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WATER POLLUTION ASSESSMENT OF GHAGGAR RIVER

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Abstract- A Study of Physicochemical Parameters in River Ghaggar was carried out for post monsoon in Oct.2016. The water quality was studied at 16 sites at upstream and downstream among the towns traversed by the River. Physicochemical parameters of the samples were measured; moreover, possible sources of contamination were analysed. Total 40 parameters were analysed including; Colour, Temperature, Turbidity, pH, Electrical Conductivity (EC) Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Sulphate, Total Hardness, Dissolve Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Iron (Fe), Mercury (Hg), Lead (Pb), Copper (Cu), Zinc (Zn) Total Nitrogen, Total Phosphorous, Pesticides, MPN etc.. The findings show that river is affected by industrial as well as domestic waste water. All the sites were infected by Coliform. This study provides critical information for river conservation and its protection by suggesting possible treatment of domestic wastewater before letting in the river.

Keywords: Pollution, Physico-chemical, Ghaggar

I Introduction

Water pollution is a serious problem in India as almost 70 per cent of its surface water resources and a growing percentage of its groundwater reserves are contaminated by biological, toxic, organic, and inorganic pollutants. In many cases, these sources have been rendered unsafe for human consumption as well as for other activities, such as irrigation and industrial needs. This shows that degraded water quality can contribute to water scarcity as it limits its availability for both human use and for the ecosystem. In1995, the Central Pollution Control Board (CPCB) identified severely polluted stretches on 18 major rivers in India. Not surprisingly, a majority of these stretches were found in and around large urban areas. The high incidence of severe contamination near urban areas indicates that the industrial and domestic sectors contribution to water pollution is much higher than their relative importance implied in the Indian economy. Agricultural activities also contribute in terms of overall impact on water quality. Besides a rapidly depleting groundwater table in different parts, the country faces another major problem on the water front groundwater contamination a problem which has affected as many as 19 states, including Delhi.

Polluted water not only affects the life of present generation but it also affect the life of upcoming generations because its effect remains for long. If water is polluted in a area, then the all living creatures and people are faced to drink polluted water because they have no other option. It affects their bodies, skin, lungs, brain, liver and kidneys, caused cancers, birth defects and other diseases. (Khatun, Rozina, 2017) The fate and transport of many anthropogenic pollutants are determined by not only hydrological cycles, but also physicochemical processes. Rivers are vital and vulnerable freshwater ecosystems that are critical for the sustenance of all life. However, the declining water quality of these ecological systems threatens their sustainability and is therefore a matter of serious concern. Rivers are waterways of strategic importance across the world, providing main water resources for domestic, industrial and agricultural purposes (Jain, 2009).Water is the most essential and prime necessity of life. It is an essential requirement for the life supporting activities. Surface water generally available in Rivers, Lakes, Ponds and Dams is used for drinking, irrigation and power supply etc. The usual source of drinking water is from streams, rivers, wells and boreholes which are usually not treated (Pareek et al., 2018). Effluents of large and small scale industries, agricultural runoff and city sewage have been marked as sources of pollution during various researches. Effect of sewage on the quality of river Ganga in Kanpur was studied by Ray and David (1966). The same study was repeated in Patna by Singh and Bhowmik in 1985. Heavy metals in sewage sludge have been found by Oake (1985). Chemistry of urban runoff water had been studied by Lee and Bang (2000). Similar study in the sewage of Ahmedabad was conducted by Kothandaraman et al. (1963). Effect of sewage disposal in the chemistry of water bodies had been studied by Cooke (1994). Biology of sewage was studied by Sutton and Ornes (1977). Pollution aspect of sewage overflow was studied by Balmforth (1990). Change in chemistry of Chambal river due to sewage was studied by Agarwal (1983).

Ghaggar River is one of the major seasonal rivers passing through two most fertile states (Punjab and Haryana) of India. It receives domestic, industrial and municipal wastewaters/effluents all along its course. The base flow generated in the river system is utilized at various points for various purposes like drinking, irrigation and industrial. Water is pumped directly from the Ghaggar River and tributaries at several places for irrigational and drinking activities along its journey from upstream to downstream. Some industrial regions along with municipal councils/committees/corporations are discharging their wastewaters and effluents directly or indirectly into the Ghaggar River water through different channels. Therefore, it is necessary that the quality of water should be monitored at regular time intervals. Furthermore, the protection and maintenance of water quality is emerging as a great public concern in all over the world.

The quality of water is described by its physical, chemical and microbiological characteristics (Venkatesharaju et al., 2010). Therefore a regular monitoring of river water quality not only prevents outbreak of diseases and checks water from further deterioration, but also provides a scope to assess the current investments for pollution prevention and control. Monitoring programs result in a huge and complex data matrix consisting of a large number of physico-chemical parameters (Alkarkhi et al., 2008, Shah et al., 2015). One of the methods in water resources quality assessment is the use of Multivariate statistical techniques to characterize and evaluate freshwater quality and these are useful in verifying temporal and spatial variations caused by anthropogenic factors (Shrestha et al., 2007; Venkatesharaju et al., 2010; Ekwere et al., 2011). In this study variations of physico-chemical and biological parameters of water quality in Ghaggar River were assessed using multivariate statistical tools like PCA.

II Study Area

In the present study, the Ghaggar River was selected to evaluate the heavy metal characteristics of its surface water in upper reaches. The Ghaggar River originates from the Siwalik Hills of Himachal Pradesh and Haryana. It runs along the foot of the Siwaliks and flows through Haryana and Punjab to Rajasthan and then disappear itself in the sands of the Thar Desert. The selected study area falls within the boundaries of several states and covering parts of different districts of Haryana and Punjab and Rajasthan. At downstream sites various point sources viz., Medkhali Nallah, Sukhna Choe, Jharmal Choe, Dhabi Nallah, Dhakansu Nallah, Patiala Nadi, Markanda River, and Shaabaad Nallah are joining the Ghaggar River and discharging their untreated effluents into it.

The area under investigation lies between North latitudes 30˚45′5.93″ to 29°11′49.29″ and East longitudes 76˚54′36.79″ to 73˚13′26.88″ Area under investigation covers parts of different districts of Haryana, Punjab and Rajasthan like Panchkula, SAS Nagar (Mohali), Patiala, Ambala ,Kaithal, Fathehabad, Sirsa, Hanumangarh and Sri Ganganagar. The research area enjoys humid to sub- humid type of climate characterized by extreme summers and chilly winters with large seasonal fluctuations in both temperature and rainfall. The temperature may raise upto 47°C in hottest month and may drop to less than 1°C in winter. In the upper part of the Shivalik hills precipitation of 1000-1500 mm and in lower regions precipitation is only 200mm.

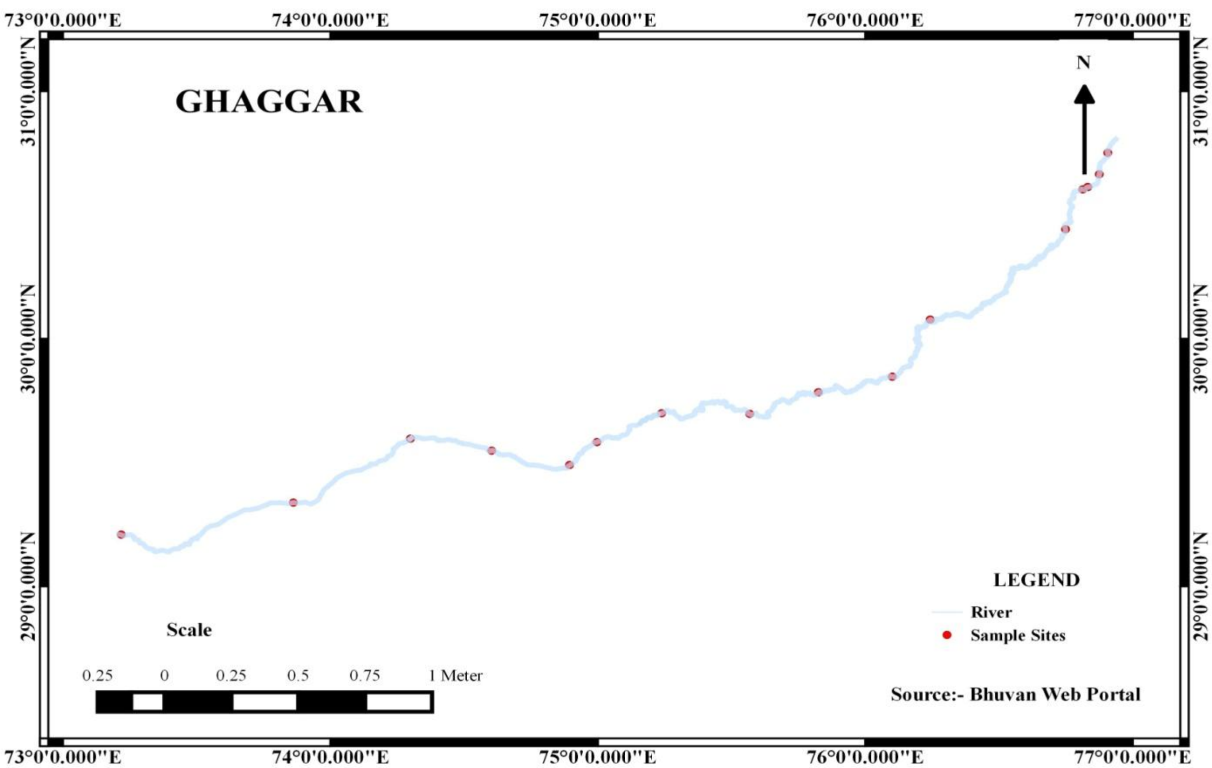

Fig: 1 ***Fig 1 Study Area Map Ghaggar River***

The brief description of sampling stations is as follows:

1. S-1 (Amaravati Enclave): Sample was collected from Amaravati Enclave, here Ghaggar is known as Kaushalya River.
2. S-2 Chandi mandir- Here two streams meet, and from Here River is known as Ghaggar.
3. S-3 (Sec. 25 Panchkula): Further, downstream the Ghaggar River water was sampled near sec. 25 here another stream meets to Ghaggar River.
4. S-4 Daffarpur- Upstream to this sampling site Medkhali Nallah is joining the Ghaggar River course, so river water was collected from downstream side to check the impact of effluents.
5. S-5 (Mubarkpur): Here Baltana Drain meets Ghaggar River which carrying waste (industrial & sewage) Chandigarh and Panchkula.
6. S-6 (Bhagwanpur): this site is in-between Mubarkpur and tepla. Here there is no point source added into the Ghaggar river.
7. S-7 (Tepla): Here Jharmal Choe meets the Ghaggar River, which carrying industrial and domestic sewage of Derabasi, Lalru and Zirakpur.
8. S-8 (Surala): Here Dhakansu Drain meets the Ghaggar River which is a combined drain of Mohali, Chandigarh and Rajpura Industrial waste
9. S-9 (Ratnedi) downstream: Here Patiala River meets the Ghaggar River. Jacob drain meets the Patiala River which carries industrial waste from Patiala region. Patiala River itself carries the sewage and industrial waste from Patiala.
10. S-10 (Ratnedi) upstream
11. S-11 (Khanori, Punjab)
12. S-12 (Jakhal). It is an agricultural area
13. S-13 (Ratia). Ratia is a municipal town of Haryana. Sewage and industrial effluents (mainly soap factories) discharged into the Ghaggar River.
14. S-14 (Sardulgarh). Sardulgarh is a municipal town of Punjab. Sewage and industrial effluents (mainly soap factories) discharged into the Ghaggar River.
15. S-15 (Dabwali Road, Sirsa): Here Samsabad drain meets the River, which carries the Sewage and industrial waste (Mainly card board industries, Soap industries, Rice mills).
16. S-16 (Ottu Wier): The river water is blocked at weir; as such the river does not have any water downstream. All river water was diverted to canal in Haryana.
17. S-17 (Talwara Jheel): Sampling is not possible here due to dry bed of river.
18. S-18 (Hanmungarh Bridge): Sampling is not possible here due to dry bed of river.
19. S-19 (Drishadvati Chautang) River: Sampling is not possible here due to dry bed of river.
20. S-20 (Annopgarh Bridge): Sampling is not possible here due to dry bed of river.

Sample Collection:

Water samples were collected during the month of Oct 2016. Figure 1 shows the sampling sites. Grab water samples (2000 mL each) were collected manually at each site using acid-washed (10%, v/v HCl) into High-Density Polyethylene (HDPE) bottles to avoid any contamination from metal and non-metal ions. The pre-washed bottles were rinsed thrice with water samples on the site before sample collection. Sampling was always done in clear weather condition to prevent any abrupt changes in measurements and to avoid unsteady conditions. Water samples were stored in a cooler box and transported to the laboratory and analysed within a period of 48 hours. The parameters like, pH, EC, DO, temperature were analysed in-situ. Biochemical Oxygen Demand (BOD) concentration was determined by analyzing the oxygen demand using colorimetric method. Also analysed were Total: Sulphate (TS), Phosphate (TP), Nitrate (TN), pH, DO, electrical conductivity, alkalinity (TA) and chloride (TC). Na and K were analysed by flame photometer.

III RESULTS AND DISCUSSION

The results of the physicochemical parameters for water samples are presented in Table 1(a, b & c).

Table 1(a, b & C): Physico chemical Analysis of Ghaggar River (Oct 2016)

Site	Color	Temp	Turbidity	pH	Electrical Conductivity	Total Suspended Solids	Total Dissolved Solid	Calcium (as Ca)	Magnesium (as Mg)	Chloride (as Cl)	Sulphate (as SO_4)	Total Alkalinity	Acidity
1	10	25.6	0	7.9	0.337	12	379	54	22	32	34	222	0
2	16	25.6	4	7.9	0.332	16	321	42	22	33	32	191	6
3	17	25.6	96	7.8	0.321	22	223	32	23	35	32	189	8
4	112	25.6	112	7.6	0.455	45	221	36	38	45	42	191	11
5	189	25.6	312	6.9	0.877	109	645	45	32	58	32	222	14
6	200	25.6	312	7.2	0.825	98	456	32	26	52	28	181	11
7	189	25.6	221	7.7	0.888	298	721	42	21	188	35	221	31
8	188	25.6	321	7.2	0.882	121	562	39	21	61	29	222	13
9	500	25.6	43	7.9	1.555	133	721	61	32	121	65	245	9
10	127	25.6	56	7.7	0.888	31	211	34	21	189	34	254	24
11	500	25.6	32	7.9	1.212	143	643	54	32	132	76	231	8.76
12	389	25.6	23	7.6	1.11	87	512	34	24	156	63	121	9
13	412	25.6	24	7.9	1.02	121	546	65	38	178	78	189	14
14	500	25.6	43	7.4	1.332	134	1231	43	32	21	32	343	11
15	500	25.6	32	8.9	1.332	112	1145	32	12	21	23	178	10
16	114	25.6	54	8.5	0.876	113	432	34	34	112	49	186	11
Min	10	25.6	0	6.9	0.321	12	211	32	12	21	23	121	0
Max	500	25.6	321.0	8.9	1.6	298.0	1231.0	65.0	38.0	189.0	78.0	343.0	31.0
Avg	247.7	25.6	105.3	7.8	0.9	99.7	560.6	42.4	26.9	89.6	42.8	211.6	11.9

(a)

Site	Total Hardness	Sodium (as Na)	Potassium (as K)	Carbonate as $CaCO_3$	Bicarbonate as $CaCO_3$	Residual Free Chlorine as Cl_2	Dissolved Oxygen	Biochemical Oxygen Demand as BOD (3 days)	Chemical Oxygen Demand as COD	Iron Content (Fe)	Mercury (Hg)	Arsenic (As)	Lead (Pb)
1	232	3	3	0	143	0	7.3	12	32	0.11	0	0	0.018
2	221	5	4	0	123	0	7.5	14	52	0.19	0	0	0
3	161	8	6	0	121	0	7.5	12	64	0.243	0	0	0
4	171	8	6	6	125	0	6.8	15	45	0.825	0.021	0	0.016
5	226	9	6	15	132	0	2	14	38	0.9	0.018	0	0
6	223	5	5	20	121	0	6.2	20	56	1.2	0.016	0	0
7	241	12	4	0	233	0	6.3	21	69	2.2	0	0	0.012
8	221	6	5	15	141	0	4.3	22	119	0.9	0	0	0
9	187	23	12	0	298	0	1.89	36	223	0.31	0.012	0	0
10	181	11	4	0	233	0	6.2	12	31	0.98	0	0	0
11	211	25	16	0	312	0	5.1	42	265	0.24	0	0	0
12	187	28	36	7	123	0	8.1	12	92	0.2	0	0	0
13	215	42	67	0	212	0	6.8	22	67	0.2	0	0	0
14	223	32	23	0	286	0	5.7	37	245	0.31	0	0	0.045
15	223	32	32	0	232	0	5.9	34	222	N.D.	0	0	0
16	116	11	14	0	115	0	6.2	19	58	N.D.	0	0	0

Min	116	3	3	0	115	0	1.89	12	31	0.11	0	0	0
Max	241.0	42.0	67.0	20.0	312.0	0.0	8.1	42.0	265.0	2.2	0.0	0.0	0.0
Avg	202.4	16.3	15.2	3.9	184.4	0.0	5.9	21.5	104.9	0.6	0.0	0.0	0.0

(b)

Site	Copper (Cu)	Zinc (Zn)	Cadmium (as Cd)	Nickel (Ni)	Chromium (Cr)	Nitrate (as N)	Total Nitrogen (as N)	Phosphate (as P)	Total Phosphorus (as P)	Aldrin	Dieldrin	Endosulfan	DDT (o,p &p, p-isomers of DDT, DDE & DDD)	MPN
1	0	0	0	0	0	0	0	0	0	BDL	BDL	BDL	BDL	86,000
2	0	0	0.021	0	0	0	0	1	2	BDL	BDL	BDL	BDL	98,000
3	0.022	0.021	0	0.01	0	0	0	1	2	BDL	BDL	BDL	BDL	88,000
4	0.022	0.86	0	0.02	0	0	0	2	2	BDL	BDL	BDL	BDL	100,000
5	0.021	0	0	0.03	0.012	8.89	11	6.89	11	BDL	BDL	BDL	BDL	22000
6	0.021	0	0	0.04	0.046	8.89	10	7.21	12	BDL	BDL	BDL	BDL	86,000
7	0	1.89	0.045	0	0.023	12.32	23.22	9.11	17.21	BDL	BDL	BDL	BDL	202,212
8	0.021	0.096	0.036	0	0.054	8.11	13	6.78	11	BDL	BDL	BDL	BDL	121,000
9	0	0	0	0.01	0	8.44	21	11	14	BDL	BDL	BDL	BDL	2360000
10	0	0.89	0	0	0	5.12	12.21	8.7	16.21	BDL	BDL	BDL	BDL	201,000
11	0	0	0	0	0	7.4	24	13	15	BDL	BDL	BDL	BDL	1,100,000
12	0	0	0	0	0	12	14	4	8	BDL	BDL	BDL	BDL	3403900

13	0	0	0	0	0	23	22	20	12	BDL	BDL	BDL	BDL	221,000
14	0	0.023	0	0	0	14	18.88	13.54	21	BDL	BDL	BDL	BDL	4,800,000
15	0	0	0	0.015	0	12	19.22	12	13.21	BDL	BDL	BDL	BDL	1,800,000
16	0.012	0.014	0.021	0.0112	0	6.9	11	13.98	18.98	BDL	BDL	BDL	BDL	221,000
Min	0	0	0	0	0	0	0	0	0					22,000
Max	0.0	1.9	0.0	0.0	0.1	23.0	24.0	20.0	21.0					4800000.0
Avg	0.0	0.2	0.0	0.0	0.0	7.9	12.5	8.1	11.0					931882.0

(c)

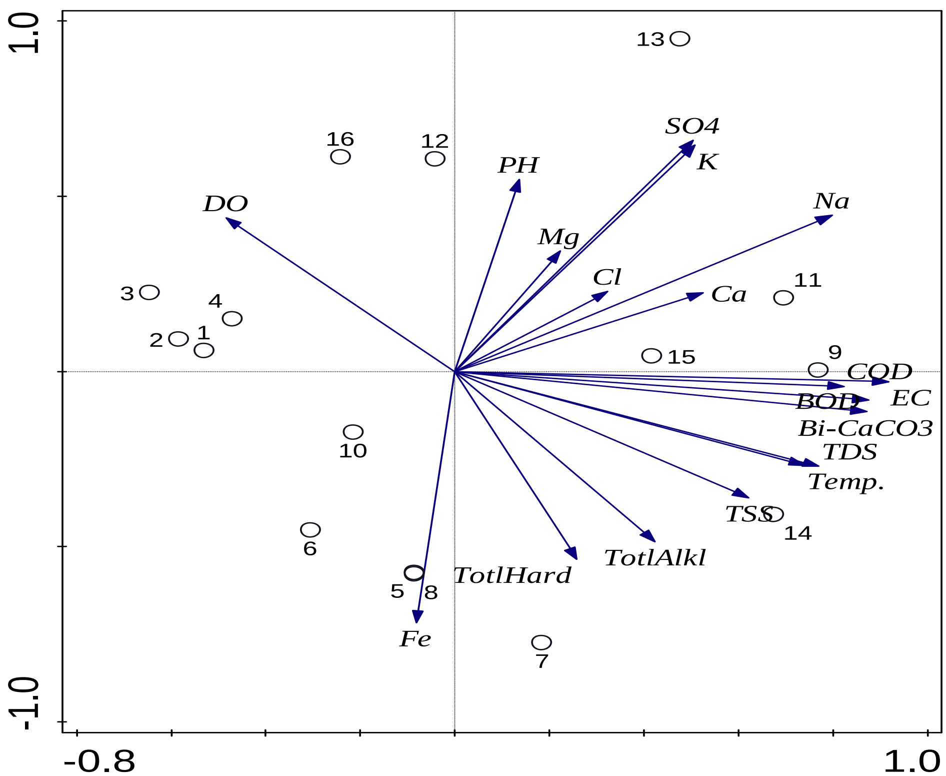

Fig.2 PCA on physical and chemical variables of selected sampling sites (Oct.2016)

A PCA was performed based on the physic-chemical data of Oct 2016 to explain the relationship between sampling sites and environmental variables. The first four axes explained 87.38% of the total variability. Physical and chemical parameters such as BOD, total alkalinity, total hardness, Mg, COD and CaCO3 had high loading values along the PC1 axis and are closely associated with the sites S9 and S14. Variables such as Ph, Mg & SO_4 showed strong positive correlation along the PC2 axis. Sites such as S1, S2 and S3 are closely associated with the vector of DO. Parameters such as DO and temperature showed negative correlation from each other. Some of the sites along the PC2 axis are not associated with any of the physic-chemical parameter. Site S9 were the most polluted site and are strongly associated with the vectors of BOD, EC, TDS, COD and Bicarbonates.

Electrical Conductivity (EC) in natural waters is the normalized measure of the water's ability to conduct electric current. This is mostly influenced by dissolved salts such as sodium chloride and potassium chloride. Most freshwater sources will range between 0.1-10 µs/cm. Field measurements of EC reflect the amount of Total Dissolved Solids (TDS) in natural waters.

EC of River Ghaggar water was significantly different among sampling sites and in both the seasons, however higher in pre monsoon season than post monsoon seasons. Dissolved Oxygen (DO) is essential to all forms of aquatic life including the organisms that break down man-made pollutants. Oxygen is soluble in water and the oxygen that is dissolved in water will equilibrate with the oxygen in atmosphere. Oxygen tends to be less soluble as temperature increases. According to Welch (1952), no other factor has so much influence as temperature. Water temperature controls the solubility of gases and salts in water and behavioral characteristics of organisms. Table shows that in the Ghaggar River, temperature ranges from a minimum of 25.6°C at Amravati Enclave to a maximum of 31.6°C at Ratnedi. During Study it was found that river water temperature is influenced by point sources where high temperature wastewaters/effluents mixing up into the Ghaggar water.
The turbidity in water is mainly caused by sand, silt, clay, phytoplankton, microorganism or organic material suspended or dissolver in it (Saksena et al 2008). There is great variation in turbidity throughout the stretch of a Ghaggar river. At upper reaches of river it is within the prescribed limit where as at middle and lower stretch it is far beyond the prescribed limit of WHO in both the seasons. Highest TDS value was observed during post monsoon season at S14.
Heavy metals are usually present in trace amounts in water. Increased concentrations of heavy metals in water can be attributed to both natural and manmade sources. Some of the heavy metals or trace elements are essential for physiological functions of living tissue and regulate many biochemical processes. The deficiency of heavy metals is harmful (Champan, D. 1996). The deficiencies of heavy metals in human beings and animals have been identified (Frieden, E. (1972). The same metals, however, at increased level may have severe toxicological effects on human beings. They are generally responsible for various health hazards when present in excessive amounts. Kaushik et al and Sukhdev Kundu also studied the heavy metals in upper regions of Ghaggar River. In the selected research area, the Ghaggar River is receiving the domestic, industrial and municipal wastewaters/effluents all along its course. All in all, the dominancy of the analyzed heavy metals in the surface water of Ghaggar followed the sequence: Fe> Zn > Ni > Cu > Cd > Cr >Pb > Hg >As. As iron is the dominating heavy metal and it is average concentration of iron was high in pre monsoon season. Average concentration of Hg, As, Pb, Ni. Cr were also Observed high during pre monsoon season where as Cu and Cd have the same concentration in pre monsoon and post monsoon season.
Samples were analysed for Aldrin, Dialdrin, Endo-sulfan and DDT, though in all the samples pesticides were below detection limit. Kaushik et.al. did similar study in 2010, he found that Aldrin and Dildrin were below detection limit but the concentrations of HCH and DDT in all the samples were above the permissible limits prescribed by the European Commission Directive for drinking purposes. Similar Study was also carried out in May 2015 and Oct 2015, but none of the sample has pesticides. (Pareek et al., 2018)
The fairly high values of total coliform were indicative of increasing pollution of the Ghaggar River by organic means particularly through the discharge of sewage and domestic effluents into the ponds. All the sites were infected by coliform with an average of 931882 mg/l. Site S9 to S16 are worst affected because of direct discharge for sewage water into the river.

IV Conclusion

This study assessed the physicochemical properties of Ghaggar River water from twenty different locations. In the present investigation, it was found that the maximum parameters were at the level of pollution except few parameters like pH, total hardness and chloride. The results of water quality are presented in Table 1 (a, b & c). It clearly indicates that river water is not suitable for domestic purposes. Ranges of key water quality parameters, e.g. DO, BOD, COD, TDS, and MPN were several times higher than the prescribed standards for inland water bodies.

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