



## Research Paper

### Seasonal Variations of Physicochemical Parameters in the River of Ken Madhya Pradesh India

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**Abstract:** The Ken River, a significant hydrological feature in the Bundelkhand area of Central India, flows through the states of Madhya Pradesh and Uttar Pradesh, acting as a tributary to the Yamuna River. The Ken River begins at Ahirgawan village on the north-west slopes of the Kaimur Range in Katni district, Madhya Pradesh. It travels for a distance of 427 kilometres until joining the Yamuna River in Chilla village in Fatehpur, Uttar Pradesh. Chilla village is located at coordinates 25°46'N and 80°31'E. The river is among the sixteen permanent rivers in Madhya Pradesh and has a significant impact on supporting the wildlife of Panna National Park. It serves as an essential drinking water supply as it passes through about 55 km of the park from south to north. In order to assess the fluctuations in water quality throughout the year, samples were gathered from multiple sites within and near Panna District. These samples were then examined for important physicochemical factors including temperature, pH, electrical conductivity, turbidity, total

dissolved solids (TDS), total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), chloride, sulphate, phosphate, nitrate, alkalinity, total hardness, calcium hardness, and magnesium hardness. The water quality evaluation was performed with the established techniques endorsed by the American Public Health Association (APHA-AWWA) for the testing of water and wastewater. The results were contrasted with the drinking water quality requirements set by the World Health Organisation (WHO). This research offers crucial insights into the seasonal variations in the quality of surface water in the Ken River. It specifically focusses on the appropriateness of the water for drinking purposes at specific locations. The findings of this study give essential information for regulatory bodies and policymakers involved in the management of the Ken River basin.

**Keywords:** Physiochemical parameter, Water quality, Kenya river

## Introduction:

Over the last several years, the continuous increase in population, increasing industrialisation, and the introduction of numerous technologies have greatly accelerated the pace at which pollutants are released into the environment. Regrettably, the pace at which pollutants are being released beyond the capacity of natural purification processes, resulting in a continuous deterioration of the quality of water bodies, including both surface and groundwater. The repercussions of this decline are significant, impacting not only the nearby surroundings but also having enduring ramifications for ecosystems, human well-being, and overall environmental durability. Within this particular framework, the evaluation of water quality has emerged as a crucial undertaking for the purpose of managing pollution and safeguarding critical water resources.

In India, the situation is very serious, as the release of untreated residential sewage from rapidly growing cities, towns, and villages has become the main cause of pollution in surface water. The unregulated release of garbage has resulted in the pollution of water sources, thus causing the emergence of waterborne illnesses, presenting a substantial public health concern. An important issue related to this pollution is the existence of biodegradable organic substances, which directly impact the amount of dissolved oxygen (DO) in the water. Dissolved oxygen is a crucial measurement and primary indication of the pollution level in surface waters.

According to the World Health Organisation (WHO), almost 80% of water contamination in developing nations such as India is attributed to household garbage. This concerning data highlights the immediate need for efficient water quality management measures that may alleviate the consequences of pollution and protect water resources. Multiple studies have

been carried out across India to evaluate water quality by analysing different physicochemical, biological features, and the presence of heavy metals in surface and groundwater. These investigations have emphasised the extensive pollution and urgent need for action to enhance the quality of water (Haribhau, 2012; Patil et al., 2012; Manimaran, 2012; Parihar et al., 2012; Ranjan, 2012).

The increasing population of individuals who do not have access to clean drinking water and sufficient sanitary facilities is a direct result of the fast urbanisation occurring in India. The growing urban population puts further strain on already overwhelmed water supplies, resulting in further deterioration of water quality. Gleick (1993) argues that the future increase in the population without access to clean water and sanitation would mostly be influenced by the pace of urbanisation. Hence, the primary goal of a water quality management plan should be to achieve equilibrium among the varied concerns of water users, while fostering the sustainable advancement of water resources and concurrently enhancing and conserving the environmental quality.

The Ken River, a prominent waterway in the Bundelkhand area of Central India, represents these difficulties. The Ken River is an important tributary of the Yamuna River, running through the states of Madhya Pradesh and Uttar Pradesh. The river begins at the hamlet of Ahirgawan on the north-western slopes of the Kaimur Range in Katni district, Madhya Pradesh. It flows for a total distance of 427 kilometres until joining the Yamuna at Chilla village in Fatehpur, Uttar Pradesh. The coordinates of Chilla village are 25°46'N and 80°31'E. The Ken River is of significant significance among the sixteen perennial rivers in Madhya Pradesh, since it plays a crucial role in preserving the environment of Panna National Park. The river flows for roughly 55 km through the

park in a south to north direction, serving as a vital water supply for the area's unique fauna.

Assessing the water quality of the Ken River is crucial due to its ecological importance and its role in maintaining both human and animal populations. The objective of this research is to assess the changes that occur in the physical and chemical characteristics of the Ken River during different seasons. The main goal is to comprehend the impact of these variations on the quality of the water and its appropriateness for different purposes, such as drinking. This project aims to get valuable insights into the present condition of the water quality in the Ken River by analysing water samples obtained from several places within and around Panna District. The results will be very helpful for regulatory bodies, environmental policymakers, and stakeholders responsible for managing and conserving the Ken River basin. They will provide recommendations on the essential actions to protect and improve the water quality of the river.

### Review of Literature:

Ahirwal (2022) Water is an essential component for all living things, and the degradation of water quality has resulted in a wide range of negative consequences being experienced. As a consequence of human activity, water is considered to be "polluted" when it undergoes changes in its composition or quality, either directly or indirectly, to the point that it is no longer appropriate for drinking, as well as for use in the home and for other practical reasons. It is mostly the dumping of rubbish that is responsible for the contamination of fresh water. Sewage, chemicals, and other unpleasant external extraneous materials have contributed to the darkening of the majority of the rivers. As an additional point of interest, the rivers transport and dump their

contaminants into the ocean. Furthermore, hazardous wastes contribute to the pollution of the seas, which in turn leads to the poisoning of seafood on a massive scale. Physicochemical characteristics of the Sonar river in the Damoh district have been analysed in this investigation, which was carried out today. A variety of physicochemical characteristics, including temperature, pH, total dissolved solids (TDS), conductivity, dissolved oxygen (DO), free carbon dioxide (CO<sub>2</sub>), sulphate, phosphate, nitrate, biological oxygen demand (BOD), and chemical oxygen demand (COD), were analysed using samples that were collected seasonally from certain sampling sites. In light of the characteristics described above, the investigation sheds light on the state of the water in this river throughout the different seasons.

**Barman et al. (2022)** In any hilly region, spring is an essential season. Indisputable evidence suggests that springs have played a significant role in the development of human civilisation. Villages in the Northeast get their water supply from mountain springs. The ecological research that was carried out in Dhalai, Tripura, during the springtime has significant implications for socio-economic policy policies. Jamircherra (JS) and Govindabari (GS) were specifically selected as the springs to be used. There was an investigation on the seasonal characteristics of each spring. The flow of life-giving water from perennial springs is delivered throughout the monsoon season. Several water quality indicators as WT, pH, EC, TDS, Turb, TH, DO, BOD, Ca<sup>+2</sup>, Mg<sup>+2</sup>, Cl<sup>-</sup>, No<sub>3</sub>, Po<sub>4</sub> were evaluated to determine the danger of spring contamination. Among the most often seen deviations from the norm, samples that exhibit elevated levels of phosphate (PO<sub>4</sub><sup>2-</sup>) and turbidity are the most frequently encountered. Using the weighted arithmetic index approach, the

water quality of the spring was evaluated. Throughout the course of the year, the water quality at the two springs was satisfactory but not particularly high, which resulted in the deaths of humans due to illnesses that were transmitted by water. It was thus emphasised that policy implementation be prioritised in order to safeguard both human life and the spring. In order to clarify a technological-legal aspect of environmental rules, a physicochemical analysis of both springs was carried out.

Gangwar et al. (2019) The present research was conducted with the intention of acquiring a comprehensive understanding of the trophic condition of the Kolar reservoir. Over the course of one year, from January to December, at the Kolar reservoir, the physicochemical properties of the ambient water were evaluated on a monthly basis to determine the degree of variation. In the current investigation, the pH ranged from 7.1 to 8.3 units, the turbidity ranged from 2 to 8 NTU, the total dissolved solids ranged from 115 to 156 mg/l, the specific conductivity ranged from 177 to 240 mg//l, the dissolved oxygen ranged from 4.4 to 7.6 mg/l, the total hardness ranged from 39 to 62 mg/l, the total alkalinity ranged from 100 to 132 mg/l, chloride ranged from 9 to 19 mg/l, nitrate ranged from 0.008 to 0.53 mg/l, and the phosphate phosphorous ranged from 0.0005 to 0.173 mg/l as well. According to the findings, the physicochemical characteristics of the water body were found to be within the acceptable limits. As a consequence, the water from the Kolar reservoir is suitable for consumption and may be utilised for household purposes.

Awasthi et al. (2018) In the Bundelkhand area of Central India, the Ken river is considered to be one of the most important rivers. Between the states of Madhya Pradesh and Uttar Pradesh, it runs through both of them. It is a river that flows into

the Yamuna river. Ahirgawan, which is located on the north-west slopes of the Kaimur Range in the Katni district of Madhya Pradesh, is the point of origin for the Ken river. It traverses a distance of 427 km before joining the Yamuna at Chilla, which is located in Fatehpur, Uttar Pradesh, at a coordinate of 25°46' North and 80°31' East. In the state of Madhya Pradesh, it is one of the sixteen rivers that are perennial. Panna National Park is traversed by it for about 55 km, moving from south to north. In light of this, it serves as a source of water for the wild creatures that live inside Panna National Park. A number of different river water samples were taken from a variety of locations inside and around the Panna District, and then their physicochemical properties were analysed. Temperature, pH, electrical conductivity, turbidity, total dissolved solids, total soluble solids, dissolved oxygen, biological oxygen demand, chemical oxygen demand, chloride, sulphate, phosphate, nitrate, alkalinity, total hardness, calcium hardness, and magnesium hardness were the characteristics that were chosen. Standard procedures for the assessment of water and wastewater (APHA-AWWA) were used in order to carry out the procedures for the investigation of water quality. A comparison was made between the findings and the requirements for the quality of drinking water that were established by the World Health Organisation (WHO). A research like the one described above will be helpful in determining the quality of surface water and the consequent suitability or unsuitability of water for drinking purposes at specific locations where the study was conducted. Additionally, the regulatory authorities and policy makers in relation to the river Ken basin will find the research to be beneficial.

Silas et al. (2018) It is possible that the indiscriminate dumping and discharge of

wastes that include hazardous compounds into rivers might result in environmental disturbance, which could be regarded as a potential cause of stress for the biotic community. Some of the villages that are located along the river bank and farmers use the River Mkomon, which is one of the tributaries of the River Benue, as an ideal disposal agent. An investigation of the seasonal fluctuation in physicochemical and bacteriological features of River Mkomon water was the purpose of the research. The investigation was carried out at four separate sample points along the River. In 2015, analyses of the river water quality were carried out throughout both the dry and wet seasons, and the analyses included sixteen different parameters. A decline in water quality was seen across all of the locations, as a result of seasonal variations, according to the findings. The statistics have been compared with the standards for river water that have been established by the World Health Organisation (WHO), the National Environmental Standards and Regulations Enforcement Agency (NESREA), and the standard organisation of Nigeria (SON). The results that were obtained indicated that there was an increase in the water temperature ( $28.8 \pm 0.08$ ) degrees Celsius, the turbidity ( $8.5 \pm 0.15$ ) NTU, the cadmium ( $0.087 \pm 0.00$ ) mg/L, the lead ( $0.299 \pm 0.00$ ) mg/L, the chromium ( $0.521 \pm 0.00$ ) mg/L, the total coliform ( $159.1 \pm 24.9$ ) CFU, and a decrease or normal level of phosphate ( $3.7 \pm 0.05$ ) mg/L, chloride ( $55.2 \pm 1.35$ ) mg/L, electrical conductivity ( $56.2 \pm 0.49$ )  $\mu$ S/cm, biological oxygen demand ( $3.3 \pm 0.08$ ) mg/L, suspended solid ( $48.9 \pm 0.31$ ) mg/L, pH ( $6.5 \pm 0.07$ ), dissolved oxygen ( $4.0 \pm 0.09$ ) mg/L, total dissolved solids ( $47.7 \pm 0.15$ ) mg/L, and total hardness ( $83.2 \pm 1.13$ ) mg/L. Furthermore, a rise in the pollutant load during the rainy season suggested an increase in the amount of organic matter in the water of the river

throughout the season. This was seen as a result of an increase in the amount of human interferences in the regions around the river.

### Materials and Methods:

In order to achieve the objectives of this study and ensure that a comprehensive analysis of the water quality of the Ken River is carried out, it was decided to choose four main sample sites that are situated along the river. The geographical location of these stations, their proximity to potential sources of pollution, and the ecological significance of their respective regions were all factors that were considered throughout the selection process. Monitoring and assessment of river quality were carried out throughout the duration of the several seasons in order to capture the seasonal variations in water quality. For the purpose of conducting the examination of the physical, chemical, and biological features, the approaches and procedures that were specified by recognised protocols were used (Saxena, 1994; APHA, 2005; NEERI, 2010). In Table 1, you will find not only a detailed description of the sample sites, but also an explanation of the significance of these locations in relation to the quantitative evaluation of environmental water quality indicators.

**Table 1: Details of Sampling Stations**

| S. No. | Description of Sampling Locations                 |
|--------|---------------------------------------------------|
| 1.     | Nehra Ghat (1) – Located upstream near Panna city |
| 2.     | Barouni Ghat (2) – Downstream within Panna region |
| 3.     | Chandoura Ghat (3) – Near Panna National Park     |
| 4.     | Beera Ghat (4) – Confluence area within Panna     |

### Sample collection:

Carboys with a capacity of two litres and a colour that was either blue or black were used to collect water samples from the chosen stations throughout the pre and post monsoon. This was done in order to reduce the amount of light that the water was exposed to and to avoid any photodegradation of highly sensitive water components. It was ensured that the samples correctly reflected the water quality at each location by conducting the collecting procedure with the greatest care to prevent any contamination from occurring. To ensure that the samples would not be compromised while being transported, they were immediately put in dark, insulated crates once they were

collected. Within the first six hours after collection, each and every sample was treated to guarantee that the physical, chemical, and biological properties remained constant for the purpose of correct analysis.

### Results and Discussion:

During the pre-monsoon and post-monsoon seasons, the values of all the water quality parameters at four sampling sites along the Ken River in the Panna area are shown in Tables 2 and 3, respectively. These tables indicate the average values of all the parameters over a period of one year.

**Table 1: Average Values of Physico-Chemical Parameters during Pre-Monsoon Season.**

| S. No | Parameter                        | Station 1 | Station 2 | Station 3 | Station 4 |
|-------|----------------------------------|-----------|-----------|-----------|-----------|
| 1     | Water Temperature (°C)           | 27.0      | 28.0      | 27.5      | 27.0      |
| 2     | Conductivity (µS/cm)             | 900       | 1200      | 1000      | 1100      |
| 3     | pH                               | 7.21      | 7.76      | 8.25      | 7.35      |
| 4     | Alkalinity (mg/l)                | 400       | 370       | 385       | 410       |
| 5     | Total Hardness (mg/l)            | 300       | 310       | 350       | 340       |
| 6     | Total Dissolved Solids (mg/l)    | 330       | 300       | 280       | 270       |
| 7     | Dissolved Oxygen (mg/l)          | 7.5       | 7.0       | 7.5       | 7.8       |
| 8     | Biochemical Oxygen Demand (mg/l) | 2.0       | 2.0       | 2.5       | 2.0       |
| 9     | Total Coliform (MPN/100ml)       | 250       | 200       | 200       | 300       |

**Table 2: Average Values of Physico-Chemical Parameters during Post-Monsoon Season**

| S. No | Parameter                        | Station 1 | Station 2 | Station 3 | Station 4 |
|-------|----------------------------------|-----------|-----------|-----------|-----------|
| 1     | Water Temperature (°C)           | 26.0      | 27.5      | 28.0      | 26.5      |
| 2     | Conductivity (µS/cm)             | 600       | 1100      | 900       | 1000      |
| 3     | pH                               | 7.22      | 7.80      | 8.43      | 7.38      |
| 4     | Alkalinity (mg/l)                | 380       | 360       | 375       | 400       |
| 5     | Total Hardness (mg/l)            | 325       | 300       | 320       | 330       |
| 6     | Total Dissolved Solids (mg/l)    | 300       | 290       | 250       | 235       |
| 7     | Dissolved Oxygen (mg/l)          | 8.5       | 9.2       | 9.0       | 9.2       |
| 8     | Biochemical Oxygen Demand (mg/l) | 1.8       | 1.8       | 2.0       | 1.7       |
| 9     | Total Coliform (MPN/100ml)       | 200       | 150       | 150       | 150       |

#### • Temperature of the Water

The temperature of the water plays a significant role in determining the biological activities that take place in the river. Although there were some tiny fluctuations, the temperatures that were reported at each of the sample locations were constant. At each of the locations, the temperature varied from 26.5 degrees Celsius to 28.0 degrees Celsius. The fluctuation may be related to the natural environmental conditions that were present at the sample locations, such as the temperature of the atmosphere and the amount of sunshine that was there.

#### • Conductivity

The conductivity of water is a measure of its capacity to carry electrical current, which is directly proportional to the amount of ions that are present in the same volume of water. During the winter season, the conductivity values along the Ken River varied from 900 to 1200 µS/cm in the pre-monsoon period, and from 600 to 1100 µS/cm in the post-monsoon period

(Tables 2 and 3). There is a possibility that the increased conductivity readings that occur prior to the monsoon season are indicative of greater concentrations of dissolved salts and other minerals as a result of falling water levels. The rush of moisture that occurred during the monsoon most likely diluted the ionic content, which had the effect of lowering the conductivity values (Figure 1).

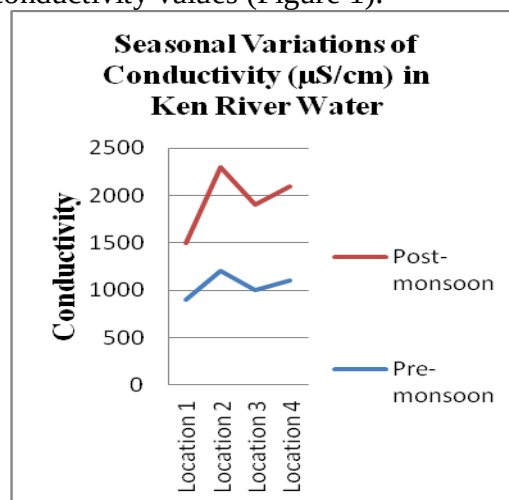


**Figure 1: Seasonal variations of Conductivity in Ken River water**

### • pH Value

All of the sample sites had pH values that were somewhat alkaline, with concentrations ranging from 7.21 to 8.25 during the pre-monsoon season and from 7.22 to 8.43 during the post-monsoon season. It is possible that a well-buffered system that is capable of neutralising acids is responsible for the pH's consistency over the seasons. According to Figure 2, the abundance of carbonate and bicarbonate ions in the water is consistent with the alkaline character of the water. This is common for rivers that are located in places that abundantly contain limestone.

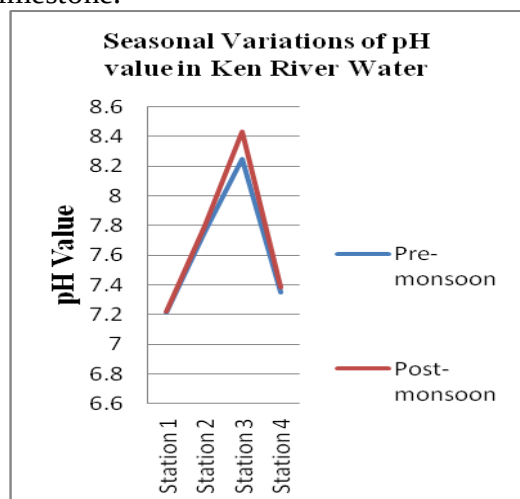


**Figure 2: Seasonal Variations of pH in Ken River Water**

### • Alkalinity

During the pre-monsoon season, the alkalinity of the water ranged from 370 to 410 mg/l, whereas during the post-monsoon season, the alkalinity ranged from 360 to 400 mg/l. Alkalinity is a measure of the buffering capacity of water. It is possible that rainfall, which contains less dissolved salts, is responsible for the modest decrease in alkalinity that occurs after the monsoon season. The fact that the alkalinity is similar across all of the sample sites indicates that the chemical composition of the river water is stable, which is impacted by the geology of the surrounding area (Figure 3).

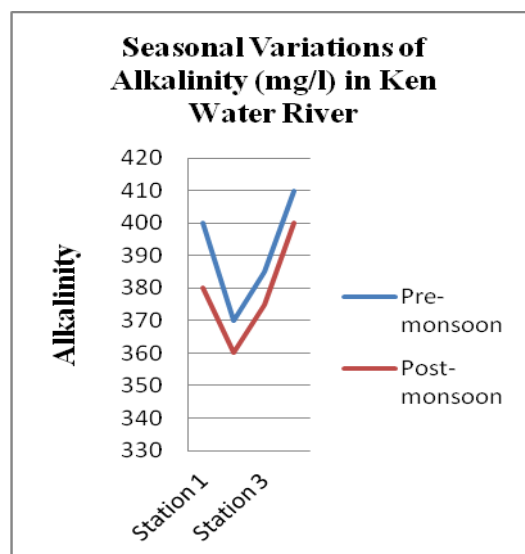


**Figure 3: Seasonal variations of Alkalinity in Ken River water**

### • Total Hardness

Under pre-monsoon conditions, total hardness, which is a measurement of calcium and magnesium ion concentration, was found to be within the range of 300 to 350 mg/l, while under post-monsoon conditions, it was found to be between 300 and 330 mg/l. It is usual for rivers that run through regions that have considerable mineral concentrations to have water that is somewhat hard, as shown by the hardness values that were recorded. It is possible that the diluting effect of increased water volume is responsible for the minor drop in hardness that occurred during the monsoon season (Figure 4).

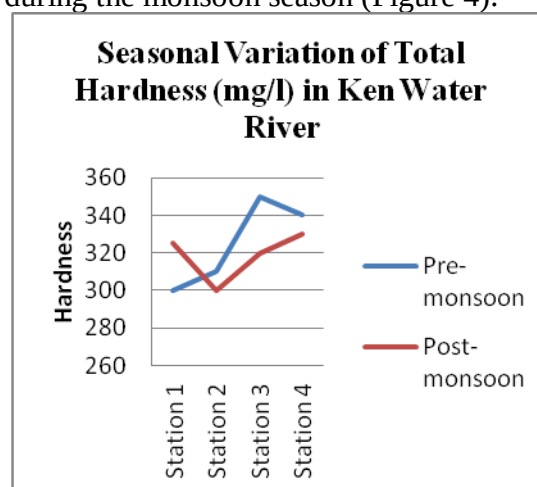


**Figure 4: Seasonal variations of Total hardness in Ken River water**

- **Total Dissolved Solids (TDS)**

The Total Dissolved Solids (TDS) measurement, which determines the total concentration of chemicals that have been dissolved, exhibited values that ranged from 270 to 330 mg/l during the pre-monsoon season and from 235 to 300 mg/l during the post-monsoon season. Following the monsoon season, there was a decrease in total dissolved solids (TDS), which suggests that the rains was successful in reducing the quantities of dissolved chemicals in the river (Figure 5).

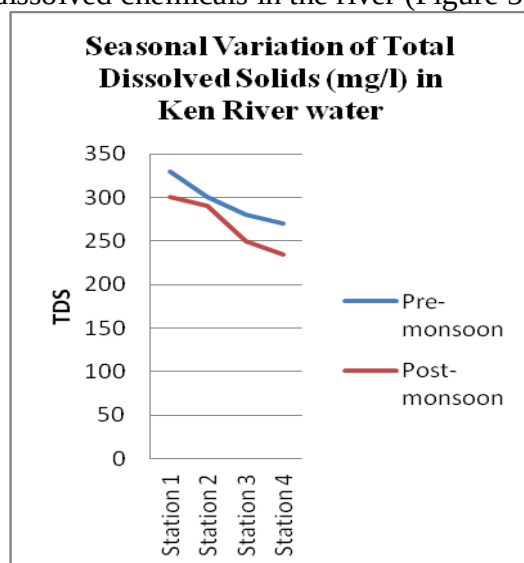


**Figure 5: Seasonal variations of Total dissolve solids in Ken River water**

- **Dissolved Oxygen (DO)**

The quantities of dissolved oxygen are very important for the survival of species that live in water. During the pre-monsoon period, the DO values were in the range of 7.0 to 7.8 mg/l, but once the monsoon occurred, they jumped to between 8.5 and 9.2 mg/l. It is possible that the increased water flow and aeration that occurred during the monsoon season contributed to the increased oxygenation of the water, which resulted in higher DO levels at this time period. This rise in DO is indicative of a healthy aquatic environment, especially after the monsoon season has passed (Figure 6).

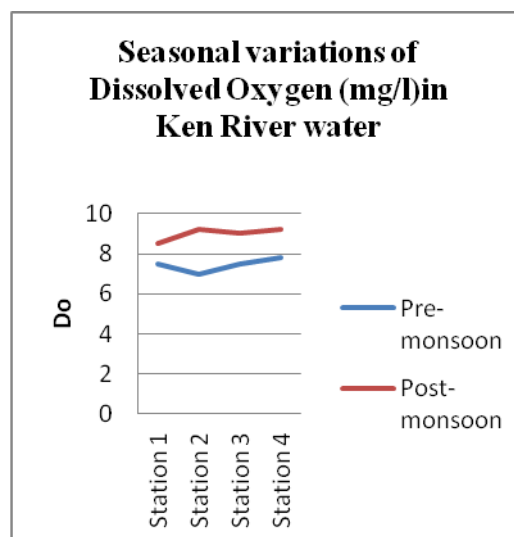


**Figure 6: Seasonal variations of Dissolve oxygen in Ken River water**

- **Biochemical Oxygen Demand (BOD)**

The Biochemical Oxygen Demand (BOD) is a measurement of the amount of oxygen that is inhaled by organic matter during the process of decomposition. Before the onset of the monsoon, the biological oxygen demand (BOD) values in this research were from 2.0 to 2.5 mg/l, but after the monsoon, they dropped to between 1.7 and 2.0 mg/l. Following the monsoon season, the BOD levels were found to be lower, which indicates that the organic pollution load of the river was lowered as a result of the diluting action of rains (Figure 7).

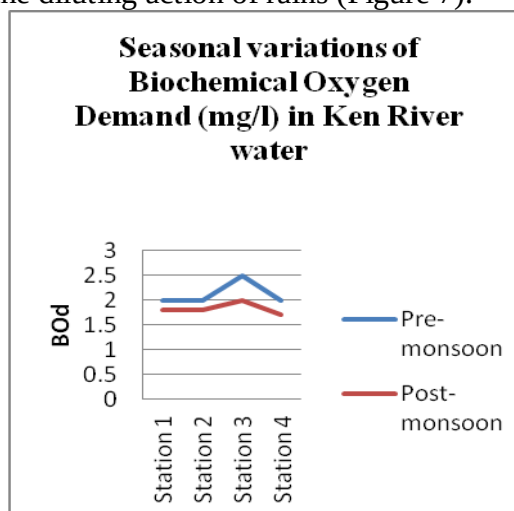


**Figure 7: Seasonal variations of Biochemical oxygen demand in Ken River water**

### • Total Coliforms

In the pre-monsoon period, total coliform counts ranged from 200 to 300 MPN/100 ml, whereas in the post-monsoon period, they ranged from 150 to 200 MPN/100 ml. These numbers are indicative of the possibility of contamination by faecal matter. After the monsoon, there was a fall in the number of coliforms, which shows that there was a dilution effect, which reduced the concentration of pollutants. On the other hand, the presence of coliforms at each and every site suggests that there is a continuous input of faecal pollution, which may originate from neighbouring towns or agricultural runoff.

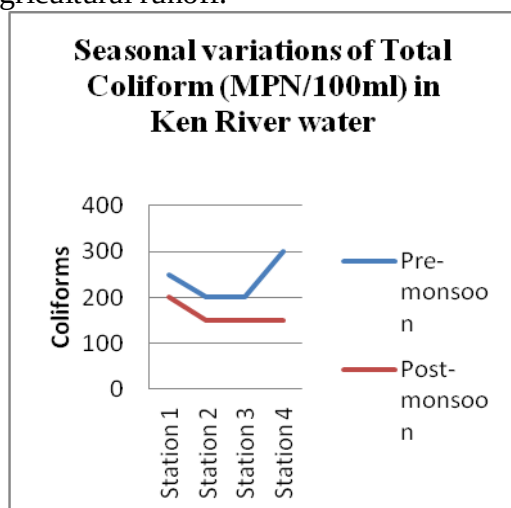


**Figure 8: Seasonal variations of Total coliform in Ken River water**

### Conclusion:

The data indicate that there are noticeable changes in the water quality parameters at each of the four locations between the pre-monsoon and post-monsoon seasons. Following the monsoon season, there is a slight decrease in the water temperature, mostly due to the cooling effect of rainfall. In the post-monsoon season, conductivity levels decrease due to the removal of dissolved salts and ions by precipitation. Following the monsoon, there is a little increase in pH values, indicating a shift towards more alkaline conditions. This shift may be attributed to the use of alkaline chemicals or changes in the water's composition resulting from runoff.

Following the monsoon, there is a decrease in both alkalinity and overall hardness, most likely due to the process of diluting occurring once again. Conversely, there is an increase in dissolved oxygen levels, likely due to lower temperatures and higher water velocity, which improves the ability of oxygen to dissolve in the water during this period. In the post-monsoon season, there is a slight drop in the Biochemical Oxygen Demand (BOD), suggesting an improvement in water quality and a reduction in organic contaminants. Finally, the overall coliform levels fall during the monsoon season, indicating a reduction in microbial contamination. This is mostly due to the diluting and flushing effect of the monsoon rains on the populace. In general, the water quality tends to improve during the post-monsoon season due to the natural cleansing and dilution effects of the monsoon rains.

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