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RESEARCH ARTICLE

INSTREAM SAND MINING IMPACT ON WATER QUALITY AND BENTHOS COMMUNITY IN AN ALLUVIAL REACH: A CASE STUDY ON RIVER KANGSABATI, WEST BENGAL

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ABSTRACT

Physical habitat is the living space of instream biota i.e. all aquatic community, fish community, riparian and instream vegetation. It is a spatially and temporary dynamic entity determined by the interaction of the structural features of the channel and the hydrological regime. Human activities especially sand mining is obstructed instream biota. This study is conducted from upper, middle and lower course in Kangsabati River in West Bengal. Physiochemical parameters were determined by water quality analyzer and species were identified by the field survey in sandchar, mining, and post-mining sites. The result shows that all the deterioration process situated in mining sits and pits but stable ecosystem find out in the entire sandchar sites. Most of the change occurs in the middle course than upper and lower course due to huge mining takes place in the middle course. Therefore, it is a point that mining activities change the aquatic ecosystem.

Key words: Aquatic community, instream biota, Physiochemical parameters, hydrological regime.

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INTRODUCTION

Biological communities are quietly developed by the presence of habitat potentiality (South wood 1977). For streams, an empirical approach to assessing the structure of the surrounding habitat includes an evaluation of the variety and quality of the substrate, channel morphology, bank structure and riparian vegetation. Moyle and Leidy (1992) stated that human activities have now damaged the natural flow patterns and ecological processes of rivers affect their biological wealth. Many species are under threat due to habitat destruction. All of the rivers in the world have been successively altered due to indiscriminate sand mining during the past 3-4 decades. Sand mining plays a vital role to deleterious on the riverine biota by direct and indirect effects on the physical, chemical and biological environments of river systems. Aquatic and fish communities affected by granular shifting in sediment texture and habitat loss arising from the selective removal of fine aggregates from the river bed deposit. High turbidity depleted fish populations and habitat destruction of in situ species due to the presence of siltation (Ambak and Zakaria, 2010). Benthic and fish communities affected by granular shifting of sediment texture whereas habitat loss arising from the selective removal of fine sand from the river bed (ECD 2001). Sand mining can be destructed benthic habitats as well as interrupts food chains in river ecosystem caused by reducing of the food supply.

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Depletion of water quality causes due to channel coarsening and sedimentation in the water bodies. Sand mining plays a vital role to riverine biota through the direct and indirect effects on the physical, chemical and biological environments of river systems (Yen et al. 2013; Bayram *et al.,* 2015). Similarly, situations have been found in Kangsabati River in south Bengal. There is an attempt to document course wise effects of river sand mining on instream biota in Sarenga (upper), Mohanpur (middle) and Palaspai (lower) respectively.

Study area: Kangsabati (also variously known as the Kasai, Kansai, and Cossye) a non perennial alluvial river which is originated from the Chotonagpur plateau in the state of Jharkhand, India and passes through the districts of Purulia, Bankura and Paschim Midnapore of West Bengal. This river basin is bounded by latitude 21°45´N to 23°30´N and longitude 85°45'E to 88°15'E. The basin covers an area of about 9658sq.km. Kangsabati River has been divided into three courses. The upper course is extended between Jhalda to Sarenga, middle course extended between Sarenga to Mohanpur and lower course lies from Mohanpur to Bandar near Ghatal (Rupnaryan branch). This alluvial river exhibits dendritic to sub-dendritic drainage pattern (Fig.1). The basin is segregated on the basis of physiographic divisions into six divisions; three comes under the study area. Geologically the study area is constituted by various stratigraphic units, ranging from the oldest Archaeans (pre-Cambrian) to the younger Tertiary-Quaternary formations (Mukhopadhyay, 1992). Land use types are distinctly governed by physiographic and climatic characteristics with natural and planted forest. The present investigation is confined to course wise three physiographic regions because naturally deposited sands are extracted from instream and floodplain areas leading to irregular changes in the river bed.

MATERIALS AND METHODS

Sample collection: Collection of samples and analysis are selected along the river Kangsabati, namely: Sarenga, Mohanpur, and Kapastikri during pre-monsoon, monsoon, and post-monsoon from 2010 to 2016.Species sample is collected from the mining pit and an upper portion along thalweg line.

Processing of samples and method of analysis: Several types of physicochemical properties like temperature, PH, TDS, conductivity, DO, EC were measured in situ in the following water quality assessment tools name as GPS Aqua Meter-AP-1000, Aqua Read Ltd, U.K, which was calibrated each time before use with the help of Rapid Calibration Solution. Water samples were collected in a plastic bottle washed with double distilled water. All samples were rinsed with 15 % (v/v) HNO_3 and filtered with Whatman-542 filter paper (G.E. Healthcare U.K. Limited) for 24 hours within 4°C before washed it. Auto-titration method (Micro-ohm) was used to measure alkalinity in water. All the statistical analysis processes using by SPSS statistics 17.0 software.

RESULT AND DISCUSSION

Determination of physicochemical parameters in water samples: Physiochemical parameters of the water quality like BOD, Salinity, TDS, T, EC, DO, P^H, major cation-Mg^{2+} are analysis at a total eight segments of Kangsabati River within the extend of about 191km. All of these observed values are compared following the standard limit proposed by the Indian Standard Specification for Drinking Water, 1991-BIS, and World Health Organization, 2011-WHO.

Biological Oxygen Demand- BOD: Stabilization of industrial and household wastes in water is essentially required of oxygen which is determined by BOD (De, 2003). Surface and ground water quality deteriorated through the contamination of effluents from domestic and industries wastes that can be measured by the BOD (Sawyer *et al.,* 1994).

BOD measures in water of Kangsabati River at 27 points including sandchar, mining and pits and also find out in the range of 1-1.8 mg/l. Most of the mean variation has been seen from mining pits to sandchar site (1.46-1.33mg/l) than upstream to downstream (1.37-1.46 mg/l). The result indicates that mining activity can be changed BOD status entire this alluvial stretch (Fig.2.a).

Salinity: Course wise salinity ranges from 0.767-0.012 ppt in Kangsabati River. Average value of salinity gradually increased along the lower segment (0.30 ppt) than the middle (0.17 ppt) and upper (0.15ppt) course with the presence of huge siltation and human activities. Sand mining creates an inverse situation on salinity status in the sand chair sites due to over-extraction of sand along with contaminating of salt, oil and inorganic particles in mining sites. Salinity value of mining sites is higher (0.767-0.012 ppt) than sandchar sites (0.237-0.049 ppt) and pits (0.597-0.032 ppt) due to contamination of ingredients during bar skimming mining (Fig.2.b).

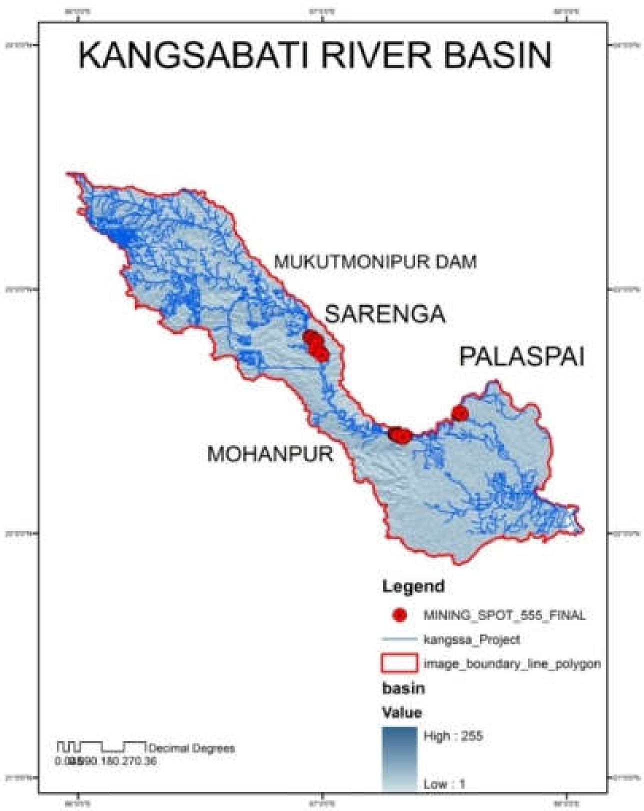
Variation of Total Dissolved Solids-TDS: Mining activities lead to the flux of suspended sediment particles in the flowing water (Zhang *et al.,* 1995). The value of TDS ranges from 773.6-27.86 mg/l and the average TDS value on this stretch of Kangsabati River is 163.78 mg/l (Fig.2D). Average value of TDS in this study area is more than double than that of global value (65 mg/l). The progressive trend of TDS is found towards the downstream of the river (258 mg/l) than the middle (127 mg/l) and upper stream (105 mg/l). High TDS values are concentrated in the mining sites (225 mg/l) followed by sandchar (150.94 mg/l) and pits (115 mg/l) (Fig.2.c).

Turbidity-T: Water quality and aquatic life greatly affected by the increase of turbidity due to the presence of suspended solids from sewage water through heavy soil erosion during monsoon season (Verma *et al.,* 1984). It is found as 35.4 NTU at the upstream sandchar site and 0.96 NTU at downstream pit site throughout the course. Most of the average turbidity values are 10.81 NTU in sandchar sites whereas mining and pits are low concentrated as 6.47 and 5.74 NTU. As a result, significant increase of 18.85% from mining to sandchar and 28.10% increase from pit to mining sites whereas course wise range from downstream to middle stream (2.9%) and middle to upstream (12.29%). It is to be noted that instream sand mining play vital role to determine the turbidity as well as runoff partially (Fig.2.d).

Electrical conductivity-EC: Another important physicochemical property is electrical conductivity (EC). Instream mining can change the consistency status of EC in sandchar and mining sites whereas EC increased in a common manner along the middle to downstream. The EC values in upper course range from 256-55.9 µS/cm which is higher in middle course as compared to 478-65 µS/cm. Maximum EC values are concentrated along the lower course ranges from 515-98.5 µS/cm. On the other hand, sandchar sites face higher EC values (515-65 µS/cm) than mining (376-114 µS/cm) and pit sites (478-55.5 µS/cm). It can be said that EC value denotes the limits range of guideline values of BIS and WHO (Fig.2.e).

Potential Hydrogen ion- P^H: Field study reveals that in the water samples of the Kangsabati River P^H range between 8.59 to 4.708. An increasing trend of alkalinity is found (8.59-7.76) towards the middle course. Field data represents the distribution of P^H values from Table 1. P^H value of river water along the upper course ranges from 7.56-4.708 whereas lower stream correspondences with 7.12-5.86. On the other hand P^H values in mining sites are ranges between 7.99-4.70 while sandchar sites are associated with the range of 7.8-6.25 in all segments. Higher P^H value is seen in mining pit sites with a variation of 8.59-5.56 (Fig.2.f).

Dissolved Oxygen-DO: The rate of photosynthesis of community depends on the presence of DO in stream water whereas temperature, microbial loads, atmospheric pressure and sample collection season determined DO status in stream water. Dissolved Oxygen (DO) value ranges from 0.63 - 1.59 mg/l along the course denotes that photosynthesis process of river biota become reduces. The maximum range of DO is found in middle course whereas upper course concerned with the lower range of 0.96 - 0.67mg/l and lower course vary from 0.98 to 0.67mg/l. Mining intensity plays a significant role to fluctuate the DO value (1.45-0.63 mg/l) than sandchar or non mining (1.59-0.66 mg/l) and mining pits sites (1.07-0.63 mg/l) (Fig.2.g).



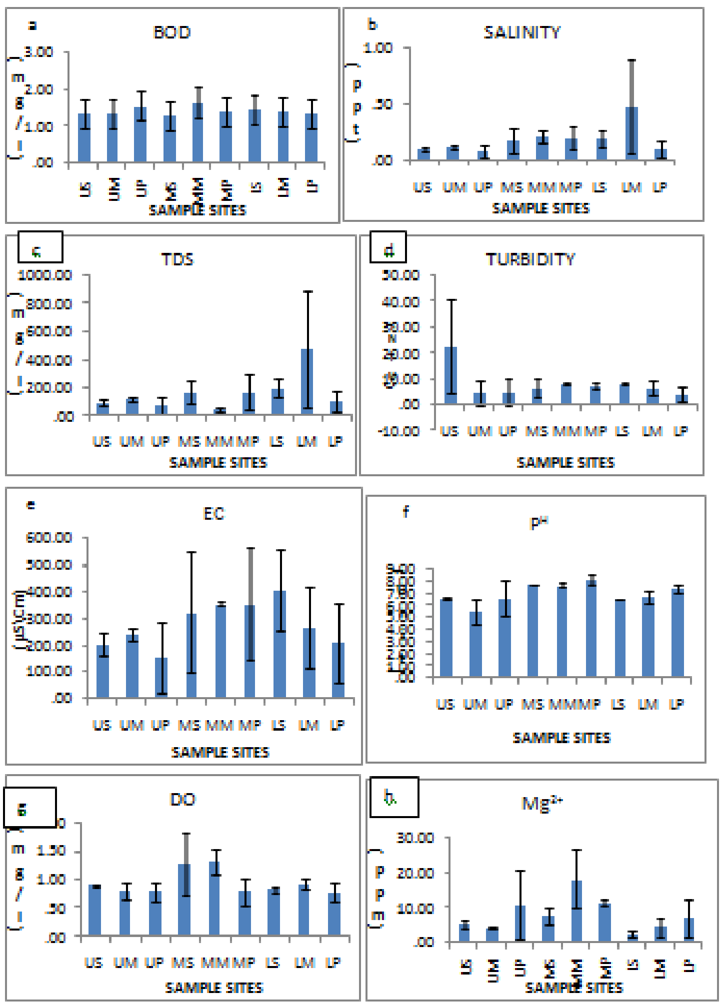


Fig.2. Physiochemical parameter wise sample site- Standard deviation and mean (a) BOD; (b) Salinity; (c) TDS; (d) Turbidity; (e) EC; (f) PH; (g) DO and (h) Mg2+ Physiochemical properties impact on the aquatic ecosystem

Table 1. Threatened freshwater fishes in the study area and reasons for threat as per IUCN (1990)

Sl. no	Taxa/families	Number of Species	Percentage of missing (%)	Threat	IUCN Category
1	Family: Cyprinid	17	10	Damming, Fishing, Human interference,	VU
2	Family:Ambassidae	2	60	Fishing, genetic problems, over exploitation,	
3	Family: Cichlidae	2	60	Fishing, Trade(local),loss of habitat	LRic
4	Family: Osphronemidae	1	80	Fishing, genetic problems, over exploitation, poisoning, pollution, trade	CR
5	Family: Anabantidae	1	80	Human interference, loss of habitat, over exploitation	EN
6	Family: Gobiidae	1	80	Loss of habitat,poisoning,pollution,trade(local)	DD
7	Family: Siluridae	2	60	Human interference, loss of habitat,	EN
8	Family: Claridae	1	80	Overexploitation, dynamiting and another destructive method of fishing,	VU
9	Family: Heteropneustidae	1	80	Diease,predation by exotic animals, trade(local)	CR
10	Family: Bagridae	2	5..12	Over exploitation, pollution	EN
11	Family: Schilbeidae	1	80	Loss of habitat, poisoning	CR
12	Family: Channidae	3	50	Fishing, genetic problems, over-exploitation,	LRnt
13	Family: Notopteridae	2	60	Fishing, genetic problems, over-exploitation,	VU
14	Family: Mastacembelidae	2	60	Loss of habitat, poisoning	VU
15	Family: Anguillidae	1	80	Disease, predation by exotic animals	CR

Magnesium cation-Mg^{2+}: Another important parameter of water quality or a crucial factor of species richness is a concentration of magnesium cation that can changes from sandchar to mining pit sites. Course wise change of Mg^{2+} indicates that most of the nutrient elements presence in middle course (5-24ppm) or mining pits sites (8.41ppm) than the upper course (8ppm) or sandchar site (2-24ppm). It can be said, the presence of Mg^{2+} continuous increased in pits due to trapping all cations caused by instream sand mining. As a result of all the benthos community rich fully concentrated entire the pit sites while species diversity is extremely high throughout the middle course like Dherua and Mohanpur segments due to the rate of massive sand mining (Fig.2.h).

Aquatic Communities: Bottom sandy substratum in the alluvial stream is a favor for inhabits of all benthic fauna which adverse effects by indiscriminate sand mining from the active channel of the river. Excessive sand extraction from instream affects the eco-biology of many terrestrial insects whose initial life history begins in aquatic environments. Bera.A et al (2014) conducted a study on the impact of sand mining on the benthic fauna of the Kangsabati River reach along Sarenga to Palaspai. The study is concerned that many aquatic organisms especially the benthos, are affected severely by instream sand mining. The insects include different species zooplanktons i.e. Rotifera, copepods, cladocera, along with protozoa and Ostracoda are more vulnerable. Several aquatic organisms like Polychaeta, Crustaceans, and Mollusca are harmful affected by instream sand mining. Dispersal of eggs and larvae is an important aspect of the biological processes of aquatic organisms. According to fisheries point of view, loss of food in the form of benthic invertebrates is a major negative impact which will ultimately end up in the decline of inland fishery resource of the area.

Fish community: Already many studies on the fresh water fishes of Kangsabati River are available in the literature; most of them are either concerned with taxonomy or with capture fisheries/quadrature. Moyle and Cech (1996) stated that fishes in riverine biodiversity monitoring are crucial for their enormously diverges with various species reflecting different environmental conditions. Second, fishes often have a major bearing on the distribution and abundance of other organisms in the water they inhabit. Third, fishes form an important ecological link between aquatic and terrestrial environments as it forms food for many terrestrial organisms. According to F.A.O (1998), fishes are open substrate spawners that do not guard their eggs. So pollutant water or turbidity flow is a hindrance to survival, growth or reproduction. The composition of fish community by the order in Kangsabati River is started from Cypriniformes (43.58%), Perciformes (17.95%), Siluriformes (17.95%), Channiformes (7.69%), Osteoglossiformes (5.13%), Synbranchiformes (5.13%) to Anguilliformes (2.57%) in table 1. Last three orders are very in dangerous due to changes the bio-physical quality of water.

Conclusion: Finally, this study reveals that how channel sand mining process impacts on instream organisms in river Kangsabati. Maximum species are vulnerable especially Mastacembelidae and Anguillide family in near future. Habitat loss and pollution of toxin elements both are a hindrance on benthic zoos in the study area. Over exploitation of sand mining is a threat to habitat destruction of fishing community. The result shows that maximum families are faces of habitat loss due to the removal of sediment. On the other hand, physiochemical properties of river water are direct changes through the sand mining process and then those are leads to interrupts the ingredient of water.
All of these changes play a vital role in a succession of stream biota as well as habitat suitability.

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