Water Quality Assessment of Some Fish Landing Sites of Beki River, of Barpeta, Assam, India

Pallabi Goswami and Siddhartha Singha

***Abstract*—Water quality monitoring and assessment has become a critical issue because it affects human and aquatic life. In recent years Beki River of Assam, India have encountered serious threats which includes sand mining, use of fertilizers on the river banks, uncontrolled fishing that have altered the water quality of the river specially in the fish landing sites. These have caused significant reduction in abundance of the fresh water fishes in the region. This study identifies the parameters that are responsible for decreasing the water quality in the six fish landing sites of the river. The study shows low pH of the river water indicating its acidity nature. Decrease in Dissolved oxygen (DO) during the monsoon in Dumnigh at, Sapakama and Madulijar suggested poor quality of water indicating the slow rate of photosynthesis by phytoplankton present in the Beki River. The concentration of Iron in Gobardhana, Sapakama and Dumnigh at during post monsoon was higher than the maximum limit of 0.3 mg/l. Concentration of nitrate was found to be higher than the limit of 45 mg/l in all the landing sites except for Gobardhana due to application of inorganic nitrogen fertilizers in the agricultural farm in the river bank. Concentration of manganese, arsenic and lead was found to be higher than the maximum limit in the fish landing sites. The spatial variations of the major ions reflects the influence of various anthropogenic and lithology's activities in the river system.**

***Index Terms*—Beki river, water quality, fertilizers, anthropogenic, dissolved oxygen, arsenic, lead.**

I. Introduction

North-east India is blessed with freshwater sources in the form of various rivers, streams, lakes, swamps, marshes, etc. The State Assam that forms about 30% of the North Eastern region has Brahmaputra and Barak River systems and their numerous tributaries (combined length 4820 km), a large number of flood plain, wet lands (Beel) and swamps (1.12 lakh ha.) [1]. These rivers are the lifelines of these regions and support the social, ecological, cultural and overall environmental setup. Additionally, these rivers along with their numerous wetlands formed and feed by them host diverse organisms and sub-ecosystems [2].

In the last few decades these natural resources are continuously being exploited all around the world for the sake of development. The freshwater resources are continuously being polluted to an inconceivable stage. Water pollution from various point and non-point sources, dam construction, over abstraction and human encroachment have been of increasing concern which have already adversely affected the ecosystem dwelling in the water bodies.

Beki River is an important tributary of Brahmaputra River. It flows down from the Bhutan region but a large portion flow in Indian state Assam. It flows from Bhutan touching Mathanguri, Naranguri, Khusrabari, Valaguri, Mainamata, Udalguri, Barpeta Road, Nichukha, Sorbhog, Kalgachia, Balaipathar, Kharballi, Bardanga, Kamarpara, Srirampur, Daoukmari, Jania, Chanpur, Rubi, Sawpur, Gobindapur, Moinbariand Balikuri. Tourists can have beautiful view of the river and its natural surroundings from the bridges situated on NH no- 31 [3]. Erosion and the recurring floods of characteristically high magnitude by Beki River have been heavily affecting the agricultural lands, crops, cattle and people of Barpeta district of Assam [4], [5]. This river has a rich ichthyofaunal diversity which has suffered a lot due to serious anthropogenic stress [6]. With the increase in demand of fishes, extensive fishing is carried out in the river leading to increase in settlement of large number of fishermen on the river bank. These fishermen have also used the river bank for agricultural practices and have exposed the river to fertilizers which are washed into the river during rainy season changing the quality of river water [6]. Sand and Gravel mining from the Beki River have caused severe degradation on the river bank [6], [7]. This have led to heavy erosion and loss of fertility of river bank. Thus, the use of fertilizer for agriculture in the river bank have increased. The overall aim of the present investigation is to assess the water quality of the Beki River in the fish landing sites where the multipurpose uses of water and human activities are intense. It also aims to reveal the interrelationships between different physical and chemical parameter studied.

II. Materials and Methods

A. Study Area

Beki River, also known as the Kurissu river in Bhutan, lies between 26 °20'00"N; 90 °56'00" E and located in Barpeta district and flows from North to South through Barpeta district. The climate is extremely varied. From May to October, Tropical monsoon climate provides two distinct seasons- summer and winter. The summer season of March to May is followed by the Monsoons from June to September. This is followed by cool winter season from October to February. Beki Riverine areas receive annually over 4,000 - 4,200 millimetres in the southern parts and 550–700 millimetres precipitation in the northern parts [5].

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The survey was conducted in six different fish landing zone of Beki River (Fig. 1).

1) Gobardhana (L_1): (26 °34′.88″ N and 90 °50′.94″ E)
2) Sapakama (L_2): (26 °33′.71″ N and 90 °58′.87″ E)
3) Dumnighat (L_3): (26 °32′.79″ N and 90 °57′.78″ E)
4) Nizdamaka (L_4): (26 °29′.61″ N and 90 °54′.95″ E):
5) Uttarganakguri (L_5): (26 °29′.00″ N and 90 °54′.15″E)
6) Madulijar (L_6): (26 °27′.56″ N and 90 °54′.37″ E)

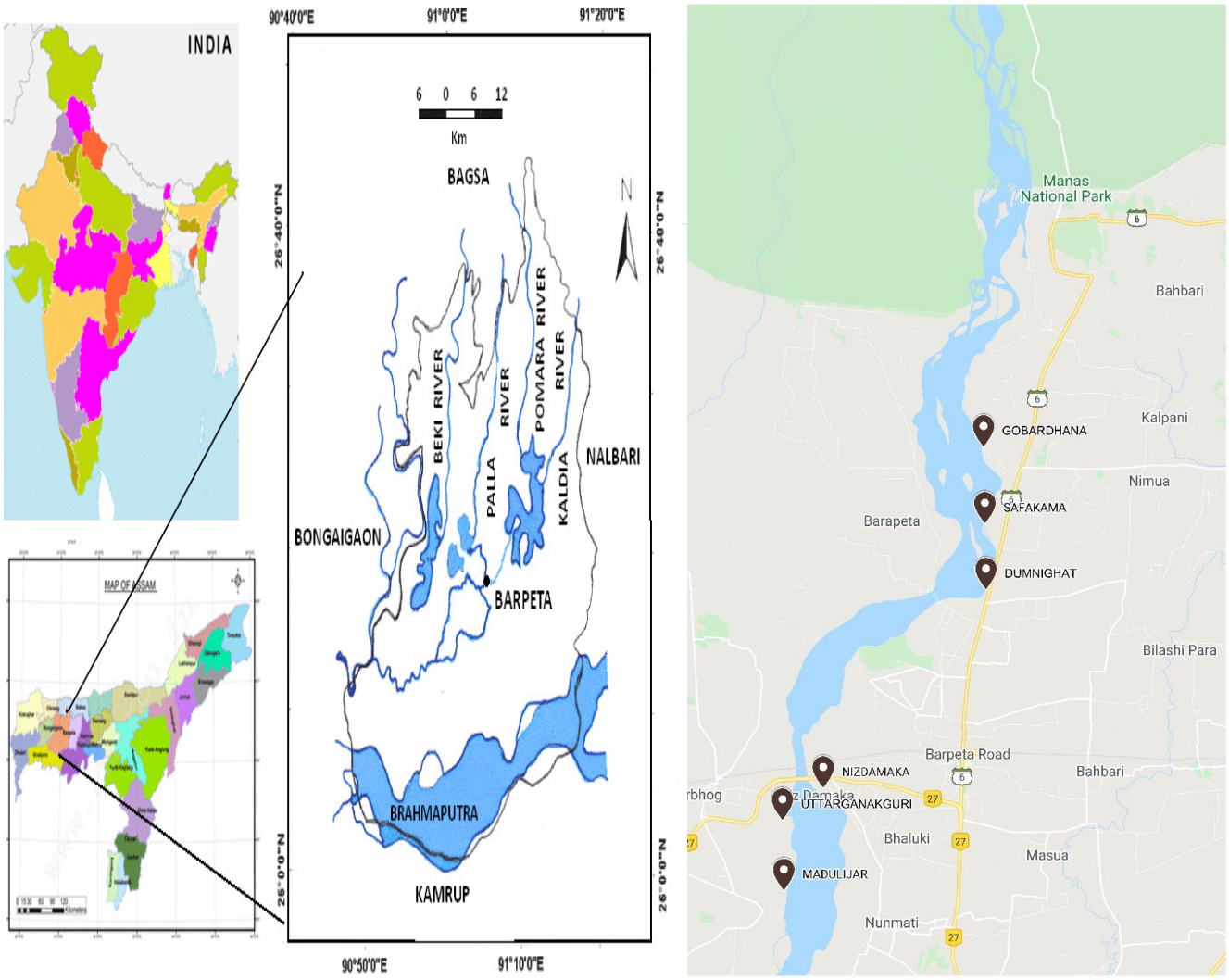

Fig. 1. Survey area location map.

B. Data Collection and Analysis

For the study of water quality parameters, ten random samplings were made in the fish landing sites of Beki River at different depths 0 meters, 10 meters and 20 meters. Sampling was made twice in a month and data were presented seasonally viz., pre-monsoon (March to May), monsoon (June to September), post monsoon (October to February).

The methodology adopted for the analysis of water samples are:

1) Water temperature: - Mercury thermometer graduated up to 110 ℃.
2) pH:- Digital pH meter (model LT -11, Labtronics)
3) Total dissolved solid (TDS): method by Trivedy and Goel [8]
4) Dissolved oxygen (DO):- Winkler's modified method [9]
5) Total alkalinity: - Titration method is using methyl orange as an indicator
6) Turbidity: Nepheloturbidity method
7) Free CO_2: Titration method is using phenolphthalein as indicator
8) Conductivity: Electrometric
9) Iron: Spectrophotometric
10) fluoride: Spectrophotometric
11) Nitrate: Spectrophotometric
12) Manganese: Spectrophotometric
13) Arsenic: Spectrophotometric
14) Lead: Spectrophotometric
15) Total hardness: Titrimetric

III. Results and Discussion

The analysis of result of chemical parameters of the water provides a considerable insight of water quality of the Beki River. This study identifies the parameters which are responsible for decreasing the water quality. The obtained physicochemical parameters' average values were compared with the Bureau of Indian Standard for each sampling site in Beki River (Table I and II).

TABLE I: WATER QUALITY PARAMETERS [PH, TEMPERATURE (OC), DISSOLVED 02 (MG/L),TDS (MG/L), TOTAL ALKALINITY (MG/L), TURBIDITY (NTU), FREE CO2(MG/L), CONDUCTIVITY (µS/CM), TOTAL HARDNESS (MG/L), IRON (MG/L), FLUORIDE (MG/L)] OF BEKI RIVER. MEAN ±SD

Parameter	**BIS (IS -10500: 2012) Guideline value**		**L_1**	**L_2**	**L_3**	**L_4**	**L_5**	**L_6**
PH	6.5 – 8.5	PRE MONSOON	7.21 ±0.56	7.44 ±0.23	7.22 ±0.39	7.10 ±0.66	7.22 ±0.35	7.56 ±0.22
		MONSOON	6.5 ±0.05	6.6 ±0.14	6.65 ±0.22	6.19 ±0.26	6.71 ±0.45	6.6 ±0.66
		POST MONSOON	6.95 ±0.52	6.78 ±0.06	6.82 ±0.34	6.83 ±0.81	6.90 ±0.33	6.83 ±0.48
Temperature (^OC)	--	PRE MONSOON	25.13 ±0.11	24.21 ±1.03	26.21 ±0.81	26.60 ±1.12	25.21 ±1.15	25.5 ±1.21
		MONSOON	22.22 ±0.25	23.11 ±1.11	23.80 ±1.23	22.33 ±0.35	21.24 ±0.22	20.22 ±0.88
		POST MONSOON	17.21±1.26	16.38 ±0.36	17.38±1.24	17.39 ±1.36	16.48 ±1.26	17.23 ±2.22
Dissolved 02 (mg/l)	≥ 6.5 – 8	PRE MONSOON	11.15 ±1.69	9.46 ±0.22	10.28 ±0.40	11.87 ±1.07	7.88 ±1.23	7.69 ±1.74
		MONSOON	6.86 ±0.1	5.69 ±2.88	5.46 ±0.53	6.57±0.06	7.53 ±0.5	5.66 ±1.9
		POST MONSOON	9.22 ±0.9	8.11 ±0.71	9.52 ±0.63	9.17 ±0.56	7.71 0.37	7.22 ±0.41
TDS (mg/l)	2000	PRE MONSOON	92.34 ±25.30	111.16 ± 56.31	98.38 ± 19.35	89.52 ± 22.95	92.34 ± 36.21	88.90 ±26.12
		MONSOON	202.87 ±60.52	179.61 ± 48.01	198.27 ± 44.72	177.89± 45.38	192.23 ± 72.42	189.84 ± 52.63
		POST MONSOON	63.10 ±26.72	56.83 ± 21.63	81.92 ± 23.02	67.2 ±28.42	34.82 ± 12.10	40.32 ±13.18
Total alkalinity (mg/l)	600	PRE MONSOON	211.2 ±21.64	210.33 ± 45.44	210.37 ± 43.6	212.56 ± 53.11	211.32 ± 31.44	210.44 ± 53.22
		MONSOON	240 .12 ±14.55	233.42 ± 31.59	231.62 ± 12.23	235.18 ± 23.44	236.22 ±58.11	232. 33 ± 23.87
		POST MONSOON	182.25 ±45.98	193.49 ± 71.52	204.98 ± 58.10	188.12 ± 65.9	193.44 ± 55.6	192.38 ±43.8
Turbidity (NTU)	5	PRE MONSOON	0.04 ±0.03	0.52 ±0.11	0.01 ±0.00	0.42 ±0.06	0.52 ±0.14	0.45 ±0.11
		MONSOON	1.23 ±0.35	1.11 ±0.21	0.92 ±0.06	1.06 ±0.07	1.12 ±0.03	0.78 ±0.07
		POST MONSOON	0.05 ±0.03	0.50 ±0.31	0.01 ±0.00	0.36 ±0.02	0.51 ±0.27	0.32 ±0.08
Free CO_2 (mg/l)	-	PRE MONSOON	8.23 ±2.17	8.21 ±2.19	9.26 ±1.83	9.05 ±1.92	8.25 ±1.43	9.82 ±1.19
		MONSOON	26.19 ±3.45	30.50 ±1.37	26.50 ±2.67	28.58 ±3.45	18.45 ±2.68	28.80 ±6.83
		POST MONSOON	9.22 ±1.15	10.82 ±2.54	10.56 ±1.37	10.20 ±3.60	8.71 ±1.22	8.74 ±1.41

Conductivity (μs/cm)	-	PRE MONSOON	162.25 ±33.18	171.16 ± 33.91	158.27 ± 30.18	156.90 ± 22.95	170.95 ± 35.22	173.59 ± 43.82
		MONSOON	263.50 ±60.52	236.23 ± 21.63	222.66 ± 19.35	202.84 ± 32.97	218.29 ± 91.22	220.56 ± 68.49
		POST MONSOON	138.99 ±16.24	148.23 ± 88.26	128.29 ± 34.28	132.19 ± 28.12	123.37 ± 33.66	130.29 ± 26.25
Total hardness (mg/l)	600	PRE MONSOON	88.41 ±18.4	62.53 ± 16.12	112.30 ± 23.14	108.53 ± 21.7	113.28 ± 34.11	112.22 ± 15.75
		MONSOON	69.78 ±13.5	53.20 ± 13.26	74.29 ± 14.16	82.34 ± 25.30	77.15± 25.30	93.24 ±17.25
		POST MONSOON	105.16 ±18.7	75.31 ± 17.11	135.13 ± 24.9	135.28 ± 25.20	120.16 ± 17.77	135.59 ± 23.25
Iron (mg/l)	0.3	PRE MONSOON	0.14 ±0.10	0.21 ±0.14	0.11 ±0.05	0.10 ±0.07	0.22 ±0.08	0.28 ±0.11
		MONSOON	0.08 ±0.02	0.09 ±0.02	0.03 ±0.01	0.01 ±0.00	0.04 ±0.01	0.10 ±0.03
		POST MONSOON	0.38 ±0.01	0.39 ±0.01	0.43 ±0.04	0.21 ±0.01	0.24 ±0.06	0.10 ±0.19
Fluoride (mg/l)	1.5	PRE MONSOON	0.03 ±0.01	0.26 ±0.03	0.08 ±0.02	0.08 ±0.01	0.01 ±0.00	0.07 ±0.02
		MONSOON	0.02 ±0.01	0.38 ±0.04	0.11 ±0.03	0.21 ±0.06	0.04 ±0.01	0.11 ±0.02
		POST MONSOON	0.01 ±0.00	0.31 ±0.02	0.09 ±0.02	0.11 ± 0.03	0.01 ±0.00	0.09 ±0.01

TABLE II: WATER QUALITY PARAMETERS [NITRATE (MG/L), MANGANESE (MG/L), ARSENIC (MG/L), LEAD (MG/L)] OF BEKI RIVER. MEAN ±SD

Parameter	**BIS (IS -10500: 2012) Guideline value**		**L_1**	**L_2**	**L_3**	**L_4**	**L_5**	**L_6**
Nitrate (mg/l)	45	PRE MONSOON	28.21 ±4.26	32.58 ±4.25	27.21 ±1.59	41.12 ±2.35	32.08 ±2.47	31.26 ±1.63
		MONSOON	38.18 ±2.61	54.88 ±6.21	62.15 ±12.33	58.18 ±6.27	56.21 ±4.99	52.21 ±3.30
		POST MONSOON	24.74 ±5.96	38.22 ±4.50	36.14 ±2.21	44.11 ±3.57	26.42 ±2.51	36.12 ±2.81
Manganese (mg/l)	0.3	PRE MONSOON	0.33 ±0.07	0.36 ±0.04	0.31 ±0.13	0.39 ±0.11	0.31 ±0.09	0.36 ±0.11
		MONSOON	0.32 ±0.05	0.34 ±0.11	0.33 ±0.12	0.28 ±0.08	0.26 ±0.08	0.27 ±0.08
		POST MONSOON	0.50 ±0.08	0.52 ±0.13	0.58 ±0.18	0.59 ±0.17	0.55 ±0.15	0.32 ±0.11
Arsenic (mg/l)	0.05	PRE MONSOON	1.69 ±0.73	1.66 ±0.52	1.58 ±0.30	1.72 ±0.40	1.44 ±0.17	1.63 ±0.82
		MONSOON	1.32 ±0.51	1.42 ±0.21	1.22 ±0.43	1.28 ±0.22	1.34 ±0.10	1.21 ±0.31
		POST MONSOON	1.71 ±0.36	1.83 ±0.58	1.44 ±0.18	1.56 ±0.27	1.48 ±0.38	1.71 ±0.39

Lead (mg/l)	0.01	PRE	6.8 ±1.93	7.36 ± ±1.35	7.12 ±1.48	6.32 ±1.58	6.66 ±1.45	5.68 ±0.70
		MONSOON						
		MONSOON	1.81 ±0.36	1.91 ±0.80	1.63 ±0.38	1.68 ±0.55	2.11 ±0.15	1.62 ±0.12
		POST MONSOON	2.34 ±0.32	2.18 ±0.25	3.63 ±0.22	7.11 ±1.27	4.43 ±0.49	3.11 ±0.40

The highest temperature values were recorded during pre-monsoon with 26.6 ± 1.12℃ in Nizdamaka and a minimum of 16.38 ± 0.36℃ recorded in the Sapakama during post-monsoon. There is a seasonal variation of the temperature.

The pH of the Beki River ranges from 6.19 ±0.26 to 7.56 ± 0.22. The highest value 7.56 ± 0.22 was observed in Madulijar in pre-monsoon and minimum 6.19 ± 0.26 in Nizdamaka in monsoon. The low pH indicates acidity nature, which is due to the deposition of acid forming substance. The high organic content will tend to decrease the pH due to its carbonate chemistry.

The DO values were found in the range of 5.46 ±0.53 – 11.15 ±1.69 mg/l. The lowest DO was observed in 5.46 ± 0.53 during the monsoon in Dumnighat and the highest was recorded in Gobardhana during winter. The low DO suggests the poor quality of water indicating the slow rate of photosynthesis by phytoplankton present in the Beki River. This made the water unsuitable for drinking purpose. The concentration of DO was recorded highest in all the location during premonsoon. The DO values also depend on temperature, microbial population, pressure, and time of sampling.

Turbidity was found to vary between season and location of the sampling sites. Turbidity ranges from 0.01 ±0.00 to 1.11 ±0.21 NTU. The highest in Sapakama during monsoon suggesting greater addition of particulate matters. High deposition of sediments makes the river turbid and deterioration of water quality.

In the present study free carbon dioxide was present throughout the year in all the sampling sites. Total hardness, TDS,flouride and total alkalinity all were withinthe guidelines of BIS in all the sampling sites.

The Conductivity values of the study site range from 123.37 ±33.66 to 263.50 ± 60.52 µs/cm. The lowest values were observed in Uttarganakguri during post-monsoon and highest in gobardhana during monsoon. The higher value of EC is attributed to the high degree of anthropogenic activities like waste disposal, household waste, and chemicals runoff from agricultural activities. The seasonal variation shows the increased in EC along the downstream.

The concentration of Iron was 0.38 ±0.01 mg/l, 0.39 ±0.01 mg/l and 0.43 ± 0.04 mg/l in Gobardhana, Sapakama and Dumnighat during post monsoon which was higher than the maximum limit of 0.3 mg/l. Concentration of nitrate was found to be higher than the limit of 45 mg/l in all the landing sites in the monsoon seasonexcept for Gobardhana. Concentration of manganese was also found to be higher than the maximum limit of 0.3 mg/l in all the landing sites. Concentration of Arsenic and lead was found to be higher than the maximum limit of 0.05 mg/l and 0.01 mg/l during all the season in all the landing sites. The highest concentration of nitrate is mainly from agricultural activity including application of inorganic nitrogen fertilizers and manures in the aquaculture and agricultural farm in and around the location. The spatial variations of the major ions are essential as it reflects the influence of various anthropogenic and lithology's activities in the river system.

In a study by Singh *et al*., 2019 on Beki Rivershannon entropy was used as a tool for assessing water quality [10]. Entropy weights were used to develop the weighted water quality index (EWQI). The temperature, pH, DO, BOD, Total suspended solids (TSS), Total dissolved solids (TDS), Total hardness (TH), Sodium, Chloride, and several other chemical and biology parameters were used to determine the water quality. The water quality classification scale used was based on the EWQI standard. It was found that, using EWQI technique, the quality of Beki River water is between excellent to poor and ranged from 29.3 to 150.6 using EWQI classification. This result was influenced by several factors derived from a source of static studies showing that the Beki River was contaminated by the disposal of domestic wastewater that caused it to be contaminated. The present study similar to the study by Singh *et al*., 2019 indicates poor water quality of Beki river considering parameters like DO, temperature, pH, TDS, Total hardness [10].

In another study Singh *et al*., 2020 on three rivers of Assam - Pagladia, Beki and Kolong rivers it was found that DO varied from 8.60 mg/L to 8.91 mg/L similar to the present study [5]. In the same study on Beki River, the average concentrations of Fe, Mn, Cr and Pb were found to be higher than the permissible limits [5]. In the present study the concentration of manganese, arsenic, Iron, nitrate and lead was found to be higher than the maximum limit in the fish landing sites.

There are some serious problems in Beki River that have degraded the water quality of Beki River (Fig. 2). Some of the important problems associated with the Beki River are as follows:

Fig. 2(a). Beki River.

Fig. 2(b). Fishing in the river.

Fig. 2(c). Sand and stone mining.

Fig. 2(d). Erosion in the river banks

Fig. 2(e). Dumping of domestic waste and sewage waste in the water body.

Fig. 2(f). Crop field on the river bank.

Fig. 2(g). Crop field on the river bank.

A. *Sand and Stone Mining:*

Sand and Gravel mining from the Beki River is one of the major threats to the fish diversity of Beki river. Excessive mining have caused severe degradation on the river bank. This has led to heavy erosion and loss of fertility of river bank thus the use of fertilizer for agriculture in the river bank have increased. This have also resulted in flood in the nearby areas due to the rise in the river bed causing havoc among the people dwelling nearby with loss of both property and lives.

B. *Agriculture Practice and Use of Fertilizers*

Various crops are grown in the river bank and fertilizers are used. These fertilizers are washed into the river during rainy season changing the quality of river water which affects the fishes. This may be a factor for reduction of fish diversity in the Beki River.

C. *Pollution*

Various domestic wastes are dumped into the river directly. Washing of domestic animals, utensils, clothes and other wastes have reduced the water quality. During different puja's (especially in Durga puja) idols of God and Goddess are thrown in the Beki River.

IV. Conclusion

Beki river is gifted with immense resources of nature but the ichthyofaunal diversity of Beki River has suffered a lot due to different serious anthropogenic stress.

Clean and undefiled water is a valuable asset to any

country. It contributes to the social and economic development of a country where clean water produces a healthier environment. In the present study on Beki River it can be understood that the water quality is affected adversely due to various anthropogenic factors like sand and gravel mining, agriculture practice and use of fertilizers and other types of pollution. Parameters like DO, pH and concentration of metals like Iron, nitrate, manganese, arsenic and lead are affected. Low DO, low pH, high concentration of Iron, nitrate, manganese, arsenic and lead have created a challenge for the survival of various ichthyofaunal species in the river at the fish landing sites.

To ensure the quality of the water, the Physico-chemical parameters in the water must be regularly reviewed and tested. Water quality of the river needs to be restored by adopting measures like restricting inflows of raw sewage from domestic sources, limiting direct discharge from agricultural fields into the river and preventing unabated dumping of solid waste by communities residing along the river. Besides, desilting measures to improve the carrying capacity of the river channel needs to be adopted and existing encroachments for settlement and infrastructural development should be removed.

Conflict of Interest

All authors declare no conflicts of interest in this paper.

Author Contributions

Dr. Pallabi Goswami conducted the research collecting samples and data for anthropogenic threats and Dr. Siddhartha Singha along with Dr. Pallabi Goswami analyzed the data and both the authors had approved the final version.

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