Assessment of Heavy Metal Toxicity in Surface Water of River Bandi, Pali, Rajasthan

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ABSTRACT

Concentration of six heavy metals (Fe,Cd,Pb,Cu,Cr and Zn) in surface water of river Bandi from Pali to downstream Nehda along the course of river were determined to evaluate their levels. Iron, lead, zinc, copper and chromium are present in alarming concentration in industrial effluent while concentration of lead and chromium in industrial effluent exceeds limit set by UNICEF for discharge of industrial surface water of 0.1mg/l. River Bandi is of ephemeral nature up to Pali in monsoon. While from Pali to Nehda river has regular flow of wastewater from the industrial and urban area throughout the year. The high levels of cadmium (0.07mg/l), lead (0.18mg/l) and chromium (0.16mg/l) is a matter of environmental degradation as flora and fauna are directly exposed to wastewater. The presence of toxic concentration of lead, chromium, cadmium and iron in river water illustrate the impact of trace metals by the dyeing and printing industries functioning in Pali. A significant aspect of pollution of river water is the degradation of potable character.

Keyword: Heavy metals, toxicity, Bandi River, Pali, Dyeing and Printing effluents.

1. INTRODUCTION

Many of our rivers, lakes and oceans have been contaminated by pollutants. Some of these pollutants are directly discharged by industrial plants and municipal sewage treatment plants other come from polluted runoff in urban and agricultural areas and some are the result of historical contamination. Among the inorganic contaminants of river water, heavy metals are getting importance for their non-degradable nature and often accumulate through tropic level causing a deleterious biological effect. Anthropogenic activities like mining, ultimate disposal of treated and untreated waste effluents containing toxic metal chelates from different industries (1,2) and also the indiscriminate use of heavy metal containing fertilizers and pesticides in agriculture resulted in deterioration of water quality rendering serious environmental problems posing threat on human being and sustaining aquatic biodiversity .Through some of the metals like Cu, Fe, Mn, Ni and Zn are essential as micronutrients for life processes in plants and microorganism while many other metals like Cd, Cr and Pb have no known physiological activity but they are detrimental beyond a certain limit environmental contamination and exposure to heavy metals such as Hg, Cd and Pb(3)

is a serious growing problem throughout the world . Human exposure to heavy metals has risen dramatically in the last 50years as a result of an exponential increase in use of heavy metals in industrial processes and products. Many occupations involve daily heavy metal exposure; over 50 professions entail exposure to Hg alone .In today′s industrial society, there is no escaping exposure to toxic chemicals and metals. In general, heavy metals are systematic toxins with specific neurotoxin, nephrotoxic fetotoxic and teratogenic effects.

Heavy metals can directly influence behavior by impairing mental and neurological function, influencing neurotransmitter production and utilization and altering numerous metabolic body processes(4,5). Systems in which toxic metal elements can induce impairment and dysfunction include the blood and cardiovascular, eliminative pathways (colon, liver, kidneys, and skin), endocrine (hormonal), energy production pathways enzymatic, gastrointestinal, immune, nervous (central and peripheral) ,reproductive and urinary (5,6) . One of the problems with metals is their environmental persistence. Once mined and brought into the ecology, they last almost indefinitely. Also, we face the usually-ignored problems of potentiation(7,8), which means two relatively small doses of two different substances may have a dramatically enhanced effect when present together e.g. it is widely known that the presence of lead makes Hg 100 times more toxic. Therefore, the aim of study is to assess the level of metal concentration in river water and hence to assess pollution status of river.

2. STUDY AREA

Bandi river is a major tributary of Luni river. It is primarily an ephemeral stream which originates near Bumadra village about 15 km west of Pali district lies between $24^0 50'$ and$26^0 75'$ north latitude and $72^0 48'$to$74^0 20'$ east latitude. It is situated on the banks of river Bandi. It is formed due to confluence of two monsoon streams Khari and Mithri. these streams mainly drain the monsoon runoff from foothill zones of high mountain Aravalli ranges running south=east in the district .monsoon runoff of some streams are checked at Hemswas dam and it′s overflow contributes significantly to the Bandi river during monsoon. Bandi flows in almost east to west direction and passes through south of Pali city. The river has highest altitude of about 450 m and lowest of less than 51 m. The slope of the drainage flowing in the area is generally less than 5% suggesting sluggish nature of the flow which enhances and at places impoundment of waste water in the river.

3. MATERIAL AND METHODS:

In order to assess the effect of heavy metals chemical investigation of river water were carried out. Water samples from different representative sampling station along the rivercoursehave been collected in pre monsoon period 2007 (fig 1)

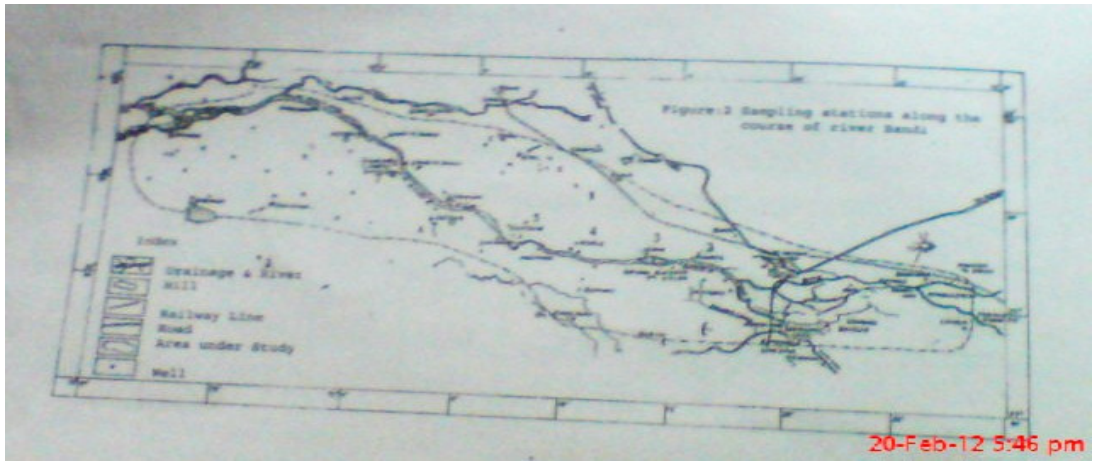

Figure 1 Map of bandi river flow in Pali , Rajasthan

Effluent sample was collected from three main industrial drainage sites, which were key locations of industrial effluent discharge. The water sample has been collected in poly ethylene bottles of one liter capacity. Before collecting water samples, these bottles has been thoroughly washed with 10% HCl and rinsed with distilled water. The water samples have been analyzed using standard methods of chemical analysis of water and wastewater. The trace element such as Fe, Cu, Zn, Cd, Pb &Cr were determined (9, 10) by atomic absorption technique using atomic absorption spectrophotometer (Varian Techtron). The water samples filtered through 0.45µm membrane filter and acidified with concentrated HNO_3 (AR grade).In order to get better results the concentration techniques, i.e., evaporation, chelation extraction and standard addition method were adopted. The different wavelengths and other instrumental conditions used for metal ion determination were normal and given below:

Table: 1 Wavelength and Instrumental used for metal ion determination

Element	Lamp Current mA	Flame & Stoichiometry	Wave length nm	SlitWidth nm	Working Range,mg/l
Copper	3	Air-Acetylene;Oxidising	324.7	0.2	0-2
Chromium	5	Air-Acetylene;Oxidising	357.9	0.2	0-2
Cadmium	3	Air-Acetylene;Oxidising	228.8	0.5	0-2
Iron	5	Air-Acetylene;Oxidising	248.3	0.2	0-4
Lead	6	Air-Acetylene;Oxidising	217.0	1.0	0-2
Zinc	5	Air-Acetylene;Oxidising	213.9	0.2	0-2

4. RESULTS AND DISCUSSIONS:

Table: 2 Heavy Metals Concentration along the Flow of River

Metals	Industrial Effluent*	Pali	Punaita	Jawdia	Kerla	Chatelao	Jetpur	Dholeria	Nehda
Iron	0.24	0.28	0.28	0.28	0.22	0.25	0.22	0.31	0.19
Cadmium	0.04	0.05	0.05	0.05	0.04	0.04	0.04	0.05	0.07
Lead	0.18	0.17	0.13	0.13	0.13	0.13	0.07	0.16	0.07
Copper	0.16	0.05	0.25	0.01	0.06	0.06	0.05	0.06	0.10
Zinc	0.18	0.07	0.04	0.04	0.05	0.04	0.04	0.05	0.04
Chromium	0.13	0.16	0.16	0.06	0.06	0.06	0.16	0.06	0.11

Average value of three industrial effluents collected; Values are in mg/l

Pali district in Rajasthan has got largest number of textile dyeing printing industries more than 900 units, mostly engaged in cotton and synthetic textile printing and dyeing .These industries liberate a variety of chemicals, dye, acids and alkali besides other toxic compounds like heavy metals. These units discharge their untreated effluent directly into river Bandi. Further, increasing trend of requirement and productivity of dyes and dye intermediates is associated with generation of waste containing toxic and hazardous substances, which are not acceptable to the recipient environment, if released uncontrolled.

The compound of Cu, Pb, Cd, Fe, Cr and Zn are used in dyes , pigments printing inks, their salts such potassium dichromate, copper sulfate , ferric chloride ,lead chromate, chromium chloride etc are used as mordents in textile dyeing and printing industry. As seen in table -1 iron, lead, zinc, copper and chromium are present in alarming concentration. While concentration lead and chromium in industrial effluent exceed limit set by UNICEF for discharge of industrial surface water of 0.1mg/l.

River Bandi is ephemeral nature up to Pali in monsoon. While from Pali to Nehda river has regular flow of wastewater from the industrial and urban area throughout the year. Further downstream of Nehda river flow generally seeps in wider river span. The river waters arid region are mineralized due to various physiochemical factors like high rate of evaporation, inadequate and low precipitation, soil salinity, base exchange phenomenon etc. Sometimes physiographical factor also contribute towards mineralization of river water. The high levels of cadmium (0.05mg/l), lead (0.12mg/l) and chromium (0.12mg/l) is matter of environmental degradation as flora fauna are directly exposed to wastewater. The presence of toxic concentration of lead, chromium, cadmium and iron in river water illustrate the impact of trace metals by dyeing and printing industries functioning in Pali.

Iron-the higher concentration of iron leads to astringent taste, discoloration, turbidity, deposits and growth of iron bacteria in pipes. The BIS has prescribed maximum limit of iron in the industrial effluents that can be discharged into stream 3.0mg/l. the maximum permissible iron content in domestic water is up to 1.0mg/l. the iron contamination is low and it varies with flow in river . Its content varies from 0.19to0.28mg/l with an average of 0.025 mg/l.

Cadmium- the maximum permissible limit of cadmium in the domestic water supply is 0.01mg/l. Consumption of cadmium salts causes cramps, nausea, vomiting and diarrhea. Cadmium tends to concentrate in lever, kidney, pancreas and thyroid of human being. The chemical data shows that the river generally contains its concentration more than potable limit. Only water at three sampling station Kerla, Chatelao and Jetpur have cadmium content less than the permissible limit. Its concentration is more at Pali and Jawadia stations which are centres of release and blending of from textile industries in river water.

Lead - the maximum permissible limit of concentration of lead0.1mg/l beyond which water becomes toxic, can be injurious to health and even lethal if taken for short or prolonged period. The BIS has prescribe maximum limit of lead in the industrial effluents for discharging into stream water as 0.1mg/l. the concentration of lead in river water is a matter of concern. The chemical analysis data shows that nearly seventy five percent of the samples contain lead content more than the maximum permissible limit of domestic water.

Chromium - the maximum permissible limit of chromium in water for domestic use is 0.05mg/l.above this limit it may be carcinogenic. The BIS has prescribed maximum limit of chromium in the industrial effluent as 0.1mg/l for discharging into stream.The chromium in river water downstream of Pali, is also a matter of concern. All the river water samples contain chromium content more than the permissible limit domestic use. Pali-Chatelao section contains higher chromium concentration in water. In other parts however there is no specific trend observed regarding concentration of chromium in river water.

Zinc- water samples at all sampling stations were found to contain zinc in permissible limit for domestic use. Zinc content varies from 0.04 to 0.07 mg/l with an average of 0.04mg/l.

5. CONCLUSION

The presence of toxic concentration of lead, chromium and cadmium in river water illustrate the impact of trace element by the dyeing printing industries. The river has been polluted due to higher concentration of trace metals and effect of pollution varies significantly with the quantum of flow in the river. The downstream part of Bandi river from Pali, where effluent from textile industries

are being discharged regularly, is most effected part of the river. Lead, chromium and cadmium content have been far above the describe limit of 0.05, 0.01, and 0.05mg/l respectively in all sample except at one or two sites.

A significant aspect of pollution of river water is the degradation of potable character. The potable quality of river water plays an important role in arid climate where local population depends on this natural recourse of water for meeting out their domestic requirements. Moreover, the water has become aesthetically unaccepted for drinking due to presence of colour, turbidity, foul smelling and absence of dissolved oxygen. Therefore, water flowing in river is totally unfit for human consumption. The wastewater from dyeing and printing industries is cause of severe environmental degradation and scarcity of potable water in Bandi river.

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