iJRASET
International Journal For Research in Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 4 **Issue:** VII **Month of publication:** July 2016

**DOI:**

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

Volume 4 Issue VII, July 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

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

Shankhadeep Chakraborty[1], Sujoy Biswas[2], Nabonita Pal[3], Sufia Zaman[4], Abhijit Mitra[5]
[1]*Department of Oceanography, Techno India University, Salt Lake, Kolkata, West Bengal, India*
[2]*Department of Civil Engineering, Techno India University, Salt Lake, Kolkata, West Bengal, India*
[3]*Department of Marine Science, University of Calcutta, 35 B.C. Road, Kolkata, West Bengal, India*

***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].

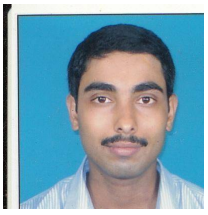
With rapid development of electronic industries in West Bengal and large number of electronic wastes discarded into the environment might cause serious mercury pollution in Sundarban mangrove ecosystem in near future. To fully understand the fate of total mercury in the Sundarban wetland ecosystem, these 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.

## REFERENCES

[1] APHA. Standard methods, 19th Edition, American Public Health Association, Washington, DC; 1995.
[2] Bastidas Carolina, Bone David, Garcia Elia M. Sedimentation rates and metal content of sediments in a Venezuelan coral reef. Marine Pollution Bulletin 38 (1999): 16-24.
[3] Boening Dean W. Ecological effects, transport and fate of mercury: a general review. Chemosphere 40 (2000): 1335–1351.
[4] Chakraborty Shankhadeep, Zaman Sufia, Fazli Pardis, Mitra Abhijit. Bioaccumulation pattern of heavy metals in three mangrove species of *Avicennia* inhabiting lower Gangetic delta, Journal of. Physical, Chemical and Biological Sciences 4.4 (2014): 384-396.
[5] Krishna Murti CR and Viswanathan Pushpa. Toxic metals in the Environment, Tata McGraw- Hill Publishing Company Ltd. (1991): 246.
[6] Lindqvist Oliver, Johansson Kjell, Aastrup Mats, Andersson Arne, Bringmark Lage, Birgitta Tim et al. Mercury in the Swedish environment- Recent research on causes, consequences, and corrective methods: Water Air Soil Pollution (1991): 55.
[7] Malo BA, Partial extraction of metals from aquatic sediments", Environmental Science and Technology 11 (1977): 277 – 288.
[8] Manahan Stanley E, Environmental Chemistry, Fourth Edition, Willard Grant Press, Boston (1994): 597.
[9] Mitra S, Mercury in the Ecosystem, Trans. Tech. Publishers Ltd., Switzerland, 1986.
[10] Mitra Abhijit, Status of coastal pollution in West Bengal with special reference to heavy metals. Journal of Indian Ocane Studies 5 (1998): 135-138.
[11] Mitra Abhijit, In: Sensitivity of Mangrove ecosystem to changing Climate. Springer (DOI: 10.1007/978, 81-322-1509-7) (2013): 323.
[12] Mitra Abhijit and Zaman Sufia, Basics of Marine and Estuarine Ecology. Publisher, Springer, India, ISBN 978-81-322-2707-6. (2016): 1-481,
[13] Moreno Fabio N, Anderson Chris WN, Stewart Robert B, Robinson Brett H, Mercury volatilization and phytoextraction from base-metal mine tailings. Environmental Pollution 136 (2005): 341–352.

## 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.

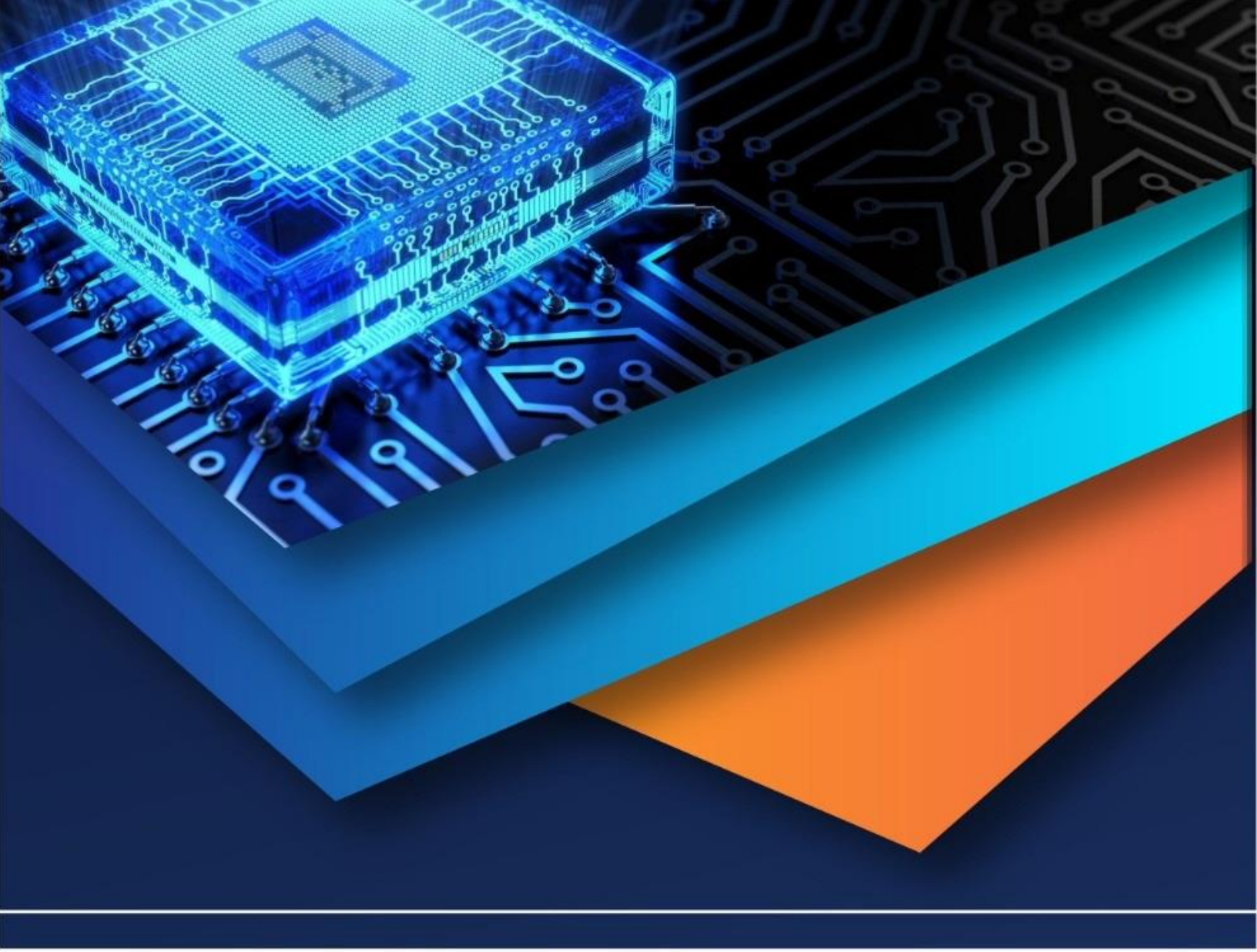
**Prof. (Dr.) Sujoy Biswas** is a Chartered Engineer and is currently the Director & Chief Executive Officer of

Techno India University and Techno India Group and also Professor in the Department of Civil Engineering in Techno India University. Dr. Biswas secured first poition in his MBA examination and received the gold medal from Indian Institute of Social Welfare and Business Mangement under Calcutta University.

**Ms. Nabonita Pal,** Research Scholar in the Department of Oceanography, Techno India University is a post graduate in Biotechnology. Ms. Pal is credited to have 10 publications in National and International journals of repute. Ms. Pal has experience in working in the mangrove ecosystem of Indian Sundarbans. On behalf of Techno India University, she attended several National and International seminars. Ms Pal was honoured with **Young Scientist Award** in 2014 by the Centre for Ocean and Environmental Studies (COES), New Delhi.

**Dr. Sufia Zaman,** presently serving as Adjunct Assistant Professor in the Department of Oceanography in Techno India University (Kolkata) started her career in the field of Marine Science since 2001. She worked in the rigorous region of Indian Sundarbans and has wide range of experience in exploring the floral and faunal diversity of Sundarbans. She has published 3 books on carbon sequestration, 86 scientific papers and contributed chapters in several books on biodiversity, environmental science, aquaculture and livelihood development.

**Dr. Abhijit Mitra,** Associate Professor and former Head, Dept. of Marine Science, University of Calcutta (INDIA) has been active in the sphere of Oceanography since 1985. He is a Gold Medalist in Marine Science (M.Sc.) and obtained his Ph. D as NET qualified scholar in 1994. Dr. Mitra is credited to have about 350 scientific publications in various National and International journals, and 28 books of postgraduate standards. Dr. Mitra also successfully guided 24 Ph.D students. Presently his research areas include environmental science, mangrove ecology, sustainable aquaculture, alternative livelihood, climate change and carbon sequestration.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY