IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 09, Issue 2 (February. 2019), ||S (II) || PP 27-37

Assessment of Ganga water contamination at Haridwar: Studies on Some Physico-Chemical and Microbiological Characteristics

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Abstract: The present investigation has brought out the ground truth, how religious festivals, customs and rituals play a far reaching role to lead the pollution of water. The strength of water pollution of the river Ganga and other streams fluctuates seasonally. Due to further supply of water through heavy rainfall, the DO, BOD, COD, Hardness, Alkalinity, Total Nitrogen in water, Heavy Metals, Detergents, Velocity, Temperature and pHlevel slightly fluctuates during the monsoon. It becomes alarming during the festivals as huge number of pilgrims and tourists gather from different parts of the country and world. Present study concluded that there were minor differences in physico-chemical parameters of all the three sampling stations selected for their study. Research show that all the parameters which have been studied are still under the standard limits but some of them are very closer to them is an alarm for increasing pollution status. Due to regular dumping of ashes and bones of dead body, effluents of industries, hotels and sewage water of city should be treated before mixing in the river Ganga. Besides, this much consideration should be paid to control the pollution maintain the limits. The study not only comprises all types of threats of the area but also comprises the suggestions and recommendations concerning the management of natural hazards and combating the illegal human interference on entire environment.

Keywords: Ganga River, pollution, physico-chemical parameters, DO, BOD, COD, Hardness, Alkalinity, Total Nitrogen in water, Heavy Metals, Detergents, Velocity, Temperature, pH

Date of Submission: 26-01-2019 Date of acceptance:09-02-2019

I. INTRODUCTION

The Ganges is one of the biggest Rivers in Asia. It ascends in the Himalaya Mountains and flows more than 2,500 km through India and Bangladesh into the Bay of Bengal. Be that as it may, the Ganges, India's heavenly River, is additionally a standout amongst the most contaminated. The Ganges River basin has a size of more than 1 million square km. It lies in a standout amongst the most crowded districts on earth. Around 500 million individuals, half of India's general populace, live in the Ganges River fields. There are numerous reasons for GangaRiver contamination. Around 2 million Hindus bathe in the River each day. Amid religious functions, up to a hundred million individuals clean their wrongdoings away in the Ganga River. They trust that washing in the River will make them pure. What's more, a great many bodies are incinerated close to the River, particularly around the heavenly city, Varanasi. The fiery debris is regularly discharged into Ganga.

The Ganga likewise gives water to cultivating land, which is expanding at a huge rate. Water system ventures cause dilute dimensions to come the River. An ever increasing number of dams are being raised along India's sacred River, chiefly to deliver vitality for Delhi and other vast urban areas in the zone. The River courses through 30 urban areas with a populace of more than 100,000 each. Consistently, 3 billion liters of untreated water from these huge urban communities go into the Ganga River, alongside stays of creatures. Industries along the Ganga River release several poisonous and toxic materials into the river. In some places they are a thousand times over the permissible limit. Especially India’s traditional leather industry needs great amounts of water. In addition, fertilizers from the fields discover their way into the ground water, and finally flow into the river. In total, the amount of industrial pollution has doubled in the past 20 years.

This far reaching contamination of the Ganga River has likewise prompted real medical issues. Numerous infections are normal, including cholera, hepatitis and diarrhea. While India's general population continues developing, an ever increasing number of individuals are leaving the farmland and moving to huge urban areas along the Ganga. Accordingly, the River won't have the capacity to adapt to significantly more individuals. Life in the River is additionally in danger. Latest reports have demonstrated that there is ahigh level of mercury in some fish. The development of dams is devastating woods and vegetation, murdering off numerous creature and plants. Indian authorities are fighting an upward battle towards cleaning up the Ganges

River. International organizations have offered help. The World Bank has consented to give India an advance of up to a billion dollars to tidy up the Ganga River.

II. REVIEW OF LITERATURE

Abdin (1948) examined the relationship of physical and compound qualities identifying with algal development in the River Nile. Giriffith (1955) broke down the microscopic fish yield in connection to certain physical and synthetic elements of Lake Michigan. Chakarbarty et al. (1959) made a quantitative investigation of tiny fish and physico-synthetic state of the River Jamuna at Allahabad. Das (1961) considers the hydrogen particle focus in new water pools of India. Deshmuk et al. (1964) dissected the physico-compound qualities of Kanhan River water of Nagpur. Lakshminarayana (1965) considered on the physico-chemical qualities of RiverGanga. Beam et al. (1966) made an investigation of a few parts of the River Ganga and Jamuna at Allahabad. Singh (1967) considers the phytoplankton and water temperature, silicon and pH in a lake in Delhi. Venkateswarlu (1969) made an investigation of the River Mossi at Hyderabad with extraordinary reference to physico-chemical edifices. Cosey and Newton (1973) assessed the substance organization and River of the River Frome and its primary tributaries. Aggarwal et al. (1976) examined the physico-substance characters of Ganga at Varanasi. Robinson and Kaller (1976) considered the correlation of the water attributes of four northern West Virginia Rivers. Kant and Anand (1978) dealt with between relationship of phytoplankton and physical factors in Mansarowar lake Jammu. Singh et al. (1982) considered the environment the River Nayar. Dobriyal et al. (1983) dealt with diurnal variety in hydrobiological parameters of two slope floods of Garhwal. Bhowmick and singh (1985) examined the phytoplankton populace connection to physico-synthetic factor for River Ganga at Patna. Dobriyal (1985) considered environment of "Chakagadera" a tributary of River Mandakini in Garhwal. Sharma (1986) dissected the impact of physico-chemical factors on Benthic fauna of Bhagirathi River at Garhwal Himalaya. Shiva Kumar et al. (1987) watched the impact of contamination on the physico-synthetic characteristics of the River Amaravati at Tamil Nadu. Bhattacharya & Saha (1988) made a relative investigation of the physico-substance properties and microscopic fish thickness of two River and a tributary of Gomti River in Tripura. Mowli and Seshaiah (1988) assessed nitrate defilement of ground water of Tirupati. Sinha et al. (1989) examined the physico-synthetic properties of River Ganga water at Kalakankar at Pratapgarh. Mittal and Sengar (1990) examined phytoplanktonic assorted variety in connection to certain physico-synthetic attributes of River water. Bisht and Chopra (1992) dealt with occasional diurnal cadence of some physio substance characteristics of the River Pinder of Garhwal Himalaya. Daker and Vashishtha (1992) watched the physico-compound parts of contamination in River Betwa. Dass et al. (1992) considered the physico-compound qualities of Brahmaputra water at Tezpur. Shukla et al. (1992) considered on the physico-synthetic and Bacteriological properties of the water of River Ganga at Ghajipur. Joshi and Bisht (1993) broke down a few parts of physico-synthetic qualities of western Ganga trench close Jwalapur at Haridwar. Joshi et al. (1993) made an investigation on the physico-compound attributes of River Bhagirathi in uplands of Garhwal Himalaya. Israili and Ahmad (1993) contemplated synthetic qualities of River Yamuna from Deharadun to Agra. Kapoor (1993) made physico-synthetic and natural investigation of four River at Bareilly. Pandey et al. (1993) made a starter examine on the physico-compound nature of water of the River Koshi. Saxena and Chauhan (1993) examined the physico substance parts of contamination of River Yamuna at Agra. Chopra et al. (1994) watched the impact of local sewage on self-cleansing of Ganga water at Rishikesh in reference to physico-synthetic parameters. Khan et al. (1994) made a complete report on water quality parameters on the River Ganga among Narora and Kannauj (U.P.) in reference of physico-compound attributes, Chopra and Rehman (1995) researched on the self purifiction of physico-chemical properties of Ganga River at Jwalapur Haridwar, Kataria and Jain (1995) broke down the physico-synthetic parameters of River Ajnar. Kataria et al. (1995) watched the physico concoction characterstics of water of Kubja River of Hoshangabad. Sahu et al. (1995) contemplated on some physico concoction attributes of the Ganga River water (Rishikesh-Kanpur) with in twenty-four hours amid winter. Joshi et al. (1996) researched the planktonic populace in connection to certain physico-substance components of Ganga channel at Jwalapur (Haridwar). Kataria (1996) assessed the BOD and COD substance in bore well water of Bhopal (M.P.) Kumaresan et al. (1996) examined the physico-substance and microbiological parts of courtallam water. Srivastava et al. (1996) revealed the phytoplankton efficiency and physico-synthetic properties of Repti River. Dutta et al. (1997) contemplated the physico compound qualities of water and spineless creatures in River Tawi close Nagrota sidestep Jammu. Gupta and Saxena (1997) evaluated the nitrate tainting in ground water of Agra and its connection with different water quality parameters including substantial metals. Joshi and Singh (1997) examined the phytoplanktonic populace in connection to certain physico-substance qualities of River Ganga at Rishikesh. Khanna et al. (1997) considered the number of inhabitants in green growth in connection of physico-compound components of the River Ganga a Lalji wala Haridwar. Khanna et al. (1997) examined the number of inhabitants in green growth in connection of physico-chemical components of the River Ganga a Lalji wala Haridwar. Khanna et al. (1998) made an investigation on phytoplanktonic networks in connection to certain physico-substance parameters of Ganga River at Haridwar.

Agarwal (1998) dissected the physico-synthetic part of ground water quality in Chikhli town of Buldana. Jameel (1998) made physico-substance contemplate in Uyyakondan channel water of River Cauvery. Mogal and Desai (1998) contemplated the physico-synthetic characters of River Purna at Nausari. Joshi and Singh (1999) investigated some physico compound estimations of River Ganga among Devprayag and Rishikesh. Gautam et al. (2000) broke down the diurnal variety in the physico-chemical qualities of Ganga water at Rishikesh amid winter period. Mishra et al. (2000) evaluated the dispersion of nitrate nitrogen in ground water in some dirt of Bihar. Seth et al. (2000) examined the some physico-compound characters in the River Ganga in connection of phytoplanktonic decent variety. Khanna et al. (2002) examined the effect of paper process effluents on some water parameters of Hindon River at Saharanpur. Kumar and Sharma (2002) considered the water nature of River Krishni with reference to physico compound parameters. Mahajan et al. (2002) discover the physic-synthetic and organic portrayal of the River Kunda at downRiver of Khargone (M.P.) Sarkar (2002) contemplated physico-compound attributes of Hindon and Narmada River. Ara et al. (2003) made an investigation on the physico-chemical qualities of Dal Lake of Kashmir Valley. C.P.C.B. (2003) distributed an investigate shading issue of River Ganga. Khanna and Bhutiani (2003) examined the limnology attributes of River Ganga. Pandey et al. (2003) explored the physico synthetic investigations of Ganga River at Haridwar amid Kumbh period (1998). Khanna and Chugh (2004) made an investigation of River Ganga in reference to microbial nature. Arora et al. (2005) contemplated the physico-substance attributes of Aachal Dairy process effluents. Khanna and Bhutiani (2005) considered the nature of River Ganga from Rishikesh to Haridwar. Khanna et al. (2005) made a physico-substance investigation of River Panvdhoi at Saharanpur. Deshmukh and Ambore (2006) considered the regular variety in physical parts of contamination in Godavari River. Khanna and Vats (2006) examined the biology of River Ganga at foot slopes of Garhwal Himalaya. Kumar et al. (2006) took a shot at some physico-chemical factors. Tyagi (2006) contemplated on the water nature of River Hindon. Singh (2006) contemplated the physico-compound characters of Yamuna at Yamuna Nagar. Dalal and Arora (2008) discover the occasional physico-chemical changes of water nature of River Hindon.

III. MATERIAL AND METHODS

For physico–chemical and Microbiological Characteristicsstudy of river Ganga water at Haridwar, the water samples were collected bimonthly and periodally from different sampling sites i.e. (A) near Alaknanda Ghat, (B) near LokNath Ghat and (C) near Matrisadan, Kankhal during October 2015 to April 2017 in morning hours (from 7:00 A.M. to 10:00 A.M.). The samples were taken in borosil glass bottles of 300 ml, plastic cans of 1 lt. from each location.The chemical used in the present investigation were of analytical grade and were supplied by B. D. H. India, E. Merck India and S. D. fine chemicals.For cleaning the glassware, washing soda or chromic acid was used.300 ml capacity BOD bottle made of borosil were used. They were washed with washing soda or chromic acid and rinsed with tap water followed by distilled water. The neck and stopper were wrapped by butter paper with the help of rubber band. Sterilization of the sample bottle was done in autoclave at 15 lbs/inch^2 pressure and 121°C for 20 minutes.Different volume size pipettes were washed and fitted with cotton plug at the upper end. These were wrapped in butter paper and sterilization was done in autoclave at 15 lbs/inch^2 pressure and 121°C for 20 minutes.

Borosil test tubes were washed and then plugged with non-absorbent cotton wool. These were arranged in test tube racks and sterilization was done in autoclave at 15 lbs/inch^2 pressure and 121°C for 20 minutes.For physico–chemical parameters and Microbiological Characteristics, Ganga river water samples were collected from three sites in plastic cans about ½ meter below the surface of water. Sampling for dissolved oxygen (DO) analysis was done separately.Sampling for dissolved oxygen and BOD were collected in clean and sterilized 300 ml capacity BOD bottles. The bottles were filled completely with Ganga water and stoppered was placed inside the water only. Immediately DO was fixed by adding 2 ml of each alkaline KI and $MnSO_4$ at the sampling site. While the sample for BOD was incubated for 5 days in BOD incubator at 20°C.Samples were analysed for the Physical Characteristics like Water Velocity, Water Temperature, Conductivity, Turbidity, Total Solids in water, Colour of water and Chemical Characteristics like Bio-chemical Oxygen Demand (BOD), Chemical Oxygen demand (COD), pH of water, Dissolve Oxygen in water (DO), Total Nitrogen in water, Heavy Metals (Cd, Pb, Hg, Ni), Detergents (Sulphate, Phosphate, Carbonate), Velocity, Temperature, pH, DO, carbonate were analysed immediately after sampling.

IV. RESULT AND DISCUSSION

Haridwar is one of the primary towns when Ganga rises up out of the mountain and contacts the plaines. The water in the Ganga River is generally clear and cold with the exception of in the rainyperiod, during which soil from the upper regions flows down in to it. Different investigations demonstrate that contamination in Ganga begins from Rishikesh and continuously increments in Haridwar. In Haridwar contamination of Ganga has turned out to be serious to the point that washing and savoring the water has turned out to be exceptionally

hazardous. It very well may be well felt this contaminated River water conveys an assortment of toxins of similarly unique physico-chemical nature and Microbiological Characteristics.

The velocitystarted increasing from May onwards due to melting of snow at this place of origin of water. In the present study average velocity of water at different sampling site, maximum range varied from 1.90 m/sec. Annual average of maximum range of velocity of water was observed at sampling site B i.e. 0.98 m/sec ± 0.05 and minimum range was observed at sampling site A i.e. 0.70 m/sec ± 0.03

In the present study, a difference in the fluctuation of watertemperature was observed 10.80°C ± 0.35 to 11.50°C ± 0.35 (minimum) in the month of January in winter period and 19.00°C ± 0.00 to 20.8°C ± 0.00 (maximum) in summer in all the three sampling sites. Annual average value of temperature varied between 16.89°C. Minimum average value of temperature was observed at sampling site C, 16.89°C ± 0.21 and maximum was observed at sampling site A, 17.08°C ± 0.09. The Ganga River water temperature indicatedarising trend from winter period to summer period followed by descending from monsoon period onwards.

The present study showed average conductivity fluctuation of 0.98 m S/cm ±0.02 to 1.08 m S/cm ± 0.01 in all the three sampling site. It can be said that the presence of higher conductivity values in July (monsoon period). From monsoon period onwards the conductivity decreases and the lowest conductivity 0.20 m S/cm was observed in winter period.The water becomes turbid on or after summerperiod and in rainy period the water was extremely turbid. It showed that turbidity and total solids were closely interrelated with one another. Annual average value of turbidity varied between 3.97 NTU ± 0.27 to 3.86 NTU ± 0.28.

The total solids were maximum in monsoon period 3080 mg/l ± 1025.30 and minimum 140 mg/l ± 14.14 in winter period. The total solid varied between 594.98 mg/l ± 4.12 (at site B) to 709.15 mg/l ± 6.48 (at sampling site C).The water Colour in Haridwar was pure and bluish in the month of October and November. After November the colour appears to be greenish up to the month of April because of algae and phytoplankton proliferation. In the month of May the water colour of Ganga becomes slightly turbid because of the melting of snow and progressively fluctuates to turbid onward in monsoon period due to rains.

The Biochemical Oxygen Demand (BOD) was maximum (3.85mg/l ± 0.14) in monsoon period and minimum (1.79 mg/l ± 0.00) in winter period. The annual average value of Biochemical Oxygen Demand ranged between 2.61 mg/l ± 0.04 to 2.79 mg/l ± 0.03. The minimum value was found at the sampling site B, and maximum in year at sampling site A. Highest annual average value of bio chemical oxygen demand at sampling site A may be due to drainage of several small sewage drains into the river and runoff of sludgy silted sewage during months of rainy period.Chemical Oxygen Demand (COD) represents chemicallyoxidisable load of organic matter in water. It was noted highest (6.75 mg/l ± 0.07) in monsoon period (July) and minimum (2.69 mg/l ± 0.03) in winter period (February). The annual value of COD ranged between 4.30 mg/l ± 0.12 to 4.70 mg/l ± 0.00 where least average value was found in sampling site B and maximum at sampling site A.

It was recorded that pH wasalways slightly alkaline at all the three sampling sites. The Ganga River at Haridwar showed high pH value 8.30 ± 0.00 in winterperiod and minimum pH value 7.84 ± 0.03 was observed in rainy period. The annual average pH value varied between 7.80 ± 0.02 to 7.87 ± 0.00. Maximum annual value was recorded at sampling site C and minimum at sampling site A.Maximum dissolved oxygen was recorded 12.39 mg/l ± 0.28 in in the month of February (winter period). The minimum value of dissolved oxygen 7.51 mg/l ± 0.21 was observed in July (monsoon period). The annual average value of dissolved oxygen ranged between 9.29 mg/l ± 0.12 to 9.49 mg/l ± 0.05 where the minimum annual average value of DO was observed at sampling site C and maximum at sampling site A.

The value of totals nitrogen was observed high in the summer(June) 0.48 mg/l ± 0.07 and decreased from summer when water level increased. Lowest value 0.07 mg/l ± 0.01 of total nitrogen was noted in winter period. The annual average value of total nitrogen fluctuated between 0.21 mg/l ± 0.01 to 0.28 mg/l ± 0.00, whereas the minimum annual average of total nitrogen was observed at sampling site C and maximum at sampling site A.

In the present study of heavy metal Cd, Pb, Hg, Ni, Pb ranged between 0.0012 mg/l ± 0.0005 to 0.0017 mg/l ± 0.0009. The minimum value was found in winter period and maximum in monsoon period at all the three sampling sites.

In the present investigation it was noted that the Sulphate wasmaximum in monsoon periodperiod (19.10 mg/l ± 0.70). The Sulphate was recorded minimum 15.00 mg/l ± 1.00 in winter period. Annual average values of total Sulphate varied between 15.23 mg/l ± 1.53 to 16.79 mg/l ± 1.76. Minimum average value of Sulphate observed at sampling site B and maximum at sampling site A. Minimum value of phosphate was observed during summer 0.96 mg/l ± 0.02 and maximum value during monsoon period (1.30 mg/l ± 0.10). Annual average of total phosphate varied between 0.90 mg/l ± 0.04 to 0.98 mg/l ± 0.05 in which minimum average value obtained from sampling site B and maximum from sampling site A. Maximum carbonate value (4.40 mg/l ± 0.20) in Ganga river was found in sampling site B and minimum (4.1 mg/l ± 0.10) in sampling site C in summer period. In monsoon and winter period it was found to be nil.

Bacterial parameters serve as indicators of fecal pollution. Coliform group of bacteria include genera *Escherichia* and *Aerobacter*. The values of standard plate count (SPC) and most probably numbers (MPN) were ranged at different sampling sites of near Alaknanda Ghat, near LokNath Ghat and near Matrisadan, Kankhal and these were quite higher to the values of SPC and MPN. Among different sampling sites the most values of SPC (5.8×106 SPC ml -1) and MPN (3.9×108 MPN100 ml -1) were observed and it is likely due to the mass bathing and to perform of various religious rituals.

V. CONCLUSION

The water nature of Ganga, the biggest River in Indian sub-continent and life line to many million individuals, has extremely weakened. Studies have demonstrated the presence of several cancer-causing components in Ganga river water. Flow information examination demonstrated that Ganga water quality is breaking down step by step and at a few places even in upper stretch of Ganga the water isn't reasonable for household employments. In spite of the fact that there is certain effect of restriction on persistent pesticides with diminishing pattern of pesticide buildups in Ganga water, the expanding pattern of follow and dangerous components is disturbing and the drag out introduction to contaminated Ganga water and additionally utilization of Ganga water fishes may cause genuine disease including malignancy. Examinations demonstrate that every one of the parameters contemplated are still under as far as possible however some of them are closer to them is an alert for expanding contamination status of River Ganga. Because of ordinary dumping of slag and bones of cadaver, effluents of ventures, ashrams, inns, visitor houses, nallah of several Ghats and sewage water of city ought to be treated before blending in the River Ganga. In addition, this much consideration ought to be paid to control the contamination keep up the parameters.

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IOSR Journal of Engineering (IOSRJEN) is UGC approved Journal with Sl. No. 3240, Journal no. 48995.

Priyvrat Singh Chauhan. "Assessment of Ganga water contamination at Haridwar: Studies on Some Physico-Chemical and Microbiological Characteristics." IOSR Journal of Engineering (IOSRJEN), vol. 09, no. 02, 2019, pp. 27-37.