*International Research Journal of Environment Sciences*_____ ISSN 2319–1414
Vol. **5(1),** 39-42, January **(2016)** *Int. Res. J. Environment Sci.*

Effect of Anthropogenic activities on the Physico-chemical quality of River Rapti at Gorakhpur, India

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Available online at: www.isca.in, www.isca.me
Received 10th December 2015, revised 23rd December 2015, accepted 19th January 2016

Abstract

Anthropogenic activities on the banks of river in India like prayers, laundry, washing dishes and bathing strongly influence the hydrology and chemistry of river. These human activities lead to addition of tons of soaps and detergents in the river as the anthropogenic pressure on Rapti catchment is comparatively high near Gorakhpur city. The present investigation was therefore conducted to study the effect of these organic compounds coming from an area on the bank of river marked for washing clothes by the professionals (Dhobi ghat) on the physico chemical properties river Rapti. The results indicate a significant increase in the level of pH, total dissolved solids, chlorides, sulphate, free carbon dioxide, nitrate, phosphate, carbonate, bicarbonate, hardness, chemical oxygen demand and biological oxygen demand and a significant decrease in dissolved oxygen.

Keywords: Physico-chemical quality, river Rapti, Human activities, Soaps, detergents, surfactants.

Introduction

Anthropogenic activities like washing, bathing etc., are the tasks that require enormous usage of water, soap and detergents. Detergents are defined as organic compounds with both polar and non polar characteristics with different chemical components like surfactants, fillers, builders, bleaches, optical brighteners, enzymes, perfume and color. These can be ionic and non ionic and they make our clothes seem whiter or brighter by absorbing ultraviolet light and remitting blue light. Foam boosters add suds but do not improve the cleaning action, enzymes attack grim, soil and stains but cause allergies[1]. These detergents along with fillers and other useful agents like common salt are drained either into the drainage system or poured into the rivers leading to choking of sewage system, drains and pollution of river water. Salts like sodium sulphate drained with wash water can wreck havoc on septic system[2]. Hence, the main environmental impact of these detergents can be observed as their post use effect when the wash water is discharged into sewage system or in the river.

Ghai in his article, "Soap nut detergent-the best HE detergent" has reported detergent being used for daily laundry as one of the major pollutants responsible for water pollution[3]. Detergents are non degradable products and they remain in the environment for years. The effect of detergent pollution can be observed in the form mortality of several fishes and other aquatic creatures. Alternative remedial measures to counter the impact of detergents for controlling pollution can only be suggested by studying the impact of detergents towards water pollution[4]. Therefore, an attempt to study the effect of detergents dumped into the water of river Rapti, a tributary of Ghaghra near Gorakhpur, Uttar Pradesh, India is made in this study.

Materials and Methods

Sampling stations: Three water sampling stations were selected over 12 kms stretch of river Rapti. Station I (R_{H1}), upstream of Human activity area, Station II (R_{H2}): Human activity area where laundry is done by professional washer men in large quantities (Dhobi ghat) this was about about 6 kms away from the station I, station III (R_{H3}), downstream of human activity area that was about 6 kms away from station II.

Sample collection and their physico-chemical analysis: The study of the river Rapti at Gorakhpur was done for twelve months. Samples of river water were collected in summer, winter and rainy season from all three stations. Samples were collected in plastic bottles for physico-chemical analysis. For biochemical oxygen demand (BOD) and dissolved oxygen (DO) samples were collected in BOD bottles. Temperature, pH and dissolved oxygen were measured at the site.

Methods for analysis of physico-chemical parameters: The physico-chemical analysis was carried out using the methods given by APHA[5]. pH was measured using pH meter and temperature was measured using simple, mercury filled Celsius thermometer. Nitrate, phosphate and sulphate test kits were purchased from Hi-media Laboratories Pvt. Ltd., Mumbai, India.

Results and Discussion

The average physico-chemical quality of river Rapti at three

sampling stations in Gorakhpur during summer and winter season are presented in Table-1. Temperature of the river water changed throughout the year from a minimum of 20.2^{0}C in winter season at station R_{H1} to a maximum of 33.5^{o}C at station R_{H2} in summer season. The pH value of the river water at different stations was recorded to be within 7.9 at station R_{H1} in winter season to 8.5 at station R_{H2} in summer season. Electrical conductivity of water at different stations was recorded to be 208 at station R_{H1} in rainy season to a maximum of 318µmhos/cm at station R_{H2} in summer season. Total dissolved solids (TDS) varied from a minimum of 126 ppm at station R_{H1} in winter season to a maximum of 255 ppm at station R_{H2} in rainy season. Dissolved Oxygen (DO) ranged between a minimum of 3.5 ppm at station R_{H2} in summer season to a maximum of 9.0 ppm at station R_{H1} in winter season. Free CO_2 ranged between a minimum of 3.0 ppm at station R_{H3} in winter season to a maximum of 17.5 ppm at station R_{H2} in summer season. The value of chloride ranged from a minimum of 12.0 ppm at station R_{H1} in rainy season to a maximum of 270 ppm at station R_{H2} in summer season. The carbonate alkalinity varied from a minimum of 15.6 ppm at station R_{H3} in rainy season to a maximum of 24.4 ppm in summer season at station R_{H2}. Bicarbonate alkalinity varied from a minimum of 74 ppm at station R_{H1} in rainy season to a maximum of 510 ppm at station R_{H2} in summer season. Total hardness value varied from 120 ppm to 250 ppm. The lowest value was noticed at station R_{H1} in rainy season and highest at station R_{H2} in summer season. Value of calcium hardness varied between 38.3 ppm at station R_{H3} in rainy season to 156.9 ppm at station R_{H2} in summer season. The values of Magnesium hardness were ranging from a minimum of 10.38 ppm in rainy season at station R_{H1} to a maximum of 58.92 ppm in summer season at station R_{H2}. The lowest value was 0.029 ppm at station R_{H3} in winter season. The highest value was 0.72 ppm in summer season at station R_{H2}. The value of phosphate varied between a minimum of 0.012 ppm at station R_{H1} in winter season to a maximum of 0.28 ppm at station R_{H2} in summer season. The value of sulphate recorded from a minimum of 9.6 ppm in summer season at station R_{H1} to a maximum of 16.2 ppm in winter season at station R_{H2}. The BOD of river water varied from a minimum of 3.9 ppm station R_{H1} in rainy season to a maximum of 75.9 ppm station R_{H2} in summer season. The values of COD were recorded from a minimum of 22.4 ppm at station R_{H1} in rainy season to a maximum of 46.2 ppm at station R_{H2} in winter season.

Discussion: In present investigation the level of pH, TDS, free CO_2, carbonate and bicarbonate alkalinity, total, Ca and Mg hardness, chloride, sulphate, bicarbonate, nitrate, phosphate, BOD and COD significantly increased at wash water mixing point while a significant decrease in DO was observed at wash water mixing point. The reason for higher concentration of TDS, chloride, carbonate and bicarbonate can be attributed to the wash water that had powder detergents probably with excessive filler and builders that were used in preparation of the detergents. Xul reported that more than 2000 metric tones of washing powder every year is poured into Dianchi lake along with urban sewage causing damage to the environment[6]. The findings of the present study reconfirm the fact that the filler/builders used in detergents play a major role in chemical contamination of water. However, a change in these parameters was observed at the station away from wash water mixing point (downstream). The increase in the value of pH at station R_{H2} in comparison to stations R_{H1} and R_{H3} might be due to the addition of detergents. The higher value of pH of the wash water containing detergents is also reported by Goel and Kaur[4]. A highest value of electrical conductivity was recorded at station R_{H2} in summer season. This might be due to the addition of wash water into it. An increase in electrical conductivity is regarded as pollution indicator in water bodies[7,8]. Pollution in the river water due to mixing of wash water into it is also indicated by an increase in the TDS of station $R_{H2.}$ Water with high dissolved solid is of inferior quality and may induce adverse response in the body of the consumer[8,9] . Low level of DO is again indicative of polluted nature of water body as noted by Iqbal[10]. At station R_{H2} saturation level of dissolved O_2 was very low in winter. It may be due to high rate of oxygen consumption by oxidizable matter coming in along with wash water. Free CO_2 present in large amount at station R_{H2} can be attributed to high BOD load that comes with consumption of oxygen and release of CO_2 by the respiratory activity of the living organisms. Maximum values of free CO_2 recorded at station R_{H2} during summer might be due to acceleration in the rate of decomposition of organic matter by microbes, decrease of photosynthetic activity and high rate of respiration by benthic biota and microorganisms[11,12]. Maximum values of bicarbonates alkalinity recorded at station R_{H2} and R_{H3} were probably due to the input of wash water. Shah also noticed higher concentration of bicarbonate alkalinity in the wash water during the study of river Jhelum[13]. High fluctuation of Ca, Mg and total hardness were recorded at station R_{H2}. In the present study higher values of Ca, Mg and total hardness observed at all the three sampling stations (Table-1) may be due to input of wash water that contains organic matters. Cl_2 was found to be highly marked, higher values of Cl_2 recorded at station R_{H2} was due to the continuous influx of contaminated wash water. Similar results were reported by Sinha in the case of river Yamuna and river Damodar[12]. The maximum values of phosphate observed at station R_{H2}, in comparison to other stations throughout the study period may be due to the discharge of contaminated domestic sewage containing decayed organic matter[13,14]. Higher values of BOD were recorded at station R_{H2}, owing to high amount of organic matter. An increase in BOD is recorded as indicative level increasing pollution[12,15,16]. Station wise, maximum values of COD were recorded at station R_{H2} indicating presence of organic wastes in wash water.

Table-1
Physical and chemical parameters of summer, winter and rainy seasons in river Rapti at Gorakhpur

Tests	Stations									Between Stations	Between Seasons
	Summer			Winter			Rainy				
	R_{H1}	R_{H2}	R_{H3}	R_{H1}	R_{H2}	R_{H3}	R_{H1}	R_{H2}	R_{H3}		
Temp (^{0}C)	33.000	33.500	32.800	20.200	20.400	20.500	27.200	27.400	27.200		**(p<0.01)
pH	8.000	8.500	8.000	7.900	8.400	8.000	8.200	8.400	8.000	*(p<0.01)	
Elec Cond (µmhos/ cm)	223.000	318.000	218.000	210.000	243.000	212.000	208.000	254.000	209.000	*(p<0.01)	
TDS (ppm)	150.000	235.000	145.000	126.000	196.000	150.000	140.000	255.000	130.000	*(p<0.01)	
DO_2 (ppm)	8.000	3.500	7.000	9.000	3.600	8.400	8.500	3.800	7.800	**(p<0.01)	*(p<0.05)
Free CO_2 (ppm)	4.900	17.500	6.000	4.000	5.000	3.000	5.000	15.000	4.000	*(p<0.05)	
Cl_2 (ppm)	28.700	270.000	74.200	20.200	209.000	80.500	12.000	82.000	40.500	*(p<0.01)	
CO_3 (ppm)	20.000	24.400	19.800	18.500	20.500	18.000	15.800	18.200	15.600	*(p<0.01)	*(p<0.01)
HCO_3 (ppm)	426.000	510.000	344.000	229.000	318.000	204.000	74.000	102.000	98.000	*(p<0.05)	*(p<0.01)
Tot Hard (ppm)	178.000	250.000	122.000	182.000	230.000	158.000	120.000	197.000	195.000		
Ca Hard (ppm)	90.800	156.900	92.200	66.600	115.200	82.300	64.600	49.800	38.300		*(p<0.01)
Mg Hard (ppm)	15.130	49.840	15.510	18.770	58.920	12.320	10.380	35.450	20.560	*(p<0.01)	
NO_3 (ppm)	0.069	0.720	0.056	0.039	0.079	0.029	0.061	0.560	0.037	*(p<0.05)	
PO_4 (ppm)	0.230	0.280	0.035	0.012	0.019	0.015	0.028	0.260	0.018		
SO_4 (ppm)	9.600	15.500	11.500	10.600	16.200	12.600	10.400	15.800	11.800	**(p<0.01)	*(p<0.01)
BOD (ppm)	4.400	75.900	15.200	2.800	46.200	9.500	3.900	49.800	9.800	*(p<0.01)	
COD (ppm)	25.300	42.100	28.400	26.200	46.200	37.400	22.400	42.500	30.500	*(p<0.01)	*(p<0.05)

**(p<0.01) indicates highly significant differences, *(p<0.01) and *(p<0.05) indicates significant differences.

Conclusion

This study produces data to understand the pollution caused by major anthropogenic activity, washing clothes on the banks of river. Physico chemical characteristics of water changed significantly on the station where wash water that carried detergents as major pollutant mixed with the river. However the study also indicates that the parameters changed to normal downstream as no other point was observed from where waste water mixed with the river water indicating self purification capability of river.

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