

The Potential of Ecotourism Development in Water Reservation Area of Mahseer (*Tor spp.*) in Bungo Regency of Jambi, Indonesia

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Abstract

River waters in Bungo Regency are the habitat of mahseer (*Tor spp.*), which has a potential for ecotourism development. This study aimed to examine the potential of mahseer resources as the main commodity in river ecotourism development. The study was conducted at the Lubuk Alay water reservation area in October 2019. Observations were made for water quality (temperature, depth, transparency, TSS, pH, DO, nitrate, and total phosphate) and general tourism conditions in the region. The analysis was carried out on the river tourism suitability index (TSI), carrying capacity, and management strategies. Based on the observations, the water quality was generally in good condition and suitable for ecotourism requirements. Types of suitable activities for river ecotourism consisted of relaxing sitting-in (TSI 2.08 – 2.45, suitable) with a carrying capacity of 149 persons/day and playing water (TSI 2.35 – 2.45, suitable) with a carrying capacity of 2194 person/day. The management strategies for developing river ecotourism covered the classification of zones in the Lubuk Beringin, ecotourism development in accordance with the existing potential, coordination between the government and public for ecotourism development, and development of ecotourism through improving facilities and infrastructure.

Keywords: Carrying capacity, conservation, river ecotourism.

INTRODUCTION

Bungo Regency is one of the regencies in Jambi Province, with an area of 4,659 km² (9.80% of the total area of Jambi Province), and has a population of 303,135 inhabitants. The regency is located between 101°27'-102°30' E and between 01°08'-01°55' S, a lowland at an altitude of 0-25 meters above sea level [1]. River waters in the Bungo Regency are one of the conservation areas of the mahseer (*Tor spp.*) habitat, which is also potential to be developed as an ecotourism area.

Mahseer is one type of fish that has an important economic value as consumption fish and ornamental fish [2]. The fish is an endemic fish and rare fish that has the potential to be an attraction for visitors. The fish have the characteristics of slow to heavy current habitats, sand and gravel substrates, and the bottom of the water generally in the form of rocks, clear water, and river environments [3]. The mahseer habitat, especially in the Lubuk Alay water reservation area, has been protected by the local community to preserve the fish and its habitat [4]. However, even though it is protected for the mahseer, its habitat has potential for ecotourism development.

River ecotourism development research activities have been carried out by several researchers, including river ecotourism development for rafting activities in the upper Pekalen River of Probolinggo Regency, East Java Province [5], and river ecotourism development for river rafting activities carried out in the Karaj river of Iran [6]. The development of fish based on ecotourism in Indonesia has been carried out around Mount Ciremai, Kuningan of West Java Province, ecotourism development for fishing and boating activities in the Kuala Sepetang River of Malaysia [7], and development of hot spring ecotourism in Buluh River, which is in the Tangkahan tourist area Langkat, North Sumatra Province [8].

The development of appropriate ecotourism requires an analysis of resource potentials that are priority activities. To ensure the sustainability of rehabilitation and conservation in ecotourism management, it is necessary to include local communities, as well as to improve the community's economy. Ecotourism development in an area requires an assessment based on ecological suitability parameters and the carrying capacity of the region [9,10].

Several reasons related to this study are the Mahseer is a native fish in Jambi, which has high economic value, so its existence needs to be preserved in the study location, 2. The river has clear water conditions and quite beautiful natural scenery in this area, 3. The location is not far from urban areas, which access to the location is

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faster. This study aimed to examine the potential of mahseer resources as the main commodity in the river ecotourism development. The results of this study are expected to be a basis for the management of the mahseer-based ecotourism activities in the water reservation area of Bungo Regency.

MATERIALS AND METHODS

Study Area

The study was conducted at the Lubuk Alay water reservation of Lubuk Beringin Village, Bungo Regency of Jambi Province (Fig. 1) in October 2019. Location is geographically at 101°51'59.512"-101°51'59.854" E and 1°42'46.854" – 1°42'39.686" S. The northern site is overgrown by many trees that grow on the hillside, while the southern directly adjacent to the settlement. This tourism area is shaped extending from East to West with a length of ± 400 m, located at an altitude of 584 m above sea level.

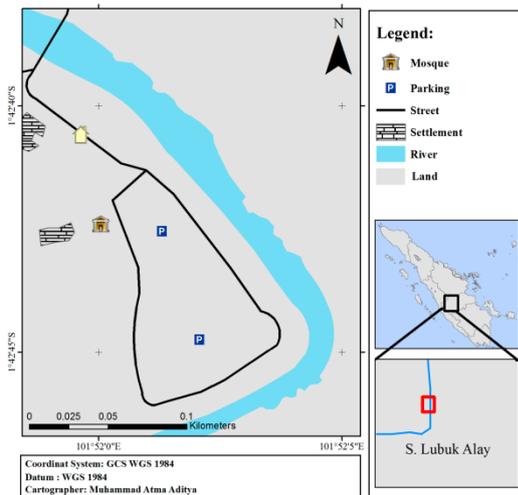


Figure 1. Study Location at Beringin Village of Bungo Regency, Jambi Province, Indonesia

Data Collection

Primary Data

Primary data consisted of the general condition of the location, perception of the community, and water quality parameters. Sources of data were based on the respondents and field condition observations, while data collection techniques were conducted through field observations and questionnaires activities.

Field Observation

Field observations were conducted to gain primary data such as environmental parameters and visitor perception. Observed resource suitability parameters for river ecotourism were divided into two categories, namely, relax sitting-

in and playing water. Observed parameters were water quality, environmental conditions around the water reservation area, and activities carried out around the area. Water quality parameters measured in the field included the water transparency measured using a Secchi disk, currents measured using a flow meter, and water discharge and odor measured through visual observations. Observed environmental conditions consisted of river width, land type, landscape, cover vegetation, and harmful biota.

Interviews and questionnaires

Direct interviews with visitors and area management agencies were conducted to obtain information on the number of visitors, education, profession, income, etc., in the study area. Respondents were determined by using the purposive sampling method. The method was selected for ease of data retrieval. Thirty respondents who were interviewed consisted of visitors and area management agencies.

Data Analysis

Water Quality Analysis

Water quality parameters were measured four times in December 2018, April, July, and October 2019 (once a month). The conditions of aquatic environmental parameters were measured in the field, including temperature, depth, transparency, pH, dissolved oxygen (DO), while Total Suspended Solid (TSS), nitrate, total phosphate were analyzed in the laboratory (Table 1). The bottom substrates of the waters, which are generally sandy and slightly rocky gravel, were also observed descriptively.

Table 1. Water quality parameters and analysis methods

Parameter	Unit	Tools/Method
Physics		
Temperature	°C	DO meters
Depth	Cm	Secchi disk
Transparency	Cm	Secchi disk
TSS*	mg.L ⁻¹	Gravimetry
Chemistry		
pH	-	Litmus paper
DO	mg.L ⁻¹	DO meters
Nitrate*	mg.L ⁻¹	Spectrophotometry
Total phosphate*	mg.L ⁻¹	Spectrophotometry

Note: * = Laboratory Analysis

Analysis of the Tourism Suitability Index (TSI)

The development of aquatic ecotourism needs to pay attention to the suitability of resources and the environment by meeting the required criteria and ecological aspects, and aspects of resource use by humans [10]. Analysis of tourism suitability in this study used the Tourism Suitability Index (TSI) of river tourism

areas by assessing resource parameters based on categories and scores. The score of each parameter was used to calculate the potential of the area for ecotourism. TSI formula is presented as follows [11]:

$$TSI = \sum_{i=1}^n Wi \times Si$$

Description:

- TSI = Tourism Suitability Index
- N = Number of conformity parameters
- Wi = Weight of i parameter
- Si = Score of i parameter

Criteria for Tourism suitability index (TSI) [11]

- 1.0 ≤ TSI < 2.0 = Not Suitable
- TSI > 2.0 = Suitable

Area Carrying Capacity of Ecotourism (ACC)

The carrying capacity of ecotourism considers two characters. First is the ability of nature to tolerate disturbances or pressures from humans, and second is the authenticity of natural resources. The ability of nature to tolerate and create a natural environment was calculated by approaching the ecological potential of visitors. i.e., the ability to accommodate visitors based on the type of tourism activity in a particular area. The carrying capacity of the area is the maximum number of visitors that can be physically accommodated in the existing area at any given time without causing disturbance to nature and humans. Knowing the carrying capacity can minimize the impact caused by the number of visitors who exceed the capacity [12]. Carrying capacity is adjusted to the characteristics of resources and designation, calculated based on the following formula [10].

$$ACC = E \times \frac{Au}{Ac} \times \frac{Tt}{Tp}$$

Description:

- ACC = Carrying capacity of tourist areas (person.day⁻¹)
- E = Ecological potential of visitors per unit area (person)
- Au = Area (m²) or length of area (m) that can be utilized
- Ac = Unit area for certain categories (m² or m)
- Tt = Time provided by the region for tourism activities in one day (hours)
- Tp = Time spent by visitors for each particular activity (hours)

Strategy Analysis

Analysis to formulate ecotourism development strategies was carried out using SWOT analysis. The SWOT analysis was used to systematically determine attractions based on internal and external factors [13]. Internal and external factors were determined through visitor and stakeholder interviews. The interview results were matched with the conditions of observation

in the field facts. The results obtained were then grouped into internal and external factors. Determination of ecotourism development strategies was obtained through a SWOT analysis using a matrix system (Table 2).

Table 2. Matrix of SWOT strategy analysis to evaluate ecotourism development

	Internal	Strength (S)	Weakness (W)
External			
Opportunity (O)		S-O Strategy (Strategy uses strength to take advantage of opportunity)	W-O Strategy (Strategy minimizes weakness to take advantage of opportunity)
Threat (T)		S-T Strategy (Strategy uses strength to overcome threat)	W-T Strategy (Strategy minimizes weakness to avoid threat)

RESULTS AND DISCUSSION

Physical and Chemical Parameter Conditions of the Aquatic Environment

River water quality in the tourist area of Lubuk Beringin was influenced by activities in the area. The environmental conditions of the waters in Lubuk Beringin were suitable for tourism activities, and the parameters were still in good condition. However, these waters had a high total of phosphate (Table 3).

Temperature is a crucial variable that can be influenced by sunlight radiation, cool at night, and by the influence of wind [14]. In the Lubuk Beringin region, the water temperature in this location ranged from 26°C to 28°C. The effect of vegetation cover around the river causes indirect sunlight on the waters. Surely this is good for organism life in the waters, because it is suitable for the organism. Temperature conditions become one of the parameters of comfort for visitors to move in the ecotourism area.

The availability of water resources can be influenced by the environment, i.e., no rain during the long dry season or high evaporation levels [15]. Such conditions will affect the existence and beauty value of the waters of Lubuk Beringin. Regional TSS values were below the quality standard of 3-15 mg.L⁻¹. Low TSS value caused water transparency at some points to equal to the depth. Water transparency is one of the important parameters to support ecotourism activities.

Turbid waters in the Lubuk Beringin Region are caused more by rain. However, tourism and other activities of surrounding communities such

as agriculture and animal husbandry also impact the water [16]. TSS, transparency, and turbidity are interrelated parameters [17]. The physical parameters of the water in the area can be used as a consideration in managing the area with the designation of nature conservation [18].

The pH conditions in the Lubuk Beringin waters were still normal in the range of 6. Ideal pH for the life of aquatic organisms in the range of 6-9 [19]. This pH condition is also still good for ecotourism activities. Dissolved oxygen ranged from 5 to 7 mg.L⁻¹, which is a very important compound for aquatic biota. It is also one of the chemical compounds needed by aquatic biota. The critical factor for most aquatic organisms is dissolved oxygen [20], which is measured as a supporting parameter to reflect water fertility and water conditions. In addition, it also reflects the dynamics of water, such as currents.

Table 3. The physico-chemical parameters condition of the aquatic environment

Parameters	Quality Standard	Recent Study
Physics		
Temperature (°C)	Change 3	26 – 28
Transparency (cm)	Not Listed	30 - 150
Depth (cm)	Not Listed	30 - ±200
TSS (mg.L ⁻¹)	50	3 - 15
Chemistry		
pH	6 - 9	6
DO (mg.L ⁻¹)	4	5 - 7
Nitrate (mg.L ⁻¹)	10	0.1 - 0.5
Total phosphate (mg.L ⁻¹)	0.2	0.1 - 1

Source: Primary data processed in 2020

Visitor Characteristics

Characteristics of visitors were dominated by male gender with an age range that dominated the age of 15-25 years. The dominant visitors were the Senior High School students. The average occupational status of visitors was still a student. The average income of visitors ranged from IDR 500,000 – 2,000,000 (Table 4).

Visitors aged 20-40 years were included in the young age group with a high curiosity; therefore, this group had a high tourist motivation [21]. The arrival of visitors to a tourist area can be income for the local community around it. Visitors, managers, and communities are inseparable parts of ecotourism development [22]. Characteristics of visitors are an essential tool for planning tourism management [23]. Education is a critical success factor in the development of river ecotourism. The visitors mostly are young people (high school education), because generally, the activities offered are playing water

and swimming. Meanwhile, visitors who see the scenery (which are generally the elderly) are a few people.

Table 4. Characteristics of visitors in Lubuk Beringin reservation area

Parameter	Criteria	Percentage (%)
Gender	Male	77
	Female	23
Age (years old)	15 - 25	70
	26 – 40	17
	>40	13
Education	Senior High/ Vocational School	67
	College Student (bachelor/master/doctor)	33
Profession	Student	60
	Private	23
	government employees	17
Income (IDR)	500,000 – 2,000,000	70
	> 2,000,000	30

Source: Primary data processed in 2020

The majority of visitors interviewed at the Lubuk Beringin tourism area came from Bungo Regency and outside Bungo Regency. It indicates that the area was not yet known to wider communities (Fig. 2). The motivation of visitors to come to a tourist area was to refresh themselves from their daily activities [24].

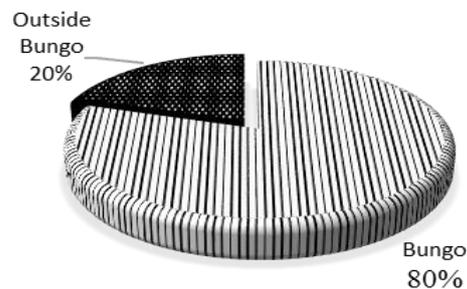


Figure 2. Composition of the area of origin of visitors

Perception and Concern Visitor

The level of understanding of visitors in ecotourism was relatively low level in which 70% of visitors did not know what ecotourism was, and only 30% of visitors did. The existence of mahseer, according to 83% of visitors, could be used as a tourist attraction. The concern of visitors to the Lubuk Beringin tourism area was quite high based on the data obtained by 93% of the visitors, and there were still 7% of visitors who did not care (Table 5). Ecotourism activities are expected to be able to increase the ultimate knowledge of ecotourism and the importance of the existence of river and fish ecosystems in the Lubuk Beringin area.

Table 5. Perceptions and concerns of Visitor

Parameter	Criteria	Percentage (%)
Ecotourism	Understand	30
	Did not understand	70
Mahseer as tourism attraction	possible	83
	impossible	17
Visitor concern	Care	93
	Does not care	7

Source: Primary data processed in 2020

Suitability of Relax Sitting-in

The suitability of relax sitting-in considers nine parameters in which the priority parameter was the width of the river. Scenery conditions around the area are forests and hills. The environmental conditions of the waters are slightly murky along the river. The relax sitting-in area was observed starting from near the entrance Area 1 to area 12 (Table 6, Fig. 3). The area that is suitable based on the TSI is Area 2, Area 4, Area 6, Area 7, Area 9, and Area 11.

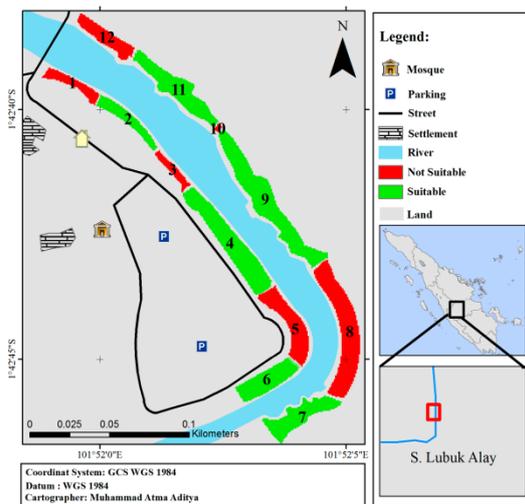


Figure 3. Tourism suitability index of relax sitting-in

Table 6. Tourism suitability index (TSI) in Lubuk Beringin for Relax Sitting-in

Area	River Width (m)	Ground Surface	Vegetation Cover (%)	Harmful Biota	Odor	Current Velocity (cm.sec ⁻¹)	Depth (m)	Relax Sitting- in	
								TSI	Description
1	34.30	Soil	10	None	None	-	-	1.80	Not suitable
2	49.00	Soil	12	None	None	1.88	0.05	2.08	Suitable
3	22.18	rock	20	None	None	2.22	0.45	1.68	Not suitable
4	76.00	grass	10	None	None	2.86	1.29	2.35	Suitable
5	53.50	small rocks	15	None	None	2.70	2.20	1.75	Not suitable
6	36.40	grass	5	None	None	2.80	1.06	2.15	Suitable
7	36.60	grass	35	None	None	2.80	1.06	2.45	Suitable
8	73.40	Soil	20	None	None	2.20	1.15	1.95	Not suitable
9	97.00	Soil	70	None	None	2.86	1.26	2.35	Suitable
10	10.50	Soil	20	None	None	1.88	0.05	1.68	Not suitable
11	58.50	Soil	10	None	None	1.88	0.05	2.08	Suitable
12	34.00	Soil	10	None	None	-	-	1.80	Not suitable

Source: Primary data processed in 2020

The observation area is very potential for the development of river ecotourism in the sit back and relax category. The Lubuk Beringin tourism area for this category is included in the suitability and unsuitability seen from the TSI value. The high TSI value is a priority for management, while priorities for the low value need to be improved and carried out with careful management. Some areas were not suitable due to the type of land overlay in the form of gravel. The type of stretch given the highest score was grass [10]. The condition of the waters in this tourism area is a bit murky, but the transparency of the waters is still visible to the bottom. The crystal clear waters are an attraction for traveling. Slightly turbid waters are suitable for river ecotourism activities for the water play or for relaxing sit-down alongside the river.

Suitability of Water Playing Recreation

The suitability of playing water recreation considers five supporting parameters (water transparency, depth, current velocity, odor, vegetation cover) with the priority parameters of transparency and depth (Table 7). Overall, the condition of the waters of the study area was a bit murky and smelled a little. Clear waters invite visitor curiosity [25]. In first Area 1, playing water was not suitable because there was no current river water at the time of study in the field. Depth is one factor that tourists most consider to do playing water activities. Area 4 and Area 6 were in a sloping state of approximately 45° with TSI value of 1.35 (not suitable). Maps produced from the suitability of take a relax sitting-in and playing water are combined into one suitability map with regard to space utilization (Fig. 6). Suitable areas for water recreation are Area 3, Area 5, Area 7, and Area 9.

Table 7. Tourism suitability index (TSI) in Lubuk Beringin for Water Playing Recreation

Area	Water Transparency	Vegetation Cover (%)	Odor	Current Velocity (cm.sec ⁻¹)	Depth (m)	Playing Water Recreation	
						TSI	Description
1	a bit murky		A bit smelled (natural mud)	-	-	0	Not suitable
2	a bit murky	15	A bit smelled (natural mud)	1.88	0.05	1.35	Not suitable
3	a bit murky	15	A bit smelled (natural mud)	2.22	0.45	2.25	Suitable
4	a bit murky	15	A bit smelled (natural mud)	2.22	0.45	1.35	Not suitable; slope of 45°
5	a bit murky	15	A bit smelled (natural mud)	2.60	0.45	2.25	Suitable
6	a bit murky	30	A bit smelled (natural mud)	2.60	0.45	1.35	Not suitable; slope of 45°
7	a bit murky	30	A bit smelled (natural mud)	2.86	1.29	2.35	Suitable
8	a bit murky	15	A bit smelled (natural mud)	2.86	2.20	1.65	Not suitable
9	a bit murky	10	A bit smelled (natural mud)	2.77	0.89	2.25	Suitable

Source: Primary data processed in 2020

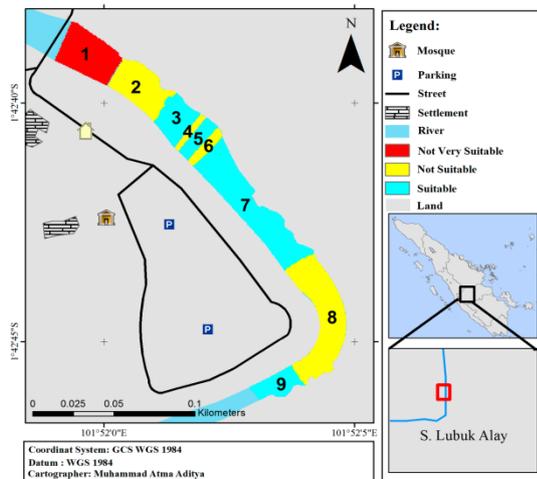


Figure 5. Tourism suitability index of playing water recreation

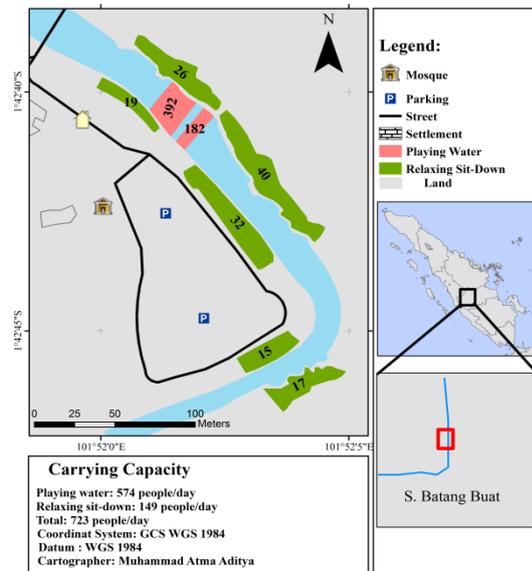


Figure 6. Tourism suitability index and carrying capacity

Carrying Capacity of Lubuk Beringin Tourism Area

One way to maintain the sustainability of tourism activities is to pay attention to the

carrying capacity of the region. The calculation of carrying capacity was based on the suitability analysis results, which have appropriate and highly appropriate values. If an activity in the tourist area starts from 08.00 AM to 04.00 PM, it means the time provided by the area for tourists (Tt) is 8 hours.day⁻¹. The carrying capacity of the Lubuk Beringin area can accommodate 2354 persons.day⁻¹.

The length of the area required for the relax sitting-in category was 10 m per 1 visitor; therefore, the length of the area that can be utilized was 374 m with a carrying capacity of 149 persons.day⁻¹. The time provided by the region was 8 hours.day⁻¹, while the maximum time for the relax sitting-in category was 2 hours; therefore, in 1 day, it can be divided into 4 hours sit back and relax recreations. The carrying capacity area for the relax sitting-in category was highest in the Area 9 by 40 persons.day⁻¹ and the lowest in the Area 6 was 15 persons.day⁻¹.

The area required for the playing water category was 20 m² per two visitors, so the area that can be utilized is 2743 m² with a carrying capacity of 2194 persons.day⁻¹. The time provided by the region was 8 hours.day⁻¹, while the maximum time for the relaxing playing water category was 1 hour, and in 1 day, it could be divided into eight relax playing water trips.

Restrictions on visitors can minimize the negative impacts on the region, and also visitors can get the satisfaction of traveling [26]. The level of visitor satisfaction is something that the manager needs to pay attention to. Since this affects the comfort of visitors travels in the area and also affects the number of visitors who come.

Visitors who come to this tourism area are still small in number. Based on the existing area, the carrying capacity of visitors is smaller than

tourism potential in the Bingai Namu Sira Sira-Langkat River (North Sumatra) [27].

Development Strategies

Based on field observations conducted in October 2019, several factors related to the ecotourism development strategy are presented in Table 9. The strength factor is related to the potential of mahseer resources, while the weakness factor is related to the management not being optimal yet. The opportunity factor is related to positive things from outside that support the management of Mahseer and its management. The threat factor is related to activities or phenomena that are disturbing or threatening the existence of the Mahseer ecosystem and its management.

Alternative strategies are obtained from the combination of each existing factor. Some management strategy recommendations are prioritized in the top four rankings, which are the top priority for management strategies. The recommendations generated based on the strategy are as follows:

Table 9. Internal and external factors in Lubuk Beringin tourism management

Symbol	Internal and External factors
Strength	
S1	The existence of Mahseer, rare fish
S2	There is socialization or warning to preserve resources
S3	There is already a water reservation area of the Mahseer
Weakness	
W1	The absence of information on activities that are prohibited and which are permitted in ecotourism activities
W2	Not optimal utilization of fish resources for ecotourism activities
W3	No formation of culture to maintain sustainability
Opportunity	
O1	Public awareness of the sustainability of Mahseer
O2	High visitor interest
O3	Customary rules/laws that have a very positive impact on the survival of Mahseer
Threat	
T1	Waste from visitors' activities
T2	Waste from surrounding community activities
T3	Lack of understanding of the community and visitors related to ecotourism

Source: Primary data processed in 2020

1. Zonation in The Lubuk Beringin Region

Special studies related to the zonation of this tourism area have never been carried out. However, zonation is necessary to be done for legal aspects and to avoid overlapping interests in the future [28]. The

first alternative strategy is the WO (weakness-opportunity) strategy. This strategy needs to be applied in the management and development of ecotourism in the Lubuk Beringin Region. The zonation of the water reservation zone and the utilization zone for tourism have not been clearly divided, and visitors do not know which part is the water reservation and which part is for tourism activities. It causes the disruption of the Mahseer due to stunted growth of the fish, or fish become araid.

2. Ecotourism Development in accordance with the Existing Potential

The second alternative strategy is the SO (strength-opportunity) strategy. The Lubuk Beringin area has a potential for very high ecotourism developments. The results of this study indicate this area can be developed into two categories of river ecotourism: relax sitting-in and playing water. On the field observations, this area includes an area that has no hot climate and clear water, which it suitable for tourism development [29].

3. Coordination Between Government and community For Development of Ecotourism

The third alternative strategy is still the SO (strength-opportunity) strategy. Coordination of the government as Lubuk Beringin area manager with the surrounding communities that support each other is the basis of ecotourism management. Coordination between community and managers conducted by discussions aimed at planning programs to develop ecotourism activities. Ecotourism should be able to increase community welfare [30]. There has been no special study related to cooperation between government agencies and communities in this region. However, there are several agencies (Ministry of Public Works, Fisheries Office, Forestry Office, and Local Government) and the community that are potentially able to support developing ecotourism [31].

4. Ecotourism Development through the Improvement of Infrastructure

The first alternative strategy is the WT (weakness-threat) strategy. Infrastructure is one of the problems in developing ecotourism in the area. It is unfortunate because the tourism potential in this area is huge. Development of infrastructure is necessary to support tourism activities. However, the development of infrastructure has to continue

to maintain the sustainability of the mahseer and its habitat. Based on field observations, access roads to this location are still narrow, and some are unpaved. Therefore, it is important to build and repaired the road for better transportation access to this tourism location [32].

The condition of the study area is still suitable enough to be developed. In this area, based on field observations, there is no population pressure on the river ecosystem (namely pollution, waste disposal, sedimentation, or other uses). Thus, the environmental parameters (physical-chemical) become an important element in the designation of tourism potential.

CONCLUSION

The Lubuk Beringin area had the potential to develop Mahseer-based ecotourism. The quality of water, in general, was good and meets the requirements for ecotourism activities. Tourism activities that can be developed include playing water with a carrying capacity of 574 persons.day⁻¹ and relax sitting-in with a carrying capacity of 149 persons.day⁻¹. An evaluation in the area management is required to implement a management strategy by zonation, ecotourism development in accordance with the existing potential, coordination between government and local community, and improvement of infrastructure.

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