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Heavy metal status in different drains discharge into the River Ganga and accumulation in land and plant at Allahabad, Uttar Pradesh

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ABSTRACT

The heavy metal concentrations in the environment are due to primarily natural and anthropogenic activities, and because the heavy metals are very persistent pollutants, they get accumulated in the water, soil and plants, finally entering in the food chain. This paper assess the quality of wastewater and contamination of heavy metals like Fe, Cd, Pb, Zn and Cu from these selected drains discharging effluent in the river Ganga at Allahabad, Uttar Pradesh during 2012-2013. The heavy metals Fe, Cd, Pb, Zn and Cu were concentration estimated by using Atomic Absorption Spectrophotometer. The presence of heavy metals were observed in all sites throughout the year, summer season recorded maximum concentration of Fe (0.498 mg/l), Zn (0.095 mg/l), Cu (0.009 mg/l), Pb (0.007 mg/l) and Cd (0.006 mg/l) in Mori gate drain, Fe (0.257 mg/l), Zn (0.056 mg/l), Pb (0.042 mg/l), Cd (0.036 mg/l) and Cu (0.019 mg/l) in Mawaiya drain and Fe (0.494 mg/l), Zn (0.093 mg/l), Cd (0.006 mg/l), Cu (0.008 mg/l) and Pb (0.005 mg/l) in Bairagiya drain respectively. Maximum level of heavy metal contamination was observed in Mori gate drain as compared to Mawaiya drain and Bairagiya drain. The presence of heavy metal in our environment shows the great concern because of their toxicity when their concentrations are more than possible level.

Key words: Allahabad, domestic effluent, industrial effluent, river Ganga and heavy metal pollution.

INTRODUCTION

The Ganga River is an important river of the India which flows from western Himalayas irrigating the northern plains of India and ended in Bay of Bengal. During its course it receives effluent arising from different cities, towns, villages and industries located on its bank. Most of the pollutants are discharged in to the rivers every day through different drains. Heavy metal contamination may have drastic effects on the ecological balance of environment and diversity of aquatic organisms (Ashraj 2005). The river enters in the Allahabad city from western side flowing first towards east and then changes its course towards south direction and loops like the northern and eastern boundaries of Allahabad city. It meets with the river Yamuna at Sangam, after confluences, the stream is known as Ganga which then flows in the eastern direction away from the city. The major source of heavy metal pollution in the river Ganga is small scale industries situated in different areas like, Naini ITI, BPCL, Alstham and Sewage of Naini, Allahabad, Fertilizer factory IFFCO Phoolpur Allahabad and shows small scale industries like petrol pumps, battery stores, automobile service centers, bakeries etc. Wastewater carries appreciable amounts of trace toxic metals (Pescode 1992, Yadav et al. 2002). The toxic elements accumulated in organic matter in soils are taken up by growing plants and lastly exposing humans to this contamination (Khan et al. 2008).

In Allahabad besides sewage, industrial waste from industries of Naini causes high level of metal pollution in the River Ganga. The present investigation was carried out to see the concentration of heavy metals in two drains Mori gate drain and Mawaiya drain, draining effluent of eastern Allahabad city and Naini respectively. The third drain is Bairagiya drain flowing in rural area of the district and utilized for irrigation by the farmers involved in rice and wheat cultivation along with the seasonal vegetables in the region. It showed Zn, Cu and Pb to be the main pollutants in the different sites. Markandya and Murthy (2000), in their study of the Kanpur-Varanasi region in India, found that though the mean levels of Cd, Cr, Ni and Pb in the soils were above their respective tolerable limits for agricultural crops, since the pH of the receiving soil was alkaline, their effects were less harmful than expected. There are many reports regarding water quality of the Ganga River due to increasing trend regular screenings of the pollution status of river is required. Urban wastes, such as sewage sludge, are increasingly used to amend soils, especially those with a low organic matter content, to improve their fertility (Garc´ıa et al., 1994).

MATERIALS AND METHODS

Study area

The wastewater samples were collected from three drains (Mori gate drain, Mawaiya drain and Bairagiya drain) of Allahabad district which final pour its wastewater in river Ganga. Mori gate drain collects the domestic effluent of eastern Allahabad city through underground sewerage drain network of the city which opens at 25°26'10.64"N 81°51'37.61"E outside the city and join river Ganga at 25°26'23.15"N 81°53'4.26"E. Mawaiya drain flows in the south side of the river Ganga 9 km south of Allahabad city (25°22'54.26"N 81°54'31.37"E to 25°22'15.47"N 81°52'35.98"E) which collects wastewater from Naini, a suburban area of Allahabad. The Bairagiya drain flows from Phoolpur (25°32'31.90"N 82°02'24.05"E) carrying mainly domestic sewage and runoff water from villages to Rasulpur (25°18'58.48"N 82°05'00.43"E) where it joins the river Ganga at Dumduma village.

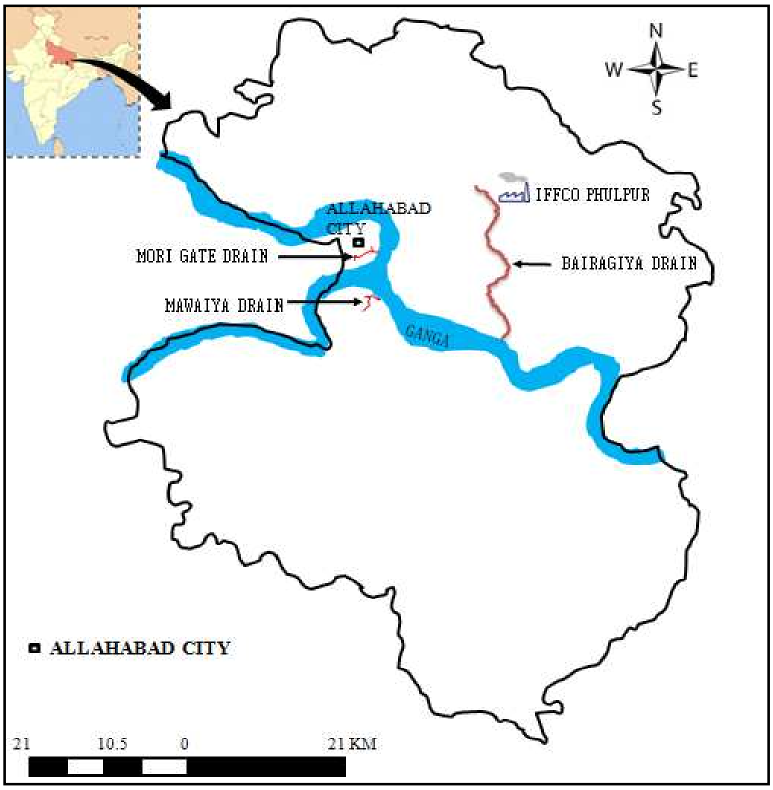

Fig.-1.Map of Allahabad District showing three drains used in study

Method of Study

The water quality survey was conducted at three drains, Mori gate Drain, Mawaiya Drain and Bairagiya drain during different seasons of the year from December 2012 to December 2013. The samples were collected in 5L plastic container between 8 to 10 AM. The containers were thoroughly washed and rinsed with concentrate HNO_3 fallowed by distilled water. For heavy metal analysis fifty milliliters of contaminated water sample was digested with 10 ml of concentrated HNO_3 at 80°C until the solution became transparent (APHA 1985). The solution was filtered through Whatman no. 42 filter paper and the filtrate was diluted to 50 ml with distilled and dehumanized water. Trace elements concentrations in wastewater samples were estimated by an atomic absorption spectrophotometer (Perkin Elmer AAnalyst 300). Blank samples were analyzed after three samples. Concentrations were calculated on a dry weight basis. All analyzed replicated sample were three times. The precision and analytical accuracy were checked by analysis of standard reference material, NIST-SRM 1570 for water. The results were found to be within 2% of certified values for every heavy metal. Statistical summary and analysis was performed using Microsoft Excel (version 2007).

RESULTS AND DISCUSSION

The data obtained from the present study revealed that higher metal concentration occurs in Mori gate drain as compared to Mawaiya drain and Bairagiya drain. Minimum concentration was recorded during Monsoon season and Maximum in summer season in all waste water samples like (Mori gate drain, Mawaiya drain and Bairagiya drain). It was also reported that in general, the metal concentrations were lowest in Bairagiya drain and did not exceed the stabilized quality standards for Pescode (1992) and WHO (2007). The order of heavy metal concentration was found in Mori gate drain Fe > Zn > Cu > Cd and Pb, in Mawaiya drain Fe > Zn > Pb > Cd > Cu and in Bairagiya drain Fe >Zn > Cu > Cd and Pb. In case of Mori gate drain the heavy metal concentration ranged from Fe is (0.485-0.498 mg/l), Cd is (0.004-0.006 mg/l), Pb is (0.004-0.007 mg/l), Zn is (0.093-0.095 mg/l) and Cu is (0.006-0.009 mg/l) in (Table 1). The Mori gate drain relatively higher amount of metals. The higher concentration in Mori gate drain may alter the levels of various biochemical parameters. The seasonal variations of heavy metals concentration in Mawaiya drain has been shown in Table 2. In case of Mawaiya drain Fe, Cd, Pb, Zn and Cu were varied from Fe is (0.249-0.257 mg/l), Cd is (0.028-0.036 mg/l), Pb is (0.035-0.042 mg/l), Zn is (0.049-0.056 mg/l) and Cu is (0.015-0.019 mg/l), respectively. In case of Bairagiya drain heavy metal concentrations ranged from Fe is (0.490-0.494 mg/l), Cd is (0.004-0.006 mg/l), Pb is (0.004-0.005 mg/), Zn is (0.091-0.093 mg/) and Cu is (0.005-0.008 mg/l) respectively in (Table 3).

Table – 1: Heavy metal concentrations (mg/l) in wastewater of Mori gate drain

Heavy metals	Year 2012-2013				
	Winter	Summer	Monsoon	Mean ± SD	Safe limit*
Fe(mg/l)	0.486	0.498	0.495	0.493±0.006	2.0
Cd(mg/l)	0.005	0.006	0.004	0.005±0.001	0.01
Pb(mg/l)	0.005	0.007	0.004	0.005±0.001	0.5
Zn(mg/l)	0.093	0.095	0.094	0.094±0.001	2.00
Cu(mg/l)	0.006	0.009	0.007	0.007±0.001	0.2

**Source: Pescode (1992) and WHO (2007).*

Table – 2: Heavy metal concentrations (mg/l) in wastewater of Mawaiya drain

Heavy metals	Year 2012-2013				
	Winter	Summer	Monsoon	Mean ± SD	Safe limit*
Fe(mg/l)	0.253	0.257	0.249	0.253±0.004	2.0
Cd(mg/l)	0.033	0.036	0.028	0.032±0.004	0.01
Pb(mg/l)	0.039	0.042	0.035	0.038±0.003	0.5
Zn(mg/l)	0.053	0.056	0.049	0.052±0.003	2.00
Cu(mg/l)	0.015	0.019	0.018	0.017±0.002	0.2

Table – 3: Heavy metal concentrations (mg/l) in wastewater of Bairagiya drain

Heavy metals	Year 2012-2013				
	Winter	Summer	Monsoon	Mean ± SD	Safe limit*
Fe(mg/l)	0.491	0.494	0.490	0.491±0.002	2.0
Cd(mg/l)	0.005	0.006	0.004	0.005±0.001	0.01
Pb(mg/l)	0.004	0.005	0.004	0.004±0.0005	0.5
Zn(mg/l)	0.092	0.093	0.091	0.092±0.001	2.00
Cu(mg/l)	0.007	0.008	0.005	0.006±0.001	0.2

It has been known that the accumulation was dependent on various a biotic environmental conditions (Posch & de Vries 2009, Abdel-baki et al., 2011). The concentration of Mori gate drain is highest and the lowest concentration is Bairagiya drain. The metal Fe shows in all selected sites shows the highest distribution pattern was different from Mori gate drain, Mawaiya drain and Bairagiya drain. Fe concentration was observed maximum in Mori gate drain with 0.498 mg/l in summer season and minimum for Mawaiya drain with 0.249 mg/l in Monsoon season. The mean concentration of Fe was measured 0.253±0.004 mg/l in Mawaiya drain, 0.491±0.002 mg/l in Bairagiya drain and 0.493±0.006 mg/l in Mori gate drain. The highest concentration of Fe in all sites shows the different small scale industries and manufacturing plants. According to WHO guidelines (2007) and Indian standard for (Pescode 1992) permissible limit of Fe concentration in water is 2.0 mg/l standard. Present finding is less than WHO guidelines and Pescode (1992).

Cd concentration was observed highest 0.036 mg/l in Mawaiya drain summer season and lowest concentration for the 0.004 mg/l in Monsoon season. The mean concentration of Cd was recorded (0.005±0.001 mg/l) in Mori gate drain, (0.005±0.001 mg/l) in Bairagiya drain and (0.032±0.004 mg/l) in Mawaiya drain. Cd concentrations show the main source like batteries. According to WHO (2007) guidelines permissible limit of Cd in water is (0.01 mg/l). These results were similar to the finding of Pathak *et al*. (1992). They found the iron concentration in the river Ganga of all the states more than the permissible limits. Roy and Kumar (1989) found higher concentration of iron in the river Ganga. The higher concentration of Fe may be due to slow leaching of rocks. The maximum concentration of Pb was observed 0.042 mg/l in Mawaiya drain in summer season and minimum 0.004 mg/l in Bairagiya drain Monsoon season. The mean concentration of Pb was observed 0.004±0.0005 mg/l in Bairagiya drain, 0.005±0.001 mg/l in Mori gate drain and 0.038±0.003 mg/l in Mawaiya drain. The main source of Pb pollution in the atmosphere is natural and anthropogenic activities. The statistical analysis of Pb in three sites like Mori gate drain, Mawaiya drain and Bairagiya drain showed higher mean values above the detection limits. Pb maximum concentration in Mawaiya drains as compared to Mori gate drain and Bairagiya drain. Lead toxicity induced effect on pituitary and gonads.

The maximum concentration of Zn was observed 0.095 mg/l in Mori gate drain in summer season and minimum for 0.049 mg/l in Mawaiya drain in Monsoon season. Zn concentration was observed maximum in Mori gate drain as compared to Mawaiya drain and Bairagiya drain. Zn is a essential element for embryo development and is important to reproductive organs. The result of present study was found that, the mean concentration of Zn (0.052±0.003 mg/l) in Mawaiya drain, (0.092±0.001 mg/l) in Bairagiya drain and (0.094±0.001 mg/l) in Mori gate drain. According to WHO (2007) guideline the permissible limit of Zn in water is (2.00 mg/l). Histological and biochemical studies due to zinc toxicity on male reproduction rate were reported by Saxena *et al*. (1989). Immune responses were also reported to be impaired due to excessive zinc (Chandra 1984).

The maximum concentration of Cu was observed 0.019 mg/l in Mawaiya drain in summer season and minimum concentration for 0.005 mg/l in Bairagiya drain in monsoon season. Cu concentration was observed maximum in Mawaiya drain and minimum in Bairagiya drain. Cu is essential components for living and non-living elements. The result of present study was found that, the mean concentration of Cu is (0.006±0.001 mg/l) in Bairagiya drain, (0.007±0.001mg/l) in Mori gate drain and (0.017±0.002 mg/l) in Mawaiya drain. According to WHO (2007) guideline the permissible limit of Zn in water is (0.2 mg/l). Cu toxicity on various parameters was shown by the studies of Mishra & Srivastava (1980), Abbasi *et al.* (1995), Andersons and Kautsky (1996).

CONCLUSION

The results of our present study show that there is no threat of any hazards at present because the concentration of heavy metals is under WHO permissible limits. However the increasing tendency of water indicates that a constant monitoring of these drains and river is needed before the level cross its threshold and become toxic to the plant, animals and predators including. The increase in concentration of metals in wastewater could be mainly due to metals contaminated diet that comes from discharge of effluent into the river from different drains and other sources in the form of suspended solids and solution. The contamination of a metal depends to a large degree on the presence of the metal in the water body system

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