Int. J. Chem. Sci.: 12(1), 2014, 191-198
ISSN 0972-768X
www.sadgurupublications.com

EVALUATION OF HEAVY METALS LOADING OF RIVER GANGA IN GAZIPUR (U.P.) INDIA

HEMANT KUMAR SINGH[*] and N. B. SINGH

S. G. R. P. G. College, Dobhi, JAUNPUR (U.P.) INDIA

ABSTRACT

The concentration of chromium (Cr), copper (Cu), nickel (Ni), lead (Pb) and zinc (Zn), which may effect human health and the health of the aquatic system were determined in the rivers Ganga on four sample station at Gazipur using Atomic absorption spectrophotometer, Spectra AA220G Varian Pvt. Ltd. Hyderabad. The levels of heavy metals were compared with BIS 2005 and WHO 1993. All the heavy metals at all the sampling stations were found above the permissible limits. The concentration of these heavy metals in the study area indicates that the river is highly polluted. The possible sources of these heavy metal pollutions are diverse, originated from natural or anthropogenic sources and point sources.

Key words: Sampling station, Heavy metals and permissible limits.

INTRODUCTION

The Ganga river is one of the most utilized rivers in the world. Due to abundant availability of water throughout the year, it has played an important role in the development of Indian civilization and economy. Increased urbanization and industrialization in the basin, has resulted in polluting the river, since the river has been preferred waste disposal site for industrial and domestic effluents[1,2]. The pollution of aquatic ecosystem by heavy metals has assumed serious proportions due to their toxicity and accumulative behavior. Unlike organic pollutants, natural processes of decomposition do not remove heavy metals. Metals are introduced into the aquatic system as a result of weathering of soil and rocks, from volcanic eruptions and from a variety of human activities involving mining, processing use of metals or substances containing metal contaminants[3]. Trace metals entering natural water become part of the water-sediment system and their distribution processes are controlled by a dynamic set of physical-chemical equilibria. The metal solubility is principally controlled by pH, concentration and type of ligands and chelating agents, oxidation-state of mineral components and the redox environment of the system[4]. Since each form may have different bioavailability

---

[*] Author for correspondence; E-mail: deepak.jnp145@rediffmail.com

and toxicity, the environmentalists are rightly concerned about the exact forms of metal present in the aquatic environment[5,6]. Thus, distribution of heavy metals in water and sediments play a key role in detecting sources of heavy metal pollution in aquatic ecosystem[7,8].

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of live. Natural river water contains some type of impurities whose nature and amount vary with source of water. Metals for example, are introduced into an aquatic system through several ways which include weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities. Metals after entering the water many be taken up by fauna and flora and eventually, accumulated in marine organisms that are consumed by human being. The increased use of metal based fertilizer in agriculture revolution of the government could result in continued rise in concentration of metal pollutions in fresh water reservoir due to the water run-off. Metal in water occur as complex and mixture of soluble and insoluble form, such as ionic species, inorganic and organic complexes associated with colloids and suspended particulate matter. Metals are probably the most harmful pollutants because of their non-biodegradable nature and their potential to cause adverse effects to human beings, it their concentration is higher than the permissible limits. Metals enter into the water system by natural or anthropogenic sources. The anthropogenic sources include various industries and domestic sewage. The industries, which emits the metals in electroplating industries, paint and pigment industries, ceramic pulp and paper industries, cotton textile, steel plant, galvanization of ion product, iron and mining industries. Various environmental factors such as temperature, pH, water hardness, dissolved oxygen light, salinity and organic matter can influence the toxicity of the metals in the solution.

As a result, metals shift from one compartment within the aquatic environment to another including the biodata often with detrimental effects, through sufficient bioaccumulation. As a result of adsorption and accumulation the concentration of metals in bottom sediments is expected to be higher than in the water above and this sometimes can causes secondary pollution problems, therefore, bottom sediments are repository of heavy metals. Metals in natural waters can exist in truly dissolved colloidal and suspended forms. The proportion of these forms varies with metals and for different water bodies. Consequently, the toxicity and sedimentation potential of metals change depending on their forms[9]. Non essential metals often exerts their action through their chemical similarity to essential elements e.g. Cd with Cu or Zn. However, the effects of toxicity are usually additive and or synergistic. Essential heavy metals are less toxic than non-essential metals. Metal such as cadmium, chromium, copper, iron, nickel, lead and zinc exhibits aquatic toxicity when present above recommended standard in that they can contaminate surface and ground water bodies, soil, plant, aquatic life and man, through bioaccumulation. The heavy metals pollution is one of the five major types of toxic pollutants commonly present in surface and ground water. The environmental pollutants tend to accumulate in organisms and become persistent because of their chemical stability or poor biodegradability and those they are readily soluble and therefore environmentallly mobile[10,11]. Heavy metals form one of the major contributors to the pollution of natural aquatic ecosystem[12,13].

Study area

The river Ganga at Ghazipur lies at 25º34’ N longitudinal and 84º34’ E longitudinal. Ghaziur situated at bank of river North direction. So Ghazipur city area decided with Ganga river in south direction flowing from West to East direction. Four experiment site have been selected for study purpose of Ganga river water at Ghazipur of different stretches. The flows of Ganga river near Ghazipur city area covered near about 2.270 Km distance from S_1 site to site S_4 near the bridge name S_1- Patthar Ghat, S_2- Navapura Ghat, S_3- Chitnath Ghat and S_4- Nepali Ghat.

EXPERIMENTAL

Material and methods

Sample collection

Water sample were collected from the Ganga river from upstream and downstream in sterile containers and transport to the laboratory on ice. All glass wares were properly cleaned with acid cleaning agents and rinsed thoroughly with distilled water. The water sample were collected from four sampling station. The analysis were carried out twice on the basis of six months intervals. First analysis was carried out in September 2012 and another analysis was carried out in March 2013.

Determination of heavy metals

In sample 5 mL conc. HNO_3 was added to minimize adsorption of the metals on the container metals. For the analysis of heavy metals, one litre of sample along with 4 mL conc. HNO_3 was evaporated in a beaker on a water bath to approximately 50 mL and then cooled. The concentrate was transfer to 100 mL measuring cylinder and 2 mL conc. HCl was added. The solution was added to 100 mL with distilled water. The acidified samples were then analysed for heavy metals with the help of Atomic Absorption spectrophotometer spectra AA 220G (Varian Pvt. Ltd., Hyderabad). The samples were directly aspirated into an air C_2H_2 flame of an AAS and absorbance was measured at different wavelength. The metal determined were iron (Fe), copper (Cu), zinc (Zn), nickel (Ni), chromium (Cr) and lead (Pb)[14].

RESULTS AND DISCUSSION

Iron

The value of iron ranged from 2.0 to 5.3 mg/L (Table 1, 2), which was found to be above the permissible limits. The highest value was reported in summer and lowest in winters. Varied results were obtained with the range of 0.7-1.9 mg/L. Lower values were obtained (0.8 mg/L) of iron. The values of iron could be attributed to high concentration of iron is soil. Iron has been mostly derived from metallic pollutants but anthropogenic sources of iron may be confined to effluent from industries like steal, milk and metal pipes. Similar result reported that the presence of iron well above the stated limit is objectionable because they leave stains of oxide or hydroxide on laundry, sanitary wares, rusting of pipes in supply line.

Cu

Copper value ranged from 12.13-21.35 mg/L, which is above the permissible limits. The minimum values of copper concentration were found in the winter season. Copper concentration ranged from 0.01-0.07 ppm. Copper is an essential metal required by almost all living organisms in some of their enzyme systems but higher concentration it works as essentially a pollutant. Copper is useful to the human body in very small concentration, but at higher concentration of 25 mg/100 gram copper can be poisonous. Cu is an essential component of numerous key metal enzymes, which are critical in melanin myelin formation and cross linking of collaged and Dustin. It plays a vital role in hemopoiesis maintenance of vascular and skeleton integrity and function of nervous system.

Zinc

In this study, the values of Zn determined was 8.4-15.75 mg/dl, which was found to be above the permissible limit (WHO 1993) but falls within the range of (BIS 2005). Zinc is an essential component in human metabolism. But excessive concentration in drinking water may cause undesirable aesthetic effect. Deficiency of zinc in human body may results in infantilism and impaired wound healing. The high values could be attributed to the human activities such as use of chemicals and zinc based fertilizers.

Nickel

In this study, the concentration of ranged from (1.2 to 3.9 mg/L), which was found to be above the permissible limits. Ni interacts with organic matter and settled down, resulting in its higher concentration in sediments. Minimum concentration of Ni in river water was recorded at upstream at Ghazipur while maximum value of Ni was obtained at downstream at Kanpur. Higher as well as lower concentrations of the heavy metal in drinking water are equally harmful to human beings.

Table 1: Heavy metal analysis by AAS at different wavelength of different sampling station in the year Sept. 2012 (mg/L)

Sampling sites	Fe 248.3 nm	Cu 324.8 nm	Zn 213.9 nm	Ni 232 nm	Cr 358 nm	Pb 217 nm
S_1	3.1	12.13	6.52	1.9	2.0	1.05
S_2	2.0	14.5	8.9	1.20	1.0	2.8
S_3	3.2	16.8	10.2	4.2	2.5	3.1
S_4	3.4	14.23	9.5	2.4	2.8	3.2
BIS (2005)	0.3-0.5	1.5	1.5	0.02	0.05	0.1
WHO 1993	0.3	2.0	5	0.02	0.05	0.01
Mean	2.8	14.03	9.388	2.27	1.81	2.421
S.D.	0.737	2.183	1.635	1.024	0.698	0.731
C.V. (%)	26.3	15.5	17.4	45.09	38.56	30.2

S_1- Patthar Ghat, S_2- Navapura Ghat, S_3- Chitnath Ghat, S_4- Nepali Ghat,
S.D.- Standard deviation, C.V.- Cofficient of variation

Table 2: Heavy metal analysis by AAS at different wavelength of different sampling sites in the year March 2013 (mg/L)

Sampling sites	Fe 248.3 nm	Cu 324.8 nm	Zn 213.9 nm	Ni 232 nm	Cr 358 nm	Pb 217 nm
S_1	3.8	19.12	9.72	2.9	2.2	1.09
S_2	2.4	16.09	9.01	2.4	1.2	3.10
S_3	4.8	21.35	15.75	4.4	3.2	3.31
S_4	5.3	16.63	12.31	3.4	5.4	4.01
BIS (2005)	0.3-0.5	1.5	1.5	0.02	0.05	0.1
WHO 1993	0.3	2.0	5	0.02	0.05	0.01
Mean	3.63	16.99	11.825	3.36	2.471	2.73
S.D.	1.405	3.027	2.451	0.766	1.461	0.915
C.V. (%)	38.7	17.81	20.7	22.5	59.01	33.4

S_1- Patthar Ghat, S_2- Navapura Ghat, S_3- Chitnath Ghat, S_4- Nepali Ghat,
S.D.- Standard deviation, C.V.- Cofficient of variation

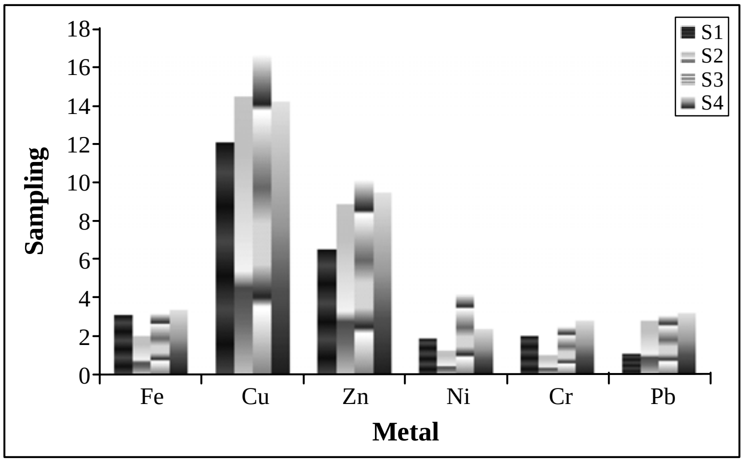

Fig. 1: Heavy metal analysis by AAS at different wavelength of different sampling station in the year 2012

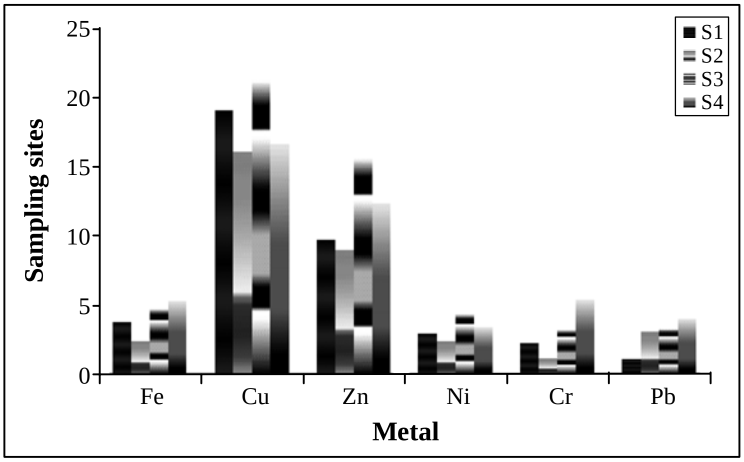

Fig. 2: Heavy metal analysis by AAS at different wavelength of different sampling station in the year 2013

Chromium

In this study, chromium value ranged between 1.0 to 5.4 mg/L of water, which is greater than permissible limit. Higher concentration of Cr in water causes disorder of skin and respiratory tract. Higher concentration of chromium in river near Ghazipur is due to the presence of dairies, sugar, opine and other industries. The maximum value of chromium may be attributed to huge amount of domestic sewage with organic pollutant is disposed into the river.

Lead

The study evaluated the range of lead in all the four sampling stations is the range of 1.05-4.01 mg/L, which is above the permissible limit. Lead is higher toxic metal and its concentration in natural water increases mainly through anthropogenic activities. The source of lead in surface as well as in ground water is through large no. of industries such as batter manufactures, paints, ceramics, pesticides, cable insulation and plastic which use lead in their operation. It is known to be an accumulative type of poison in the human body. Varied results were obtained at different sampling station in water of Ganga in Gazipur. Lead may enter into sewage system through dust, soil erosion, leaching urban waste discharges and run off from steels and other surfaces. This toxic metal may cause anemia, kidney disease and nervous disorder above the tolerance limits 0.05 mg/L. From the above values of mean, S.D. and coefficient of variation (Table 1) shows that the coefficient of Cu in water sample of different sampling station was consistent followed by concentration of Zn and Fe. There is very less variation in the concentration of these metal between different sampling station. C.V. value of Ni (45.09%) showed high variation in the concentration values of Ni at different sampling stations. Followed by Cr and Pb, which also shows high variation in concentration at different sampling station. From the above values of means, S.D. and coefficient of variation (Table 2) shows that the concentration of Cu in water samples at different sampling station was consistent i.e. very less variation in concentration of Cu at different sampling sites followed by Zn and Ni. C.V. value of Cr shows high variation in the concentration of Cr at different sampling station followed by Fe and Pb, which also show high variation in the concentration at different sampling station.

REFERENCES

1. U. Fostner and G. T. W. Whittmann, Metal Pollution in the Aquatic Environment, Springer Verlag Berlin, Heidelberg N.Y. (1981) pp. 486.
2. D. P. Modak, K. P. Singh, H. Chandra and P. K. Ray, Mobile and Bound Forms of Trace Metals in Sediments of the Lower Ganges, Water Res., **26(11)**, 1541-1548 (1992).
3. Suresh Prasad and D. C. Ruapanwar, Separation of Selected Heavy Metals from Bank Sediment of River Ganga by Solvent Extraction, Pollution Research, **9(1-4)**, 15-21 (1990).
4. K. R. Beg and S. Ali, Chemical Contamination and Toxicity of Ganga River Sediment from up and Down Stream Area at Kanpur, American J. Environ. Sci., **4(4)**, 362-366 (2008).

5. P. Purushothaman and G. J. Chakrapani, Heavy Metal Fractionation in Ganga River Sediments, India, Environ. Monit. Asses., **132**, 475-489 (2007).
6. N. Stamatis and D. Ionnidou, A. Christoforidis and E. Koutrakis, Sediment Pollution by Heavy Metals in the Strymonikos and Ierissos Gulf, North Aegwan Sea, S. Greece, Environ. Monit. Assess., **80**, 33-49 (2002).
7. NRCD Status Paper on River Action Plan, Ministry of Environment and Forests, Government of India, New Delhi (1999).
8. P. K. Rai, Heavy-metal Pollution in Aquatic Ecosystems and Its Phytoremediation using Wetland Plants, An Ecosustainable Approach, Int. J. Phytoremediation, **10(2)**, 133-160 (2008).
9. P. K. Rai, Heavy Metal Phytoremediation from Aquatic Ecosystems with Special Reference to Macrophytes, Critical Rev. Environ. Sci. Technol., **39(9)**, 697-753 (2009).
10. P. K. Rai, Microcosm Investigation on Phytoremediation of Crusing Azolla Pinnata, Int. J. Phytoremediation, **12**, 96-104 (2010).
11. P. K. Rai and B. D. Tripathi, Heavy Metals in Industrial Wastewater, Soil and Vegetables in Lohta Village, India. Toxicol. Environ. Chem., **90(2)**, 247-257 (2008).
12. P. K. Rai and B. D. Tripathi, Comparative Assessment of Azolla Pinnata and Vallisneria Spiralis in IIg Removal from G.B. Pant Sagar of Singrauli Industrial Region, India Environmental Monitoring and Assessment, **148**, 75-84 (2009).
13. K. P. Singh, D. Mohan, S. Sinha and R. Dalwani, Impact Assessment of Treated/untreated Wastewater Toxicants Discharged by Sewage Treatment Plants on Health, Agricultural and Environmental Quality in the Wastewater Disposal area, Chemosphere, **55**, 227-255 (2004).
14. APHA, Standard Methods for the Examination of Water and Wastewater, 10th Ed. Washington DC, American Public Health Association (2000).

Accepted : 16.09.2013