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Inadequate Liquid Waste Management in Kharagpur and Midnapore Municipalities and its Impact on The Kangsabati River Through Physico-chemical analysis of The River water

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Abstract

River management is inextricably linked with Indian civilization and public life. Most of the cities in India are developed along the river banks. Urbanization has increased significantly since independence. This urban expansion increased the GDP share from the secondary, tertiary, quaternary, and quinary sectors, thereby strengthening the overall economy. Conversely, the agriculture sector's percentage contribution to the national GDP has decreased. According to the Economic Survey report for 2017–18, the agricultural sector employs 50% of the workforce but only contributes 18% to the GDP. A clean and healthy urban environment hinges on a proper and scientifically developed waste management system. Liquid waste management in most Indian cities is either underdeveloped or inadequate. Nonetheless, for the city's environmental well-being, effective liquid waste management is paramount. Due to the lack of sewage treatment plant (STP) most of the Indian cities disposed of their raw wastewater into surrounding waterbodies. Thus the water health quality is going to decrease day by day. However, several studies claimed that there is so much financial and environmental potentiality in the proper sewage treatment. In the present study, an attempt has been made to find out how the wastewater discharged from the municipalities of Kharagpur and Midnapore is being mixed with the river Kangsabati, affecting the health quality of the river water.

Keywords: - Urbanization, GDP, Liquid Waste Management System, Sewage Treatment Plant,

Introduction: - India is a riverine country. Rivers are a crucial part of life in India, supporting agriculture, transportation, source of domestic water supply in urban areas and for various industries. It may be pointed out that historically a significant percentage of the Indian population depended on river systems for their lives and livelihood with estimation often exceeding more than 50%. However, the exact fraction could have faltered due to various dynamics, like the rate of urbanization, industrialization, and changing percentage of agricultural practices in rural India over time. Different categories of cities depend on river water as the key source of water for their domestic use. Some major Indian rivers, including the Yamuna, Godavari, and Ganga Brahmaputra, and so many tributaries and distributaries are the major sources of water to the Class-I, II, III & IV cities across the country. It may be noted that the dependency on river water varies across the regions based on infrastructural achievements with time and demand. The Central Pollution Control Board conducted research and released a report (CUPS/61/2005-06) on the state of municipal wastewater generation and treatment capacity in India's metropolitan areas, class I cities, and class II towns. Approximately 38254 MLD of sewage are generated annually, but only approximately 12,000 MLD of treatment capacity has been constructed, and there are 269 STPs installed in India.

Magnitude of the problem

Water is undoubtedly one of the most vital resources on Earth, as life is not possible without it. It greatly aids in supporting human health and welfare. Despite its importance, it is estimated that 780 million people lack access to clean, safe water, and 2.5 billion lack adequate sanitation. Consequently, water-related illnesses and disasters kill between 6 and 8 million people annually. Drinking contaminated water worldwide leads to over fifty distinct kinds of diseases, including cancer, skin disorders, malnutrition, diarrhea, and accounts for fifty percent of child fatalities (UN-Water, 2013; Lin et al., 2022). Water covers 71% of the Earth's surface. Most water on Earth is located in oceans and other large bodies of water, with 1.6% found in underground aquifers and 0.001% in the atmosphere as precipitation, clouds, and vapor made up of suspended solid and liquid water particles. Of the surface water, 97% is found in the oceans, 2.4% in glaciers and polar ice caps, and 0.6% in other terrestrial surface water such as rivers, lakes, and ponds. Only a very small portion of the water on Earth is found in artificial objects and biological organisms (Akkaraboyina, Mahesh Kumar et al., 2012).

The contamination of surface water by anthropogenic activities, resulting in chemical, physical, and biological pollutants, is a global environmental concern. Surface water systems, which include bodies of water naturally exposed to the atmosphere such as lakes, rivers, and reservoirs, are particularly affected. Rivers, being among the most vulnerable water bodies to pollution, play a crucial role in a watershed by removing runoff from agricultural lands, urban areas, and industrial sites. The continuous discharge of industrial and domestic wastewater, coupled with seasonal surface runoff influenced by climatic conditions, has a significant impact on river discharge and water quality. Addressing this issue requires comprehensive strategies to monitor, regulate, and mitigate pollution sources to protect these vital water resources.

River pollution is multifaceted, requiring expertise from various disciplines to monitor and manage it effectively. It is a global issue, with significant implications for environmental and public health. In India, for example, it is estimated that over 70% of available water is contaminated (Kamble, Snehal et al., 2014). Addressing river pollution demands a comprehensive and interdisciplinary approach to ensure the sustainability and safety of these vital water resources.

Studies have shown that sewage is the primary cause of contamination, accounting for 84–92 percent of wastewater, while industrial wastewater contributes 8–16 percent. Consequently, for effective pollution control and water resource management, having accurate information on the quality of the water is essential (Xiaoyun Fan et al., 2010). This data is crucial for developing strategies to mitigate pollution, protect ecosystems, and ensure the availability of clean water for various uses.

The potentiality of the problem

On June 30, 2021, the Ministry of Housing and Urban Affairs, Government of India, published a report following a critical analysis of the advisory report titled 'Recycling and Reuse of Treated Wastewater in Urban India,' published by IWMI in 2016. The report outlines numerous policy recommendations for wastewater recycling and reuse. It highlights several key aspects of liquid waste management, including the potential of recycled wastewater as a non-potable water source and the revenue-generating potential of treated wastewater for Urban Local Bodies (ULBs), which could be utilized to develop city infrastructure, particularly drainage systems. Furthermore, the report emphasizes that wastewater treatment, recycling, and reuse can play a pivotal role in addressing the social and environmental challenges faced by cities.

Treating and selling urban wastewater through advanced technologies generates revenue of about ₹3,285 crores annually in India (IWMI, 2016). Analysis from several studies, including WII (2006), Londhe et al. (2004), and Amerasinghe et al. (2013), indicates that farmers who cultivate with treated and untreated wastewater may benefit economically more than those who cultivate with freshwater because of higher yields, lower fertilizer requirements, and improved yield quality, which raises the price of the produce. Making wastewater suitable for agricultural use by using high technology and using it for irrigation can save a farmer around ₹17,000 per hectare annually. Or to put it another way, the annual farmer's income could increase by ₹17,000 per hectare (IWMI, 2016).

The state government and the electricity utility estimate that the substitution potential of wastewater irrigation and the assumption of a reduction of pumping use by at least a third of the current use in the wastewater-irrigated areas would result in significant savings in grid electricity supply requirements, estimated to be around ₹600 crores annually or ₹1.6 crores daily (IWMI,2016).

If various nutrients in the wastewater are recovered, financial benefits of ₹1,095 – 1,460 crore annually can be achieved (IWMI,2016). Several studies such as Minhas 2002; Silva and Scott 2002; CPCB 2009a; and WII 2006 have estimated the daily nutrient potential in wastewater in the range of 0.054-0.073 tonnes MLD-1. Thus, the total wastewater generated from Class I and II cities in India has an estimated nutrient load of about 2,500 tonnes day-1. At an estimated nutrient value of INR 8,000 tonne-1 of nutrients (CPCB 2009a estimate), this indicates a potential value of about INR 500 MLD-1 of wastewater or about INR 19.5 million daily for the total amount of wastewater being generated in Class I and II cities in the country at present. The use of such nutrients in agricultural activities instead of chemical fertilizers would be more environmentally friendly as well as economically more beneficial to the farmers.

In 2011, the Infrastructure Development Finance Company (IDFC) released the 'India Infrastructure Report: Water - Policy and Performance for Sustainable Development.' According to this report, over 60% of the country's irrigation needs are fulfilled by groundwater. To extract this groundwater for irrigation, agricultural activities require approximately 1.75 million MWh of electricity annually, resulting in the emission of about 1.5 million tons of CO2 and greenhouse gases from conventional energy sources. Therefore, utilizing wastewater as an alternative to freshwater in agricultural operations could serve as a significant strategy to address environmental concerns by reducing CO2 emissions and enhancing environmental sustainability.

About the Study Area

The Kharagpur and Midnapore Municipality both are located in the Paschim Midnapore district, West Bengal, India. The Kharagpur Municipality is extended from 87º12′ E to 87°22′ E longitude and 22°17′ N to 22° 22′ N latitude with slight undulating topography with an average elevation of 40 m above the Mean Sea Level(MSL). The geographical location of Midnapore Municipality is the intersection of 22°23'44.56" to 22°26'34.91" North Latitude and 87°17'18.57" to 87°20'30.12" East Longitude. Both of the municipalities are situated along the banks of the Kangsabati River. The Kharagpur municipality consisted of 35 wards with a population of 293719 as per the 2011 census report. Whereas, the Midnapore Municipality has extended over 25 wards with a population of 169127 and a population density of 9212 persons per square kilometer (approximately) according to the 2011 census report. The River Kangsabati is the main river located at the south-east portion of Midnapore Municipality and the north-eastern side of Kharagpur Municipality. The Kangasabati River plays an important role in the drainage system, especially in terms of the wastewater generated from different parts of these two municipalities. The Kangsabati is a non-perennial river, primarily fed by rainwater during the monsoon season. Consequently, the riverbed remains dry for most of the year except during the rainy season. Due to the construction of the Anicut dam near Gandhighat in Midnapore city, the water is nearly always pent up to a distance of approximately 10.40 kilometers from the dam. This modification in water flow affects the natural habitat and breeding patterns of various aquatic species, thereby impacting the overall ecosystem of the river.

Literature review

Sarker et al. (2015) examined water samples from the Oloa, Gighulia, and Kagmari Bridge locations of the Louhajong River to determine how seasonal variations affected the physicochemical parameters. The findings demonstrated that several parameters—such as acidity, TDS, and alkalinity—had raised the standard level during the dry season in every point, which was inappropriate for various uses, such as aquaculture and the farming of shrimp.

Islam and Azam (2015) looked studied how the physicochemical and hazardous metal concentrations in the rivers near Dhaka city—the Shitalakhya, Buriganga, and Turag—varied seasonally as a result of the debris that various companies put into the waterways. According to the findings, the monsoon had good water quality, and the seasonal order of pollutant magnitude was post-monsoon > pre-monsoon > monsoon. The post-monsoon period's water quality circumstances made sense given the rise in human meddling, the lack of precipitation, and the flow of rivers. Additionally, it was discovered that these heavily contaminated rivers are unfit for irrigation and drinking. The physicochemical parameters, such as pH, EC, TDS, DO, BOD, and COD, as well as the concentrations of hazardous metals, such as Fe, Zn, Cu, Ni, Al, Pb, Hg, and Cr, were found to be highest in the post-monsoon and lowest in the monsoon. An integrated scenario of water contamination of Bangladesh's Shitalakhya, Buriganga, and Turag rivers was disclosed using WQI computation in this work. Therefore, it was advised to take appropriate precautions to safeguard the aquatic ecosystem when disposing of sludge, sewage water, and industrial effluent.

Shegani (2016) conducted research to examine seasonal variations in various physical, chemical, and bacteriological parameters. Based on weather patterns during the rainy and dry seasons, the study aimed to evaluate the pollution state of the Asumi River. Total suspended solid (TSS) levels were several times higher than the EU Directive's 50 mg/L threshold for freshwater quality that supports aquatic life. The Osumi River's seasonal values for its physical, chemical, and bacteriological characteristics varied depending on the sample sites and the amount and activity of the source of contaminants in the river water. Seasonal differences did not follow any particular patterns.

Analysis of Physico-chemical Parameters of Kangsabati River.

Selection of Sampling Station Along the Bank of Kangsabati River

For assessing the water quality of the Kangsabati River using various physicochemical parameters, three sampling stations have been designated: Gandhighat, Istriganj, and Shivananda Yogashram.

Gandhighat, situated at the major wastewater discharge point of Midnapore Municipality via Daribadh Khal, serves as one of the sampling stations. Its geographical coordinates are 22°24'54''N latitude and 87°20'35''E longitude. Gandhighat's selection as a sampling site aims to evaluate the impact of wastewater discharged from Midnapore municipality on the Kangsabati River's physico-chemical parameters.

Keshpal, located along the Kangsabati River in the vicinity of Kharagpur Municipality, is another sampling station. It lies at 22°39'21''N latitude and 87°32'39''E longitude, approximately 2.45 kilometers away from Gandhighat. This site is chosen because it receives wastewater from agricultural fields and industrial effluents located in the peripheral areas of Kharagpur Municipality.

The third sampling station, Istriganj, is situated in the Midnapore Municipality along the Kangsabati River, approximately 4.57 kilometers away from Gandhighat. Here, the river water is extensively used for domestic purposes such as bathing and washing clothes by the local residents. Additionally, some amounts of domestic and agricultural wastewater are discharged, particularly during the monsoon period. The geographical coordinates of the Istriganj sampling station are 22°24'20''N latitude and 87°18'1.73''E longitude.

Selection of Months in a year as period: -

During the research period spanning from 2019 to 2023, an extensive study was conducted on the Kangsabati River, involving the collection of water samples from three selected sample sites on a monthly basis. Sampling activities were carried out between the first and second week of each month, typically occurring from 10 am to 12:30 pm to ensure consistency in data collection. The entire year was divided into three distinct periods for assessment purposes: the pre-monsoon period, comprising March, April, May, and July; the monsoon period, encompassing July, August, September, and October; and the post-monsoon period, including November, December, January, and February. This systematic division allowed for the examination of water quality variations across different seasons and timeframes. To determine average values for various physico-chemical parameters of the Kangsabati River water, monthly values were aggregated and then divided by the total number of months in the research period. This approach facilitated a comprehensive analysis of the river's health and provided valuable insights into its environmental condition throughout the study period.

Methodology: -

The water samples collected underwent a comprehensive physicochemical examination, encompassing various variables including temperature, pH, turbidity, conductivity, dissolved oxygen (DO), chemical oxygen demand (COD), and biochemical oxygen demand (BOD). These measurements were obtained from the water quality monitoring stations on a monthly basis, with grab sampling being the typical method used during sample collection. To ensure accuracy and maintain safety, the samples were transported to the laboratory in BOD bottles and plastic canes, with each sample meticulously labeled for identification. Established procedures were followed for the analysis of each sample, both in terms of on-site data collection such as recording the river water's temperature, and laboratory-based measurements utilizing standard titrimetric procedures for DO and BOD determination.

Furthermore, the water temperature of the Kangsabati River at the three designated sampling sites - Gandhighat, Keshpal, and Istriganj, located along the riverbanks in the sites of Midnapore and Kharagpur City - was measured using a water analyzer instrument known as the Systronics (type: 371) water analyzer. These measurements were conducted at various time points throughout the assessment period spanning from 2019 to 2023, providing valuable insights into the temperature variations of the river across different seasons and years.

Assessing Period	Sample sites	Five-year average value of measured parameters					
		Temperature (°C)	Turbidity (NTU)	pH	BOD (mg/l)	DO (mg/l)	COD (mg/l)
Pre-Monsoon		35.81°	17.80	7.73	4.60	3.71	23.42

Monsoon	**Gandhighat**	29.9°	34.90	7.63	3.56	6.55	17.33
Post-Monsoon		22.05°	20.40	7.59	4.55	6.1	16.16
Pre-monsoon	**Keshpal**	35.99°	14.46	7.62	4.58	4.10	18.27
Monsoon		29.92°	27.67	7.58	3.75	6.93	12.85
Post-Monsoon		19.87°	14.3	7.66	4.31	7.5	12.68
Pre-Monsoon	**Istriganj**	34.65°	15.02	7.44	3.76	4.53	18.93
Monsoon		30.06°	31.86	7.21	3.45	6.64	15.03
Post-Monsoon		19.04°	13.89	7.37	4.15	7.2	13.65

Source: - Laboratory analysis

Results and Discussion

1. Temperature

The water temperature of the Kangsabati River was found to be minimum in the winter season and maximum in the summer season. Within the assessing year of 2019 to 2023 the maximum temperature of 33.75°C was recorded at Gandhighat in the year 2021 during the pre-monsoon period. During this period the temperature ranges from 31.15°C to 33.5°C. In the period of monsoon and Post monsoon, the value ranges between 28.25°C – 29.95°C and 17.65°C - 19°C. The minimum temperature of 17.75°C was recorded at Keshpal, which is 4.57 km far away from Gandhighat, during post monsoon period. Here, in the pre-monsoon period the temperature ranges between 30.15°C to 32.15°C. The temperature ranges from 26.25°C- 29.15°C and 17.75°C – 19.75°C in monsoon and post-monsoon period respectively.

At the sample sites of Istriganj, the pre-monsoon recorded temperature value ranges between 30.15°C – 30.75°C. The temperature ranges from 26.5°C – 27.95°C and 17.95°C – 18.2°C during monsoon and post-monsoon respectively. Gandhighat is located along the bank of Kangsabati River in the sites of Midnapore Town. Daribandh Khal is the main canal in the town. The maximum wastewater generated within the municipal area is discharged through it. The Daribandh Khal is disposed of Kangsabati River at Gandhighat. The domestic effluent from the Midnapore Municipality's residential sector is dumped into the Kangsabati River water body through Daridandh Khal. The stretch of river in question experiences an increase in temperature due to the constant discharge of wastewater in huge quantities, which has a slightly higher temperature in compare with other two sampling sites. The sampling stations Keshpal and Istriganj are located 2.74km and 4.57km away from Gandhighat respectively. These two sampling stations did not meet any large emission sewers. The existing sewer network remained dry or narrow water channel within the sewage system during the pre and post-monsoon period. As a result, the water temperature in these two parts of the river Kangsabati is slightly less than that of Gandhighat. The amount of wastewater discharged at both sample sites of Gandhighat and Keshpal during the monsoon period due to rainwater. The huge mixing of rainwater with the Kangsabati River increased the volume and depth of river water. This mixing reduced the water temperature of the river during the monsoon period.

2. Water Transparency

Transparency of Kangsabati River water Fluctuates from 6.0 cm to 92.0 cm. The Maximum (92.0cm) was recorded in the post-monsoon period and the minimum (6.0cm) in the pre-monsoon period.

Khan and Chowdhury [7] reported that higher transparency occurred, during winter and summer due to the absence of rain, runoff and flood water as well as the gradual settling of suspended particles. Kadam, et al; [8], also reported similar observations from the Masoli reservoir of Parbhani district, Maharashtra.

3. Turbidity

The high turbidity level was recorded at Gandhighat. The maximum turbidity of 43 NTU was measured at Gandhighat in the year 2021 during the monsoon period. Rainwater during the monsoon period flows from various parts of Midnapore municipality through the existing drainage network and is finally discharged into Kangsabati River through Daribadh Khal at Gandhighat. The maximum amount of 31.45 NTU and 34 NTU turbidity levels were measured at Keshpal and Istriganj respectively during the rainy season.

In the pre-monsoon period, the turbidity level is also quite high at Gandhighat. Here, 18.23 NTU maximum turbidity value was recorded in the pre-monsoon period. However, the turbidity values measured from 2019 to 2023 at the Gandhighat sampling station indicate the presence of large amounts of suspended particles in this part of the river water of the Kangsavati River.

Keshpal and Istriganj, these two stretches of river Kangsavati water indicate moderate levels of suspended particulate matter during the pre and post-monsoon period.

4. pH

The periodical assessing pH values of Kangsabati River water at Gandhighat suggests alkalinity. However, it fluctuates in different periods within the assessment year of 2019 to 2023. In the same period of study, the pH values ranged between 7.23 to 8.16. As mentioned earlier a non-perinial and stagnant water of the river due to the Anicut dam and the regular mixing of domestic effluents through Daribandh Khal increased the alkalinity of the water. The maximum pH value of 8.16 has been recorded during 2023 at post-monsoon.

During Pre-monsoon, Monsoon and Post-Monsoon periods, the average pH value of Kangsabati River water at Keshpal ranges between 7.55 – 7.78, 7.87 – 8.3 and 7.55 – 7.77 respectively. The maximum pH value of 8.3 is recorded during the monsoon period in the year 2023 whereas the minimum pH value of 7.55 was recorded during the post-monsoon period in the year 2020 and 2021.

The sampling station Istriganj of Kangsabati River water contains a high pH value. The sampling stations are surrounded by agricultural fields on both sides along the river bank. The wastewater from such agricultural fields contains different types of chemical fertilizers and pesticides that are used in agricultural activities. The maximum pH value of 7.85 is recorded during the pre-monsoon period in the year 2023. However, within the assessing year from 2019 to 2023, the pH value ranges in between 7.10 to 7.85. The overall periodical assessment of the pH value at this sampling station has shown the water is alkaline.

5. Biological Oxygen Demand (BOD)

During the pre-monsoon season, the highest periodic average values of BOD at Gandhighat, Keshpal, and Istriganj were found to be 5.05>4.90>4.15 mg/l respectively according to the measured value of BOD level in the three sample sites during the assessing year of 2019 to 2023. During the period of study at the monsoon season, the average BOD values in Ghandhighat, Keshpal and Istriganj, ranged from 4.02 to 5.05, 3.54 to 4.84, and 3.32 to 4.15 mg/l respectively. During the period of monsoon season, the maximum average BOD value of 5.05mg/l was recorded at Gandhighat in the year 2023.

Biochemical oxygen demand (BOD) is defined as the amount of dissolved oxygen required for the stabilization of organic matter that is biodegradable by aerobic bacteria and the oxidation of specific inorganic components (Tikariha, A. and Sahu, O., 2014). It refers of the quantity of oxygen needed for organic molecules to break down in water. The WHO has set an acceptable level of 5 mg/L for BOD. According to reports by Clair et al., water bodies are considered highly contaminated if their BOD content is between 2 and 8 mg/L. When Edori and Nna analyzed effluents at discharge locations into the new Calabar River, they found average BOD values of 4.92 mg/L, which was greater than the WHO-endorsed threshold of 4.0 mg/L. A variety of inorganic and organic material types can have an impact on the BOD concentration in water.

6. Dissolve Oxygen (DO)

DO concentrations in pre-monsoon at Gandhighat range from 3.45 to 4.1 mg/l. At this sampling station, low amount of Oxygen concentration or DO value was recorded in comparison with the other two sampling sites during the same period of study. It might be said that the discharging of wastewater through Daribadh Khal at Gandhighat resulted low amount of Oxygen concentration. In the pre-monsoon period the DO value at the sample site is significantly decreased. The DO value increased at the monsoon period. In the monsoon period, the DO values range between 6.42 mg/l to 6.7mg/l. In the monsoon period due to fresh water mixing with river water through rainfall, the DO value increased During Post-monsoon DO values are measured at Gandhighat ranges in between 5.74 to 6,49 mg/l. The lowering of temperature and reducing the volume of wastewater discharge for dry seasonal conditions might be the cause of slight increase of DO value in compare with pre-monsoon measured DO value.

The sample stations Keshpal and Istriganj also experienced low DO levels during the pre-monsoon period. Comparing the DO values of these two sampling stations Keshpal and Istriganj in the pre-monsoon period, it is seen that the amount of DO is the low in Keshpal. In this period the minimum DO value of 3.90mg/l was recorded at Keshpal. It is noted that though the wastewater discharging amount is very low during the dry season but the small amount of discharge might be the cause of lowering DO value in the sample site of Keshpal. Besides it, the high water temperature during summer influenced such lowering of DO value. The increasing trend of DO value is recorded from the monsoon to the post-monsoon period. During the monsoon period, the DO value ranges at Keshpal from 6.78 mg/l to 7.10 mg/l whereas at Istriganj it ranges from 6.45 mg/l to 6.80 mg/l. The maximum DO values were measured during post-monsoon at both sampling stations. In this period the maximum DO of 7.95 mg/l was recorded at Istriganj.

The amount of oxygen gas that is present in a body of water is known as dissolved oxygen, or DO. Oxygen is necessary for all forms of life, including those that carry out self-purification processes in aquatic environments (Ostroumov, S.A. (2017).

7. Chemical Oxygen Demand (COD)

The COD value of Kangsabati River at the sampling station of Ghandhight has been recorded as high in all assessing years during the pre-monsoon period. In this period the COD values ranged between 20.8 to 26.89 mg/l. This might be the impact of mixing wastewater with the river water. In the summer due to high temperatures resulted lowering of river water depth also might be caused by high COD value. In general, biological activity is suppressed by cold temperatures, which might result in slower rates of organic matter decomposition and possibly lower COD levels. The comparatively lowering of COD value at Gandhighat during post-monsoon period might be the resulted of low water temperature. In this period the measured COD value ranges from 14,50 mg/l to 16.5 mg/l.

The sampling station of Keshpal recorded a comparatively low amount of COD value in the pre-monsoon period in compare with Gandhighat. The low amount of wastewater discharged at the sample site suppressed the biological activity, leading to lower rates of organic matter decomposition and potentially lower COD levels. In this period the COD values ranges between 16.50 mg/l to 20.45 mg/l. The amount of agricultural and industrial wastewater from surrounding areas is increased at the monsoon period. The discharging wastewater impacted on the increasing trend of COD value in the period at this area of Kangsabati river water. During the monsoon period, the COD value ranged from 14.60 mg/l to 19.5 mg/l. In comparison to summer, decreasing temperatures may result in a drop in COD levels because it slows down biological activity and lessens the breakdown of organic materials. The low amount of wastewater discharge due to dry season with lack of rainfall impacted on the lowing trend of COD value at the sample site of Keshpal during the post-monsoon period. In this period the COD values are ranging in between 12.00 mg/l to 13.25 mg/l. The minimum COD value of 12.00 mg/l has been recorded at here during all periodical assessments of such parameter in Kangsabati River water.

The COD value at Istriganj ranges between 16.32 mg/l to 20.5 mg/l during the pre-monsoon period. Whereas, it ranges from 13.00 mg/l to 14.90 mg/l at post-monsoon period. The slight higher value of COD in these two periods might be the reason behind the recreational activities like boating, fishing, and other summertime leisure activities can transfer contaminants into the water, such as garbage and detergent residues. During the monsoon period of study within the assessing year of 2019 to 2023, the COD value ranged from 13.45 mg/l to 17.24 mg/l. The increase of water flows within the channel of Kangsabati River due to rainfall resulted slight fall of COD value at the sample site of Istriganj.

Determining the concentration of organic and inorganic contaminants in river water and comprehending the consequences for ecosystem health and water quality are necessary steps in determining the Chemical Oxygen Demand (COD) value of the water. Determine the probable sources of pollution that are causing the river's increased COD levels. Untreated sewage, industrial discharge, agricultural runoff, and urban runoff are examples of common sources. Comprehending the origins of pollution is crucial for efficient handling and restoration endeavors. Contemplate the possible ecological effects on the river ecosystem of high COD levels. Reduced dissolved oxygen levels brought on by high COD levels can harm aquatic life and alter ecosystem dynamics. To determine the severity of ecological damage, evaluate the river's aquatic life's diversity and health.

Conclusion

In the near future, river water is expected to become the primary source of water supply for most cities in India. However, most Indian cities lack sewage treatment plants to treat wastewater generated before it is discharged into water bodies. As a result, the water quality and aquatic ecosystems of surface waters are deteriorating day by day. The study highlights that wastewater treatment presents several benefits to Urban Local Bodies (ULBs). Currently, there are no sewage treatment plants in the Kharagpur and Midnapore municipalities. The continuous discharge of untreated wastewater from these municipal areas into the Kangsabati River has deteriorated the river's water quality. Assessing various physico-chemical parameters of the Kangsabati River water and its seasonal fluctuations can support this claim. The study also suggests that to reduce over-dependence on groundwater and ensure future water supply to Kharagpur and Midnapore cities, special attention should be given to preventing pollution of the Kangsabati River. This study also suggests establishing a sewage treatment plant in both municipal areas to treat the wastewater before discharging it into the Kangsabati River.

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