The impact of ecotourism on the water quality in sedim river, kedah, malaysia

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Abstract. This study was aims to evaluate the impact of ecotourism on the water quality in the Sedim River Recreation Centre, Kulim Kedah, Malaysia. Ecotourism activity development, such as chalet construction, homestay, recreation for picnics, kayaking and proper disposal of solid wastes in the area, will affect the quality of Sedim River. The period of this study was conducted between February to April 2018, with six time water sampling during this period. Sample water quality was then analysed using the Water Quality Index (WQI) in situ and in the laboratory, as set by the Malaysian Department of Environment. Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia Nitrogen (NH3N), pH and Suspended Solid (SS) were used as water quality parameters. The findings show that the value of WQI Sedim River is in Class I and II, with WQI=92.3 as an average value that safe for raw water supply, suitable for fish rearing and water activities such as water rafting and kayaking. This shows that the unpolluted and clean status of the Sedim River water allows ecotourism activities to go further and at the same time can attract foreign tourists to come. Although, management will have to take more precise measurements of the water and plan for any development activities to be undertaken in the future to maintain the clean condition status of the Sedim River water quality.

1. Introduction
Malaysia is a country rich in varieties of interesting natural resources. The varying biodiversity and interesting ecosystems in the country have become an attraction to the rapidly expanding tourism sector in the country, especially ecotourism. Malaysia is a country with an equatorial climate that is home to a unique diversity of flora and fauna in tropical rainforests and coastal and riverside areas that are attractive and always visited by local or foreign tourists. According to Er and Nurul [1], ecotourism is an on-going tourism activity in conserving and providing a tourism space with a concept of natural environment or artificial ecology. It is undeniable that natural resources, especially the river, have attracted tourists, especially for picnics, carrying out water-based activities such as bathing, kayaking, water rafting and so on.

Undeniably, ecotourism activities have positively impacted the economic development of a country. However, at the same time, unsustainable ecotourism activities have affected the quality of the environment, especially the problem of water, air and noise pollutions as well, as solid waste disposal [2-6]. Today, the function of the river has evolved along with the times. In the past, the clear river water could be consumed directly, but today, rivers are often associated with pollution problems that are difficult to control by the authorities. One of the leading causes of river pollution in the country is the disposing of solid waste from tourism activities, which is spreading and can result in water pollution,
regardless whether it is from hotels, villas chalets and so on. Demand for ecotourism development activities has led to the opening of natural areas to be turned into recreational areas, the building of accommodation, such as chalets and resorts and many more. The purpose of this article is to study the water quality status of the Sedim River in the state of Kedah, Malaysia, as the upstream area of the Sedim River has been developed as one of the ecotourism and development areas for water-based recreational activities. The polluted water quality status will affect the people carrying out various kinds of activities in the area, especially at the Sedim River Recreation Centre.

2. Location and Methodology
The Sedim River basin is one of the sub-basins of the Muda River that borders the states of Penang and Kedah. Apart from the Sedim River basin, the other major sub-basins of the Muda River are the Ketil River, Lahar River, Endin River, Tembus River, Chepir River, Sok River, Teliang River and Boho River [7]. The Muda River basin has an area of 4,219km², with its major river length of 178km. The location of the Sedim River is shown in Figure 1.

![Figure 1. Sedim River basin](image)

The Sedim River basin is one of the unique and interesting places in Malaysia as there is a tourism centre that runs ecotourism activities located in the upstream area of this river. It is also known as Lata Sedim, Jeram Sedim and Arus Deras Sungai Sedim. Sedim River visitors can also carry out activities such as camping, recreation, kayaking, rafting, tracking and hiking up to the summit of Gunung Bintang, located at Banjaran Bintang. There are more than ten chalets and homestays that offer services to travellers who wish to stay there. There are also camps that provide outdoor activities for those who love rough activities, self-building camps and motivational camps.

In addition, the Sedim River basin also becomes a tourist attraction as it has a suspension bridge known as The Tree Top Walk. According to the Kulim Municipal Council [8], the Tree Top Walk is also one of the icons of the Sedim River as it is the longest iron-based pedestrian bridge in Asia, with a distance of 950m. In addition, there is an amenity forest area that is an attraction for ecotourism activities, the Hutan Lipur Sungai Sedim, located in the Gunung Inas Forest Reserve, which is a type of Lowland Dipterocarp Forest. There are forest trees such as Meranti Seraya, Meranti Tembaga, Meranti Melantai, Kulim, Terap, Keledang and Bintangor. The 15km long Sedim River, with a fast river current and several cascades, is suitable for kayaking activities. Among the eight streams that flow along the Sedim River are the Reyau River, Merbok River, Tebuan River, Karangan River, Terona
River, Bekui River, Bikan River and Buloh River [8]. These various water-based activities have led to the study of water quality status in the Sedim River.

Table 1. Location of water quality sampling stations of the Sedim River

| Sampling Station | Longitude | Latitude        |
|------------------|-----------|-----------------|
| 1                | 100° 47' 1.68" | 5° 24' 48.21" |
| 2                | 100° 46' 49.4" | 5° 24' 46.4" |
| 3                | 100° 46' 17.11" | 5° 24' 30.52" |

Observation on the water quality in the upstream part of the Sedim River was carried out in three different places, as shown in Figure 1 and Table 1. The Sedim River samples were taken six times total, with one sample taken two weeks for the three consecutive months of February, March and April 2018. The study on the water quality of the Sedim River was carried out by collecting river water samples and bringing them to the laboratory to test them according to the procedures and analysis specified by the American Public Health Association (APHA) [9]. Only six water quality parameters were analysed: dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), pH and ammonia nitrogen (NH₃-N). These six parameters were used as these are the parameters used by the Department of Environment (DOE) in determining the status of river water quality, which is known as Water Quality Index (WQI). This WQI is used to divide water quality into six classes and current water status, as shown in Table 2. The range of sub-index (SI) values of each WQI parameter is provided in Table 2. This WQI is determined based on the formula set by the DOE Malaysia, as the following equation:

\[
WQI = (0.22 \times S_{DO}) + (0.19 \times S_{BOD}) + (0.16 \times S_{COD}) + (0.15 \times S_{NH3-N}) + (0.16 \times S_{SS}) + (0.12 \times S_{pH})
\]

where S_{DO} is the sub-index of DO; S_{BOD} is the sub-index of BOD; S_{COD} is the sub-index of COD; S_{NH3-N} is the sub-index of NH₃-N; S_{SS} is the sub-index of SS and S_{pH} is the sub-index of pH. All data of these water quality parameters were analysed using Statistical Package for the Social Sciences (SPSS) version 22. The data for each parameter were the average data from three sampling stations and were compared in each observation conducted.

Table 2. Classes of water quality index and contamination status

| Parameter/Class | Class I | Class II | Class III | Class IV | Class V |
|-----------------|---------|----------|-----------|----------|---------|
| Ammonia Nitrogen (mg/l) | < 0.1 | 0.1 – 0.3 | 0.3 – 0.9 | 0.9 – 2.7 | > 2.7 |
| BOD (mg/l) | < 1 | 1 – 3 | 3 – 6 | 6 – 12 | > 12 |
| COD (mg/l) | < 10 | 10 – 25 | 25 – 50 | 50 – 100 | > 100 |
| DO (mg/l) | > 7 | 5 – 7 | 3 – 5 | 1 – 3 | < 1 |
| pH | > 7 | 6 – 7 | 5 – 6 | < 5 | < 5 |
| TSS (mg/l) | < 25 | 25 – 50 | 50 – 150 | 150 – 300 | > 300 |

Water Quality Index (WQI) < 92.7 76.5 – 92.7 51.9 – 76.5 31 – 51.9 < 31

Contamination status: Not Contaminated, Slightly Contaminated, Moderately Contaminated, Contaminated, Highly Contaminated.

Source: Malaysian Department of Environment [10]

3. Results and Discussion

3.1 River Water Quality Based on Six Key Parameters

Figure 1 shows the COD parameter observation of the Sedim River based on six observations done within three months of February, March and April 2018. Based on Figure 2, the highest value of COD
was recorded in Observation 5 at 45mg/l, whereas the lowest COD was recorded in Observation 4 at 13mg/l. In addition, the average value of COD for these six observations was 29.2mg/l. Based on the average observation value, the water quality of the Sedim River was in Class III.

Next, Table 3 shows the average value of the COD parameter observation analysis for the Sedim River according to month. Based on the table, the month of April recorded the highest average COD value of 41mg/l, while March recorded the lowest average COD value of 14.5mg/l. The COD indicator was used to indicate the level of water pollution as it contained high organic matter. In this case, the high COD value was caused by the various kinds of human activities carried out at the Sedim River Recreation Centre, particularly activities such as bathing and disposal of untreated sewage from food stalls and chalets, as well as other recreational activities. This is evidenced by a study conducted by Mohmadisa et al. [11] which states that the release of domestic waste from restaurants or food stalls has increased the demand for oxygen supplies to decompose the waste. The results showed that the COD value of the Sedim River water was at a high level and this indicates that the organic content of the Sedim River water was high as well.

![Figure 2. Values of COD parameter of the Sedim River in February, March and April 2018](image)

| Month  | Observation | COD value (mg/l) | Average value (mg/l) |
|--------|-------------|------------------|----------------------|
| February | 1           | 40               | 32                   |
|        | 2           | 24               |                      |
| March  | 3           | 16               | 14.5                 |
|        | 4           | 13               |                      |
| April  | 5           | 45               |                      |
|        | 6           | 37               | 41                   |
| Overall average | | 29.2             |                      |

Meanwhile, Figure 3 shows the nitrogen ammonia (NH₃N) observation of the Sedim River. The NH₃N parameter is used as an indicator for the pollutions caused by the use of fertilisers in agricultural activities, animal waste and even domestic sewage [12]. Based on the diagram, Observation 4 shows the highest NH₃N of the Sedim River at 0.06 mg/l, while the lowest NH₃N was recorded in Observation 3 and Observation 4 at 0.01mg/l. In addition, the average of NH₃N for the six observations was 0.03mg/l. Apart from that, Table 4 shows the analysis of NH₃N observation for the Sedim River according to month. Based on the table, the month of March recorded the highest average of NH₃N at 0.035mg/l, while February recorded the lowest average NH₃N value at 0.04mg/l. On the whole, all
observations indicate that the NH$_3$N parameter was in the uncontaminated status and was in Class I.

Table 4. Analysis of NH$_3$N parameter according to month

| Month | Observation | NH$_3$N value (mg/l) | Average value (mg/l) |
|-------|-------------|----------------------|---------------------|
| February | 1 | 0.05 | |
| | 2 | 0.03 | 0.04 |
| March | 3 | 0.01 | |
| | 4 | 0.06 | 0.035 |
| April | 5 | 0.01 | |
| | 6 | 0.04 | 0.025 |
| **Overall average** | | **0.03** | |

Figure 3. Values of NH$_3$N of the Sedim River in February, March and April 2018

Figure 4 shows the value of the biochemical oxygen demand (BOD) parameter of the Sedim River. According to Haslina Solha and Ghufran [13], the BOD parameter is the amount of dissolved oxygen required by aerobic biological organisms to dissolve organic matter in the water at certain temperatures and time rates. The findings showed that Observation 3 recorded the highest BOD value of the Sedim River water samples at 1.52mg/l, whereas the lowest BOD value was recorded in Observation 5 at 0.4mg/l. The average value of BOD for these six observations was 0.93mg/l, and this indicates that the Sedim River water quality for this parameter was in the non-polluted state and in Class I. Additionally, Table 5 also shows the analysis of the BOD observation for the Sedim River according to month. Based on the table, the month of March recorded the highest average of BOD at 1.16mg/l, while April recorded the lowest average of BOD at 0.72mg/l. This indicates that the organic matter content resulting from the disposal of domestic waste in the Sedim River was very low, as there was less oxygen required for the oxidation process in the water bodies.
Table 5. Analysis of BOD observations according to month

| Month | Observation | BOD value (mg/l) | Average value (mg/l) |
|-------|-------------|-----------------|---------------------|
| February | 1    | 0.6            |                     |
|        | 2    | 1.22           |                     |
| March  | 3    | 1.52           | 0.91                |
|        | 4    | 0.8            |                     |
| April  | 5    | 0.4            |                     |
|        | 6    | 1.04           |                     |
| Overall average | | 0.93 | |

Next, Figure 5 shows the values of the suspended solids (SS) parameter of the Sedim River. The SS parameter is commonly used as a reference to the production of materials such as sand, silt and other domestic waste resulting from the cleaning of an area and development done for various human activities. Based on the diagram, Observation 2 shows the highest SS value of the Sedim River at 8mg/l, whereas the lowest SS at 1mg/l was recorded in Observation 5. In addition, the average value of SS after six observations was 4.5mg/l. Apart from that, Table 6 explains the analysis of SS values of the Sedim River according to month. Based on Table 4, February recorded the highest average of SS at 6.5mg/l, while March and April recorded the lowest average of SS at 3.5mg/l. This indicates that there was no pollution in the Sedim River as the SS value was lower than 25mg/l, and the water quality status was not polluted and was in Class I.
Table 6. Analysis of SS values according to month

| Month   | Observation | SS value (mg/l) | Average value (mg/l) |
|---------|-------------|-----------------|----------------------|
| February| 1           | 5               |                      |
|         | 2           | 8               | 6.5                  |
| March   | 3           | 5               |                      |
|         | 4           | 2               | 3.5                  |
| April   | 5           | 1               |                      |
|         | 6           | 6               | 3.5                  |
| **Overall average** |            | **4.5**        |                      |

Table 7 shows the dissolved oxygen (DO) values for the Sedim River, and according to Mohmadisa et al. [11], low DO value indicates that the water content is in a polluted and contaminated environment. Indirectly, low DO values may affect aquatic life [13]. According to the table, the highest value of DO was recorded in Observation 1 in February (9.64mg/l). While the lowest value of DO was recorded in Observation 4 at 8.02mg/l. In addition, the average DO value of these six observations was 8.9mg/l. This condition shows that the aquatic life such as fish could reproduce well because the DO content in the Sedim River was higher than 7mg/l, indicating that the water quality status of the DO parameter was not polluted and was in Class I.

Table 7. Values of DO parameter of the Sedim River in February, March and April 2018

| Month   | Observation | DO value (mg/l) | Average value (mg/l) |
|---------|-------------|-----------------|----------------------|
| February| 1           | 9.64            |                      |
|         | 2           | 9.32            | 9.48                 |
| March   | 3           | 9.58            |                      |
|         | 4           | 8.02            | 8.8                  |
| April   | 5           | 8.05            |                      |
|         | 6           | 9.16            | 8.61                 |
| **Overall average** |            | **8.9**        |                      |

Figure 5. Values of SS parameter of the Sedim River in February, March and April 2018

Figure 6 shows the pH value of the Sedim River after six observations, done over a period of three months, in February, March, and April 2018. Based on the figure, Observation 5 recorded the highest
pH value of Sedim River water sample at 7.2, while the lowest pH value was recorded in Observation 1 at 6.94. The average pH of these six observations was 7.07. The pH values above 7 indicate that the water quality status was not polluted and was in Class I. Additionally, Table 8 shows the pH value analysis of the Sedim River according to month. Based on Table 8, the month of April recorded the highest average value of pH at 7.18, while February recorded the lowest average value of pH at 6.98. This indicates that the pH value of the Sedim River water was neutral. This is because the concentration of hydrogen ions in the river water was stable.

Table 8. Analysis of pH value observation according to month

| Month   | Observation | pH value | Average value |
|---------|-------------|----------|---------------|
| February| 1           | 6.94     |               |
|         | 2           | 7.02     | 6.98          |
| March   | 3           | 7.11     |               |
|         | 4           | 6.98     | 7.05          |
| April   | 5           | 7.2      |               |
|         | 6           | 7.16     | 7.18          |
| **Overall average** | | **7.07** |               |

3.2 Water Quality of the Sedim River based on Water Quality Index (WQI) of DOE Malaysia

The six water quality parameters required in calculating the WQI, as set by the DOE Malaysia, comprised dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonia-nitrogen (NH₃N), total suspended solids (TSS) and pH; these were used to determine the status of the water quality of the Sedim River. The analysis of these water quality parameters was based on the standard method recommended by the APHA [14].

The WQI analysis, as defined by the DOE, was done using an automated calculation application already in the form of the software, Microsoft Excel. This application was used to determine the class and status of the Sedim River samples analysed. Table 9 shows the average value of each observation on the water quality parameter of the Sedim River streams, and these values were added in to the WQI calculation application. The WQI value for each observation was then shown in Table 10 along with the class and the water quality status of each observation.

Based on Table 10, the water quality of the Sedim River is in a slightly contaminated status. Class I and II refer to the clean status of the Sedim River water quality and are suitable for any water-based recreational activity. The best WQI value of the Sedim River was recorded in Observation 4 at 95.1, while the lowest WQI was recorded in Observation 1 at 90.5. In addition, the average WQI for the
Sedim River after six observations was 92.3. It can be concluded that the water quality of the Sedim River is safe to be used and can be used as a raw water supply, suitable for freshwater fisheries activity, recreational activities and so on.

**Table 9. Average value for the six parameters of the Sedim River water quality**

| Observation | NH$_3$N (mg/l) | TSS (mg/l) | pH  | BOD (mg/l) | COD (mg/l) | DO (mg/l) |
|-------------|----------------|------------|-----|------------|------------|-----------|
| 1           | 0.05           | 5          | 6.94| 0.6        | 40         | 9.64      |
| 2           | 0.03           | 8          | 7.02| 1.22       | 24         | 9.32      |
| 3           | 0.01           | 5          | 7.11| 1.52       | 16         | 9.58      |
| 4           | 0.06           | 2          | 6.98| 0.8        | 13         | 8.02      |
| 5           | 0.01           | 1          | 7.2 | 0.4        | 45         | 8.05      |
| 6           | 0.04           | 6          | 7.16| 1.04       | 37         | 9.16      |

**Table 10. WQI analysis, class and status of the Sedim River water quality**

| Observation | WQI   | Class | Status                  |
|-------------|-------|-------|-------------------------|
| 1           | 90.5  | II    | Slightly contaminated   |
| 2           | 92.6  | II    | Slightly contaminated   |
| 3           | 94.2  | I     | Not contaminated        |
| 4           | 95.1  | I     | Not contaminated        |
| 5           | 90.9  | II    | Slightly contaminated   |
| 6           | 90.5  | II    | Slightly contaminated   |
| Average     | 92.3  | II    | Slightly contaminated   |

Based on the analysis results recorded in Table 10, it is clear that the ecotourism activities at the Sedim River Recreation Centre have the potential to be further developed, as the water quality of the river was in a slightly contaminated status. This is because there were no logging activities done in the Sedim River basin area, especially in the upstream area. Besides that, there were also no large-scale agricultural activities being carried out, except for ecotourism activities, such as accommodation and recreation. Because of that, the waste released into the river was only coming from the ecotourism activities, but it was still under control and did not affect the water quality of Sedim River.

**4. Conclusion**

It is undeniable that ecotourism activities do contribute to the country's economic activities and the income of the local people. However, at the same time, if the management of these ecotourism activities is not well administered, it will negatively impact the environment. This study was conducted to evaluate the extent to which ecotourism activities carried out in the Sedim River Recreation Centre affected the water quality level of the Sedim River. After observations in the field had been conducted six times, over a period of three months, it was found that the water quality status of the Sedim River was not polluted and the water quality was at a very good level.

It can also be concluded that the ecotourism activities carried out in this area, including the construction of chalets and homestays, did not cause pollution to the Sedim River. This was proven when the results of the study showed that the WQI of the Sedim River was in a slightly contaminated status and in Class II. This situation indicates that bathing activities and water-based recreational activities, such as kayaking, are safe to be carried out at the Sedim River Recreation Centre.

As a result, the Sedim River Recreation Centre area is suitable for ecotourism activities, as these activities do not affect the Sedim River water quality. In addition, this good water quality level of the
Sedim River is also ideal for ecotourism activities and has the potential to be developed so that the Sedim River Recreation Centre can become well known to local and foreign tourists.

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