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EVALUATION OF HEAVY METALS LOADING OF RIVERS GANGA AND YAMUNA IN

AVANTIKA PANDEY[1], P.W RAMTEKE[2] AND O.P VERMA*[3]

Department of Molecular and Cellular Engineering,[1,3.]SHIATS,Allahabad,India.
Department of Biological sciences,[2]

ABSTRACT

The concentration of Chromium(Cr),Copper(Cu),Iron(Fe),Nickel(Ni), Lead (Pb)and Zinc(Zn). Which may effect human health and the health of the aquatic ecosystem were determined in the rivers Ganga and Yamuna on seven sampling stations at Allahabad using Atomic absorption Spectrophotometer, Spectra AA 220 G,Varian pvt. Ltd, Hyderabad. The levels of the 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 indicated that the river is highly polluted. The possible sources of these heavy metal pollutions are diverse: originating from natural or anthropogenic sources and point sources.

KEY WORDS:Sampling stations, heavy metals and permissible limits.

O.P VERMA
Department of Molecular and Cellular Engineering, SHIATS,Allahabad,India.

**Corresponding author*

INTRODUCTION

The availability of good quality water is an indispensable feature for preventing diseases and improving quality of life [25]. Natural river water contains some types 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, including mining, processing and the use of metal based materials [15,3,4].. 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 [4].. The increased use of metal-based fertilizer in agricultural revolution of the government could result in continued rise in concentration of metal pollutions in fresh water reservoir due to the water run-off. Metals 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 [22].Metals are probably the most harmful pollutants because of their non-biodegradable nature and their potential to cause adverse effects to human beings, if their concentration is higher than the permissible limits [19].Metals enter into the water system by natural or anthropogenic sources. The anthopogenic sources include various industries and domestic sewage. The industries which emit the metals in electroplating industries, paints and pigment industries, ceramic pulp and paper industries, cotton textile, steel plant, galvanization of iron products, iron and mining industries [34].These metals have accumulative effect at low level in drinking water and ground water [27]. Various environmental factors such as temperature, pH, water hardness, dissolved oxygen, light, salinity, and organic matter, can influence the toxicity of the metals in solutions[7,10,11].Also, the lack of natural elimination processes for metals aggravates the situation. As a result, metals shift from one compartment within the aquatic environment to another including the biota often with detrimental effects, through sufficient bioaccumulation. Food chain transfer also increases toxicological risk in humans [29,21].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 cause 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[6].Non essential metals often exert their action through their chemical similarity to essential elements for example, Cadmium with Copper or Zinc [13].However, the effects of toxicity are usually additiveand / or synergistic [9].Essential heavy metals are generally considered to be less toxic than non-essential metals, [5]. Metals such as cadmium, chromium, copper, iron, nickel, lead and zinc exhibit 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. According to[21].Heavy metals pollution is one of the five major types of toxic pollutants commonly present in surface and ground waters. 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 environmentally mobile. Heavy metals form one of the major contributors to the pollution of natural aquatic ecosystems [28,31].

Study area

Allahabad is situated at 25.45°N 81.84°E in the southern part of Uttar Pradesh at an elevation of 98 metres (322 ft) and stands at the confluence of two rivers, the Ganges and Yamuna. The region was known in antiquity as the Vats country. To its south and southeast[38] is the Bundelkh and region, to its east is the mid Ganges valley of North India, or Purvanchal, to its southwest is the Bundelkh and region, to its north and northeast is the Awadh region and to its west along with Kaushambi it forms the Lower Doab region.The water samples were collected from 7 sampling stations Baluaghat, Gaughat, Saraswati, (Yamuna ghats) Dashaswamedh ghat, Ramghat, and Someshwar (Ganga ghats) and Sangam, (confluence). The analysis of samples were carried out twice on the basis of six months interval.

The seven different sampling stations were:

1. Baluagh at (upstream): This sampling site is at the banks of river Yamuna and is Approximately 3 km from the confluence point Sangam.
2. Gaugh at (downstream): This sampling site lies at the bank of river Yamuna and is 2 km from the meeting point Sangam.
3. Saraswati or Boat Club Ghat (downstream): Saraswati ghat is approximately 1 km Yamuna from the confluence point Sangam.
4. Dashaswamedh ghat (upstream Ganga) This sampling site lies at about 1km Ganga from the Sangam
5. Ram Ghat: (downstream) Ram ghat lies about 1/2 km in Ganga from Sangam
6. Someshwar ghat (downstream Ganga and Yamuna) -This sampling site lies after meeting point of Ganga and Yamuna Sangam, at about 2km from the Sangam.
7. Sangam (confluence point): The meeting point of river Ganga and Yamuna.

MATERIALS AND METHODS

Sample collection

Water samples were collected from the rivers Ganga and Yamuna and also their confluence point, Sangam .The sample were collected from the upstream and downstream of flowing water of both the rivers in sterile containers and transported to the laboratory on ice. All glasswares were properly cleaned with acid-cleansing agents and rinsed thoroughly with distilled water.The water samples were collected from 7 sampling stations Baluaghat, Gaughat, Saraswati, (Yamuna ghats)Dashaswamedh ghat,Ramghat, and Someshwar (Ganga ghats), Sangam, (confluence). The analysis was carried out twice on the basis of six months interval.First analysis was carried out in October 2010 and another analysis was carried out in April 2011.

Determination of Heavy Metals

For sampling, the containers were thoroughly washed and rinsed with 8 N HNO_3 followed by redistilled water. Then 5 ml conc. HNO_3 per litre of sample was added at the time of collection 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 50ml and then cooled. The concentrate was transferred to 100ml measuring cylinder and 2ml conc. HCl was added. The solution was added to 100ml with distilled water. The acidified samples were then analyzed for heavy metals with the help of Atomic Absorption Spectrophotometer, Spectra AA 220 G, (VarianPvt. 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 metals determined were Iron (Fe), Copper (Cu), Zinc (Zn),Nickel (Ni), Chromium (Cr) and Lead(Pb).

RESULTS AND DISCUSSIONS

Iron (Fe) **-** In this study the values of Fe ranged from 1.2-5.3mg/l (Table 1, 2) which was found to be above the permissible limits**.** The highest values were reported in summers and lowest in winters. Varied results were obtained within the range of 0.7-1.9 mg/l. Lower values were obtained (0.8mg/l) of iron in Bellandur lake [30]**.**Similar results were reported[1] in the range of (0.1-5.3mg/l) on river of Nigeria. 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 steel milk and metal pipes [18].Similar results [25] reported that the presence of iron well above the stated limit is objectionable because they leave strains of oxide, or hydroxide on laundary, sanitary wares, rusting of pipes in supply line etc. Cu (mg/l)-In this analysis the values of copper ranged from 11.5 -21.35mg/l which is above the permissible limits (BIS 2005, WHO1993)(Table 1,2).The maximum values of copper concentration were observed in the summer season while the minimum values of copper were found in the winter season. Varied results were obtained by different authors [12].Cu concentrations ranged from .01-.07ppm. The concentration of Copper varied from place to place[1].

Table1

Heavy Metals Analysis by AAS at differentwavelength of different sampling stations in the year S_1 (October2010) (mg/l)

Sampling sites Wavelengths	Fe 248.3nm	Cu 324.8nm	Zn 213.9nm	Ni 232nm	Cr 358nm	Pb 217.0nm
T1	3.1	12.13	6.52	1.9	2.0	1.05
T2	2.0	14.5	8.9	1.2	1.0	2.8
T3	3.2	11.5	9.1	1.2	1.2	2.4
T4	3.2	16.8	10.2	4.2	2.5	3.1
T5	1.5	12.30	12.0	2.6	2.0	2.3
T6	3.4	14.23	9.5	2.4	2.8	3.2
T7	3.2	16.8	9.5	2.4	1.2	2.1
BIS(2005)	0.3-0.5	1.5	15	0.02	0.05	0.1
(WHO1993)	0.3	2	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

T1-Baluaghat, T2-Gaughat, T3-Saraswati ghat, T4-Dashaswamedh ghat, T5-Ram ghat, T6-Someshwar ghat, T7-Sangam ghat. S2-April-2011, S.D-Standard deviation, C.V-Cofficient of Variation.

analysed the value of Cu as (0.18 mg/l). This could be attributed to the geological distribution of minerals that vary from one location to another. Similar variations were reported in major dams in Ekiti state, Nigeria [1]. Again varied results were obtained, for copper in the range of 0.1-0.2mg/l [24].Same results [18] observed that out that the copper is widely distributed and is an essential metal required by almost all living organisms in some of their enzyme systems but at higher higher concentrations it works as essentially a pollutant.[26] reported copper is useful to the human body in very small concentrations,but at higher concentrations of 25mg/100mg copper can be poisonous [17]proclaimed that copper is an essential component of numerous key metalloennzymes which are critical in melanin formation,mycelin formation and cross linking of collaged and elastin. It plays a vitalrole in hemopoiesis maintenance of vascular and skeleton integrity and function of nervous system. Certain live diseases can be attributed to Cu deficiency. Zinc (Zn) – In this study the values of Zinc were determined in the range of (6.5-17.5mg/l) (Table 1, 2) which was found to be above the permissible limit (WHO,1993) but falls within the range of (BIS,2005). Zinc is an essential element in human metabolism. A child requires 0.3mg/l of Zn/kg of body weight, the deficiency of which may cause growth retardation [33]. But excessive concentration in the drinking water may cause undesirable aesthetic effects. [37] deficiency in the human body may results in infantalism and impaired wound healing. The higher concentration of Zinc is due to discharge from jewelry soaps, galvanized electroplating soaps, pharmaceutical pigments,insecticides cosmetics,etc, to the city drains[8]the highest value was 15.75 mg/l. The high values could be attributed to the human activities such as use of chemicals and zinc based fertilizers [12]. High concentrations of zinc (5.5-9.2mg/l) were also reported

[1].[17]reported the value of zinc as10.6ppm which was higher than the permissible limits. Varied results were obtained from [24] for zinc. [32] has reported 21.00mg/l zinc in the sewage water of Industrial state of naini which is attributed to effluents from the discharge of industries.

Table 2
Heavy Metals Analysis by AAS at different wavelengthof different sampling stations in the yearS$_{2(}$April 2011) (mg/l)

Sampling Stations	Fe 248.3nm	Cu 324.8nm	Zn 213.9nm	Ni 232nm	Cr 358nm	Pb 217.0nm
T1	3.8	19.12	9.72	3.9	2.2	1.09
T2	2.4	16.09	9.01	2.4	1.2	3.10
T3	4.1	12.89	10.11	2.4	1.9	2.65
T4	4.8	21.35	15.75	4.4	3.2	3.31
T5	1.2	13.89	14.09	3.8	2.2	2.72
T6	5.3	16.63	12.31	3.4	5.4	4.01
T7	3.8	19.01	11.79	3.2	1.2	2.26
BIS(2005)	0.3-0.5	1.5	15	0.02	0.05	0.1
(WHO1993)	0.3	2	5	.02	.05	0.01
Mean	3.62	16.99	11.825	3.35	2.471	2.73
S.D	1.405	3.027	2.451	0.756	1.461	0.915
C.V (%)	38.7	17.81	20.7	22.5	59.1	33.4

T1-Baluaghat, T2-Gaughat, T3-Saraswati ghat, T4-Dashaswamedh ghat, T5-Ram ghat, T6-Someshwar ghat, T7-Sangam ghat. S2-April-2011, S.D-Standard deviation, C.V-Cofficient of Variation.

Nickel (Ni) **-** In this study the concentration of Nickel ranged from (1.2-3.9mg/l).(Table 1, 2).which was found to be above the permissible limits(WHO,1993and BIS,2005).Free Nickel mostly occurs in Ni^{2+} cationic form. Ni interacts with organic matter (which ranges from 3-5%to 5.3%) which is quite high in the aqueous phase and settled down, resulting in its higher concentration in sediments [16]**.** Varied results were obtained in the value of Nickel as (0.1mg/l). [16] reported that minimum content of Nickel in river water was recorded at upstream of Allahabad and Ettawah respectively, while maximum value of Ni was obtained at downstream of Delhi and Agra. Higher as well as lower concentrations of the heavy metals in drinking water are equally harmful to human beings [20]**.** Chromium (Cr) **–** In this study the chromium values ranges between 1.0-5.4mg/l of water which is greater than the permissible limit. (WHO, 1993and BIS, 2005).(Table 1, 2).Higher concentration of Cr in water causes disorder of skin and respiratory tract [15]. The high concentration of Chromium is found in ground water and at some places may possible due to the to the presence of dairies ,sugar manufacturing and refactory industries in the region which discharge their effluents.in the open drainage on the land surface and in the rivers. [24]for Cr 2.9-5.1 mg/l of water samples were above the permissible limit (WHO, 1995) Varied results were obtained [1] which ranged from 0.1-0.4 mg/l in the water samples of Ona river, Nigeria. The maximum values of Chromium may be attributed to huge amount of domestic sewage with organic pollutant is disposed off into the river. It may be due to chrome plating, which is in abundance at Moradabad [26]**.** Lead (Pb) – The study evaluated the range of Pb in all the seven sampling stations in the range of 1.05-3.31mg/l (Table 1, 2)which is above the permissible limits (WHO, 1993 and BIS, 2005). Lead is highly toxic metal and its concentrations in natural water increases mainly through anthropogenic activities. The sources of lead in surface as well as in ground water is through large no of industries, such as battery manufacturers ,paints, ceramics and pesticides , cable insulation and plastics which use lead in their operation [18]**.**[26] reported that lead can enter in river water through lead joints of C.I. pipes, lead pipes,used for connecting , plumbing fixtures (wash basins, kitchen sinks etc.) and through lead paints when used for painting steel water storage tanks. It is known to be an accumulative type of poison in the human body. [1] reported the values of Pb in One river, Nigeria in the range of (0.1-0.2mg/l) which is greater than the permissible limit [35]which supports our results. Varied results were obtained by [24] in the sampling stations of South west, Nigeria which was found to be not detected. Similarly, other variations were also there [30] reported values of Pb in Bellandur lake, Bangalore.0.04mg/l which is within the permissible limit**.** [35]and Bellandur ground water was higher than the permissible limit[35]**.** [14] reported (Lead) may enter in to the sewage system through dust, soil erosion .leaching urban waste discharges and runoff from streets and other surfaces. This toxic metal may cause anemia, kidney disease and nervous disorder above the tolerance limits 0.05mg/l. [35]**.** From the above values of mean, S.D and Coefficient of variation (Table 1) shows that th concentration of Cu in water samples of different sampling stations was consistent followed by concentration of Zn and Fe. There is very less variation in the concentrations of these metals between different sampling stations.C.V value of Ni (45.09%) showed high variation in the concentration values of Nickel at different sampling stations. Followed by Cr and Pb which also shows high variation in concentrations at different sampling stations. From the above values of mean, S.D and Coefficient of variation (Table 2) shows that the concentration of Cu in water samples at different sampling stations was consistent *i.e* very less variation in concentrations of Cu at different sampling sites followed by Zn and Ni. C.V value ofCr shows high variation in the concentrations of Cr at different sampling stations followed by Fe and Pb which also show high variation in the concentrations at different sampling stations.

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