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AQUATIC AND SEDIMENTOLOGICAL ANALYSIS OF THE DAMODAR RIVER WITHIN THE STRETCH OF ASANSOL TO DURGAPUR

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ABSTRACT

Surface water and the sediments from the two banks of Damodar River on seasonal basis, in the Asansol to Durgapur industrial area of West Bengal were analyzed for heavy metals such as, copper, chromium, zinc, lead and manganese. Physico-chemical properties of surface water like pH, conductivity, hardness and dissolve oxygen in the river also have been found. River sediment were analsed for organic carbon, pH and grain size nature. It is observed that the surface water quality parameters such as pH, hardness are mostly with in the normal range whereas the dissolve oxygen in most cases were below the desirable minimum level with lowest value of 2.6 mg/L. Metal concentrations except copper are moderately high with manganese being the highest recorded 437 μg/L. The metal concentration in sediment samples were about ten times higher than those of surface water. Grain size analysis revealed unimodeal distribution with moderate to well sorted particles.

INTRODUCTION

The 538 km long Damodar River originating from Chotanagpur hills joins the Hoogly River near Geokhali in West Bengal. The catchment area of the Damodar and the Barakar rivers are 8500 sq. m., out of which 7000 sq. m is occupied by hilly dry uneven areas. Heavy silt load is brought down the Da-

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modar river system during monsoon. The continuous silting of the river has reduced its flow to a narrow channel above the barrage. Various industries and a number of coal washeries located in the upper Damodar contributing wastes containing various toxicants were surveyed by Basu(1966). In the lower stretches, Dhaneshwar *et al.* (1972) have done a commendable work by studying various aspects of pollution like survey of industries, total pollution load, identification of pollutants, assessment of extent of pollution, etc. Job *et al*. (1952) studied impact of pollution on fish breeding and their production; Gopalkrishnan *et al*. (1966), Natarajan *et al*. (1968) and Jhingran & Natarajan(1969) carried out similar work. These studies were restricted in the upper reaches of Damodar only. Various studies have been done for the silting and sediment problem of the Damodar. A few reference that can be made are Bose *et al*. (1945 -48) and Sen *et al.* (1946-48) Works by Coal Board, Government of India, ministry of production, etc are noteworthy. The important industries which dispose their effluents in the Damodar (Reach below Maithon/ Panchet Dams upto Durgapur) include Chittaranjan Locomotive Works, Durgapur Projects Ltd., Durgapur Steel Plant, Raniganj Coal Field Area, Indian Iron and Steel Company Ltd, Burnpur, Dishergarh Power Supply, Durgapur, Thermal Power Station, Carew and Company, Reckitt Benckisher Co, Coal Washeries, Fertilizer Corporation of India, Eastern Railway (Barakar, Andal, Radhanagar, Damodar). Domestic effluent source includes Asansol Municipality, Raniganj Municipality, Andal Municipality, etc.

The aim of the present study is to assess the impact of effluent disposal from urban sources in the Damodar River across a major industrial zone of West Bengal. The paper presents results of some analysis and observation regarding the seasonal water and sediment quality of this important river along the Asansol-Durgapur stretch.

MATERIALS AND METHODS

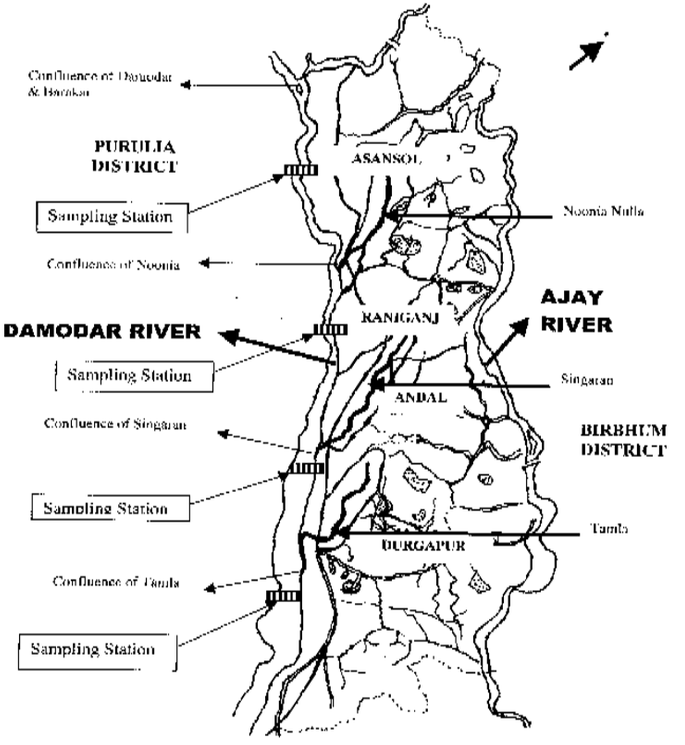
Study area and sampling

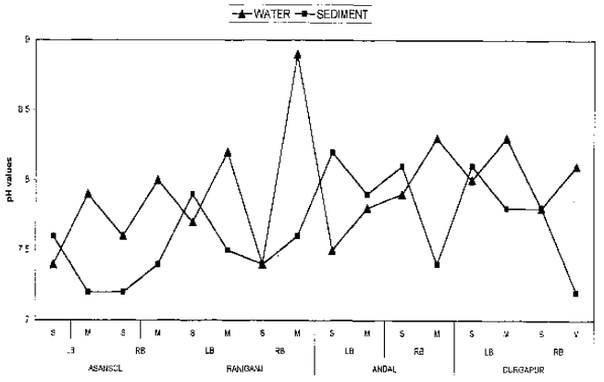
The study area falls under the Asansol-Durgapur development authority (ADDA), mainly drained by the Damodar and the Ajoy river. The Damodar is sub-basin under the 'Ganga Basin' with area of 5,591 km^2, falling in districts Purulia, Bardhaman, Bankura, Hugli and Haora. The Damodar has its source in the Khamerpat (1068 m) of the Chotanagpur plateau. Beyond its confluence with the Barakar, it enters the alluvial plains of the region and flows in a south easterly direction. The most important tributaries of the region are the Noonia Nullah, the Singaran Nullah and the Tamla Nullah. The climatic condition of the study area tends towards tropical monsoon type, humid and hot for greater part of the year. Characterised by dry cool winter (Mean January temperature 18°C), prolong hot summer (Mean May temperature 32°C) and a seasonal distributed of monsoon rainfall (below 1250mm) accounting for 80% of the annual total. Since 80% of the total rainfall occurs during monsoon, over 95% of the total discharge takes place during the rainy season, the peak discharge being from August to September. The average annual runoff of the Damodar

valley is about 50 cm, (max. 75 cm during humid year to min. 25cm in dry year). The stretch of the river from the Asansol to Durgapur receives both industrial and domestic wastes throughout the year. The industrial effluents come from a variety of factory situated in the vicinity of the river or discharge to a tributary from where they ultimately dispose off in the Damodar. The Damodar river (down to Durgapur barrage) has been assigned Category - 'C' i.e. 'Drinking water with some conventional treatment followed by disinfection' by Central Poiution Control Board.

Water and sediments were sampled for the study twice during the summer (May 03 to 08, 2003) and monsoon (August 04 to 09, 2003) seasons from the two banks (left and right) of four different locations, namely, Asansol (WSS1); RanlganJ (WSS2); Andal (WSS3) and Durgapur (WSS4) across the river Damodar, passing through these locations. The profile of the river in the study stretch and the sampling locations are represented in Figure 1. Water samping was of grab nature with pH and dissolved oxygen (DO) analysed on site. The samples were acidified for metal analysis later. Sediments were also grab sampled from the shallow river bed from both left and right banks of the river.

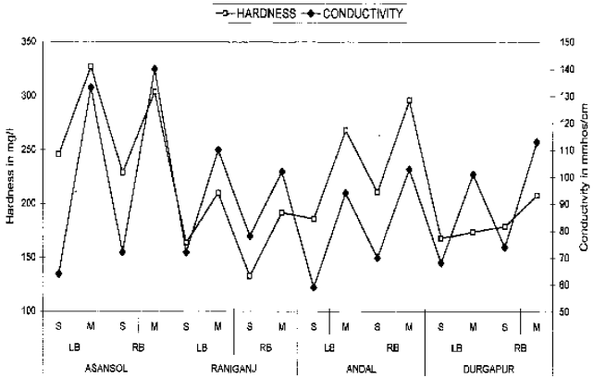
Fig. 1 Map of study area showing sampling stations (Map not to scale)





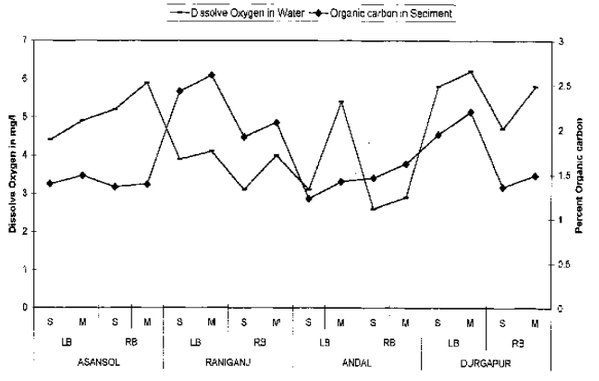
Sample details - (LB-Left Bank, RB - Right Bank, S- Summer, M - Monsoon)

Fig 2. pH characteristics of surface water and sediment in Damodar river.



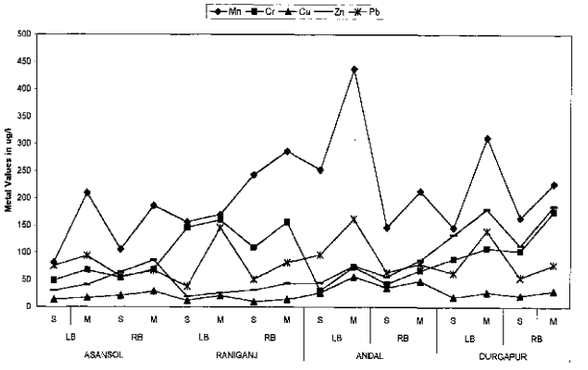
Sample details - (LB-Left Bank, RB - Right Bank, S- Summer, M - Monsoon)

Fig 3. Hardness and conductivity of surface water in Damodar river.



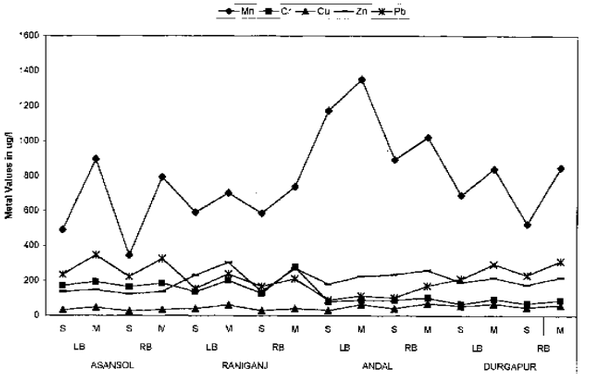
Sample details - (LB-Left Bank, RB - Right Bank, S- Summer, M - Monsoon)

Fig 4. Dissolve oxygen in Surface water and organic carbon of sediment from Damodar river



Sample details - (LB-Left Bank, RB - Right Bank, S- Summer, M - Monsoon)

Fig 5. Metal concentration in surface water of Damodar river within study area.

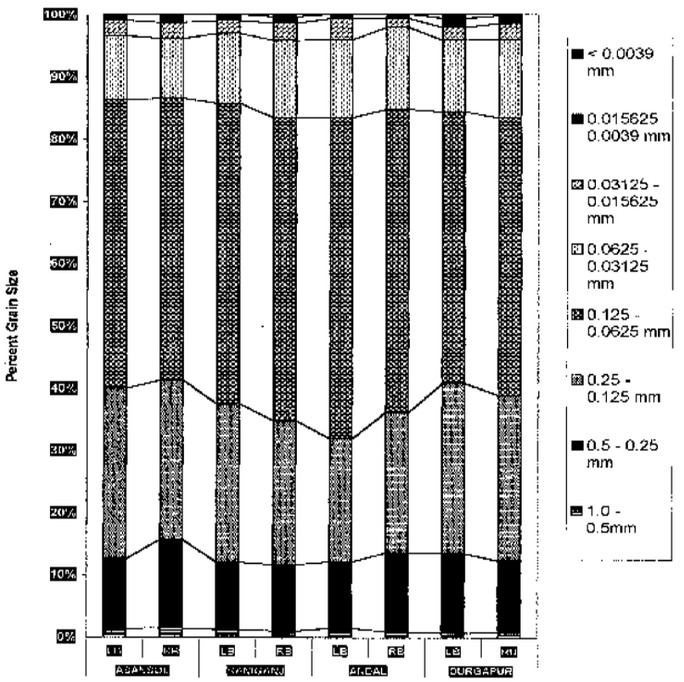


Sample details - (LB-Left Bank, RB - Right Bank, S- Summer, M - Monsoon)

Fig 6. Metal concentration in aquatic sediment of Damodar River within study area.

Analysis of samples

Chemical analysis for water quality included pH, total hardness, conductivity, dissolve oxygen, Mn (manganese), Zn (zinc), Cu (copper), Cr (chromium) and Pb (lead). All determination was conducted following standard method of APHA (20 th edition); pH was estimated onsite using digital pen-type pH-meter; dissolve oxygen was estimated using the Azide-modification method on site; hardness was estimated using complexometric titration: conductivity measurements were done using digital table-top model; heavy metals were analysed spectrophotometrically. Sediments were analysed for pH, percent organic carbon, grain size, Mn, Zn, Cu, Cr and Pb. Grain size examination was done by sieving method (50 - 320 mesh) and results were used for statistical



Sample details - (LB-Left Bank, RB - Right Bank, S- Summer, M - Monsoon)

Fig 7. Grain size analysis of aquatic sediment of Damodar river within study area.

analysis; pH was estimated by pH-meter using 1:2 sediment water suspension, organic carbon was estimated by Walkley and Black method, heavy metals were estimated by perchloric acid-nitric acid digestion followed by Spectrophotometric methods.

RESULTS AND DISCUSSION

Physico-chemical analysis of water

The pH of the water samples from Damodar varied from 7.4 to 8.0 in summer (May) and 7.8 to 8.9 in monsoon (August). The pH of the right bank (RB) of the river showed mean value of 8.0 where as that of the left bank (LB) had a mean value of 7.85. The pH was lower in summer (more acidic) with substantial increase in monsoon season (less acidic). Hardness values ranged from 133 mg/L to 246 mg/L in summer and 174 mg/L to 327 mg/L in monsoon, with the left bank showing mean value of 218.88 mg/L and right bank with mean hardness of 219.00 mg/L. The maximum hardness value was at Asansol (mean 276.5 mg/L). Their was increase in hardness in monsoon season for all stations. DO varied from 2.6 mg/L to 62 mg/L throughout the study period. The summer DO level ranged between 2.6 mg/L and 5 mg/L whereas

it varied between 2.9 mg/L to 6.2 mg/L for the monsoon period. Lower DO level were recorded at Andal for both seasons. The conductivity varied between 59 mmhos/cm *to* 78 mmhos/cm in summer and 94 mmhos/cm to 140 mmhos/cm in monsoon. Conductivity values were higher at Asansol with mean of 102.25 mmhos/cm and lowest at Andal with mean of 81.50 mmhos/cm. Manganese concentration in water ranged between 82 µg/L to 252 µg/L in summer and 170 µg/L to 437µg/L in monsoon. Chromium level varied between 30µg/L to 146 µg/L in summer and 67 µg/L to 160 µg/L in monsoon. The copper level ranged between 10 µg/L 36 µg/L in summer and 14 pgd to 56µg/L in monsoon. Copper levels were higher at Andal. *Zinc* levels ranged between 19µg/Lto 133 µg/L in summer and 26 µg/Lto 186 µg/L in monsoon. The Lead level varied between38 µg/L to 96 µg/L in summer and 67 µg/L to 146 µg/L in monsoon. The results of water quality analysis are presented in Figure 2, Figure 3, Figure 4, Figure 5 and Figure 6.

Physico-chemical analysis of sediment

The study shows that metal values in the sediment are much higher (nearly ten times) then those in the water samples. The pH values ranged from 7.2 to 8.1 in summer whereas it ranged between 72 and 7.9 in monsoon. The Organic Carbon (OC) varied between 1.23% to 2.43% in summer and 1.39% to 2.61% in monsoon. The Manganese value ranged from 346 µg/L to 1174 µg/L. In summer and 703 µg/L to 1352 µg/L in monsoon. Chromium levels ranged from 68 µg/L to 172 µg/L in summer and 89 µg/L to 279 µg/L in winter. Copper level was between 26 µg/L to 56 µg/L in summer and 34 µg/L to 95 µg/L in monsoon. The Zinc level varied between 127 µg/L and 236 µg/L. In summer and 138 µg/L to 305 µg/L In monsoon. The Lead level ranged between 91µg/L to 236 µg/L in summer and 113 µg/L to 347 µg/L in monsoon. Results of sedimen to logical analysis are represented in Figure2, Figure 4 and Figure 6.

Grain Size analysis

Grain size distribution study using sediment collected from banks of river Damodar is presented in Figure 7. The study shows that the grain size varies from 1 mm to 1/256 mm range. Negligible clay portion was observed throughout the study area. The majority part represented silt and rest sand type of sediment. Higher grain size was recorded near the 1/4 mm range, followed by 1/4 mm range. Andal showed highest percent (51.44) in the 1/8 mm range. The sediment samples show unimodal distribution with moderate to well sorted particles. Weight percentage of sit and clay were higher in the downstream region of Asansol, but were lower in the Durgapur stretch.

CONCLUSION

The Damodar River within the stretch from Asansol to Durgapur receives an assortment of multifarious waste water discharged from various industries and domestic sources. The study reveals that the water within the study stretch is quite unsuitable for the aquatic life of the system and also for its users. The sediment load is much as seen in case of the heavy metals, which are sometimes ten times their concentration in the water. Such pollutants impede the self healing competence of the river in addition to bioaccumulation among fishes. Urgent waste water treatment plant arrangement for both domestic and industrial sources is indispensable to safeguard and manage this significant river system.

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