activities like agriculture, industry, transportation, aquaculture, public water supply, etc. are dependent. Deterioration of the river water quality on large scale is due to huge loads of waste from industries, domestic sewage and agricultural practices (Khaiwal *et al.*, 2003). The water quality can be indicated and described by its physical, chemical and microbial characteristics (Dhembare *et al.*, 1997). Also it can be used to detect the effects of pollution on the water quality (Sujitha *et al.*, 2012). From the Ecological point of view to assess the quality of water, the important prime consideration is the analysis of physicochemical water parameters which tells the best usage of water for drinking, bathing, irrigation, fishing, industrial processing and other domestic purposes (Shinde and Nagre 2015). Any alteration in the physico-chemical characteristics of water adversely influences and disturbs the water quality which had a great impact on aquatic life (Malviya and Dwivedi 2015).

In aquatic ecosystems, autotrophs (algae, planktons, etc.) act as primary producers on which all the life forms depends (Ogbaugu *et al.*, 2011). To sustain a level of growth and respiration and to support a biological population, primary productivity is to be estimated (Bishnoi *et al.*, 2013).The basis of ecosystem functioning is the biological production of autotrophs which is manipulated by primary productivity of a water body (Mohanty *et al.*, 2014; Odum *et al.*, 1971). There is a main role of primary productivity in providing energy and organic matters to the entire biological community (Ahmed *et al.*, 2005). Light (solar energy) and nutrients are the main limiting factors to primary production in an aquatic ecosystem (Guildford and Hecky 2000; Simmons *et al.*, 2004), though distribution of phytoplankton (algae) are also affected by temperature and seasonal variations in light intensity (Vaillancourt *et al.*, 2003). Therefore, present studies have been undertaken to evaluate the water quality of Yamuna River canal in Yamunanagar District at three locations in terms of physico-chemical characteristics. An attempt has also been made to calculate numerical values of primary productivity to compare the water quality of Yamuna River canal at different location.

MATERIALS AND METHODS

The samples for the present study were collected from the middle course of Yamuna River canal of Yamunanagar district of Haryana, India. Three sampling locations were established along the course of the river at the average distance of 15kms, starting from Dadupur head then at Yamuna Nagar and at last Radaur in March, 2015.

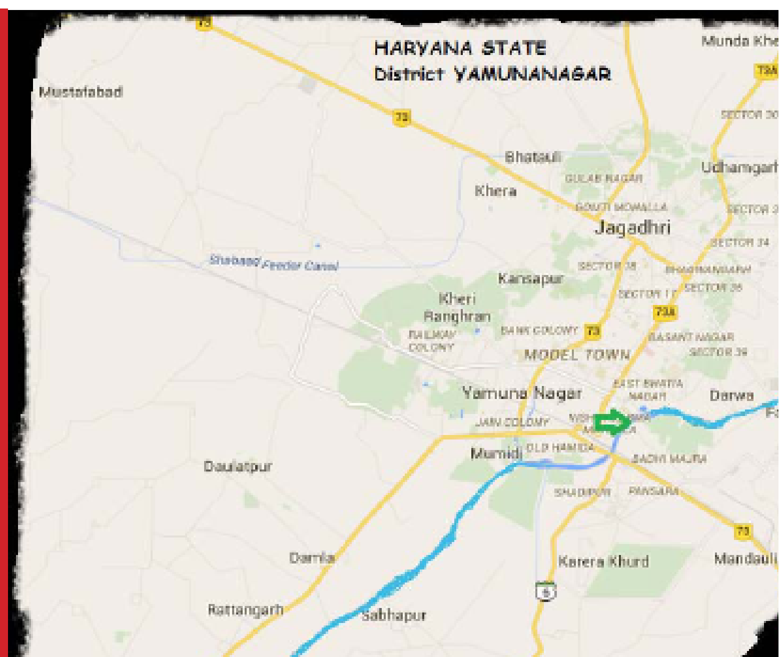

FIGURE 1: Three arrows shows the Yamuna River canal passing through Location 1, 2 and 3

TOPOGRAPHY

Yamunanagar lies in latitude 30° 5 North and longitude 77° 15' East. The district is bounded by the Yamuna River canal and across it by the Saharanpur district of Uttar Pradesh in the south east, Karnal district in south, Punjab in the north-west and Shivalik hills in the north-east (Vats *et al.* 2011). Total geographical area of the district is 1756 sq.km and comprises 4% of total area of Haryana State. Yamunanagar District is divided into one sub-division and six-development blocks viz. Bilaspur, Chachrauli, Jagadhri, Mustafabad, Radaur and Sadhaura. Atmospheric temperature ranges from between 6°C (January) to 49°C (May, June) and humidity could reach as high as 90%, usually during the wet season. The major activity of inhabitants of the area is farming, though some also engage in fishing and sand mining in this river.

Table 1: Latitude and Longitude of three selected sampling locations in Yamunanagar District

Sr. No.	Sampling Locations	Latitude	Longitude
1.	Dadupur Head (location 1)	30°20'	77°38'
2.	Yamuna Nagar (location 2)	30°12'	77°29'
3.	Radaur (location 3)	30°03'	77°17'

PHYSICO-CHEMICAL ANALYSIS

Various physico-chemical parameters like Temperature, pH, Total Dissolved Solids (TDS) and Dissolved Oxygen (DO) were determined to study primary productivity using Water Testing Kit by following standard methods (Rain and Thatcher 1990; Rao *et al.*, 1993; Clescerl *et al.*, 1993; Pelczer *et al.*, 1986; Jain and Jain 2007). A thermometer and pH meter was used to determine Temperature and pH of the water samples on the spot. DO was determined by BOD bottle method. Community Respiration (CR), Gross Primary Productivity (GPP) and Net Primary Productivity (NPP) were calculated by using the values of different parameters analyzed using the following formulas given in the Table 2.

Table 2: Formulas for calculating Gross Primary Productivity (GPP), Community Respiration (CR) and Net Primary Productivity (NPP) (Sreenivasan 1964)

Parameters	Formulas
Gross Primary Productivity (GPP)	GPP (mg C m-3 water hr-1) = (375)*(LB - DB) / PQ*T
Community Respiration (CR)	CR (mg C m-3 water hr-1) = (375)*(LB - IB)*(RQ) / T
Net Primary Productivity (NPP)	NPP (mg C m-3 water hr-1) = GPP - CR

RESULTS

The experimental data of physico-chemical parameters in the middle course of Yamuna River canal at different locations had been observed and noted at two different depths for the estimation of primary productivity in the river water to illustrate the water quality and study the influence of industrial effluents putting into the River.

TEMPERATURE

The highest and lowest temperature range of Yamuna River canal water sample as compared to location 2 is of location 3 and location 1 respectively shown in Figure 2.

ESTIMATION OF PH

The highest and lowest pH range of Yamuna River canal water sample as compared to location 2 is of location 1 and location 3 respectively. There is variation in the pH of water sample at different locations when measured at different depth shown in Figure 3.

Table 3: Physico-chemical characteristics and primary production of Yamuna River canal at 3 sampling locations.

Parameter	Location 1	Location 2	Location 3
Temperature(°C)	15.9±0.1	16.2±0.1	16.8±0.1
pH	8.15±0.02	8.02±0.02	7.99±0.02
TDS (ppm)	145±3.0	162±3.0	173±3.0
DO (mg/l)	8.55	8.12	7.64
GPP (mg C m-3 water.hr-1)	157.8	137.55	132.03
CR (mg C m-3 water.hr-1)	115.31	46.87	98.87
NPP (mgC.m-3water.hr-1)	42.49	90.68	33.59

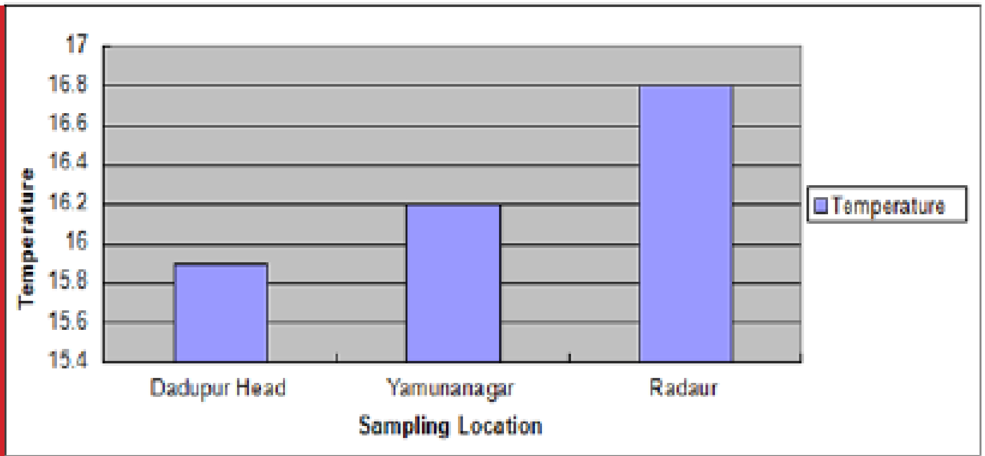

FIGURE 2: Variation in Temperature (oC) at three sampling locations

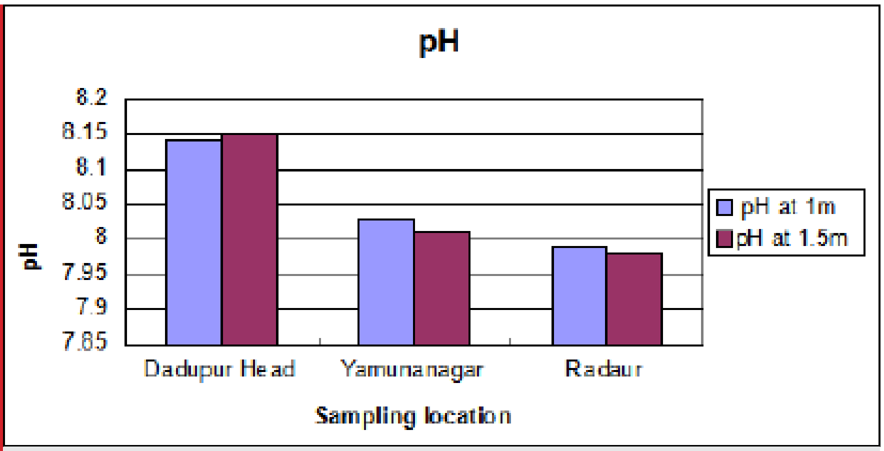

FIGURE 3: Variation in pH at three sampling locations

TOTAL DISSOLVED SOLIDS

The highest and lowest value of TDS of Yamuna River canal water sample compared to location 2 is of location 3and location 1 respectively. There is variation in the TDS of water sample at different locations when measured at different depth shown in Figure 4.

DISSOLVED OXYGEN

The highest and lowest value of DO of Yamuna River canal water sample compared to location 2 is of location 1 and location 3 respectively. There is variation in the DO of water sample at different locations when measured at different depth shown in Figure 5.

GROSS PRIMARY PRODUCTIVITY

The highest and lowest value of GPP of Yamuna River canal water sample as compared to location 2 is of location 1 and 3 respectively. There is variation in the GPP of water sample at different locations when measured at different depths shown in Figure 6.

COMMUNITY RESPIRATION

The highest and lowest CR range of Yamuna River canal water sample as compared to location 2 is of location 1 and location 3 respectively. There is variation in the CR of water sample at different locations when measured at different depths shown in Figure 7.

NET PRIMARY PRODUCTIVITY (NPP)

The lowest value of GPP of Yamuna River canal water sample as compared to location 2 is of location 3.Location 2 has maximum value of CR. There is variation in the GPP of water sample at different locations when measured at different depths shown in Figure 8.

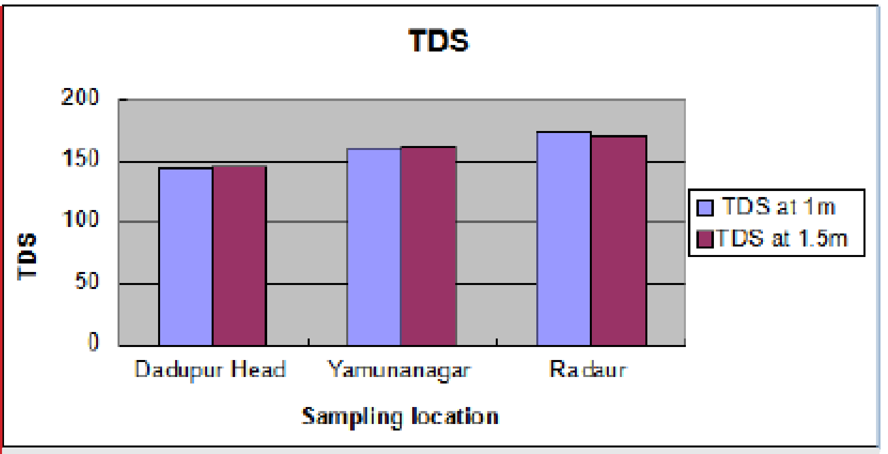

FIGURE 4: Variation in Total Dissolved Solids (ppm) at three sampling locations

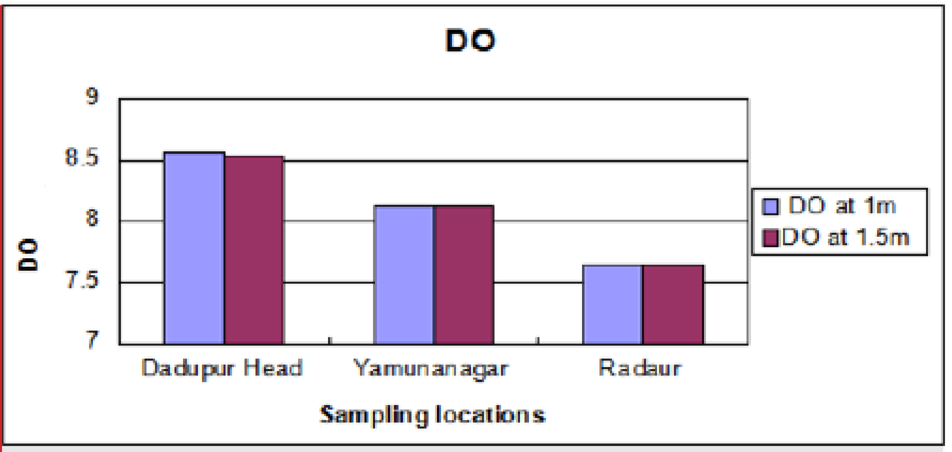

FIGURE 5: Variation in Dissolved Oxygen (mg/l) at three sampling locations

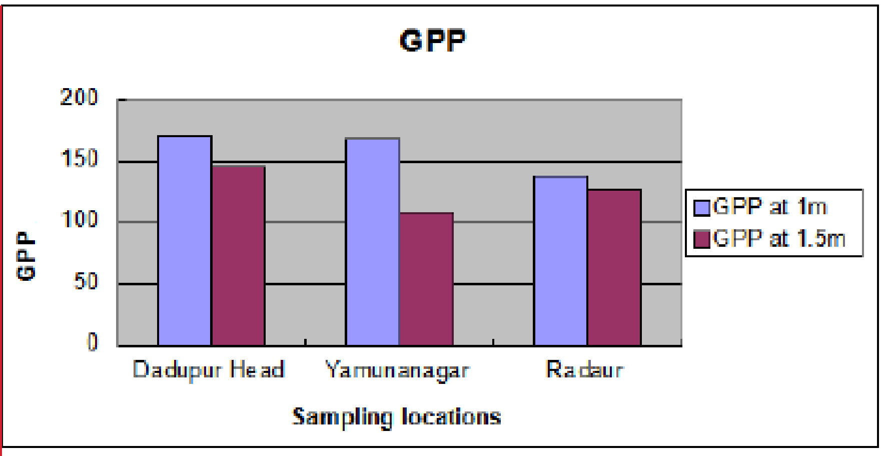

FIGURE 6: Variation in Gross Primary Productivity (mg C m^{-3} water hr^{-1}) at three sampling locations

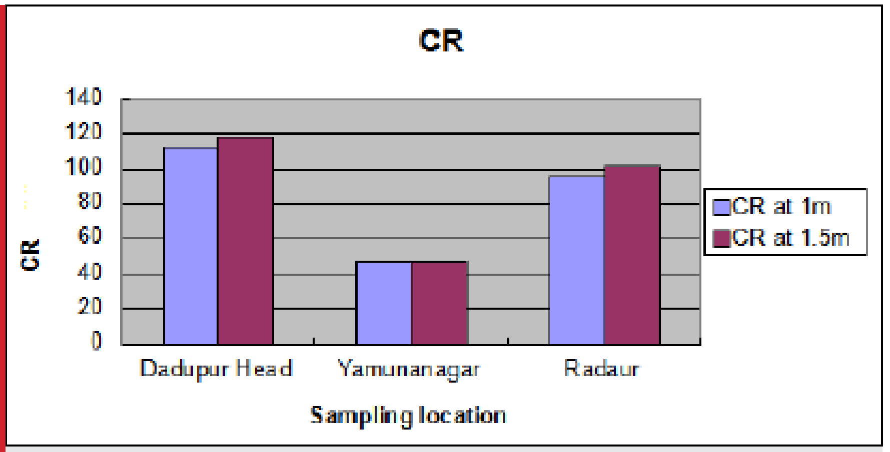

FIGURE 7: Variation in Community Respiration (mg C m^{-3} water hr^{-1}) at three sampling locations

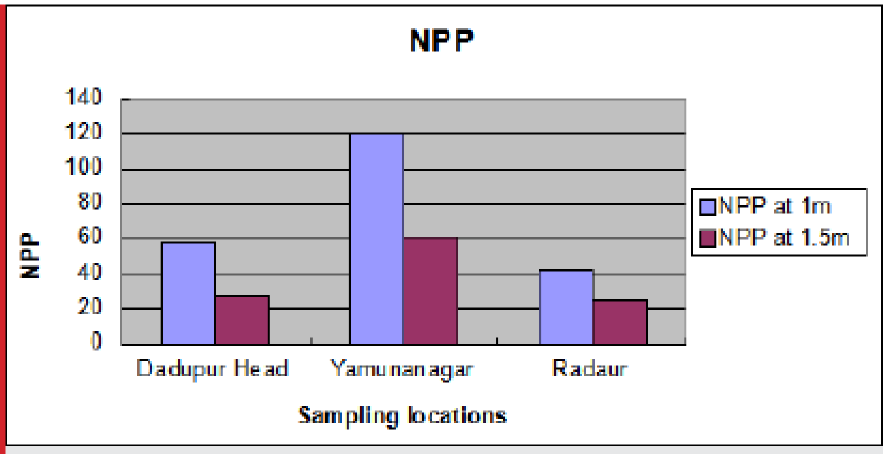

FIGURE 8: Variation in Net Primary Productivity (mg C m^{-3} water hr^{-1}) at three sampling locations

DISCUSSION

The industrial waste and domestic sewage affects the overall condition of the Yamuna canal water which is depicted by decrease in DO, increase in BOD, high ammonia, nitrite and low values of water quality indices (WQI) (Bhatnagar *et al.*, 2009). Very low DO and high Total Dissolved Solids (TDS), which were found to be important parameters for detecting river water quality illustrated the polluted water of Delhi downstream stretch and better quality of Delhi upstream stretch (Khaiwal *et al.*, 2003) High amount of organic matter under going biological degradation is the reason for the depletion of DO in water (Rim-Rukeh *et al.*, 2006). Temperature play an important role in influencing the pH, alkalinity and DO concentration in the water and lowering of pH in Delhi downstream is because of greater input of waste from different type of industries and sewage of Delhi. Flow of water in and out of an organism's cell (osmosis) can be determined by calculating the density Total Dissolved

Solids which is essential for the maintenance of aquatic life (Shinde and Nadre 2015). Physiological stress to fishes, phytoplankton and zooplankton is due to increased temperature, which not only reduced oxygen availability, but also increases oxygen demand (Desai 1995; Sharma and Selvaraj 2000). The high primary productivity promoting factor is considered to be alkaline pH (Khaiwal *et al.*, 2003). Low nutrient levels and high turbidity seems to be due to low productivity (Ogbuagu and Ayoade 2011). The decrease of oxygen in the dark bottles helps in determination of respiration rate which is given as their carbon equivalents (Rajyalakshmi *et al.*, 1975). Water quality of Yamuna is affected by the wastes from the industries, agricultural runoff and the drains carrying municipal sewage of the cities as the industrial belt of Haryana is mainly situated along the north- eastern part of the state along the Yamuna. According to the Central Pollution Control Board (CPCB, 2000), untreated sewage is responsible for 70% of the pollution in rivers which results in low DO and high BOD (Khaiwal *et al.*, 2003). According to the present study, location 2 seems to have the highest Net primary Productivity which is depicted by the lowest value of Community Respiration when observed under alkaline pH (8.02), temperature (16.2°C), TDS (162 ppm) and DO (8.12 mg/l) when compared with the location 1 and 3. Low Net Primary Productivity at Location 1 and 3 may be due to the addition of high amount of industrial wastes. Moreover domestic waste is added in high amount to Yamuna River canal located at location 1 and 3 as these are situated near rural area.

CONCLUSION

According to the physico-chemical parameters of Yamuna River canal it is concluded that NPP of different sampling location shows wide range of variations as follows:

Yamuna Nagar > Dadupur Head > Radaur

The highest primary productivity is found to be at Yamunanagar as compared to Dadupur Head and Radaur. This indicates that planktonic activity is greatest in Yamunanagar. This low productivity could be attributed to the observed low nutrient levels because of industrial effluents and high TDS (which exerts influences on photosynthetic activities of the autotrophs). Ongoing commercial sand mining in the river must have led to the depletion of nutrient stores, especially in the Benthal regions of the aquatic system. Due to addition of various products in river water the physiochemical characteristics of water changes. Industrial waste water drains are directly connected to the river & heavy metal pollution are occurred. The river pollution directly affect on the ecology, variation in the biotic factors. Therefore the present study deals with the water quality of Yamuna River canal and comparison was done to show the effect of industrial effluents and other anthropogenic activities. From the above results and discussions, we concluded that it is necessary to treat the water of Yamuna River canal and to establish efficient treatment plants by the effluents generating industries for maintaining the important parameters within the permissible limit prescribed by world health organization/Indian council of medical Research.

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