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Original Article

Water pollution effects of river Saraswati and Kunti on livelihood: a case study of fishermen communities in Tribeni and Kuntighat, Hooghly, West Bengal

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Abstract

A prolific study was conducted to find out the impact of pollution on the socio-economic status of the fishermen community of Tribeni, Kuntighat - Hooghly, West Bengal, who depend on the rivers Saraswati, Kunti and Ganga for their livelihood. Analysis of important water quality parameters clearly reflects the pollution status of the rivers Saraswati and Kunti. Investigation was carried out by a previously tested questionnaire and personal interaction with 100 fishermen based on which the probable reasons of decline in fish diversity were drawn, which consequently adversely affected the economic conditions of fishermen. The investigation revealed a positive correlation between discharge of industrial effluents, in turn depleting the availability of fish food organisms and fish diversity and warning socioeconomic conditions of fishermen. Results clearly indicate proper steps should be taken by the policy makers towards restoration of water quality and thereby helping the vulnerable fishermen.

Keywords: Fishermen community; industrial pollution; Kunti; Saraswati; socio-economic condition

1 | INTRODUCTION

Among all the vertebrates, fishes are the most diverse group and almost ~40% fishes are inhabitants of freshwater habitats (Ghorbani *et al.* 2013). In terms of freshwater mega biodiversity India ranks ninth (Mittermeier and Mittemeier 1997) and contributes about 11.72% to the global fish diversity (Mistry 2016). It has already been reported that 2546 fish species which belongs to 969 genera, 254 families and 40 orders are found in India (Talwar and Jhingran 1991) among which 742 are freshwater fish species which belong to 233 genera, 64 families and 16 orders (Jayaram 1999). Devi and Indra (2012) have estimated 667 freshwater fish species in India. Indian fish compromise ~57% of the total families, 24% of the total genera and 11% of the total species, globally (NBSAP 2005). Among all the aquatic organisms fish plays a major role in the economy of a nation occupy prime role in economy of many nations (Okyere *et al.* 2011) as they are a stable item of protein source among the diet of many people (Samad *et al.* 2010; Galib *et al.* 2016). West Bengal

plays a major role in fish production of India. Different authors have already recorded different numbers of species from different water bodies in West Bengal (Sen 1992; Mukherjee *et al.* 2002). From the river Damodar of Burdwan district about 46 species of 7 orders have been reported (Patra and Saha 2013). Roshith *et al.* (2013) reported 155 fish species which belongs to 49 families and 15 orders from tidal freshwater zone of the Hooghly estuary. Now a days fish diversity loss in large water bodies are major problem as many rivers are losing its water depth and quality and in most of the cases it is due to anthropogenic activities (e.g. Chaki *et al.* 2014; Parvez *et al.* 2017; Galib *et al.* 2018). Rivers, once navigable, have now degenerated into insignificant streams due to silting up and decay. The changing nature of the decaying rivers has huge impact on the socio-economic status of the populations surrounding those areas. It has already been reported that the major causes of the decay of the river Saraswati are due to excessive water pollution from the cattle sheds beside the river in Adisapta Gram and Mogra, dumping of domestic garbage, agricultural run offs, effluents of Tribeni chemical factories and municipality garbage of Bandel and Bansberia (Mandal 2017). In river side areas of Ganges, Saraswati and Kunti a considerable number of people live who maintain their livelihood on fishing and other related activities. Most of the people of the river basin belongs to fisherman community and is facing major socio-economic problems although once they had a huge income from those water bodies and that is why they are shifting their profession to other activities like rickshaw pulling, work in grocery shop etc.

The river Bhagirathi has branched off into three streams at Tribeni in Hooghly district of West Bengal. The branch named Saraswati has traversed towards south-west beyond Saptagram and ultimately flowed into an estuary near Tamralipta (present-day Tamluk) and receives the waters of the Damodar, Rupnarayan and several other minor streams. Tamralipta has lost its importance due to of silting up of the mouth of Saraswati and the subsequent shifting of its course after the 8th century AD (Majumdar 2005). Apart from that the river Kunti also has a huge fish diversity which was good enough to secure the socio-economic status of the fishermen community. Therefore, the present study was conducted to understand the deterioration of socioeconomic condition of fishermen, which needs our special attention. Present study was focused on the changing nature of the river Saraswati and Kunti and its impacts on the socio-economic conditions of the fishers of Tribeni and Kuntighat, West Bengal.

2 | METHODOLOGY

2.1 Study area

The survey was conducted at Tribeni (area beside the junction of the river Ganga and Saraswati; 22°58'59.2"N 88°24'05.4"E) and at Kuntighat (area beside the junction of the river Ganga and Kunti; 23°01'09.6"N 88°24'55.4"E) Hooghly, West Bengal during January 2016 to August 2017. Samples were collected for water quality analysis from three randomly selected sites of the rivers (Figure 1).

FIGURE 1 Sampling sites of the river Saraswati at Tribeni (*A*), and river Kunti at Kuntighat (*B*), Hooghly, West Bengal.

2.2 Data collection

The study stressed on the socio-economic analysis of the fishermen community (Figure 2), once which was developed beside the river Saraswati and Kunti entirely because of their dependence on the river Saraswati, Kunti and Ganga for their livelihood. The data were collected directly from the fishermen communities through personal discussions and interviews regarding the various aspects of the socio-economic conditions like age composition, education and income structure, availability of fishes in previous years, loss of fish species in present days, types of nets and gears that used for fishing, probable causes of economic loss, comparisons between the past and present socio-economic condition by adapting the methods described by Panigrahi and Bakshi (2014). In the preliminary survey, a general interviews of the old aged persons helped to discern the rate of the occupational twitching (Panigrahi and Bakshi 2014). In the later phase the total survey were done among 50 respondents from Tribeni and 50 respondents from Kuntighat which were selected randomly for the study.

2.3 Water quality analysis

Water samples were collected from three places of both the river Saraswati at Tribeni and Kunti at Kuntighat, Hooghly, West Bengal. Physico-chemical parameters (pH and alkalinity) were analysed by following standard

methods (APHA 2005). Total alkalinity in terms of the concentrations of carbonate (CO_3^-) and bicarbonate (HCO_3^-) ions were estimated by titration with sulphuric acid using phenolphthalein and methyl orange as indicators. Analysis of the dissolved oxygen (DO) and chemical oxygen demand (COD) of the water samples have been done following the method of Wetzel and Likens (1991) and Golterman (1978) respectively.

FIGURE 2 A fisherman catching fish (above) and fisherman with fishing gears (below) in the river Saraswati.

3 | RESULTS AND DISCUSSION

3.1 Water quality analysis:

Aim of the present study was to highlight the pollution status of the river Saraswati and Kunti and their impact on the human life. The study was conducted to draw special attention for the present condition of the river Saraswati which was a large river during 16th century. The investigation put emphasis on analyzing the socio-economic problems of the local people of Tribeni and Kuntighat and for that purpose we also have taken some water quality parameters into consideration. To check the pollution status of the rivers, a set of water quality parameters were assessed. Now the rivers are undergoing silting up due to enormous pollution and several natural as well as man-made causes. During the period of investigation we have found that DO was far below the acceptance range for fish growth whereas COD was much higher than the optimum COD level for fish growth (Table 1). Overall the DO of the river Saraswati and Kunti were within a range of 0.6 – 2.8 mg L^{-1} and 2 – 5.4 mg L^{-1} respectively. At site 1 In river Saraswati, where the river is branching from the main stream of Bhagirathi, higher DO was recorded than the other two sites whereas better condition was recorded in river Kunti than that of river Saraswati. COD were within the range of 56 – 88 mg L^{-1} and 48 – 66 mg L^{-1} in the river Saraswati and Kunti respectively. Bicarbonate alkalinities were within the range of 168 – 392 mg L^{-1} and 234 – 282 mg L^{-1} in the river Saraswati and Kunti respectively. Although water qualities of both the rivers were not supportive for fish growth and that is why a few fish species are available only during monsoon.

3.2 Socio economic analysis

In this study we draw comparison between previous and present condition of the fishermen community of Tribeni who depend on the rivers Saraswati and Ganga and the fishermen community of Kuntighat who depend on the rivers Kunti and Ganga, for their livelihood. According to our investigation by personal interactions and interviews with the fishermen in Tribeni we have found that about 20 – 30 years ago many of those fishermen and their ancestors had mostly depend on the river Ganga (Bhagirathi) and partially on the river Saraswati and had very good earnings and that is why they colonize beside the riverbank. In recent years the river has lost its productivity due to pollution and it is damaged at various places. As a result very few fish species are available only during monsoon otherwise during summer and winter the fishermen have to rely on the river Ganga (Bhagirathi) for their earnings. Productivity of the river has been decreased so much that it cannot fullfill the daily feeding requirements of the fishermen. On other hand fishes found in this river in the seasons other than monsoon are not suitable for human consumption and may cause various health hazards. Fishermen communities of Kuntighat also have facing the similar problems. According to our discussion with senior fishermen availability of the fish species in previous years and recent years in those rivers are shown in Table 2. On the other hand, the productivity of the Ganga River is also declining due to pollution in those areas.

In the study, 36% of the respondents of Tribeni and 34%

of the respondents of Kuntighat have shifted their occupation from fishing and now they are taking up other occupations that are not related to fishing for example, pulling rikshaw, toto, or working as labour etc. Only 46% of the respondents from Tribeni and 52% respondents of Kuntighat were found to rely entirely on fishing round the year. Remaining respondents from both the places did not have a fixed occupation rather participate on small seasonal business or work as daily labourers. All the respondents were completely dependent on fishing in past but many have changed their profession at present due to financial insecurity as lack of large fishing gears, equipment, capital or technology to catch fish in large rivers such as river Ganga have made fishing difficult for small-scale fishermen.

TABLE 1 Water quality parameters of the river Saraswati and the river Kunti.

Parameters	pH		DO (mg L^{-1})		COD (mg L^{-1})		Alkalinity (mg L^{-1})	
	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Saraswati River								
SITE I	7.33 – 8.26	7.83 ± 0.38	1.6 – 2.8	2.07 ± 0.52	56 – 76	64.67 ± 8.37	168 – 358	259.33 ± 77.74
SITE II	7.21 – 8.23	7.68 ± 0.42	1.4 – 2.6	1.93 ± 0.50	58 – 75	65.33 ± 7.13	198 – 332	268 ± 54.87
SITE III	7.32 – 8.12	7.69 ± 0.33	0.6 – 2.2	1.4 ± 0.65	57 – 88	74.67 ± 13.02	194 – 392	294.67 ± 80.87
Kunti River								
SITE I	7.85 – 8.24	8.03 ± 0.19	2.8 – 5.2	3.8 ± 1.25	48 – 60	54.33 ± 6.03	234 – 272	250 ± 19.70
SITE II	8.09 – 8.45	8.26 ± 0.18	3.0 – 5.4	4.15 ± 1.18	52 – 66	66.0 ± 7.00	234 – 276	253 ± 20.30
SITE III	7.98 – 8.21	8.08 ± 0.12	2.0 – 3.8	2.77 ± 0.93	57 – 65	61.67 ± 4.16	242 – 282	259.33 ± 19.55

TABLE 2 List of fish species in the river Saraswati and Kunti. *a*, fish species available before 10 years in Saraswati River; *b*, Fish species available in recent years in Saraswati river; *c*, fish species available before 10 years in Kunti River; *d*, Fish species available in recent years in Kunti river.

Scientific Name	Vernacular name	Order	Family	Availability
Anabas testudineus	Koi	Perciformes	Anabantidae	a, c
Anguilla bengalensis	Baan	Anguilliformes	Anguillidae	c
Awaous grammepomus	Bele	Perciformes	Gobiidae	a, b, c, d
Catla catla	Katla	Cypriniformes	Cyprinidae	a, b, c, d
Chanda nama	Chanda	Perciformes	Ambassidae	c
Channa orientalis	Cheng	Perciformes	Channidae	c
Channa punctata	Garai	Perciformes	Channidae	a, c
Channa striata	Shol	Perciformes	Channidae	c
Chitala chitala	Pulli	Osteoglossiformes	Notopteridae	c
Cirrhinus mrigala	Mrigal	Cypriniformes	Cyprinidae	a, c, d
Clarias batrachus	Magur	Siluriformes	Clariidae	a
Corica soborna	Kechki	Clupeiformes	Clupeidae	c
Gudusia chapra	Khaira	Clupeiformes	Clupeidae	c
Heteropneustes fossilis	Singhi	Siluriformes	Heteropneustidae	a
Labeo bata	Bata	Cypriniformes	Cyprinidae	c, d
Labeo calbasu	Kalbasu	Cypriniformes	Cyprinidae	a, c, d
Labeo rohita	Rohu	Cypriniformes	Cyprinidae	a, b, c, d
Mastacembelus armatus	Baim	Synbranchiformes	Mastacembelidae	b, c, d
Mystus bleekeri	Sada tangra	Siluriformes	Bagridae	a, c, d
Mystus vittatus	Lal tangra	Siluriformes	Bagridae	a, c, d
Pseudapocryptes lancelatus	Gule	Perciformes	Gobiidae	a, b, c, d
Puntius sophore	Sarpunti	Cypriniformes	Cyprinidae	a, c
Puntius ticto	Tit Puti	Cypriniformes	Cyprinidae	a, c
Rita rita	Ritha	Siluriformes	Bagridae	c
Salmostoma acinaces	Chela	Cypriniformes	Cyprinidae	c
Wallago attu	Boal	Siluriformes	Siluridae	c

Ages of the respondents of the fishermen community was reported because the age structure is a significant socio-economic research parameter. It has been reported by Bhaumik and Pandit (1994) in their study at some 'beels' of West Bengal that the age of most of the fishermen was between 18 and 62 years. In Tribeni about 7% of the total respondents were below 18 years of age, 57% belonged to the age group of 18 – 40 years, 22% to 41 – 60 years and 14% to above 60 years whereas in Kuntighat 20% of the respondents were below 18 years, 44% to 18 – 40 years, 26% to 41 – 60 years and 10% to above 60 years groups (Figure 3). It is clearly seen that, due to rapid loss of fish productivity in the Saraswati River, most of the descendants of fishermen diverge from their occupation to other occupations and most of them become addicted to different types of drugs, alcohols, and tobacco products that hamper their personal and social lives.

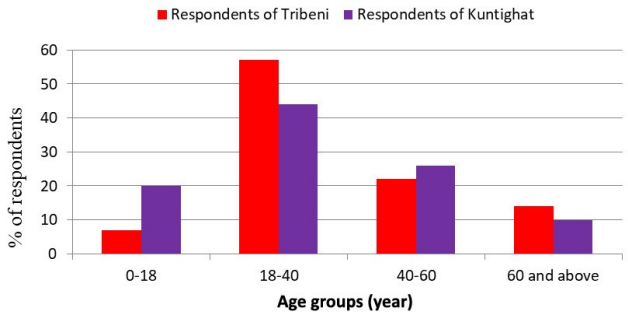

FIGURE 3 Age structures of the respondents (*n* = 100).

In Tribeni, 50% fishermen were illiterate followed by class 1 – 5 (28%), class 9–12 (14%) and class 6 – 8 (8%) (Figure 4). In Kuntighat majority of the respondents had 6 – 8 years of schooling (Figure 4). Both the places were adjacent to town areas with lots of opportunity for free education but the literacy level was not satisfactory as most of them used to drop out from school to ensure basic amenities of their family. This is also a common problem in neighbouring countries (e.g. Bangladesh; Flowra *et al.* 2009; Islam *et al.* 2013).

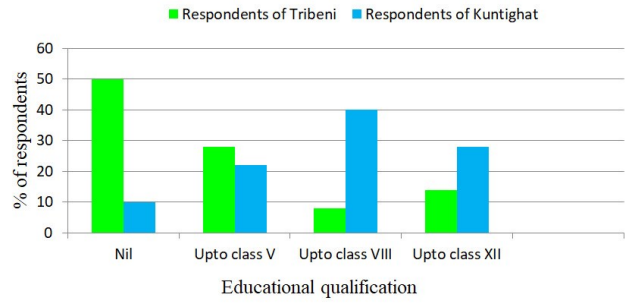

FIGURE 4 Literacy rate and educational qualification of the respondents (*n* = 100).

Economic condition of the fishermen were very poor and they usually used cast net (locally known as jakhi jal), gill nets (current jal), drag net (bed jal), push net (thelajal) and some other local contrivances for fishing. Large nets were also used to catch fishes in the river Ganga. Many of the fishermen of the study areas made their own nets and owned fishing boats. Despite availability of many modern technological fishing gadgets fishermen did not use them due to the financial crisis. Economic conditions of the fishermen were decreasing rapidly during the study period. In Tribeni about 34% of total respondents had a monthly income of Rs. 1000 – 2000 (1 USD = 74 Rs.) followed by Rs.3000 – 4000 (28%), Rs. 2000 – 3000 (24%), and above Rs. 5000 (14%) (Figure 5). Monthly income statuses of the respondents from Kuntighat were quite better than that of Tribeni. In Kuntighat about 8% of total respondents had a monthly income of Rs. 1000 – 2000, 16% had earned Rs.2000 – 3000 per month, 24% had earned Rs. 3000 – 4000 and 52% had earned above Rs. 5000 (Figure 5).

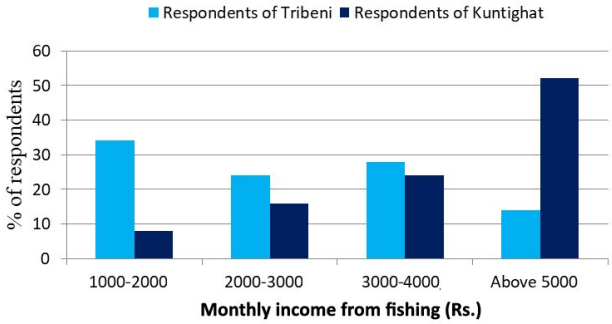

FIGURE 5 Monthly income of the respondents (*n* = 100).

It was found that most of the families had houses with tiled roofs or asbestos roof and walls were generally made by mud or bricks. In some cases 5 – 6 members used to share a single room. No proper sanitary system for some of the households was also recorded.

The outlook of the fishermen towards the socio-cultural activities *viz.* participating and attending socio-cultural gatherings listening to radio, watching television programmes etc. has taken as an important parameter in the study based on the River Churni (Panigrahi and Bakshi 2014). We have also taken it as an important parameter in the present study and it was found that about two third of total respondents from both study locations of Tribeni and Kuntighat watched TV regularly and one third of the respondents were occasionally watch TV although very few of them had their own TVs.

This study showed that the decreasing river productivity jeopardizes fishermen's socioeconomic situation and that, as well as the increasing pollution; the loss of biodiversity can lead to an ecological imbalance that needs special attention. We should at least be more careful about the condition of other rivers that are still productive but are losing their productivity due to indiscriminate pollution. Due to industrialization and urban growth the industrial effluents and sewage water are discharged into rivers

leading to increased concentration of different pollutants in the river (Sheykhi and Samani 2020). Huge amount of different synthetic pesticides, pharmaceutical residues, chemical fertilizers are indiscriminately discharged into the river every day (Rueda *et al.* 2020). Dissemination of awareness will help to prevent those rivers from dying.

4 | CONCLUSIONS

From the present study it is evident that, although the river Saraswati was once navigable but at present it becomes a defunct, narrow silted up channel. The river Saraswati has entirely lost its productivity due to indiscriminate pollutions and as a result has lost his importance regarding fishing and agriculture. Even the gas produced on this polluted river is causing various types of health problems to the fishermen families of the river side area. In addition to that the condition of the river Kunti is almost same. As a result fishermen of Tribeni and Kuntighat are facing a massive socio-economic crisis. So, effective steps should be taken to prevent the pollution of the river Saraswati and the river Kunti to maintain the ecological diversity of fish fauna and socio- economic condition of the fishermen. In addition to that, as both the rivers are connected with the river Ganga, the main river of West Bengal, increasing pollution of those rivers may also lead to the fish diversity loss of the river Ganga. There for increasing pollution, dying and decaying status of those rivers give a clear cut idea about the future prospect of other severely polluted rivers. Like as GAP (Ganga Action Plan), other awareness program and precautions should be taken to prevent pollution in the rivers thereby maintaining biodiversity.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

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CONTRIBUTION OF THE AUTHORS

AKP conceptualization, manuscript writing, formal analysis, data acquisition;
SP data validation and supervision.