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RESEARCH ARTICLE

ASSESSMENT OF PHYSICOCHEMICAL QUALITY AND HEAVY METALS STATUS IN SOME SELECTED DRAINS DISCHARGE INTO THE LOWER STRETCH OF THE HOOGHLY RIVER

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ABSTRACT

Anthropogenic activities increases the pollution level in the lower part of the Hooghly river. Several reports and research papers indicate towards the bioaccumulation of heavy metals. The present research aims to assess the concentration of the key pollutants released from adjacent drains into the Hooghly River and their presence in river water. To reach the goal, wastewater samples collected from some selected drains and river water collected from the adjacent bathing station to these drains. Collected samples are acid digested and took the results Most of the drains wastewaterwere found contaminated with different contaminants like Fe, Pb, Cd, Ni, Zn, Cu, Cr, but the river water found under control. According to the status of Relative Accumulation Indices (RAI), calculating by the ratio concentration of metals in river water to drains water, Fe<Zn<Cr<Cu were found in ascending order. For sustainable development and use of these huge water resources, we have to identify these types of drains and check the point and non point source of pollutants.

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INTRODUCTION

The 2,506 km long stream of the river Ganga sustains the life of 29 cities, seven towns, and thousands of villages which are contaminating the river by over 1.3 billion liters wastewater per day (Khan et al., 1998). Kolkata sewage discharged 534.21 Million Litres per Day (MLD) and Howrah sewage discharged 116.32 MLD (Clean Ganga Mission, 2016). Rapid industrialization and urban development during last few decades have provoked some serious concerns for the environment through inclusion of variety of pollutants into rivers including heavy metals (CPCB, 2004). Usually most of the heavy metals enter into the river from various sources, which can be either natural by erosion and weathering or anthropogenic (Bem et al., 2003; Wong et al., 2003; Adaikpohet al., 2005). The mean concentrations of Zn, Pb, Cd and Cr in the surface waters of four sampling sites at lower stretch of river Ganga varied from 0.75-0.280mg/l, 0.033-0.141 mg/l, 0.002-0.007 mg/l and 0.016-0.022 mg/l respectively, these values were mostly higher than the respective maximum permissible limits (Paul et al., 2013). In present study, we have assessed the physico-chemical quality and heavy metals intensity in water of some selected drains of Kolkata and Howrah and its effects on the Hooghly river water by calculating RAI.

Study area

To assess the pollution impact on the ecosystem of the lower stretch of Hooghly river through its adjacent drains, the wastewater were collected from four drains.

Two drains are from east bank of the river Hooghly i.e. Kolkata side and other two from west bank of the river i.e. Howrah side. The river water was collected from four bathing stations nearer to above discharge points (Fig.1). The GPS locations of the sampling sites are as follows (table.1).

Methods of Study: The study was conducted between 1st January to 10th February 2019 for winter season and all sampling was done between 8 am to 10 am. The dissolved oxygen(D.O.), free CO_2, pH, electric conductivity(EC), total alkalinity, hardness and salinity of water were checked on the field. The other parameters viz., Ca, Na, Mg, Cl were analyzed in the laboratory within few hours of collection of samples following APHA, 20th Edition.

For heavy metals, 500 ml of water were collected in finely cleaned plastic container and fixed with 5 ml conc. HNO_3in the field and brought to laboratory. The water samples were transferred to glass beakerand digested on hot plate. Finally, digested water samples were filtered with Whatman#42 filter paper and volume made up to 100 ml and reading were taken by Perkin Elmer made Atomic Absorption Spectrophotometer (AAS).

RESULTS AND DISCUSSION

The analytical results of physic-chemical parameters of drain water are shown in Table 2,

Fig. 1. Map of the sampling sites

Table 1. GPS locations of the sites

Nature of sites	Sites	Latitude	Longitude
DRAINS	Dakhsineshwar Drain (east bank)	22°39'12.97"N	88°21'26.55"E
	Bally Drain (west bank)	22°39'8.93"N	88°21'1.97"E
	Cossipore Drain (east bank)	22°37'47.65"N	88°21'53.59"E
	Belur Drain (west bank)	22°37'49.88"N	88°21'29.72"E
BATHING STATIONS	Alambazar Ghat (east bank)	22°39'0.79"N	88°21'29.56"E
	Bally Ghat (west bank)	22°39'11.15"N	88°21'1.70"E
	Cossipore Ghat (east bank)	22°37'48.61"N	88°21'53.20"E
	Belur Jetty Ghat (west bank)	22°37'48.28"N	88°21'30.34"E

Table 2. Physico-chemical parameters of drains water

Sites	Parameters											
	pH	EC (µs/cm)	Free CO_2 (ppm)	DO (ppm)	Alkalinity (ppm)	Hardness (ppm)	Salinity (ppm)	Ca (ppm)	Na (ppm)	Mg (ppm)	Cl (ppm)	NO_3-N (ppm)
Dakhsineswar drain	8.2	1329	24	4	344	240	25.82	61.88	106.24	14.54	102.94	0.716
Bally drain	8.3	1206	28	1.2	384	316	163.50	74.16	87.80	45.65	73.96	0.613
Cossipore drain	8.4	1105	24	3.2	320	328	179.72	67.16	67.44	65.11	82.95	0.546
Belur drain	8.0	990	24	3.6	296	240	192.36	33.37	43.08	241.91	89.95	1.534
Maximum range of dissolved constituents in rivers(WHO:Meybeck, 1979).	8.2	-	-	-	-	-	-	50.0	25.3	12.1	25.0	-
Tolerance limits for inland surface waters, class-D(CPCB)	-	1000 (Max.)	6.0 (Max.)	4.0 (Min.)	-	-	-	-	-	-	-	-
US EPA (Maximum limit)	-	-	-	-	-	-	-	-	-	-	-	10.0

Table 3. Correlation matrix among the physico-chemical parameter of selected drains wastewater

Parameters	pH	EC	Free CO_2	DO	Alkalinity	Hardness	Salinity	Ca	Na	Mg	Cl	NO_3-N
pH	1											
EC	0.376	1										
Free CO_2	0.293	0.224	1									
DO	-0.408	-0.050	-0.965	1								
Alkalinity	0.499	0.691	0.853	-0.754	1							
Hardness	0.865	-0.045	0.490	-0.671	0.418	1						
Salinity	-0.005	-0.875	0.200	-0.406	-0.289	0.474	1					
Ca	0.900	0.657	0.559	-0.571	0.816	0.722	-0.239	1				
Na	0.434	0.997	0.286	-0.123	0.740	0.031	-0.833	0.713	1			
Mg	-0.763	-0.886	-0.301	0.237	-0.731	-0.401	0.614	-0.908	-0.912	1		
Cl	-0.439	0.344	-0.736	0.885	-0.401	-0.814	-0.753	-0.397	0.267	-0.021	1	
NO_3-N	-0.940	-0.668	-0.347	0.374	-0.675	-0.687	0.314	-0.971	-0.715	0.937	0.249	1

Table 4. Metals concentration in drains water

Sites	Metals						
	Fe (ppb)	Pb (ppb)	Cd (ppb)	Ni (ppb)	Zn (ppb)	Cu (ppb)	Cr (ppb)
Dakhsineswar drain	2366.8	BDL	BDL	6	47.6	16.4	2.4
Bally drain	1016	BDL	BDL	0.4	90.8	64	BDL
Cossipore drain	112240	BDL	BDL	BDL	25.6	10.8	6.8
Belur drain	233.04	BDL	BDL	BDL	192	54.8	12.4
World average values of trace elements carried in solution by major unpolluted rivers (WHO:Schiller&Boyel, 1985,1987).	50	0.04	0.001	0.4	0.2	1.4	0.1

*BDL = Below Detection Limit.

Table 5. Physico-chemical parameters of river water

Sites	Parameters											
	pH	EC (µs/cm)	Free CO_2 (ppm)	DO (ppm)	Alkalinity (ppm)	Hardness (ppm)	Salinity (ppm)	Ca (ppm)	Na (ppm)	Mg (ppm)	Cl (ppm)	NO_3-N (ppm)
Alambazar Ghat	9.2	372	8	6	144	144	55.25	26.81	33.77	1.0	13.99	0.356
Bally Ghat	8.72	357	8	5.6	140	136	51.64	28.19	19.20	19.42	11.99	0.319
Cossipore Ghat	9.2	379	8	5.2	140	140	55.25	29.46	17.95	24.29	13.99	0.345
Belur Jetty Ghat	8.7	469	20	4	170	152	85.92	26.61	22.28	2.40	30.98	0.561
Maximum range of dissolved constituents in rivers(WHO:Meybeck, 1979).	8.2	-	-	-	-	-	-	50.0	25.3	12.1	25.0	-
Tolerance limits for inland surface waters, class-D(CPCB)	-	1000 (Max.)	6.0 (Max.)	4.0 (Min.)	-	-	-	-	-	-	-	-
US EPA (Maximum limit)	-	-	-	-	-	-	-	-	-	-	-	10.0

Table 6. Correlation matrix among the physico-chemical parameter of river water

Parameters	pH	EC	Free CO_2	DO	Alkalinity	Hardness	Salinity	Ca	Na	Mg	Cl	NO_3-N
pH	1											
EC	-0.453	1										
Free CO_2	-0.601	0.983	1									
DO	0.556	-0.932	-0.926	1								
Alkalinity	-0.543	0.980	0.991	-0.875	1							
Hardness	-0.197	0.922	0.878	-0.723	0.925	1						
Salinity	-0.512	0.996	0.994	-0.921	0.993	0.917	1					
Ca	0.333	-0.528	-0.581	0.230	-0.669	-0.713	-0.579	1				
Na	0.405	-0.068	-0.094	0.426	0.036	0.311	-0.048	-0.683	1			
Mg	0.102	-0.521	-0.529	0.186	-0.633	-0.769	-0.555	0.967	-0.788	1		
Cl	-0.512	0.996	0.994	-0.921	0.993	0.917	1	-0.579	-0.048	-0.555	1	
NO_3-N	-0.488	0.995	0.990	-0.902	0.995	0.934	0.999	-0.610	0.001	-0.592	0.999	1

Table 7. Metals concentration in river water

Sites	Metals						
	Fe (ppb)	Pb (ppb)	Cd (ppb)	Ni (ppb)	Zn (ppb)	Cu (ppb)	Cr (ppb)
Alambazar Ghat	660.8	BDL	BDL	BDL	44	4.4	BDL
Bally Ghat	164.8	BDL	BDL	BDL	73.2	6	BDL
Cossipore Ghat	1016	BDL	BDL	BDL	0.4	90.8	14
Belur Jetty Ghat	217.48	BDL	BDL	BDL	58	22.8	BDL
World average values of trace elements carried in solution by major unpolluted rivers(WHO:Schiller&Boyel, 1985,1987).	50	0.04	0.001	0.4	0.2	1.4	0.1

*BDL = Below Detection Limit.

Table 8. Relative Accumulation Indices (RAI) of metals in river water

	Metals						
	Fe	Pb	Cd	Ni	Zn	Cu	Cr
Drain water average concentration(mg/l)	28963.96	BDL	BDL	1.6	89	36.5	5.4
River water average concentration(mg/l)	514.77	BDL	BDL	BDL	43.9	31	3.5
RAI in river water	0.017	-	-	-	0.493	0.849	0.648

According to the status of RAI's Fe<Zn<Cr<Cu were found in ascending order.

pH among the four sampling sites, only one site (Belur) value is under the maximum limit, another one site (Dakhsineswar) is just touching the limits. Another two (Bally &Cossipore)sites exists the maximum range. In case of *EC* only Belur drain water is under maximum tolerance limits.

Others three sites water are above the maximum tolerance limit. *Free CO_2* of all the four sites water contains high ranges than itsmaximum tolerance limit. *DO* in one site (Dakhsineswar) water contains the minimum safe limit, others three sites water contain less than the

minimum tolerance limit. In case of *Ca*, only one site (Belur) water carries the safe amount, others three sites water carries over the maximum range. In case of *Na, Mg, Cl,* all the four sites contains higher amount of these ions that's its maximum range. NO_3-*N* in all samples are lower than its maximum limit. From the above results it is clear that most of the physicochemical parameters were present in higher value than their respective maximum tolerance limit. The analytical results of metals concentration in drain water are shown in Table 4. *Fe* concentration in all sites is very high than its average value in major unpolluted rivers. *Pb &Cd*, these two toxic metals are found below detection limits in all sites. *Ni* concentrations in two sites (Cossipore & Belur) were below the detection limit. Bally site contain just equal to the safe limit. Dakhsineswar sites were found higher than its safe limit. *Zn & Cu* were found higher than its safe limits in all four sites. *Cr* concentration in Bally site were found below the detection limit, others three sites were found above the safe limit. From the above results it is cleared that, except Pd & Cd all other metals concentration were found high than the average value of unpolluted river of the world. The analytical results of physic-chemical parameters of river water are shown in Table 5. *pH* in all four sampling sites were found high than its maximum range, it indicated that all samples were alkaline in nature. *EC* were found low than its maximum tolerance limit in all sampling sites. Free CO_2 is very high in Belure site river water and slightly high in other three sampling sites. *DO* in all the four river water were found towards the safe limits. All the four sites river water *Ca* ions concentration is lower than its maximum range. *Na*concentration inAlambazar site river water were found high than its safe limit, others three sites were found below the maximum range. *Mg* in two sites (Alambazar&Belur) river water were found below the maximum range, other two sites (Bally &Cossipore) river water contains higher amount of *Mg* than its maximum range. *Cl* found higher only Belure site river water, others three sites were under its maximum range.NO_3-*N* in all samples are lower than its maximum limit. From the above results, most of the river waters parameters were found safe for aquatic life. The analytical results of metals concentration in river water are shown in Table 7. The *Fe* concentration in all the sampling sites were found higher than its average limits in unpolluted river. The three toxic metals *Pb, Cd & Ni* were found below detection limit in all the four sampling sites. *Zn & Cu* concentration in all the four sampling sites were higher than its world unpolluted river average value. *Cr* concentration in one site (Cossipore) river water was found high, others three sites water were found below detection limits of this metal. Above results indicated that most of the toxic metals like Pb, Cd & Ni were below detection limits in all sites water which is good for aquatic life. We obtained Relative Accumulation Indices (RAI) of metals in river water by the ratio concentration of metals in river water to drains water (Table 8)

CONCLUSION

It is cleared that the presence in high range of those pollutants which affects the river water qualities and causes the decreasing trend of river water quality. And these pollutants with high concentration mostly enter from the above selected drains and finally get diluted into the downstream of the river. If it is continuing towards long-term then in near future all the aquatic life and our civilized society will face the vulnerability to their existence.

For future research work researcher must be focuses on the removal technology of those pollutants.

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