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Assessment of Limnochemical Profile of River Kaushiki, West Bengal, India

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ABSTRACT

This study was undertaken to assess the limnochemical profile of River Kaushiki, a distributary of River Damodar at pre-designated sampling sites, and to evaluate the impact of the pollution load on water quality of this river. The water quality data was collected from June-2019 to March-2020. Different limnochemical parameters were monitored in five sampling stations, namely Bahirkhanda (KD-1), Prasadpur (KD-2), Munshirhat (KD-3), Gobindapur (KD-4), and Banharishpur (KD-5). The pH range found in the studied stretch of the river indicated that it was sub-alkaline (6.77-8.24). Poor dissolved oxygen (DO) levels were evident at KD-3(1.73 mg /L) and KD-5 (1.91 mg/L). Total dissolved solids (TDS) levels ranged from 101.46- 423.51 mg/L. Relatively higher TDS and Electrical conductivity (EC) values were recorded during the post-monsoon months. KD-3 and KD-5 had shown high mean EC levels of 421.3 µs/cm and 453.2 µs/cm, respectively. High nitrate and phosphate concentrations were found in this river, particularly during the late monsoon or post-monsoon months at KD-3 & KD-5 sampling stations. The water quality of KD-5 and KD-3 sampling stations was relatively poorer than that of other sampling stations. Several processes like metabolic activities in water, synergies of pollution load, sediment characteristics regulate the water quality of this river. This study could provide baseline data if any monitoring and restoration programme for this riverine is undertaken in future.

***Key words*:** River, Kaushiki, Limnochemical, Water Quality, Pollution

Freshwaters, including rivers, are among the most threatened ecosystem in the world. Extensive urbanization, fast-paced industrial growth, and intensive agricultural practice are among anthropogenic activities that have been regarded as key players in changing the natural condition of a riverine ecosystem. They are responsible for alteration of the water quality and the structure and function of limnobiota present in river. Many industries are located along the river banks for easy water accessibility. They discharge waste directly and/or indirectly into rivers indiscriminately without taking environmental mitigation measures into account [1]. Farming activities in river basin and fertile flood plains add harmful pesticides and chemical fertilizer contaminants to canals or rivers. Surface water is the critical sink of industries for waste disposal [2-3]. Pollution sources can be divided into point sources and non-point sources based on the nature of the source. Point sources refer to single or recognizable sources of pollution. In contrast, diffuse sources of pollution that do not come from a single distinct source are referred to as non-point sources [4].

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India is well-known for its intricate riverine network. The country is bestowed with several large and small river basins. Kaushiki is one of the eastern distributaries of the Damodar River. It is a paleo-channel maintain feeble connection with the stem river. Kaushiki river flows through two densely populated districts of West Bengal- Hooghly and Howrah. Kaushiki basin, having flat plains and alluvial soils, is highly productive, giving rise to congestion of human settlement and agricultural practices right up to the bank of the river at many places. The riverbed has encroached at many sites. Newly set up industries near the riverbank, particularly in Howrah district, become a threat to the river as industrial effluent through shortcut canals enters the river. Agricultural runoff containing pesticides and domestic sewage is directly discharged into the river. This river needs immediate monitoring. Very little information is available on the aquatic health of the Kaushiki River. The multidimensional uses of such valuable water resources may be possible only by knowing their limnological characteristics. The present study aims to evaluate the physicochemical features of water at pre-designated stations of River Kaushiki.

MATERIALS AND METHODS

Sampling stations

In the present investigation, five sampling stations (KD-1, KD-2, KD-3, KD-4 and KD-5) in River Kaushiki were selected for collection of water samples. Descriptions of sampling sites are as follows:

Sampling station	Location	Latitude and longitude
KD-1	Bahirkhanda, Hooghly	22º85´ N, 88 º06´ E
KD-2	Prasadpur, Hooghly	22 º72´ N, 88 º09´ E
KD-3	Munshirhat, Howrah	22 º65´ N, 88 º09´ E
KD-4	Gobindapur, Howrah	22 º59´ N, 88 º08´ E
KD-5	Banharispur, Howrah	22 º55´ N, 88 º09´ E

Physico-chemical analysis of water

For the analysis of various physicochemical parameters monthly sampling of water from all predesignated sampling stations carried out for 10 months (June, 2019-March, 2020). Monthly collections of the water samples were made from each of the sampling station between 7am to10am. Some of the parameters like water temperature, Dissolved oxygen (DO), pH, Free Carbon dioxide (FCO_2), Electrical conductivity (EC) recorded on spot. Water temperature was recorded by using a mercury bulb thermometer. Dissolved Oxygen of the water was determined by Sodium azide modification of Winkler's method. FCO_2 was estimated by titrimetric method used phenolpthalin as an indicator. TDS, Nitrate nitrogen and phosphate were determined in laboratory following standard methods. Phosphate concentration was determined spectrophotometrically (690 nm) by stannous chloride method using phenolpthalin indicator, molybdate reagent and stannous chloride reagent. The concentration of nitrate was also determined spectrophotometrically [5-8].

RESULTS AND DISCUSSION

Water temperature at KD-1 fluctuated from18.30˚C (Jan, 20) to 31.50˚C (Jun, 19), at KD-2 fluctuated from16.8˚C (Jan, 20) to 31.9˚C (Jun, 19), at KD-3 fluctuated from15.3˚C (Jan, 20) to 32.1˚C (Jun, 19), at KD-4 fluctuated from16.4˚C (Dec, 19) to 31.3˚C (Jul, 19), at KD-5 fluctuated from15.8˚C (Dec, 19) to 30.2˚C (Jun, 19) [Fig 1]. Temperature is one of the determinants of any aquatic system's ecological condition and has strong effects on biotic forms therein. The effect of temperature on the solubility of gases in water is pronounced. The river water temperature usually fluctuates due to various factors, including geographical location, season, sampling time, etc. The DO level and primary productivity of a water body are strongly affected by water temperature. From the post-monsoon to pre-monsoon seasons, there was a gradual increase in temperature. The observed water temperature range 15.3˚C to 32.1˚C with a mean value of 25.14±5.03˚C falls within the range of inland water on tropical region [9-10].

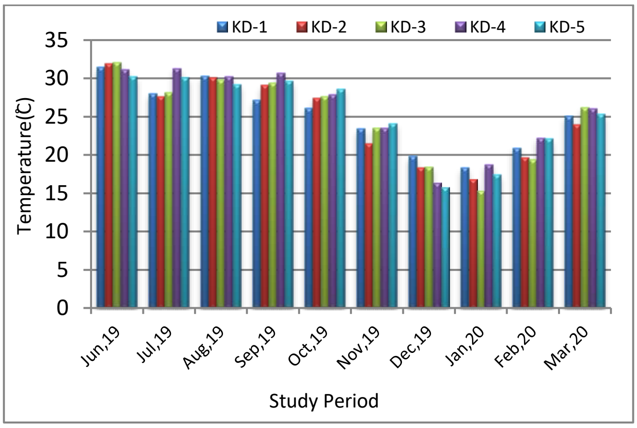

Fig 1 Spatiotemporal dynamics of water temperature (˚C)

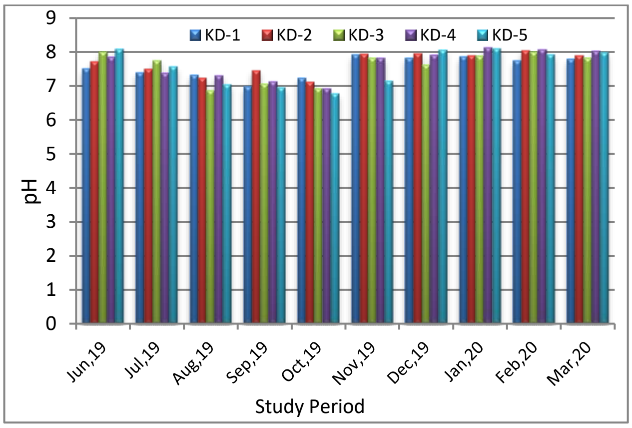

Fig 2 Spatiotemporal dynamics of water pH

The extent of pH was ranged between at KD-1 from 6.98 (Sep, 19) to 8.02 (Nov, 19), at KD-2 from 7.11 (Oct, 19) to 8.24 (Jul, 19), at KD-3 from 6.86 (Aug, 19) to 8.14 (Nov, 19), at KD-4 from 6.92 (Oct, 19) to 8.14 (Jan,20), at KD-5 from 6.77 (Oct, 19) to 8.11 (Jan, 20) [Fig 2]. The pH level as observed during the study (6.77-8.24) falls within the acceptable limit (6.5-9.2) [11].

DO exhibited considerable fluctuations. The level of DO fluctuate from 2.31mg/L (Aug,19) to 6.12mg/L (Nov,19) at KD-1, 2.36 mg/L (Aug,19) to 6.47 mg/L (Jan,20) at KD-2, 1.73 mg/L (Jul,19) to 5.04 mg/L (Dec,19) at KD-3, 2.88 mg/L (Aug,19) to 5.76 mg/L (Jan,20) at KD-4, 1.91 mg/L (Sep,19) to 5.01 mg/L (Jan,20) at KD-5 [Fig 3]. The level of dissolved oxygen is an important factor in assessing the quality of water because so many chemical and biochemical processes in a water body are largely dependent on it. The concentration of DO in a water body largely depends on temperature, air-exposed surface area, turbulence and chlorophyll content [12-13]. Poor DO level was evident at KD-3 (1.73 mg /L) and KD-5 (1.91 mg/L). Mean DO level (3.92 ± 1.19 mg/L) of this river was also not satisfactory.

Free Carbon dioxide (FCO_2) level varied at KD-1 from 7.80 mg/L (Sep, 19) to 19.38 mg/L (Dec, 19), at KD-2 from 2.48 mg/L (Nov, 19) to 17.88 mg/L (Mar,20), at KD-3 from 4.97 mg/L (Feb,20) to 14.88 mg/L (Dec,19), at KD-4 from 4.46 mg/L (Nov, 19) to 20.07 mg/L (Jan, 20), at KD-5 from 4.19 mg/L (Jun, 19) to 18.74 mg/L (Oct, 19) [Fig 4]. Fluctuation in FCO_2 level is also observed.

TDS content was found in the range of 110.01 mg/L (Jul,19) to 319.77 mg/L (Feb,20) at KD-1, 101.46 mg/L (Jul,19) to 330.03 mg/L (Feb,20) at KD-2, 106.02 mg/L (Jul,19) to 400.71 mg/L (Feb, 20) at KD-3, 102.03 mg/L (Aug,19) to 388.17 mg/L (Feb,20) at KD-4, 115.71 mg/L (Aug,19) to 423.51 mg/L (Feb,20) at KD-5 [Fig 5].

EC level showed a conspicuous monthly variation. The EC level fluctuated from 193 μs/cm (Jul, 19) to 561 μs/cm (Feb, 20) at KD-1, from 178 μs/cm (Jul, 19) to 579 μs/cm (Feb, 20) at KD-2, from 186 μs/cm (Jul, 19) to 703 μs/cm (Feb, 20) at KD-3, from 179 μs/cm (Aug, 19) to 681 μs/cm (Feb, 20) at KD-4, from 203 μs/cm (Aug, 19) to 743 μs/cm (Feb, 20) at KD-5 [Fig 6]. TDS level ranged from 101.46- 423.51 mg/L. Relatively higher TDS and EC value were recorded during post monsoon months. KD-3 and KD-5 had shown high mean EC level of 421.3 μs/cm and 453.2 μs/cm respectively.

High nitrate and phosphate concentration was observed in this river particularly during late monsoon or post-monsoon months. It can be attributed to nutrient rich surface runoff from the catchment area. Nitrate nitrogen content was found in the range of 1.55 mg/L (Jun, 19) to 4.4 mg /L (Nov,19) at KD-1, 1.43 mg/L (Mar,20) to 4.43 mg /L (Nov,19) at KD-2, 1.98 mg/L (Aug, 19) to 4.87 mg /L (Nov,19) at KD-3, 1.87 mg/L (Aug, 19) to 4.66 mg /L (Dec,19) at KD-4, 1.68 mg/L (Aug, 19) to 5.06 mg /L (Dec,19) at KD-5 [Fig 7].

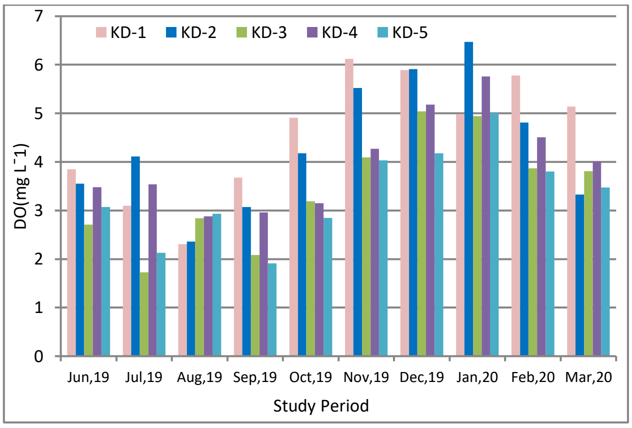

Fig 3 Spatiotemporal dynamics of DO (mg/L)

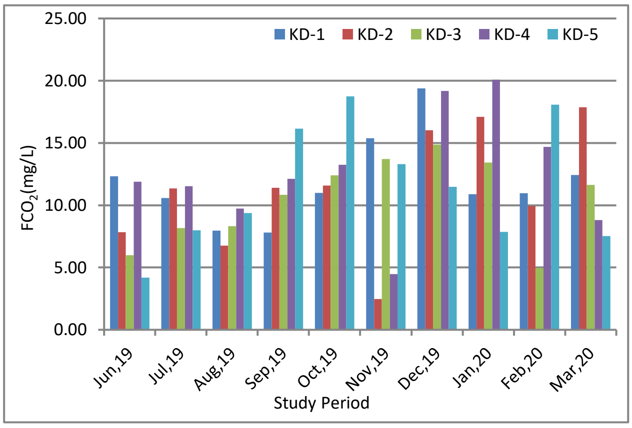

Fig 4 Spatiotemporal variation in FCO_2 level (mg/L)

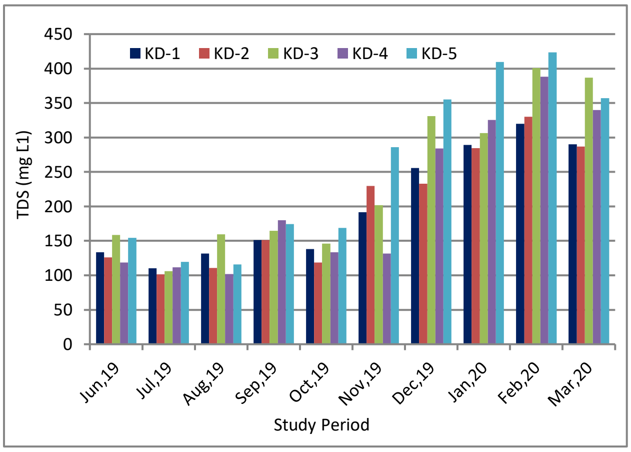

Fig 5 Spatiotemporal variation in TDS level (mg/L)

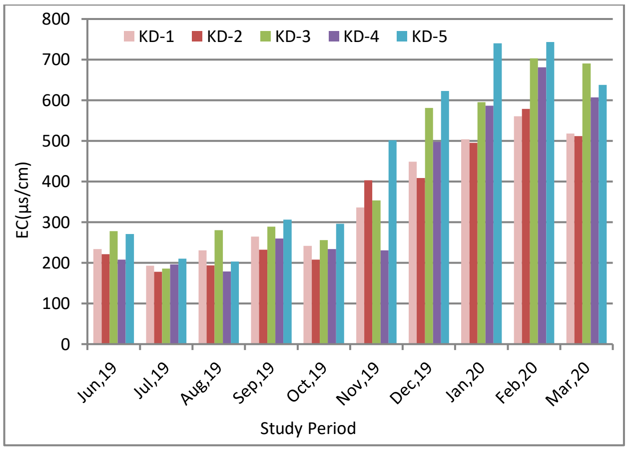

Fig 6 Spatiotemporal variation in EC level (µs/cm)

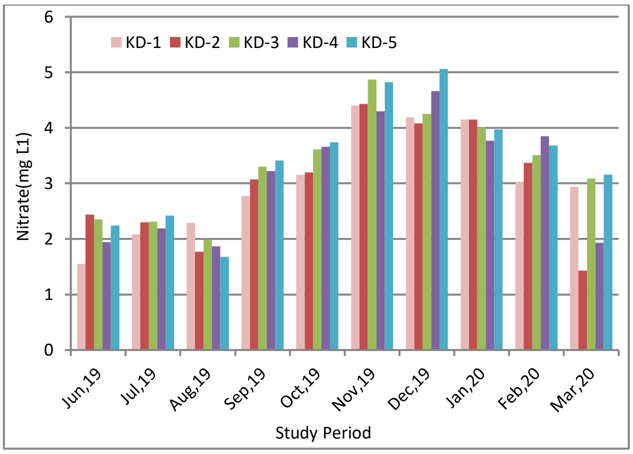

Fig 7 Spatiotemporal variation in nitrate concentration (mg/L)

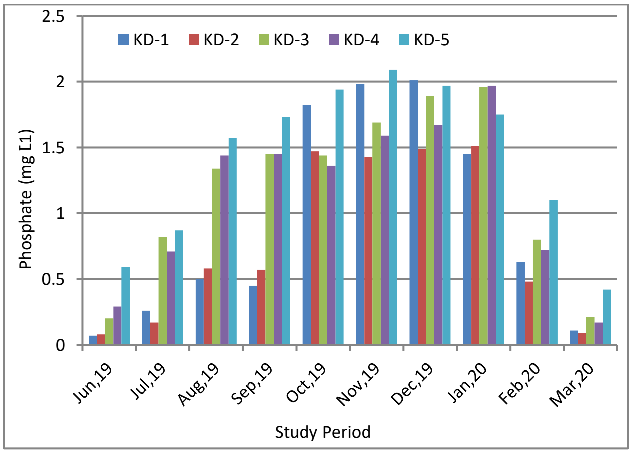

Fig 8 Spatiotemporal variation in phosphate concentration (mg/L)

Phosphate level fluctuated from 0.07 mg/L (Jun, 19) to 2.01 mg /L (Dec, 19) at KD-1, 0.08 mg/L (Jun, 19) to 1.51 mg /L (Jan, 20) at KD-2, 0.2 mg/L (Jun, 19) to 1.96 mg /L (Jan, 20) at KD-3, 0.17 mg/L (Mar,20) to 1.97 mg /L (Jan, 20) at KD-4, 0.42 mg/L (Mar,20) to 2.09 mg /L (Nov,19) at KD-5 [Fig 8].

Phosphorus can act as a limiting nutrient and its high concentration in any aquatic system can increase the eutrophication process where other nutrients such as nitrate are present [14]. Elevated levels of inorganic phosphate in various surface water results in the growth of phototrophs, resulting in a decrease in the level of dissolved oxygen [15]. The spatial distribution of phosphate follows a similar pattern to that of nitrate nitrogen in the studied river.

Microbial degradation of organic materials exerts oxygen tension and thus increases the level of BOD [16]. Organic materials tremendously pollute most natural water bodies such as rivers due to sewage industrial and agricultural waste discharge. In addition, organic waste in natural water bodies may exist in the form of detritus, soluble organic residue, etc. Regardless of sampling stations, it is common to observe that nitrate-nitrogen content was lower during the dry season, and its elevated level was observed during the monsoon period. Mostly nitrate nitrogen is found in natural water; the major sources of nitrate are land drainage, animal and plant debris, igneous rocks [17]. From this study, it is clear that the water quality of the KD-5 sampling station was relatively poorer than other sampling stations. Industrial growth along the bank of this river, particularly near KD-5 makes it a sink of industrial effluents. River bed encroachment was also observed here. The quality of water at KD-3 sampling station was not satisfactory either. Several domestic sewage discharging drains void their loads near the sampling station. Due to industrialization and urban growth, industrial effluents and sewage water are discharged into rivers, leading to an increased concentration of different pollutants [18]. Apart from that fertile soil of this river basin leads to intensive agricultural practices right up to the bank of this river. Agricultural run-off with organic pollutants gets discharged into this river, aggravating the pollution load and deteriorating water quality. The concentration of the pollutants might be diluted, and levels of different water quality parameters are heavily fluctuating in the lower tidal stretch of the river. Macrophyte clogged River channel remain dry at many points during summer. The monsoon could have an impact on the variation in different parameters [19].

CONCLUSION

Degradation of the riverine ecosystem as observed in this study at some points, could adversely affect the riverine biota. Heavy pollution load changes the physicochemical profile of water and sediment of the river. As a result, the quality of the fish breeding grounds is compromised. Consequent hindrance on fish breeding leads to a decline in total fish production. Some of the fish species require specific microclimatic condition and quality of microhabitat for their breeding.

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