An Assessment of the impact of sewer drains on the main canal of River Ganga, within Haridwar city, Uttarakhand, India

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Abstract: This report presents results on some selected physico-chemical (Temperature, pH, Turbidity, Velocity, Total Solids, Dissolved Oxygen, Bio-chemical Oxygen Demand and Chlorides) characteristics of three selected sewer drains at Govind Puri, Jatwada Pul-I and Jatwada Pul -II within Haridwar city, analyzed during 2010-11 and their immediate influence on the Ganga river canal. It was found that the Jatwada pul-II drain is the most polluting one than other two drains. The relative difference between Jatwada Pul-II and reference site was, DO 760% lower, BOD 2422.08% higher, Turbidity 534.78% higher, TS 371% higher and Chlorides 217% higher in the Jatwada pul sewage drain-II than the reference site (Prem Nagar Ghat) of the study. BOD (2422.08%) showed maximum difference while the pH (6.57%) value showed minimum difference in the Jatwada pul-II sewer drain in comparison to reference site. It was also found that rural community is responsible for the water quality degradation in Ganga river canal.

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Key words: Sewer drains, dilution, confluence zone, Ganga River canal, water quality degradation

1. Introduction

In most of the developing cities sewage water pollution, is one of the major problems, which creates lot of health issue as well as environmental pollution. In developing countries, many people are still facing the scarcity of clean water, beside other basic sanitations. Sewage disposal affects people's immediate environments and leads to water-related disease such as diarrhoea that kills 3-4 million children each year, beside other water-related diseases, which could kill 135 million people by 2020 has been reported by **Gleick (2002).** Fast urbanization and industrialization resulting in discharging of untreated waste water, coupled with massive abstraction of water for irrigation, industrial and domestic use, are main cause of water quality degradation of Ganga River. About 12,222 million liter of domestic and 2500mld of industrial waste water is generated per day in the entire Ganga basin **(Trivedi 2010).**

A variety of activities related to development, industrializations and religio-touristic industrialization quality contribute towards increasing quality deterioration within Haridwar city. The city municipality, established in 1968, so far could does not use any modern technique effectively for the sewage treatment within Haridwar city and large part of this sewage is routinely disposed directly in to the canal of the Ganga River. Therefore, the major source of this canal pollution is discharging of untreated domestic waste from the fast growing urban centers located along the river which is mostly organic waste, sewage, trash and food item. About 14 to 16 domestic sewer drains are routinely falling directly in to Ganga River canal within Haridwar City.

2. Materials and method:

In the present study water samples were taken from reference site (Prem Nagar Ghat) and three sewer drains within Haridwar city and samples taken from three different points from each sewer drain during the year of 2010-11.

Reference Site: Prem Nagar Ghat (station) was chosen for reference site because there is no affect of the selected sewer drains and Govind Puri Drain is 500 meter down to the Prem Nagar ghat.

The selected sewer drains were:

Govind Puri sewer drain- It receives about 300 house hold sewage from different colonies like as Govind Puri colony, Tibadi, Ranipur more and nearest area and finally falling in Ganga canal near Govind Puri Ghat.

Jatwada Pul sewer drain-I- It receives the sewage from 250 houses, typically belongs to rural community. Colony Kassa Baan, Kasaiyon ka mohalla, and colonies near unchi sadak are lives around this region and finally falling in to Ganga canal near Jatwada Pul (Bridge). It distance from Govind Puri drain is about 3km.

Jatwada Pul Sewer drain-II- It receives the sewage about 400 houses from Subhash Nagar, Ghas mandi, Id Gaon, Kadach colony and other rural communities which live periphery of Ganga canal. This drain falling in to Ganga river and its distance from Jatwada Pul-I drain is about 1.5km.

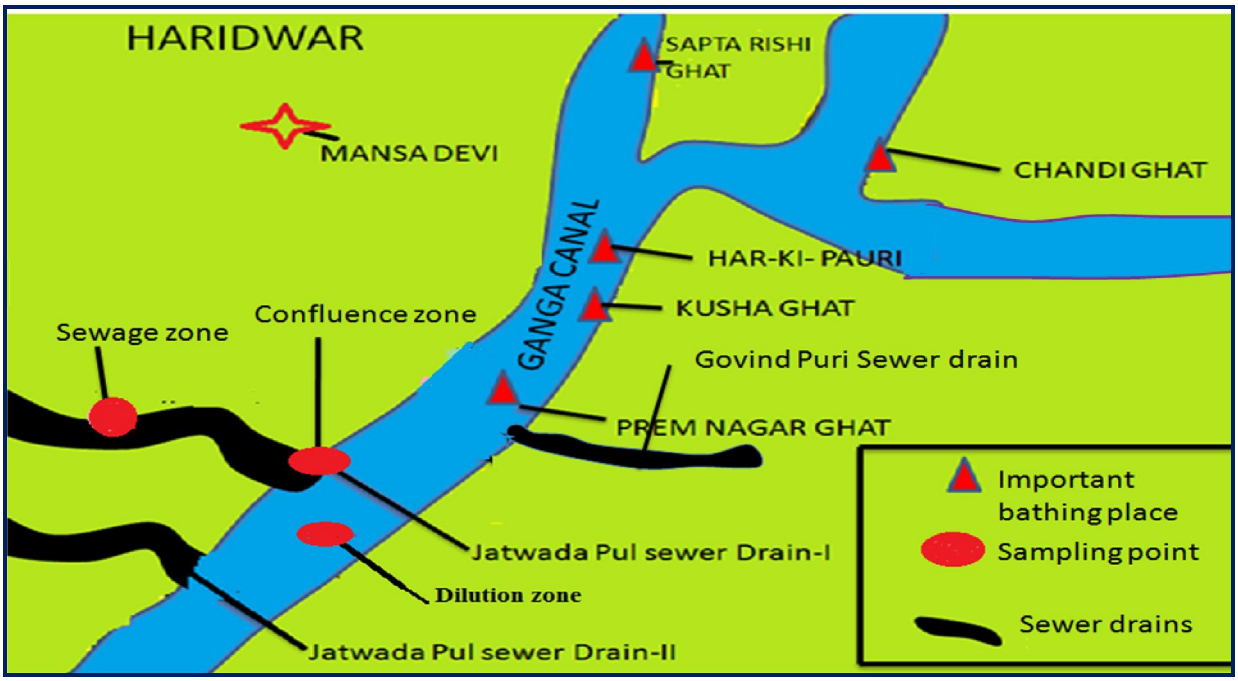


Figure 1- Map Showing Sewer Drain and important bathing place at Ganga River within Haridwar City

Fig2. A-D showing reference site and different Sewer Drain within Haridwar City

Three different points selected from each sewer drain and they were:

(i) Main sewage

(ii) Confluence zone of sewer drain and Ganga canal

(iii) Dilution zone between 400 -500 meters down to the confluence zone.

Monthly samples were taken from three points of each sewer drain round the year of 2010-2011. Some Physico-chemical parameters analyzed on spot like as temperature, pH, turbidity, with the help of soil and water analysis kit Model no.191E, velocity measured by the cork method and some parameters like DO, BOD, TS and chlorides were analyzed in the laboratory by the help of standard methods of APHA (1995) and Trivedi & Goel. (1986).

3. Results

In the present study significant difference was found in the water quality of reference site, sewage, confluence and dilution zone of three selected sewer drains. Physico-chemical parameters are affected by solid waste generation, household products, rural community, mismanagement of municipality, urbanization and other anthropogenic activities.

The comparative annual mean value and range value of physico-chemical parameters of three sewer drains are described below and also summarized in Table-1.

Temperature: The value for individual observations for temperature of reference site and three sewer drains at different zones ranged between 11.20-28.8 for reference site in the month of January and sewage zone of Jatwada Pul sewer drain-II for the month of June, respectively, the lowest and highest value recorded. The maximum mean value of temperature (21.05^0C) was at sewage zone of Jatwada Pul-II Sewer drain while minimum mean value of temperature (17.60) was at reference site.

pH: The value for individual observations for pH of reference site and three sewer drains at different zones ranged between 7.1-8.52 for sewage zone of Jatwada Pul sewer drain-I for the month of June and reference site in the month of January, respectively, the lowest and highest value noted. The maximum mean value of pH (8.25) was at dilution zone of Jatwada Pul-II Sewer drain while minimum mean values of pH (7.60) was at sewage zone of Jatwada Pul-II Sewer drain.

Velocity: The value for individual observations for velocity of reference site and three sewer drains at different zones ranged between 0.50-2.75 for confluence zone of Jatwada Pul sewer drain-II in the month of January and sewage zone of Jatwada Pul sewer drain-I for the month of September, respectively, the lowest and highest values measured. The maximum mean value of velocity (2.17) was at sewage zone of Jatwada Pul-I Sewer drain while minimum mean value of velocity (0.68) was at confluence zone of Govind Puri Sewer drain.

Turbidity: The value for individual observations for turbidity of three sewer drains at different zones ranged between 3-1010 for reference site in the month of January and sewage zone of Jatwada Pul sewer drain-II for the month of September, respectively the lowest and highest value noted. The maximum mean value of turbidity (584 NTU) was at sewage zone of Jatwada Pul-II Sewer drain while minimum mean value of turbidity (92NTU) was at reference site.

TS: The value for individual observations for TS of reference site and three sewer drains at different zones ranged between 160.0-2460.0 for reference site in the month of January and sewage zone of Jatwada Pul sewer drain-II for the month of September, respectively the lowest and highest value observed. The maximum mean value of TS (1462.5 mg/l) was at sewage zone of Jatwada Pul-II Sewer drain while minimum mean value of TS (310.0mg/l) was at reference site.

DO: The value for individual observations for DO of reference site and three sewer drains at different zones ranged between 0.90-9.1 for sewage zone of Jatwada Pul sewer drain-II for the month of June and reference site in the month of January, respectively the lowest and highest values recorded. The maximum mean value of DO (8.60) was at reference site while minimum mean value of DO (1.00) was at Sewage zone of Jatwada Pul-II Sewer drain.

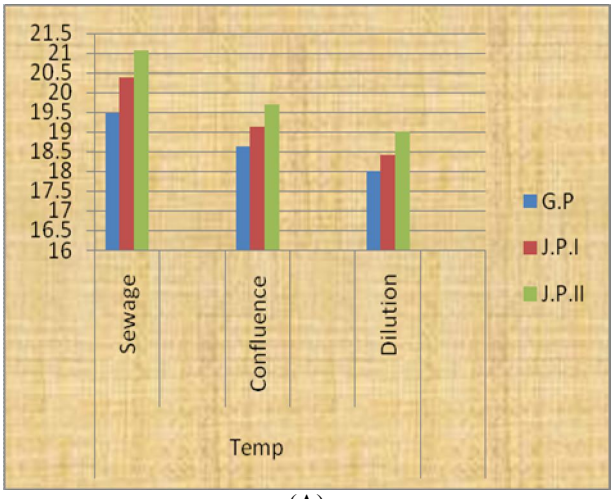
BOD: The value for individual observations for BOD of reference site and three sewer drains at different zones ranged between 1.40-70.1 for reference site in the month of January and sewage zone of Jatwada Pul sewer drain-II for the month of June, respectively the lowest and highest values recorded. The maximum mean value of BOD (60.53) was at sewage zone of Jatwada Pul-II Sewer drain while minimum mean value of BOD (2.40) was at reference site.

Chlorides: The value for individual observations for Chlorides of reference site and three sewer drains at different zones ranged between 8.62-77.2 for dilution zone of Govind Puri sewer drain in the month of February and sewage zone of Jatwada Pul sewer drain-II for the month of June, respectively the lowest and highest values recorded. The maximum mean value of Chlorides (67.95) was at sewage zone of Jatwada Pul-II Sewer drain while minimum mean value of chlorides (18.47) was at dilution zone of Govind Puri Sewer drain.

Table 1. Physico-chemical characteristics of three different sewer drains and Ganga canal within Haridwar City during year 2010-11

	Ganga Canal (Reference Site)	Sampling Points	Govind Puri Sewer Drain	Jatwada Pul Sewer Drain-I	Jatwada Pul Sewer Drain-II
Temperature	**17.60 (11.20-**22.50)	Sewage	19.48 (12.8-24.8)	20.38 (13.0-26.7)	**21.05** (13.2-**28.8)**
		Confluence	18.64 (12.2-23.2)	19.12 (12.6-24.0)	19.70 (12.8-25.7)
		Dilution	18.01 (12.0-23.0)	18.42 (12.0-23.2)	19.00 (12.2-23.8)
pH	8.1 (7.30-**8.52**)	Sewage	7.51 (7.2-7.8)	7.70 (**7.1**-7.9)	**7.60** (7.3-8.1)
		Confluence	7.72 (7.3-8.0)	7.89 (7.7-8.3)	7.96 (7.7-8.4)
		Dilution	8.04 (7.6-8.5)	8.21 (7.9-8.4)	**8.25** (7.9-8.2)
Velocity	1.92 (1.20-2.65)	Sewage	1.89 (1.75-2.2)	**2.17** (1.75-**2.75**)	2.12 (1.80-2.45)
		Confluence	**0.68** (0.60-1.2)	1.74 (1.35-2.00)	0.87 (**0.50**-1.15)
		Dilution	0.91 (0.67-1.35)	1.40 (0.95-1.85)	1.20 (0.95-1.85)
Turbidity	**92.00** (**3**-400)	Sewage	228.00 (15-750)	255.00 (40-790)	**584.00** (67-**1010)**
		Confluence	152.00 (9-530)	169.00 (11-590)	183.00 (20-610)
		Dilution	98.00 (4-411)	108.00 (7-440)	119.00 (9-515)
TS	**310.00** (**160**-790)	Sewage	876.50 (370-1610)	991.50 (570-1725)	**1462.00** (1040-**2460**)
		Confluence	700.00 (290-1400)	731.00 (310-1500)	805.00 (390-1500)
		Dilution	366.00 (170-815)	470.00 (225-870)	492.00 (210-1110)
DO	**8.60** (7.9-**9.1**)	Sewage	1.70 (1.5-2.8)	1.30 (1.0-2.0)	**1.00** (**0.90**-1.4)
		Confluence	7.80 (6.5-8.1)	7.40 (6.5-8.0)	5.00 (3.7-6.3)
		Dilution	8.40 (7.9-8.7)	8.20 (7.5-8.4)	7.80 (7.1-8.0)
BOD	2.40 (**1.40**-3.70)	Sewage	43.15 (32.0-50.5)	44.14 (35.0-51.1)	60.53 (50.1-**70.1**)
		Confluence	9.60 (5.8-12.2)	10.00 (6.2-13.1)	20.65 16.8-25.7)

		Dilution	4.10 (2.1-4.5)	4.35 (2.9-4.7))	4.70 (3.2-6.3)
Chlorides	21.37 (13.40-31.00)	Sewage	49.08 (44.2-55.6)	51.46 (47.43-57.2)	67.95 (62.19-77.2)
		Confluence	29.07 (19.17-39.2)	30.75 (21.42-40.8)	35.71 (29.87-42.18)
		Dilution	18.47 **(8.62**-28.8)	20.00 (10.52-30.6)	21.18 (12.83-30.2)



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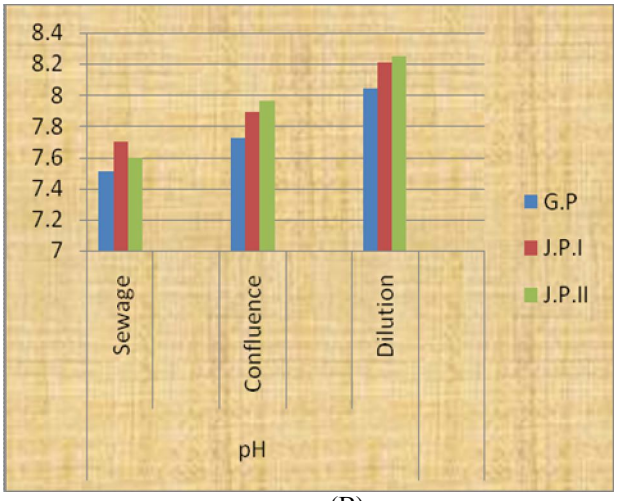

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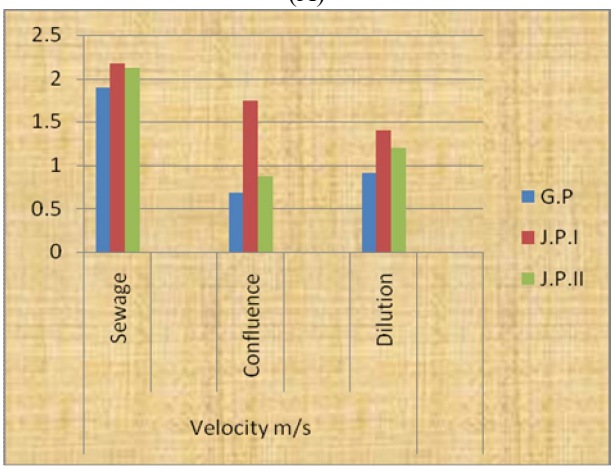

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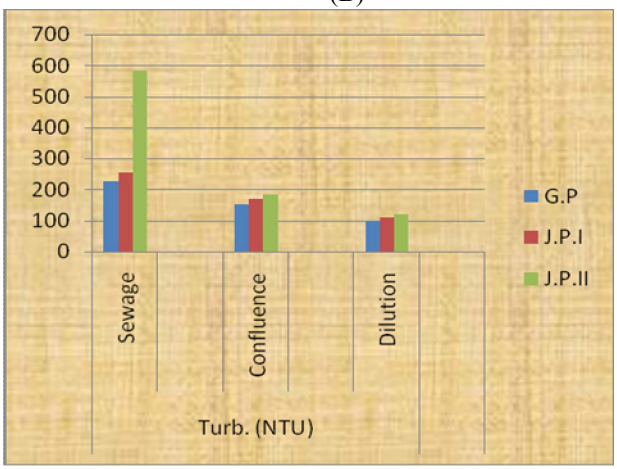

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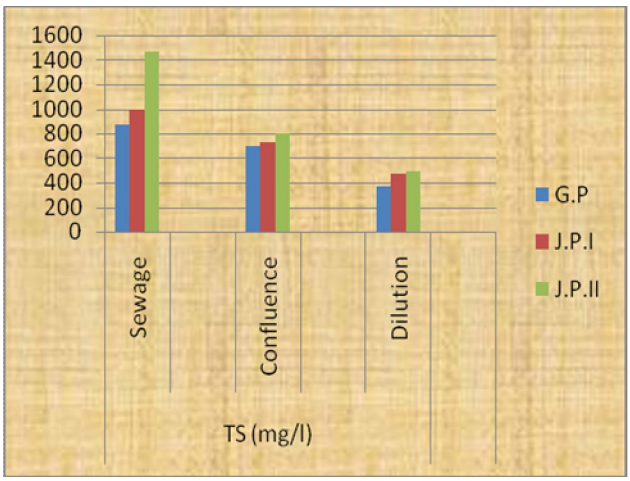

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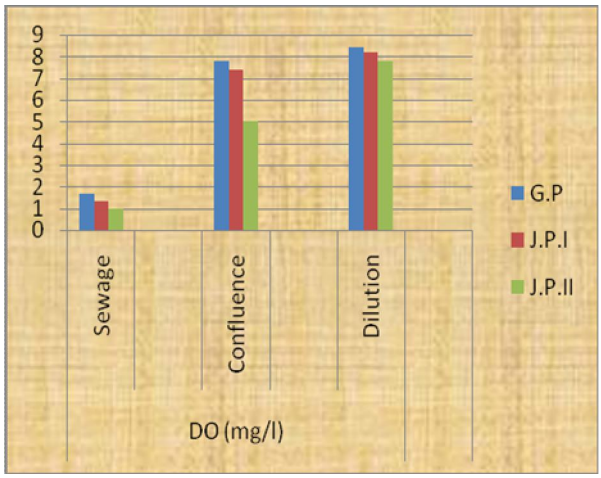

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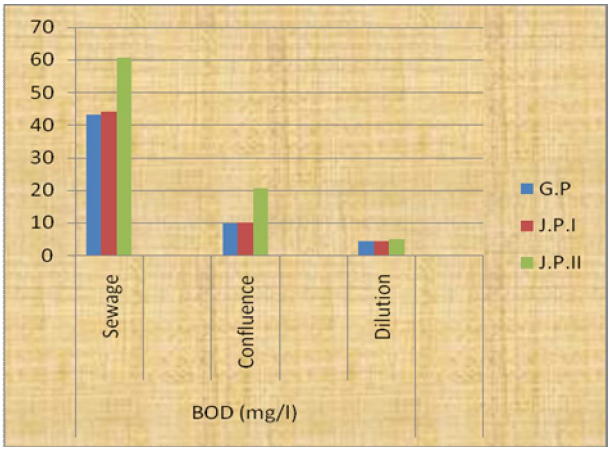

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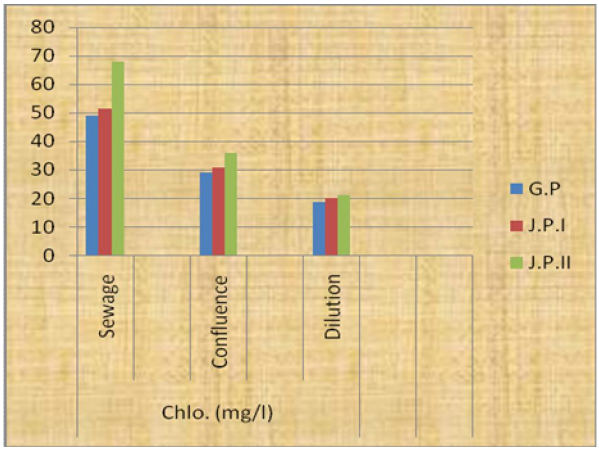

(H)

Graphs. A to H showing Physico-chemical variation of three sewer drains at sewage, confluence and dilution zone. G.P= Govind Puri Sewer drain, J.P.I = Jatwada Pul Sewer drain-I, J.P.II = Jatwada Pul Sewer drain-II

4. Discussion

The present study clearly demonstrate that domestic sewer drain is one of the major source of Ganga river pollution within Haridwar city, in which Jatwada pul sewer drain-II is most polluting among the other drains. This may be due to mismanagement of municipality and different activities of rural communities within Haridwar city. Various workers have worked on Ganga River pollution. The major source of Ganga river pollution is discharge of untreated domestic waste water from the fast growing urban centers located along the river as reported by Trivedi (2010).

The sewage water showed higher temperature in comparison of confluence and dilution zone in which sewer drain of Jatwada pul-II sewage has highest temperature value in the month of June after which it decreases gradually. Velocity is higher in sewage zone in comparison of dilution and confluence zone, as reported by **Joshi and Bisht (1993)** who also pointed out that various physico-chemical component from the collection zone degraded the sewer water drain of Jwalapur in comparison to confluence and dilution zone.

BOD and Solids material values are very high in the sewage in comparison to dilution zone of three different sewer drains, as also found by **Ogunfowokan et al. (2005),** who studied on impact of sewage on water body and described that, physico-chemical parameters like as pH, BOD and solids were badly affected due to point source discharge. In this study it was found that Jatwada Pul Sewer drain-II was most polluting and it may be due to its source, which originated from rural community. Similarly **Igbinosa et al. (2009)** have studied the impact of wastewater effluents on the physico-chemical qualities of

watershed in a typical rural community and described that the effluent could pose significantly health and environmental risk to rural communities who rely on the reverine water of their areas as their source of domestic water without treatment and may also effect the health status of the aquatic milieu in the receiving water. The impacts of sewage are not only hazardous to human health but also to whole ecosystem of water bodies. Polluted water is unsuitable for drinking, recreation, agriculture and industry and it diminishes the aesthetic quality of water bodies. Nobody can escape the effects of water pollution. Impact of sewage on aquatic bodies has been reported from time to time and it is clear that the water quality is altered due to entry of sewage and other domestic waste in the aquatic system. **Baskaran et al. (2010)** studied the impact of industrial effluents and sewage on a river and showed all the parameters were affected by the entry of sewage in to the river up to a long stretch of the river.

The higher value of total solids was observed during the monsoon period at all three sampling sites. It may be due to the washing down of the debris and flashing it in the Ganga River canal. Thus the results of this study clearly show that the sewage drain has obviously highly degrading water quality in it impacting the Ganga canal water within the study area. Similarly **Srivastava and Srivastava (2011)** studied on physico-chemical properties of sewage and a river and pointed out that water quality certainly degraded by the sewage of the city.

Conclusion

The result of this study show that the sewage could pose significant healthy and environmental risk not only for rural communities but also for whole city that rely on the receiving water as their source of domestic water purpose without treatment and may also affect the health status of users. The high values of sewage pollution indicator physico-chemical parameters detected revealed that the water quality of Sewage and confluence zone was very deprived, unsafe and not acceptable for any purpose especially in Haridwar city and nearby areas. The main cause of the Ganga water pollution is the total absence of the wastewater treatment system for all cities situated of more than 14 drains only in Haridwar city. A number of colonies discharge their domestic waste in to Ganga river canal. Due to presence of such huge amount of domestic drains in to this canal, it may lose their self purifying nature. Despite the above scenario, the people use the water of river Ganga canal water for various purposes. That's why proper treatment of waste water before merging in to canal needed for good water ecology and to avoid various human diseases. The study also shows there is a need for continuous pollution monitoring program of the Ganga River water in Haridwar city.

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