Research Paper

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A Study on the Impact of Short Term Climatic Fluctuations and Human Activities on Water Quality of River Yamuna in Agra

Environment

KEYWORDS : Climatic, Human, Quality, Sampling, Composite

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ABSTRACT

This study attempt to understand the impact of both human activities and short term climatic fluctuations on water quality of river Yamuna at four sites in Agra. First two sampling sites were taken 400 meter apart from each other near the point where river enters into Agra. Similarly remaining two sampling sites were taken 400 meter apart from each other near the point where river exits the Agra. Composite river water sample were collected from all the sampling locations on three dates i.e. on 1st March 2010, on 10th march2010 and on 30th March 2010 respectively. Water quality parameters such as Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), and Total Dissolved Solids (TDS) of the collected samples were monitored. Average values of temperature for 10 days and cumulative rainfall for all the days before the sampling date were calculated. Dissolved Oxygen (DO) was observed to be increasing from site 1 to site 4 on all three dates of sampling. Temporally DO was increasing from 1st March 2010 to 30th March 2010 at site 1. At all other site DO is increasing from 1st March 2010 to 10th March 2010 and then decreases from 10th March 2010 to 30th March 2010. Possible reason of these variations at site 2, site 3 and site 4 is that temperature has increased during the period from 1st sampling to second sampling which reduces the DO but simultaneously the impact of rainfall has been to dilute the pollutant thus leading to increase in DO after compensating for decrease in DO from 1st March 2010 to 10th March 2010. However during 10th March to 30th March 2010 temperature increase has been much more pronounced (more than 70c) as compared to previous duration therefore net result is decrease in DO insepite of some more rain added to the rain of previous duration. Biological Oxygen Demand (BOD) is observed to be decreasing from site 1 to site 4 on all three dates of sampling except on 30th march when BOD at site 2 is slightly more than that site 1. It may be due to some short term discharge or other human activities at site 2 during the period from 11th march 2010 to 30th March 2010. There is not much variation in TDS temporally at each site except at sit 2 where TDS is significantly more as compared to that on 1st and 10th march respectively. This may be due to some impurities added due to runoff because of additional rain during this period.

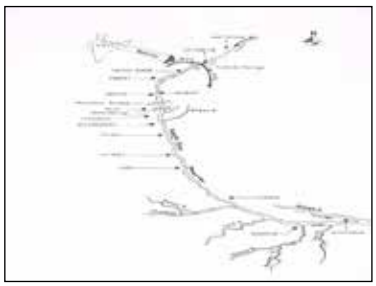
1. Introduction

Yamuna is the sub-basin of the Ganga river system. It is the largest tributary of the River Ganga. The main stream of the river Yamuna originates from the Yamunotri glacier near Bandar Punch (38o 59' N 78o 27' E) in the Mussourie range of the lower Himalayas at an elevation of about 6320 meter above mean sea level in the district Uttarkashi (Uttranchal). 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 major tributaries of the river are Tons, Betwa, Chambal, Ken and Sindh and these together contribute 70.9% of the catchment area and balance 29.1% is the direct drainage of main River and smaller tributaries. On the basis of area, the catchment basin of Yamuna amounts to 40.2% of the Ganga Basin and 10.7% of the country (Figure 1). The river is dissected at 5 barrages during its course i.e. at Dak Patthar (about 160 km from origin in Uttaranchal); at Hathnikund (172 km distance from origin, just at foothills in Haryana); at Wazirabad (in NCT Delhi, 396km distance from origin); at Okhla (in NCT – Delhi, 418 km distance from origin); and at Mathura (Near Gokul village in U.P. about 570 km distance from origin). These barrages are the major water abstraction locations on the river. The water is contributed into the Yamuna River, not only through its tributaries but also by the canals and drains from various urban centers.

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. Irrigation is the important use of Yamuna Water followed by domestic water supply, industrial and other uses. Unfortunately due to overexploitation and untreated waste discharge , certain stretches of River Yamuna are being extremely polluted. Various urban centers e.g. Delhi, Mathura, Agra etc., which are located on the banks of Yamuna river, draw fresh river water for various activities. In return, almost the entire wastewater generated by these centers. 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. The condition deteriorates further due to significant water abstraction which reduces the dilution capacity of the river. After Okhla barrage Yamuna, carry practically 95 % treated / untreated or recycled wastewater generated from townships, industries established on its bank. Both the east and west banks of the river stretch in Delhi are subjected to diverse anthropogenic activities. Biological life has been observed to be more affected on eastern bank of the river than on the western bank (Anand et al., 2002). Major industries contributing pollution load into Yamuna can be grouped into (i) Agro based units such as sugar mills, distillery etc (ii) Metal finishing units such as phospatising, Nickel & Chrome plating. Etc. (iii) Domestic residential habitats, which use soap, detergents & generate food waste etc. (iv) Rain runoff from agriculture fields (v) Textile industry which uses detergents starch dyes etc. (vi) Cooling & other wastewater from Mathura Refinery (vii) Silting at Gokul barrage

During monsoon period (July-September), the rivers receives significant amount of water, which is beyond its conveyance capacity resulting in flood. However during the non-monsoon period (October to June), the river flow reduces significantly to less than 0.012 m/s and some rivers stretches become totally dry (CPCB, 2006). River has Bloom of Blue green algae growth, which can be evident from, excessive use of Chlorine and other chemical to clear water from Suspended Solids at Agra water works. Normal aquatic life faces severe stress under those circumstances, it can be notices that Turtle, which were present till late seventies are now extinct. Most of surviving fishes and other Aquatic life component faces drop in Dissolved Oxygen thus facing threat to their life. Thus there is a need to assess the water quality variation of Yamuna in relation to variation in climatic parameter at different temporal scale. The Yamuna at Agra presents the most unaesthetic Scene leaving apart its poor quality from Delhi to Agra [Bhargava(1985c), Kumar (2004) and CPCB (2000) for the 1996 to 1998 data, HT(2004)]. Given that a large population is dependent on the river, and its significant to holy life and aquatic life it is of significance to preserve its water quality under different climatic conditions. This study has been done to understand the spatial and temporal variation trends of the water parameter/pollutant in the river water and to assess its dependency on climatic variations if any river at four different location in Agra.

Figure 1: Profile of River Yamuna (Source: CPCB 2006)



2. Methodology

2.1. Sampling Locations

Composite river water sample were collected from four different sites in Agra (Figure 2). First two sampling sites were taken 400 meter apart from each other near the point where river enters into Agra. Similarly remaining two sampling sites were taken 400 meter apart from each other near the point where river exits the Agra. First sampling location was chosen at the upper stream of Gailana village where depth and width of river were approximately 1.5 meter and 15 meters respectively. At this village Central Water Water Commission's gauge station is located. The site presents the water quality of river Yamuna before it enters Agra City. Second sampling location was chosen at 400 meter away from the first location where depth and width of river were same as in the case of first location. Third sampling location was taken at Taj Mahal when river is just about to leave Agra and fourth location were taken at 400 meter from third point where depth and width of river were approximately 1-1.3 meter and 12-13 meter respectively. Samples at each point were taken on three dates in March 2010. The date of sampling were on 1st March 2010, 10th march2010 and 30th March 2010 respectively.

2.2. Determining Water Quality Parameters of the Samples

Collected samples were analyzed to determine the water quality parameters in the environmental engineering lab of the college. Parameters analyzed were Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), and Total Dissolved Solids (TDS).

2.3. Monitoring of Weather Parameters

Since the facilities of monitoring of weather parameters were not available at the study sites, weather observations recorded by the automated weather stations at the campus of Hindustan College of Science and Technology which is about 25-30 Km away from the study sites were taken for the study. The characteristics of weather considered will not be much different than the weather which would have been actually recorded at the study sites. Hourly values of Wind speed, wind Direction, Temperature , Relative Humidity and rainfall were recorded from the period from February 15, 2010 to March 30 2010.

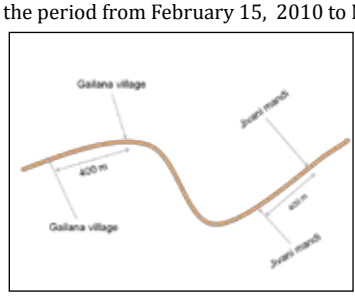


Figure 2: Sampling Locations

2.4. Analysis of Spatial and Temporal Variation in Water Quality Parameters in Relation to Short Term Climatic Variations

Average daily values of weather parameters were calculated from the hourly recorded weather variables. From this record average values of temperature for 10 days before each sampling date were calculated. Cumulative rainfall for all the days before the sampling date were also calculated to see if there is any impact of such variation in climatic parameters on water quality at the selected locations. Thus to see the impact of short term climatic variation on the river water quality on March 1, 2010, the average values of daily temperature and cumulative rainfall from February 18, 2010 to March 1, 2010 were considered. Similarly to see the impact of climatic variations on the water quality on 10th March 2010, the average values of daily temperature from March 1, 2010 to march 10, 2010 (with respect to average values from previous 10 days) and cumulative rainfall from 18th February to 10th March were considered. For 30th March average temperature between 10th to 30th march 2010 (with respect to average values from previous 10 days) and cumulative rainfall from 18th February 2010 to 30th March 2010 were considered. Water quality at each locations were analyzed with respect to these weather variations. Results are discussed in the following section

3. Results and Discussion

Spatial and temporal variations in Dissolved Oxygen at the sampling locations is shown in Figure 3 and variation in 10 days average temperature, humidity and cumulative rainfall before the sampling date is shown in Figure 4. DO is increasing from site 1 to site 4 on all three dates of sampling. Temporally DO is increasing from 1st March 2010 to 30th March 2010 at site 1. At all other site DO is increasing from 1st March 2010 to 10th March 2010 and then decreases from 10th March 2010 to 30th March 2010. Possible reason of these variations at site 2, site 3 and site 4 is that temperature has increased during the period from 1st sampling to second sampling which reduces the DO but simultaneously the impact of rainfall has been to dilute the pollutant thus leading to increase in DO after compensating for decrease in DO from 1st March 2010 to 10th March 2010. However during 10th March to 30th March 2010 temperature increase has been much more (more than 7^0c) as compared to previous duration therefore net result is decrease in DO insepite of some more rain added to the rain of previous duration. At site 1 the impact of these parameters seems to be very marginal.

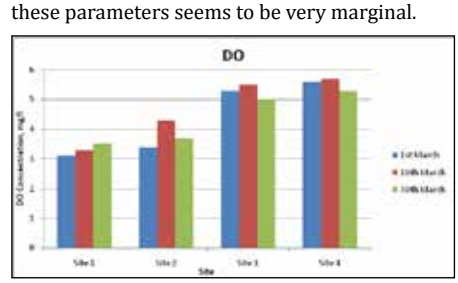


Figure 3: Spatial and Temporal Variations in DO of Yamuna Water at Different Sites in Agra During March 2010

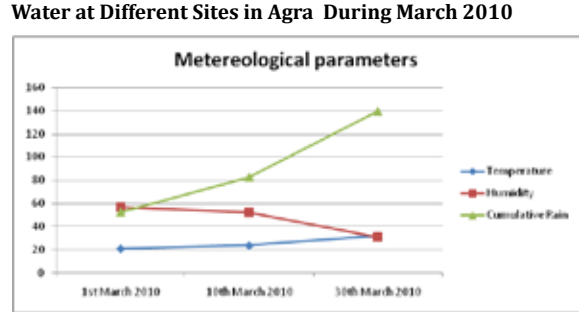


Figure 4: Average of 10 days (preceding the date of sampling) Temperature and Humidity and Cumulative Rainfall (since 18th February 2010) on the Date of Sample in Agra

Spatial and temporal variations in Biological Oxygen Demand (BOD) at the sampling locations is shown in figure 5. BOD is decreasing from site 1 to site 4 on all three dates of sampling except on 30th march when BOD at site 2 is slightly more than that site 1. It may be due to some short term discharge or other human activities at site 2 during the period from 11th march 2010 to 30th March 2010. Temporally BOD is maximum on 10th March 2013 at site 1, site 2 and site 3 whereas it is maximum on 30th march on site 2. Possible reason of these variations at site 2, site 3 and site 4 is that temperature has increased during the

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period from 1st sampling to second sampling which may have impact on increase in BOD. Impact of cumulative rainfall is not much pronounced on BOD during this period. However during 10th March to 30th March 2010 temperature increase has been much more (more than 7^0c) as compared to previous duration but some more rain is added to the rain of previous duration so some dilution may have taken resulting in marginal decrease in BOD.

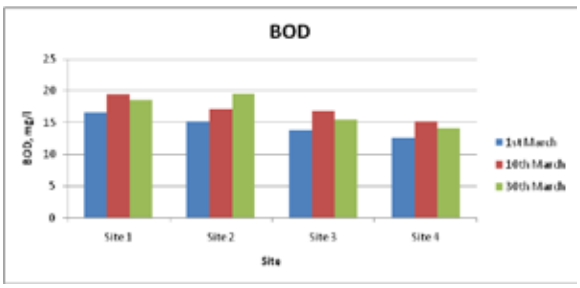

Figure 5: Spatial and Temporal Variations in BOD of Yamuna Water at Different Sites in Agra During March 2010

Spatial and temporal variation in Total Dissolved Solid in Yamuna water at Agra is shown in Figure 6. There is not much variation in TDS temporally at each site except at sit 2 where TDS is significantly more as compared to that on 1st and 10th march respectively. This may be due to some impurities added due to additional rain during this period. At site 4, TDS is slightly higher on 10th March 2010 as compared to that on 1st march 2010 and 30th march 2010.

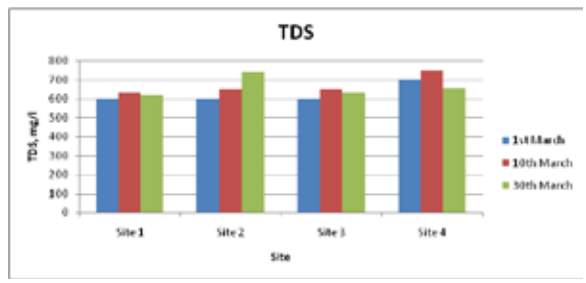

Figure 6: Spatial and Temporal Variations in TDS of Yamuna Water at Different Sites in Agra During March 2010

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