13th International Conference on Science, Technology and Management
Mahratta Chamber of Commerce, Industries and Agriculture, Pune (India) (ICSTM-18)
01st-02nd December 2018 www.conferenceworld.in ISBN:978-93-87793-58-3

Heavy Metal Pollution in Water of Yamuna River, India

Anita Singh [1], Sudesh Chaudhary [1], Brijnandan S. Dehiya [2]

[1](Centre of Excellence for Energy and Environmental Studies,

Deenbandhu Chhotu Ram University of Science and Technology, Murthal, India)

[2](Department of Material Science and Nanotechnology,

Deenbandhu Chhotu Ram University of Science and Technology, Murthal, India)

ABSTRACT

The Yamuna River, one of India's important rivers which get polluted due the release of various contaminants generated by intensified industrialisation and human activities. The aim of this study was to assess the level of heavy metal contamination (Cd, Cu, Ni, Zn, Fe, Mn, Pb, Hg) in water of Yamuna river. A total of 10 locations covering the upstream and downstream sites of Yamuna were selected for the study. High variations in the concentration of heavy metals were found in river water. Metal concentration ranged Fe 0.29-3.041, Mn 0.006-1.017, Cu 0.007-0.037, Zn 0.06-0.167, Pb 0.0-0.064, Cd 0.0-0.002, Ni 0.001-0.047 and Cr 0.003-0.021 in river water. The overall mean concentration of heavy metals was observed in the following order Fe>Mn>Zn>Ni>Cu>Pb>Cr>Cd. The finding indicates that the water needs some degree of treatment before consumption.

Keywords: *contaminants, heavy metals, water, Yamuna River*

1. Introduction

River water is considered to be a natural resource that forms the life of all the living organisms. In spite of this, due to rapid industrial development, the entry of contaminants into the environment is one of the most important issues facing by today's community. In the last few decades huge load of pollutants to our rivers are added by various Industrial and agricultural activities. [1] Natural water leading to an adverse change due to induction of contaminants and pollutants which gives rise to the problem of water pollution. [2] It is estimated that the problem of water shortage is faced by two third of the world's population by 2025. A problem of critical levels of water stress along with serious water storage, will be in front of Indian population by 2025.[3] Yamuna river is considered as lifeline of Delhi and a major Indian river.

Yamuna river originate from the Yamunotri Glacier near Bandarpunch peak of the lower Himalaya ($38^0$59'N $78^0$27'E) in the Mussoorie range at an elevation of about 6320 m above mean sea level in the Uttarkashi district, Uttaranchal. [4] Industrial effluents is one of the prime sources of metal contamination in river water. [5] As

industrial, agricultural and municipal waste water enters the river water, different organic and inorganic contaminants including heavy metals also mix with the water resource. Some heavy metals are essential as micronutrient but their higher load then the permissible limit in the food chain can cause toxicity and environmental impacts.[6,7] Sediments are components of our environment that serve as repositories for deleterious chemicals species discharged into water body through anthropogenic waste. [8,9] Due to persistent and bioaccumulation nature of heavy metals, they are of major concern.[10] The micro pollutant concentration including heavy metals like Ni, Cd, Co, Fe and Cu has been reported with maximum permissible limits for drinking water in various Canal originating from river Yamuna. Some serious toxic effects on growth and yield of crops have been observed when the same polluted water is used for irrigation. Moderate levels of toxic heavy metals in the water of Yamuna river is due to industrial discharge, release of organic materials into the water, domestic waste etc.[11]

The present study was carried out to examine the concentration of different heavy metals in water of river Yamuna. The result of this study will provide useful information about the pollution status of the river.

2. MATERIAL AND METHODS

The water samples were collected from midstream either by using a boat or from an over bridge. Samples were collected in pre-cleaned polyethylene bottles from the river Yamuna at different locations, starting from November 22, 2017 to December 2, 2017 and were stored in refrigerator below 4°c until used. The description of sampling site is provided in TABLE 1.

TABLE 1. Sampling Location Description

Location Name	Location Number	Description
Shiv Temple, Bhimawala	S-1	River is in its natural conditions.
Ponta Sahib	S-2	
Lapra	S-3	Various domestic, agricultural runoff and maximum textile industry waste are present in the stretch.
Budanpur	S-4	
Shyam Ghat	S-5	Industrial belt throwing effluents directly without treatment via several drains.
Nigam Bodh Ghat	S-6	
Darrul Hizrah	S-7	
Gandholi Puram	S-8	Sewage and various industries related to leather and also various unauthorized slaughter houses are existing in this belt.
Nangal Paimana	S-9	
Bateshwar	S-10	

2.1 Heavy Metal Analysis

Acid digestion of the samples was done using HNO_3 as to minimise the interference by organic matter prior to estimation of heavy metals. Acid digestion for water has been carried out in the following way.

100 ml of water sample was added with 20 ml of HNO_3. The mixture was digested on a hot plate at 90^0C till the volume get reduced to 10 to 20 ml. Final volume was made up to 100 ml by addition of deionised water that was followed by filtration using what man number 42 filter paper. The digested filtrates were used for the metal quantification using Atomic Absorption Spectrophotometer.

2.2 Statistical Data Analysis

Analysis of Variance (ANOVA) was used to analyze the significant variation in heavy metal concentration among different sampling sites for all studied heavy metals.

Pearson correlation matrix was applied to identify the relationship between the eight elements.

3. RESULTS

Concentration of heavy metals in river water at different locations are shown in TABLE 2

TABLE 2 Heavy metal concentration at different locations in mg/l.

Location No.	Fe	Mn	Cu	Zn	Pb	Cd	Ni	Cr
S-1	0.433	0.007	0.024	0.153	0.006	0	0.006	0.003
S-2	0.29	0.007	0.018	0.095	0	0	0.001	0.003
S-3	3.041	0.037	0.037	0.144	0	0	0.02	0.007
S-4	0.373	0.014	0.007	0.064	0.017	0.001	0.006	0.008
S-5	0.526	0.013	0.008	0.11	0.012	0.001	0.006	0.005
S-6	0.831	0.13	0.019	0.099	0.01	0.001	0.039	0.021
S-7	0.692	0.584	0.017	0.167	0.064	0.001	0.047	0.015
S-8	0.384	1.017	0.012	0.103	0.022	0	0.026	0.005
S-9	0.296	0.009	0.012	0.084	0	0.002	0.021	0.003
S-10	0.467	0.006	0.013	0.06	0.008	0.001	0.017	0.003

TABLE 3 Correlations between heavy metals in water.

	Fe	Mn	Cu	Zn	Pb	Cd	Ni	Cr
Fe	1							
Mn	-0.11703	1						
Cu	0.825049	-0.13968	1					
Zn	0.414787	0.256685	0.610775	1				
Pb	-0.15376	0.613081	-0.2087	0.440473	1			
Cd	-0.3282	-0.24533	-0.53942	-0.39528	0.118122	1		
Ni	0.172991	0.548484	0.133397	0.34553	0.647617	0.267927	1	
Cr	0.167292	0.201474	0.105561	0.235599	0.482165	0.186992	0.756052	1

TABLE 4 WHO water quality standards

S.NO.	Heavy metal	WHO limit mg/l	In Present study mg/l
1	Fe	0.300	0.7333
2	Cu	1.00	0.0167
3	Pb	0.015	0.0139
4	Cd	0.005	0.0007
5	Ni	0.02	0.0189
6	Cr	0.1	0.0073
7	Zn	3.0	0.1079
8	Mn	0.1	0.1824

Ni concentration in river water ranged from 0.001 to 0.047 mg/ litre with the mean concentration of 0.01 89 mg/ litre. The highest concentration level at location number S-7 that was several times that of the lowest location. The concentration of Zn in river water was found to be highest at S-7 with the value ranging between 0.06 and 0.167mg/litre. The mean concentration of Zn in River water was found two be 0.1079mg/litre.

The level of Fe varies between 0.29 to 3.041mg/litre with the mean value of 0.7333 mg/ litre. The highest concentration of Fe was found at location S-3. Contamination of Pb in river water 0.064 mg/ litre was observed at S-7 with a mean value of 0.0139mg/litre.

Concentration of Cu ranged from 0. 007 to 0.037 mg/litre with the mean of 0. 0167 mg/ litre. The highest traces were observed at S-3. Mn concentration raised from0.006 to 1.017 mg/ litre with the mean of 0.1824 mg/litre. The highest level was observed at S-8. Traces of Cd found at a few locations. Cd lowest concentration was found to be 0 and highest be 0.002 mg/litre in all the locations. Cd was found with the mean value of 0.0007

mg/litre. Mean value of Cr was found to be 0.0073 mg/litre with the range of 0.003 to 0.021mg/litre. The highest concentration was found to be at S6.

Mean heavy metal concentration at different location in river water was following the order:

Fe>Mn>Zn>Ni>Cu>Pb>Cr>Cd.

4 DISCUSSION

A comparison of heavy metal concentration among all the sides using WHO standards shows that there is moderate contamination of heavy metals in water along the river Yamuna. High concentration of heavy metals suspended in wastewater arising from Industrial area has been found in an earlier study indicates that these Industries could be the primary source of heavy metal in the river Yamuna.[13]

Zinc level have been found to be significantly high at S-7 and that might be the presence of electroplating industries based in that region with a supplementary drain connected with okhla drain.

High concentration of Ni at S-7 is due to the major drain at Shahdara which discharges treated effluents and untreated wastes from Delhi and joins the upstream of okhla barrage.[14].

Due to the merging of drain no. 6 in the upstream of Haryana and various industries near Panipat are the responsible factors for the highest concentration of iron near location no S-3.Various industries like electroplating, painting, batteries and automobiles maintenance and repair are located in the areas and drains emerging from these units can contribute Cu, Cr, Pb and Cd. Also drains from upstream of these location where value of these metals have been found high joins industrial town of Sonipat to Najafgarh drain.

The high concentration of Manganease may be related to the steel processing industries as they discharge processed and unprocessed effluents through the supplementary drains and Najafgarh drains respectively nearly Wazirabad barrage.

Relationship of the trace metals with each other, when studied through correlation analysis indicated some statistically significant relationships, which are depicted in TABLE 3. Amongst the metals, Fe-Cu, Ni-Cr, Ni-Pb, Cu-Zn and Mn-Pb showed strong positive correlation indicating that they may be entered through common source.

5 CONCLUSIONS

The present study concluded that river Yamuna is significantly contaminated with iron and manganese. Lead and Nickel contamination needs attention for identification and rectification of the sources. the water needs to be treated before consumption and the various human activites domiciled near the river should discontinue, preventing future and severe contamination of the river.

REFERENCES

[1] A.Kaushik, Ankur Kansal, Santosh, Meena, Shiv Kumari and C.P.Kaushik, Heavy metal contamination of river Yamuna, Haryana, India: Assessment by Metal Enrichment Factor of the Sediments, *Journal of Hazardous Materials, 164, 2009, 265-270.*

[2] Darshan Malik, Sunita Singh, Jayita Thakur, Raj Kishore Singh, Amarjeet Kaur and Shashi Nijhawan, Heavy Metal Pollution of the Yamuna River: An Introspection, *International Journal of Current Microbiology and Applied Sciences, 3(10), 2014, 856-863.*

[3] *United Nations Intergovernmental Panel on Climate Change-Fifth Assessment Report: Climate Change* 2014: Impacts, Adaptation and Vulnerability, Yokohoma, Japan

[4] TERI (the Energy and Resource Institute) (2001). How Delhi makes the sprightly Yamuna a 'dead river'. TERI report. http://www.unwac.org/research_articles.php. Accessed 15 January 2009.

[5] Ashraf W, Levels of selected heavy metals in Tuna fish. *The Arab. J. Sci. Eng., 31(1A), 2006.*

[6] J. Pandey and U. Pandey, Accumulation of heavy metals in dietery vegetables and cultivated soil horizon in organic farming system in relation to atmospheric deposition in a seasonally dry tropical region of India, *Environmental Monitoring and Assessment, 148(1-4), 2009, 61-74.*

[7] A. D. Eaton and M. A. H. Franson, *Standard Methods for the Examination of Water & Wastewater, American Public Health Association, 2005.*

[8] A. G. Korcharyan, E. V. Venitsianove, N. S. Safronova and E. P. Serenkaya, Seasonal variation in the forms of heavy metals occurrence in the Water, *4, 2003, 404-412.*

[9] C. K. Jain, D. C. Singhal and M. K. Sharma, Metal pollution assessment of sediment and water in the river Hindon, India, *Environ. Monit. Assess. 105, 2005, 193-207.*

[10] Meena Sehgal, Ankur Garg, R. Suresh and Priya Dagar, Heavy metal contamination in the Delhi segment of Yamuna basin, *Environ Monit Assess, 184, 2012, 1181-1196.*

[11] TERI, *Yamuna ,the poisoned river, 2012.*

[12] WHO International year of fresh water. *General Assembly Resolution A/RES/55/196. Official website: www.wateryear2003.org, 2003*

[13] Rawat m.,Moturi m. c. z. and Subramanian v.,Inventory complilation and distribution of heavy metals in waste water from small scale industrial areas of Delhi, India. *Journal of Environmental Monitoring, 5(6),* 2003, 906-912.

[14] CPCB Control of Urban Pollution. http://www.cpcb.nic.in.oldwebsite/new%20item/maintinance-STPS/AK-Sinha-STP2.doc., 2011