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Metals content in the water of river Birma and its impact on agricultural land and growing crops in Hamirpur, Uttar Pradesh, India

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Abstract:

Heavy metals in water, soil and vegetables were determined at five points along Birma River in Hamirpur district, U.P., India. Results indicated that the concentration of cadmium in water ranged from 0.002 to 0.008 mg/l. Maximum and minimum lead concentration 0.04 to 0.07mg/l detected. The concentration of lead in water throughout the river exceeds the WHO drinking water limit of 0.01 mg/l, ranging from 0.0002 to 0.0008 mg/l mercury concentration at all sampling points was below detection 0.001 mg/l. the concentration of Iron was generally low at all sites ranging from 0.3 mg/l to 0.9mg/l. soil analysis indicated that the concentrations of heavy metals are highest at the top soil and decreased with depth. Zinc has highest concentration 51mg/l to 56 mg/kg. lead had the highest concentrations of 2.4mg/kg which did not exceed the TZS (2003) maximum limit of 200 mg/kg for soil. The maximum and minimum concentrations of Nikil were 2.2 and 2.4 mg/kg respectively. Cadmium concentrations at all sampling points were lower than the permissible limit of 100 mg/kg in soil (TZS,2003). Heavy metal concentrations varied among the crop studied. Among the Crop Zn has the highest concentrations, but their concentration in all the crop samples studied were below the recommended safe limits of heavy metals by WHO standards.

Keywords: Heavy metals, Crop, Soil , Water, Bndelkhand region and Birma River.

Introduction:

The introduction of metallic pollutants into a river, whether it is natural (erosion) or artificial (anthropogenic), can occur in dissolved and particulate form. Depending on physico-chemical conditions, the pollutants in dissolved form can later precipitate. They can also be adsorbed by the iron or manganese oxides and hydroxides or co-precipitated with these, or form dissolved organic or inorganic complexes *(Salomons and Forstner, 1984; Drever, 1988)*. Metal partitioning appears to be metal specific and the eventual fate of various metals is a function of the distribution between the aqueous phase, suspended sediments and bed load of the river *(Salomons and Forstner, 1984; Forstner, 1985; Luoma, 1990)*. The analysis of heavy metals in

sediments permits us to detect pollution that might not be detected by analysis of single water samples *(Forstner and Salomons, 1980; Salomons and Forstner, 1984; Erel et al., 1991).*

Sakai et al. (1986) analyzed the distribution of Cd, Cr, Cu, Mn, Pb and Zn, in water and sieved sediment samples taken from the main stream of the Toyohira River, Japan and reported that the heavy metal concentrations generally increased with decreasing particle size of sediments. *Sabri et al. (1993)* determined the concentrations of various metals in water, suspended solids and surficial sediments ofthe River Tigris at Samarra impoundment and found that the concentrations of most of the elements in the surficial sediments (except for Mn and Fe) were lower than those in the suspended solids indicating the importance of the suspended solids in transportation of heavy metals. *Combest (1991)* evaluated sediment trace metals in White Rock Creek watershed located in Dallas and Collin Counties of north central Texas, in relation to sediment sorption characteristics. *Bertin and Bourg (1995)* studied the geochemical characteristics of sediments in the Lot River basin contaminated by heavy metals (Cd, Pb and Zn) and reported that the heavy metal transport in the river takes place mainly in particulate form.

As rivers are one of the most sensitive ecosystems and perhaps the first to hit a negative economic growth, many of the small catchment rivers draining the southwestern part of India are severely impaired by human activities threatening even the rural water supply schemes attached to these systems Human activities such as industrial and municipal effluents, as well as atmospheric deposition, geologic weathering, and agricultural activities are the main sources of metals in rivers It is known that serious systemic health problems can develop as a result of excessive accumulation of dietary heavy metals such as Cd, Cr, and Pb in the human body (Oliver, 1997).

Heavy metals are extremely persistent in the environment; they are non biodegradable and non thermo degradable and thus readily accumulate to toxic levels. Heavy metals can accumulate in the soil at toxic levels due to the long-term application of wastewater (Bohn et al., 1985). One important dietary uptake pathway could be through crops irrigated with contaminated wastewater. Soils irrigated by wastewater accumulate heavy metals such as Cd, Zn, Cr, Ni, Pb, and Mn in surface soil. When the capacity of the soil to retain heavy metals is reduced due to repeated use of wastewater, soil can release heavy metals into ground water or soil solution available for plant uptake. In suburban areas, the use of industrial or municipal wastewater is common practice in many parts of the world (Feigin et al., 1991; Urie, 1986), including India (Singh et al., 2004). Access to adequate water for irrigation is a matter of increasing concern in India.

To face the growing demand for irrigation water, nonconventional resources are often used. Important sources of heavy metals in wastewater are urban and industrial effluents, deterioration of sewerage pipe and treatment works, and the wear of household plumbing fixtures. Wastewater irrigation is known to contribute significantly to the heavy metal content of soils (Mapanda et al., 2005; Nan et al., 2002; Nyamangara and Mzezewa, 1999; Singh et al., 2004). Other sources of heavy metal contamination of agricultural soil are sewage sludge, fertilizers, and pesticides (Alloway and Ayres, 1993; Ross, 1994).

A number of previous studies from developing countries have reported heavy metal contamination in wastewater (Cao and Hu, 2000; Mapanda et al., 2005; Nyamangara and Mzezewa, 1999; Singh et al., 2004) and waste water irrigated soil (Cao and Hu, 2000; Mapanda et al., 2005; Nan et al., 2002; Nyamangara and Mzezewa, 1999; Singh et al., 2004). However, there are very few empirical data from India for heavy metal contamination of soil and irrigation water and its transfer to vegetable crops. The present proposed study has been undertaken for examine the impact of river metal on soil and Crops.

Materials and methods:

In the study area, Five stations were chosen on the river to reflect the effect of human activities, lacustrine and lotic habitats.

Station A (JAITPUR): - It is a littoral site that represent South-West corner the dam adjoining area of this stations is main catchment area of Birma River. It is a shallow and marginal area of the dam whoever no directs interference of man was recorded.

Station B (PANVARI) :- It is the western site of the dam which is continued with the submergence area of forest. It is noted to be an undisturbed area of present water body as no domination human activities were recorded from this region. However wandering and grazing activities of domestic animals were recorded on the adjoining area of forest land. The site B is also characterized by having rocky bottom and patches of pits on it. The depth of water was documented to be fluctuated from 1.5m to 3.5m..

Station E (AKONA):- The littoral station E represent a northern area of the lake it is the area from where water of Birma River enters in the dam..Therefore, it is a permanent submerge area with a depth range of 2.0 m t0 4.2 m. The wandering and grazing activities animals and birds were also recorded from adjoining land area.

2-Limnetic Station:

Station C (MUSKURA):-It is the Eastern and Limnetic site that was marked near the main Dam .It is deep water was recorded to be of 7.0m.The regular activities of taking bath and washing clothes were noted from this site.

Station D (JALALPUR):-It is the deepest and Limnetic and which represent the Northern-South corner of the lake. The main canal of the dam also commence from this region. The water area of the dam on station D is also restricted by the main Dam. It also has a regulatory device of

Sluice Gate.The human activities of taking bath and washing clothes are also noted from this region.

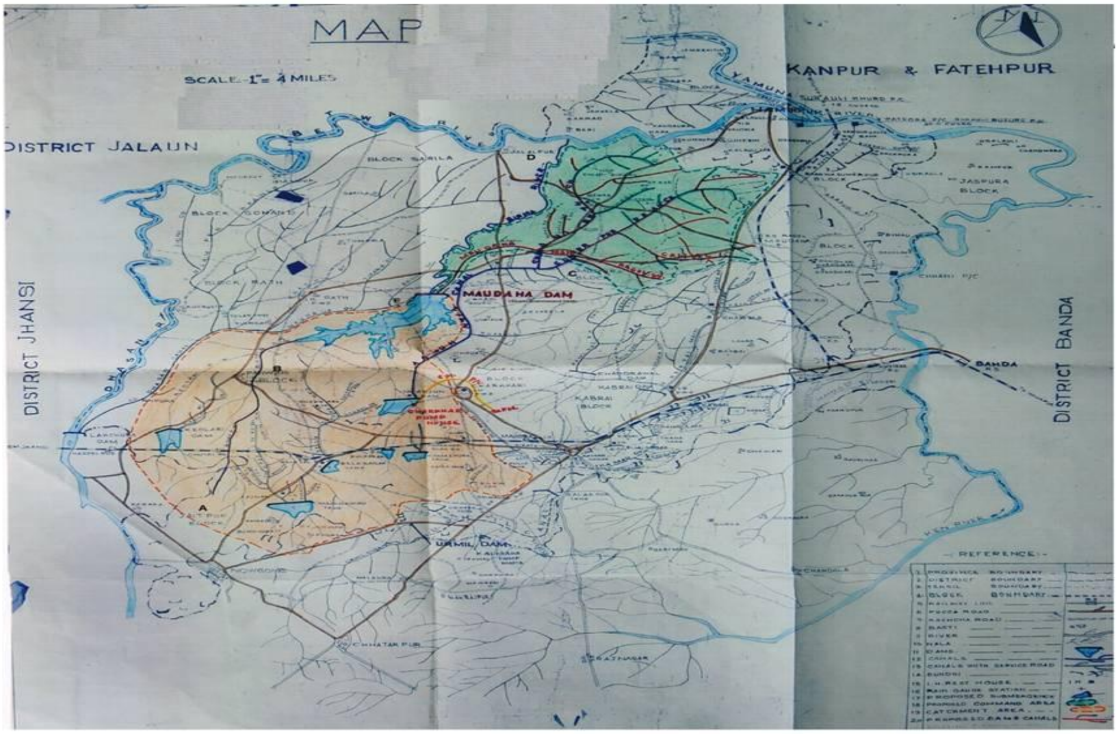

Fig: 1- Shows the sampling sites viz; 1- Station A (JAITPUR), 2- Station B (PANVARI),3-Station E (AKONA), 4- Station C (MUSKURA), 5- Station D (JALALPUR)

Analytical design:

The samples were digested using aqua regia (HCl:HNO3, 3:1, v/v) (USEPA, 2001a). Soil samples (2.0 g) were accurately weighed in polyvinyl containers and aqua regia (8 ml) added. The containers were capped, transferred to a carousel and then left for 20 min; the carousel with the samples was then placed in a microwave digester and irradiated at for 30 min (MLS 1200 MEG, Laboratory System GMbH, Germany). Samples were then filtered through Whatman GF/C filter papers in borosilicate funnels into 50 ml borosilicate volumetric flasks and made up to the mark with distilled water. Solutions were then analysed for heavy metals using Perkin Elmer Analyst 800 atomic absorption spectrophotometer (Perkin Elmer, Harare). Plant samples (0.5–1.0 g) were accurately weighed in polyvinyl containers followed by the addition of nitric acid (3.3 ml), hydrogen peroxide (1.7 ml) and water (1 ml)(USEPA, 2001b). The plant material was then treated in the same way as the soil samples.

Result and Discussion:

Heavy metal in water:

During the study maximum (.008mg/l) Cadmium (Cd) was found at site D and minimum (.0032 mg/l) at site B. mercury (Hg) found in maximum (.0008 mg/l) at site B and minimum .004 mg/l at site C. Iron (Fe) was recorded maximum (.8 mg/l) at site E and minimum (.3 mg/l) at site D. lead is also recorded maximum at ,07 mg/l at site A and minimum (.04 mg/l) at site E, Table-1.

Table : 1- Shows Heavy Metal in Water samples of Various sites in of study Area

S. No.	Site	Metals (Mean concentration of heavy metals in mg/l)			
International standard tolerable limits		Cd (.01)	Hg (.001)	Fe (1)	Pb (.1)
1	A	.005	.0002	.7	.07
2	B	.0032	.0008	.5	.05
3	E	.002	nil	.8	.04
4	C	.004	.0002	.9	.045
5	D	.008	nil	.3	.067

Heavy metal in soil:

Fertile soils supply plants with all of the trace elements essential for growth belived at the present time to be Fe, Mn, Zn, B, Cu, Mo, and Cl. These seven elements are called the micronutrients, a term that indicates the small quantities need by plants but not necessarily at the concentrations found in all type of soils. Deficiencies can occur in soils either because they contain extremely low concentrations of these elements are present in very unavailable (insoluble) forms. Conversely, many trace elements, including all of the micronutrients, can reach concentrations in soils that are toxic to plants and microorganisms. Some of the most toxic are mercury (Hg), lead (Pb), Cadmium (Cd), copper (Cu), nickel (Ni), and cobalt (Co). the first three are particularly toxic to higher animals. The last three are more toxic to plants than animals and are termed phytotoxic. In the study we find out the metal concentration in different agricultural field and crops which are give below in table 2. During the study maximum (2.43mg/l) Cadmium (Cd) found at site D and minimum (2.34 mg/l) at site A. Zinc (Zn) found in maximum (56.05 mg/l) at site C and minimum 51.76 mg/l at site E. Ni was recorded maximum (1.98 mg/l) at site B and minimum (1.02 mg/l) at site A. lead is also recorded maximum at 2.8 mg/l at site D and minimum (2.09 mg/l) at site A.

Table:2- Shows Heavy Metal in soil samples of various sites in of study Area

S. No.	Site	Metals (Mean concentration of heavy metals in mg/kg soil)			
International standard tolerable limits(0-15 cm depth)		Cd .31	Zn 1.5	Ni 8.1	Pb 13
1	A	2.34	54.09	1.02	2.09
2	B	2.27	52.19	1.98	2.99
3	E	2.24	51.76	1.78	2.79
4	C	2.45	56.05	1.88	2.87
5	D	2.43	52.08	1.44	2.80

Heavy metal in Crop:

At site **A** During the study maximum (1.37 mg/kg DW) cadmium (Cd) was extract by Spinach and minimum (1.11 mg/kg DW) cd extract by radish. Zinc (Zn) was found maximum(48.04 mg/kg DW) in spinach minimum(26.51 mg/kg DW) in Radish. Ni was found in maximum (0.95 mg/kg) in cauliflower and minimum in (.01 mg/kg) in coriander. Lead Pb was found maximum in coriander (1.79 mg/kg) and minimum (1.69 mg/kg) in cauliflower.

Table: 3- shows Heavy Metal in Crop samples of site A in study Area

S. No.	Site	crop	Metals (Mean concentration of heavy metals in mg/kg crop)			
International standard tolerable limits			Cd 1.5	zn 50	Ni 1.5	Pb 2.5
1	A	Spinach,	1.37	48.04	.66	1.69
2		Cauliflower	1.16	37.87	.95	1.69
3		Coriander	1.13	34.14	.01	1.79
4		Radish	1.11	26.51	.12	1.78

At site **B** During the study maximum (1.35 mg/kg DW) cadmium (Cd) was extract by Spinach and minimum (1.10 mg/kg DW) cd extract by radish. Zinc (Zn) was found maximum(47.04 mg/kg DW) in spinach minimum(26.44 mg/kg DW) in Radish. Ni was found in maximum (0.93 mg/kg) in cauliflower and minimum in (.02 mg/kg) in coriander. Lead Pb was found maximum in spinach (1.79 mg/kg) and minimum (1.67 mg/kg) in cauliflower.

Table:4 - shows Heavy Metal in Crop samples of site B in study Area

S. No.	Site	crop	Metals (Mean concentration of heavy metals in mg/kg Crop)			
International standard tolerable limits			Cd 1.5	zn 50	Ni 1.5	Pb 2.5
1	B	Spinach,	1.35	47.04	.68	1.79
2		Cauliflower	1.14	38.07	.93	1.67
3		Coriander	1.12	34.19	.02	1.89
4		Radish	1.10	26.44	.13	1.68

At site **C** During the study maximum (1.38 mg/kg DW) cadmium (Cd) was extract by Spinach and minimum (1.12 mg/kg DW) cd extract by radish. Zinc (Zn) was found maximum(48.09 mg/kg DW) in spinach minimum(28.34 mg/kg DW) in Radish. Ni was found in maximum (0.98 mg/kg) in cauliflower and minimum in (.07 mg/kg) in coriander. Lead Pb was found maximum in coriander (1.91 mg/kg) and minimum (1.76 mg/kg) in cauliflower.

Table :5- shows Heavy Metal in Crop samples of site C in study Area

S. No.	Site	crop	Metals (Mean concentration of heavy metals in mg/kg Crop)			
International standard tolerable limits			Cd 1.5	zn 50	Ni 1.5	Pb 2.5
1	C	Spinach,	1.38	48.09	.66	1.80
2		Cauliflower	1.16	39.17	.98	1.76
3		Coriander	1.14	36.29	.07	1.91
4		Radish	1.12	28.34	.18	1.87

At site **D** During the study maximum (1.40 mg/kg DW) cadmium (Cd) was extract by Spinach and minimum (1.15 mg/kg DW) cd extract by radish. Zinc (Zn) was found maximum(48.65 mg/kg DW) in spinach minimum(28.43 mg/kg DW) in Radish. Ni was found in maximum (0.89 mg/kg) in cauliflower and minimum in (.23 mg/kg) in Radish. Lead Pb was found maximum in coriander (1.89 mg/kg) and minimum (1.71 mg/kg) in radish.

Table : 6- shows Heavy Metal in Crop samples of site D in study Area

S. No.	Site	crop	Metals (Mean concentration of heavy metals in mg/kg Crop)			
International standard tolerable limits			Cd 1.5	zn 50	Ni 1.5	Pb 2.5
1	D	Spinach,	1.40	48.65	.76	1.75
2		Cauliflower	1.20	39.27	.89	1.83
3		Coriander	1.17	36.56	.77	1.89
4		Radish	1.15	28.43	.23	1.71

At site **E** During the study maximum (1.32 mg/kg DW) cadmium (Cd) was extract by Spinach and minimum (1.16 mg/kg DW) cd extract by radish. Zinc (Zn) was found maximum(48.79 mg/kg DW) in spinach minimum(28.46 mg/kg DW) in Radish. Ni was found in maximum (0.99 mg/kg) in cauliflower and minimum (.23 mg/kg) in Radish. Lead Pb was found maximum in coriander (1.93 mg/kg) and minimum (1.78 mg/kg) in cauliflower.

Table 7- shows Heavy Metal in Crop samples of site E in study Area

S. No.	Site	crop	Metals (Mean concentration of heavy metals in mg/kg Crop)			
International standard tolerable limits			Cd 1.5	zn 50	Ni 1.5	Pb 2.5
1	E	Spinach,	1.32	48.79	.86	1.87
2		Cauliflower	1.12	39.57	.99	1.78
3		Coriander	1.17	36.92	.18	1.93
4		Radish	1.16	28.46	.23	1.90

Conclusions

The observations were recorded on various physico-chemical parameters of water, heavy metals in water, soil and crop. Heavy metal is also recorded in water soil and crop . In water Iron was recorded maximum amount and Mercury was recorded in minimum amount. In soil zinc was recorded in maximum amount and Ni was found at lowest amount. In crop Spinach was found maximum metal extract from soil.

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