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Mercury contamination in the ambient media in and around the World Heritage Site: Indian Sundarbans

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Abstract: ***We analyzed the concentrations of dissolved mercury and biologically available mercury in the surface sediment during premonsoon, monsoon and postmonsoon seasons in the year 2015 in 12 selected stations in and around Indian Sundarbans deltaic region. Analyses were done by Atomic Absorption Spectrophotometer (Perkin Elmer: Model 3030). Significant variation of dissolved mercury was observed between seasons with highest values in monsoon followed by postmonsoon and premonsoon. Contrasting picture was observed in case of biologically available mercury in the surface sediment with highest values in premonsoon followed by postmonsoon and monsoon. Sampling stations like Lothian island, Jambu island, Chotomollakhali, Bali island, Sajnekhali, Bagmara exhibited no trace of mercury in the aquatic phase and sediment. The mercury was Below Detectable Level (BDL) in the aquatic phase around Gosaba in all the seasons.***
Keywords: Dissolved mercury, biologically available mercury, Indian Sundarbans, Atomic Absorption Spectrophotometer

I. INTRODUCTION

The estuaries and coastal zones are mostly exposed to effluent from chemical industries [5] [8]. The estuaries of Indian Sundarbans receive industrial and municipal waste along with runoff from agricultural and shrimp culture units. Beside runoff from a wide catchment areas comprising of the cities like Kolkata, Howrah and the newly developing Haldia complex along with North and South 24 Parganas districts, a huge quantity of waste arising both from industrial, domestic, agricultural and aquacultural sources is discharged in the Sundarban estuaries. These wastes contain a variety of toxic heavy metals [4] [10] [12] which often accumulate within the body tissues of edible fishes and become a matter of concern. Mercury is one of these toxic heavy metals which are known to cause several physiological disorders like neurological symptoms including paresthesias, loss of physical coordination, difficulty in speech, narrowing of the visual field, hearing impairment and blindness [9]. The Indian Sundarbans, being a World Heritage Site requires the monitoring of the toxic heavy metals in and around its vicinity to ensure the quality of the products (preferably edible fishes) obtained from the system and this forms the basis of the present work.

II. MATERIALS AND METHODS

A. Site Selection

Twelve stations namely Kakdwip (Station 1), Harinbari (Station 2), Chemaguri (Station 3), Sagar south (Station 4), Lothian island (Station 5), Jambu island (Station 6), Frasergunge (Station 7), Gosaba (Station 8), Chotomollakhali (Station 9), Bali island (Station 10), Sajnekhali (Station 11) and Bagmara (Station 12) were selected for the present programme (Table 1). All stations are located in and around Indian Sundarbans deltaic region.

Table 1: Coordinates of selected sampling stations

Stations	Geographical locations	
	Latitude	Longitude
Kakdwip	21°52′06″N	88°11′12″E
Harinbari	21°47'01.36" N	88°04'52.98"E
Chemaguri	21°38'25.86"N	88°08'53.55"E
Sagar south	21° 38' 51.55" N	88° 02' 20.97"E
Lothian island	21°39' 1.58" N	88° 22' 13.99"E
Jambu island	21°35'42.03"N	88°10'22.76"E
Frasergunge	21° 33′ 47.76″ N	88° 15′ 33.98″E
Gosaba	22° 15' 45" N	88° 39' 46"E
Chotomollakhali	22º10'21.74"N	88º53'55.18"E
Bali island	22º04'35.17"N	88º44'55.70"E
Sajnekhali	22º05'13.4" N	88 º 46'10.8"E
Bagmara	21°39' 4.45"N	89°04' 40.59"E

B. Collection of water and sediment samples

Collection of water samples for analysis of dissolved mercury was carried out during high tide condition from all the selected stations in premonsoon, monsoon and postmonsoon in the year 2015. For each observational station, at least three samples were collected from the surface during high tide condition within 500 meters of each other.

Sediment samples from surface (5 cm depth) were collected by scrapping using a pre-cleaned and acid washed plastic scale and immediately kept in clean polythene bags, which were sealed. The samples were washed with metal free double distilled water and dried in an oven at 105^{o}C for 5 – 6 hours, freed from visible shells or shell fragments, ground to powder in a mortar and stored in acid washed polythene bags. Three sediment samples were collected within 200 meters of each other to ensure quality to our results.

C. Analysis of dissolved mercury

Dissolved mercury was analyzed as per the standard method stated in APHA (1995) [1]. Before analysis, each water sample collected and stored in clean TARSON bottles was filtered through a 0.45 µm Millipore membrane. The filtrate was treated with diethyl dithiocarbamate and extracted in carbon tetrachloride. The extracted was evaporated to dryness and the residue was mineralized with 0.1 ml of concentrated nitric acid. Analytical blank was prepared and treated with the same reagents. Analyses were done in triplicate by direct aspiration into AAS (Perkin-Elmer Model: 3030) equipped with a HGA-500 graphite furnace atomizer and a deuterium background corrector.

D. Analysis of biologically available mercury

Sediment samples were washed with metal free double distilled water and dried in an oven at 105^{o}C for 5 – 6 hours, freed from visible shells or shell fragments, ground to powder in a mortar and stored in acid washed polythene bags. Analyses of biologically available metals were done after re-drying the samples, from which 1 gm was taken and digested with 0.5 (N) HCl as per the standard procedure outlined by Malo (1977) [7]. The resulting solutions were then stored in TARSON containers for analysis. The solutions were finally aspirated in the flame Atomic Absorption Spectrophotometer (Perkin Elmer: Model 3030) for the

determination of metal concentrations. No detectable trace metals were found in the reagent blank.

III. RESULT

Mercury concentrations in the ambient media of 12 selected sampling stations in and around Indian Sundarbans are presented in Table 2. A unique seasonal variation is observed in case of dissolved mercury with highest values in monsoon followed by postmonsoon and premonsoon. The picture is completely opposite in case of biologically available mercury in surface sediment with highest values in premonsoon followed by postmonsoon and monsoon. Some sampling stations like Lothian island, Jambu island, Chotomollakhali, Bali island, Sajnekhali, Bagmara exhibited no trace of mercury in the water and sediment. In Gosaba, mercury was BDL in the aquatic phase through out the entire study period.

Table 2: Mercury levels in water (ppm) and surface sediment (ppm dry wt.) in and around Indian Sundarbans

	Dissolved Hg			Biologically available Hg in surface sediment		
	A	B	C	A	B	C
Kakdwip	0.003 ± 0.001	0.009 ± 0.002	0.005 ± 0.002	0.021 ± 0.007	0.010 ± 0.004	0.019 ± 0.004
Harinbari	BDL	0.002 ± 0.001	BDL	0.013 ± 0.008	0.008 ± 0.004	0.010 ± 0.002
Chemaguri	BDL	0.003 ± 0.001	0.002 ± 0.001	0.015 ± 0.005	0.009 ± 0.003	0.013 ± 0.006
Sagar south	0.002 ± 0.001	0.006 ± 0.002	0.004 ± 0.002	0.039 ± 0.010	0.017 ± 0.005	0.024 ± 0.008
Lothian island	BDL	BDL	BDL	BDL	BDL	BDL
Jambu island	BDL	BDL	BDL	BDL	BDL	BDL
Frasergunge	0.007 ± 0.003	0.010 ± 0.002	0.009 ± 0.002	0.086 ± 0.013	0.023 ± 0.007	0.065 ± 0.006
Gosaba	BDL	BDL	BDL	0.011 ± 0.003	0.003 ± 0.002	0.007 ± 0.003
Chotomollakhali	BDL	BDL	BDL	BDL	BDL	BDL
Bali island	BDL	BDL	BDL	BDL	BDL	BDL
Sajnekhali	BDL	BDL	BDL	BDL	BDL	BDL
Bagmara	BDL	BDL	BDL	BDL	BDL	BDL
A= premonsoon, B= monsoon, C= postmonsoon, BDL = Below Detection Limit						

IV. DISCUSSION

Mercury is a global pollutant which cycles between air, water, sediments, soil and organisms in various forms [13]. With well known toxic effects the amounts of mercury, which are mobilized and released into the environment, have increased considerably since the onset of the industrial age [3]. The presence and behaviour of mercury in aquatic systems is of great interest and importance since it bioaccumulates and biomagnifies through all levels of the aquatic food chain [6]. Riverine drainage is the main source of metal contamination in coastal areas [2] [10].

It is interesting to note in this study that the level of mercury in the aquatic system is inversely proportional to that in the surface sediment. This may be considered as speciation as confirmed by the highest values of dissolved mercury in monsoon when the biologically available mercury in the sediment is least and vice versa. The fall of pH in the aquatic phase of the lower Gangetic delta region triggers the process of speciation [10] [12].

With rapid development of electronic industries in West Bengal and large number of electronic wastes discarded into the environment might cause serious mercury pollution in Sundarban mangrove ecosystem in near future. To fully understand the fate of total mercury in the Sundarban wetland ecosystem, these sources and transfer processes need to be identified, quantified and evaluated. Such a programme would facilitate to develop sustainable remedial measures in future perspectives.

The pictures of speciation of several heavy metals were pointed by several earlier workers in the present geographical locale [4] [10] [11] [12] but, for mercury this baseline data calls for a long term research in this domain as many of the sampling stations exhibit the presence of mercury in the ambient aquatic phase and sediment, which may often pave the gateway of bioaccumulation in the resident organisms of this World Heritage Site of India.

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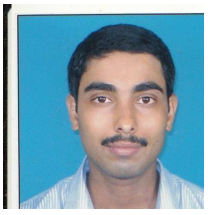
BIOGRAPHIES OF AUTHORS



Mr. Shankhadeep Chakraborty is a CSIR-UGC NET qualified senior research scholar in Techno India University (Kolkata). He has already published 20 international research articles in internally recognized journals. He has experience in working on bioremediation, metal pollution in water and sediment, carbon sequestration, mangrove ecosystem and fishery. He has also experience in teaching Biological Sciences and Chemical sciences at school level. He was honored with Young Scientist Award in 2014 by the Centre for Ocean and Environmental Studies (COES), New Delhi.

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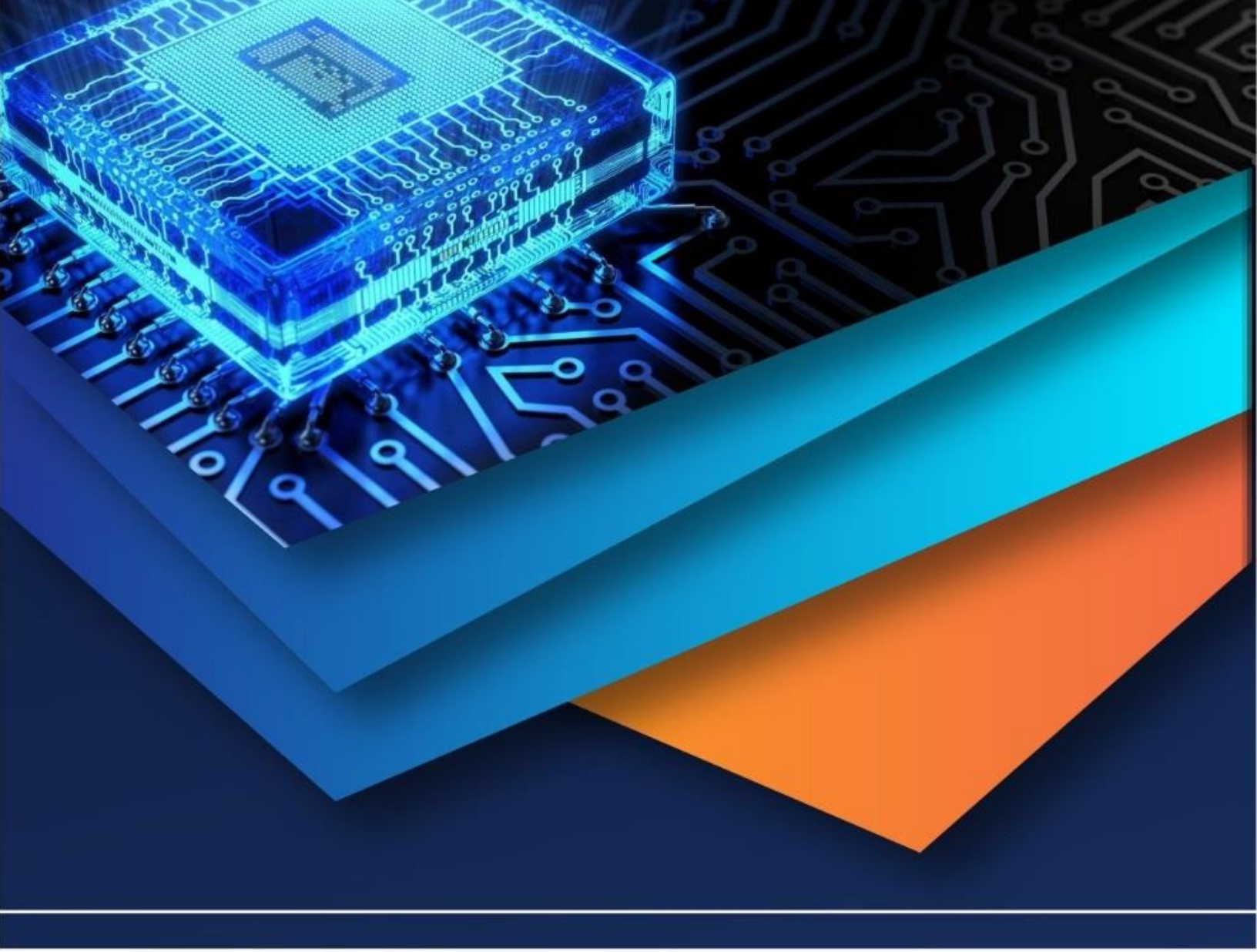

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