Study on Heavy Metal Pollution in Ganga River at Kanpur (U.P.)

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ABSTRACT

An intensive investigation has been carried out for one year to determine the heavy metal pollution in Ganga river at Kanpur (Uttar Pradesh). Due to the rapid industrialization, development in agriculture, urbanization and mining activities, the discharged untreated hazardous wastes are disposed directly or indirectly into the river and results in degradation of river water quality. The river Ganga especially at Kanpur, Uttar Pradesh, India is facing serious threat of heavy metal pollution problem. As lots of industries; especially tanneries are situated near the river bank. Tanneries are most responsible industry for disposing of untreated effluent in Ganga river at Kanpur which contains heavy metal specially chromium. These pollutants directly affect the whole aquatic ecosystem and indirectly effects animal, human and crops. In the present study, 5 stations were selected for heavy metal analysis. Study was conducted for one year on monthly interval from January 2015 to December 2015. The heavy metal like Iron (Fe), hexavalent Chromium (Cr^{6+}), Cadmium (Cd), copper (Cu) and Lead (Pb) were analyzed and results obtained are discussed in this paper.

Key words: Surface water, heavy metals, pollution.

Introduction:

The National River Ganga, work as a life line of north India. Old civilization was established on the banks of river Ganga. Ganga, from the source of origin Himalayas to end at the Bay of Bengal travels around 2525km (Joshi *et al.,* 2009) and passes through 29 major cities and 48 towns (Chauhan and Singh 2010, Agrawal *et al.,* 2010 and Biswas *et al.,* 2015). Not only on the basis of our needs but also on the basis of mythological Ganga is a holy river. Due to urbanization and rapid industrialization the water quality of Ganga river water is continuously deteriorating (Kumar and Pal, 2010). The most of the industries situated on bank of river Ganga released their untreated or semi treated waste water in the river. The tributaries of Ganga river also contribute to increase pollution load in Ganga river. It can be said that due to unplanned urbanization and rapid industrialization, the pollution of rivers in India has now reached the pinnacle of crisis (Banejee and Gupta,

2012 and Saksena *et al.,* 2008). Industrial effluents are the prime source to enhance the environmental toxicity (Sinha and Paul 2012). The toxic elements are mainly heavy metals which discharged in surface water and effect on the aquatic ecosystem and daily life of depending living beings. Diseases due to higher concentration of heavy metals ingestion in body are tumour, nephritis, pharynx congestion, increase blood pressure and cardiovascular diseases, eczema, cancer, headache and osteoporosis etc. (Jaishankar *et al.,* 2014 and Florea and Busselberg, 2006).

Kanpur, the largest industrial hub of Uttar Pradesh State having many tanneries and other industries are located on the western bank of river Ganga lying between 25°55' and 27° North latitude and 79°30' and 80°35' East longitudes. The total geographical area of the district is 3155 Km^2. Only In Jajmau area there is a cluster of tanneries (Khwaja *et al.,* 2001) which are responsible for heavy metal pollution especially due to discharge of chromium containing waste water. Besides of chromium tannery effluent contain some other heavy metal like lead, cadmium and copper which are toxic in excess amount (Huq, 1998).

These toxic heavy metals join to Ganga river through Nallas and drains and increase its toxicity, therefore continuous water quality monitoring is necessary (Simeonov *et al.,* 2002). The present study is an attempt to compare the quality of Ganga river water with their prescribed standard and to determine the Iron (Fe), Hexavalent Chromium (Cr^{6+}), Cadmium (Cd), copper (Cu) and Lead (Pb) in river Ganga.

Material and Method

Sample collection and Preservation

Water samples were collected from 5 selected stations of river Ganga in polythene bottles and study was conducted for 1 year on monthly interval during January 2015 to December 2015. The used sampling bottle were previously soaked and in 10% HNO_3 overnight and rinsed. To avoid precipitation of heavy metals, the collected unfiltered samples were acidified by adding 2ml of concentrated HNO_3 per liter of the sample. The bottles were capped tightly and stored at 4°C to prevent evaporation.

Collected samples were analyzed as per Standard method (APHA AWWA WPCF-2012). The Iron and Hexavalent chromium were analyzed by colorimetric method. Whereas Cadmium (Cd), Copper (Cu) and Lead (Pb) were through Atomic Absorption Spectrophotometer.

Table-1 Showing sampling station and station detail

S.No	Station Code	Station Detail
1.	S1	Downstream to Ganga Barrage, Kanpur
2.	S2	Permat Ghat
3.	S3	Near Shukla Ganj Bridge
4.	S4	Near Kanpur Lucknow Highway Bridge, Jajmau
5.	S5	After CETP, Jajmau

Fig-1 Showing location of sampling stations on river Ganga

Result and Discussion

Table- 2 Showing average concentration of metals and standard deviation at different stations

S.No.	Parameter	Standard limit as per IS: 10500-2012	Stations				
			S1	S2	S3	S4	S5
1.	Iron (mg/l)	0.300	0.417±0.097	0.504±0.152	0.490±0.124	0.552±0.095	0.627±0.091
2.	Hexavalent Chromium (mg/l)	0.050	0.087±0.046	0.208±0.077	0.236±0.075	0.465±0.256	2.792±0.994
3.	Cadmium (mg/l)	0.003	0.004±0.001	0.004±0.002	0.005±0.002	0.007±0.001	0.007±0.001
4.	Copper (mg/l)	0.050	0.007±0.001	0.009±0.002	0.007±0.002	0.009±0.002	0.009±0.002
5.	Lead (mg/l)	0.010	0.010±0.002	0.021±0.004	0.010±0.002	0.024±0.005	0.025±0.003

Table-3 Showing correlation between various heavy metals at different sampling stations

Parameter	Iron	Cr^{6+}	Cadmium	Copper	Lead
Iron	1				
Cr^{6+}	0.85*	1.00			
Cadmium	0.87*	0.66*	1.00		
Copper	0.75*	0.36	0.60*	1.00	
Lead	0.84*	0.60*	0.65*	0.95*	1.00

*** showing significant correlation**

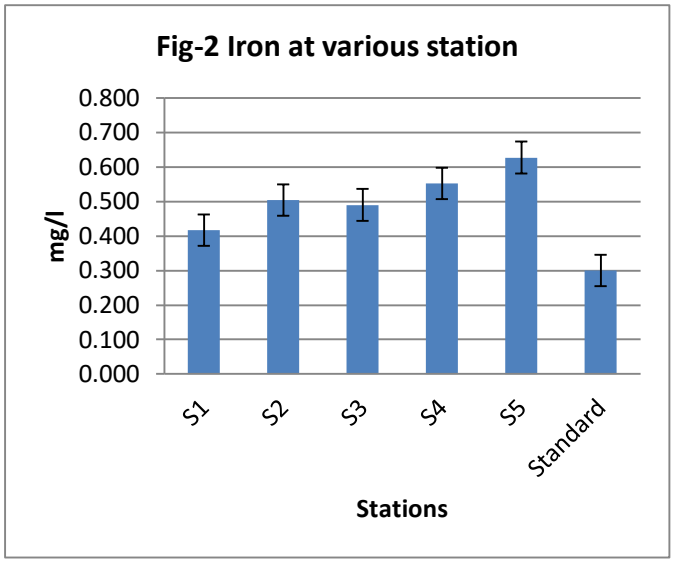
Fig-2 Iron at various station
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
mg/l
S1
S2
S3
S4
S5
Standard
Stations

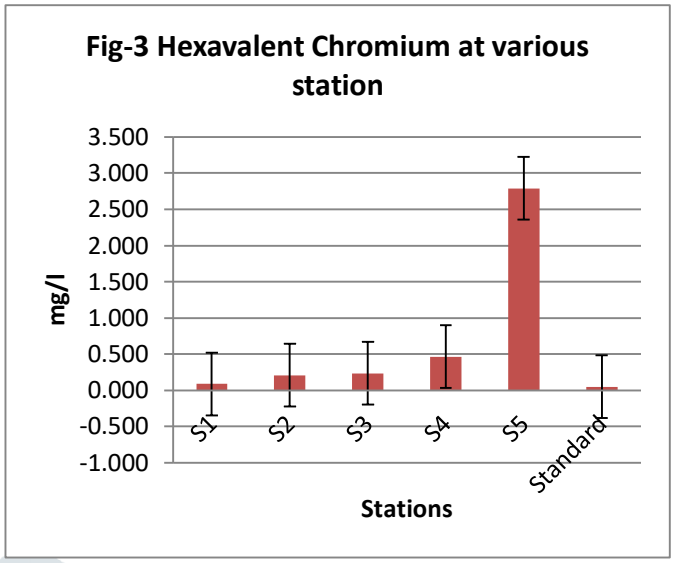
Fig-3 Hexavalent Chromium at various station
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
-0.500
-1.000
mg/l
S1
S2
S3
S4
S5
Standard
Stations

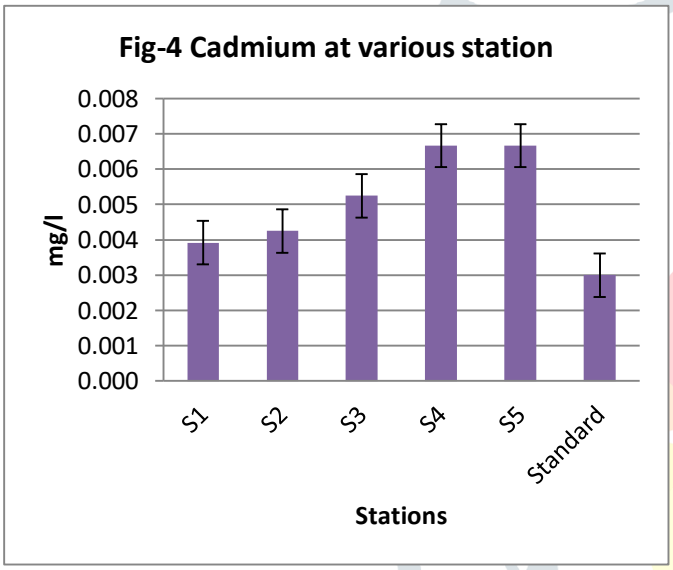
Fig-4 Cadmium at various station
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
mg/l
S1
S2
S3
S4
S5
Standard
Stations

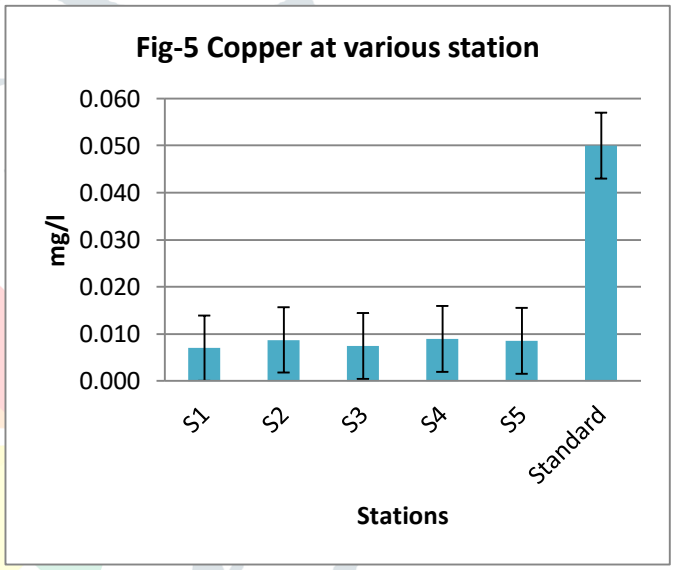
Fig-5 Copper at various station
0.060
0.050
0.040
0.030
0.020
0.010
0.000
mg/l
S1
S2
S3
S4
S5
Standard
Stations

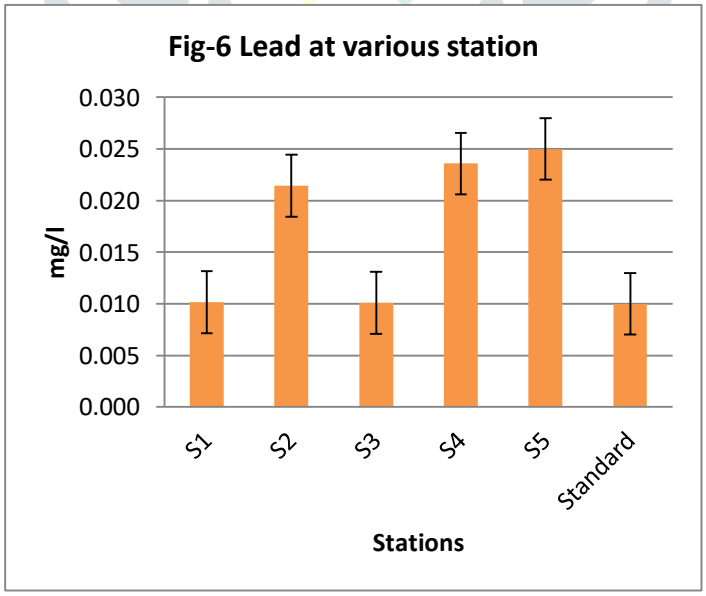
Fig-6 Lead at various station
0.030
0.025
0.020
0.015
0.010
0.005
0.000
mg/l
S1
S2
S3
S4
S5
Standard
Stations

Iron:

Iron could be dissolved in soil and rock and due to its dissolving property Iron may be present in natural waters and depending on the geology of area or and it also depends on which area it passes through. At high concentration iron has toxic properties. Higher concentration of iron prevents various enzymes and it is hard to absorb through gastro intestinal tract of vertebrates. In the Ganga water annual average of minimum Iron (Fe) was found 0.417±0.097mg/l at Ganga Barrage (S1) and maximum was found 0.627±0.091 mg/l at Jajmau (S5). Iron was found higher than permissible limit (0.3 mg/l) at all the stations. Highest value were found at S5 (0.627mg/l) Table-2, Fig-2.

Hexavalent Chromium:

The main source of chromium in Ganga is tannery effluent containing chromium. In India, 2000-3000tons/year of chromium released in environment (Altaf et al., 2008 and Dhal et al., 2013). In the Ganga river at Kanpur minimum Chromium (Cr) was found 0.087±0.046 mg/l at Ganga Barrage (S1) and maximum was found 2.792±0.994 mg/l at S5 Jajmau. Chromium was found higher than the limit which is 0.05mg/l at all stations. Station S5 is very unsafe (2.792mg/l) Table-2, Fig-3 station from ecological point of view.

Cadmium:

Cadmium, a highly toxic heavy metal which is toxic at very low exposure and affects kidneys and bones and it is carcinogenic too. Cadmium does not degrade in nature thus it stay on circulation if it is released in environment once. Minimum cadmium was found 0.004±0.001mg/l and maximum was found at 0.007±0.001 mg/l. Cadmium was found higher than standard limit which is 0.003mg/l at all station. Maximum Cadmium was observed at S4 and S5 (0.007 mg/l) Table 2 and Fig 4 as these stations are located near the tannery.

Copper:

The presence of Copper in surface water is due to dissolution of copper minerals which is abundantly found in earth crust. 33-60% of anthropogenic activities. The permissible limit for copper is 0.05mg/l. In this study Cu was observed within the permissible limit at all station. The range of Cu was found 0.007-0.009 mg/l. Highest concentration of Cu was found at S2, S4, S5 (Table2 Fig 5)

Lead:

Lead is highly toxic element released from paint, battery, automobile and pesticide industries. It inhibit important enzyme to involve in hemesynthesis process. Higher concentration of lead causes kidney dysfunction and brain damage (Sinha et al., 2016). Lead toxicity also affects the aquatic animal like fishes. Low level of lead exposure for Long term causes toxic change in its immune system. In this study minimum Lead (Pb) was found 0.010±0.002 mg/l at S1 and maximum was found 0.025±0.003 mg/l at S5. Lead was estimated higher than prescribed standard which is 0.01 mg/l at S2, S4 and S5 (Table-2, Fig-6).

Correlation of different metals are given in Table-3

Conclusion

The study reveals that Iron, hexavalent chromium, Cadmium were found higher than prescribed limit at all the stations. Lead was found higher than the permissible limit at S3, S4 and S5. Copper was within the prescribed permissible limit at all the stations. Chromium was found almost 50 times more than standard limit prescribed by BIS 10500-2012. Tanneries are mainly responsible for discharging of chromium in river Ganga. As Jajmau is hub of tanneries which discharge their effluent in Ganga river that's why stations S4 and S5 were found highly polluted. Besides of tannery there are lots of small and large dying industry, printing industry and storage battery manufacturing units which contain several compounds of metal like chromium, lead and cadmium etc. in the city which directly or indirectly discharge their effluents in to the Ganga river. It might be possible reason for high level of metal content at the Ganga river at Kanpur. The Ganga water is very unsafe for domestic use at S4 and S5.

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