Carrying Capacity Model Applied to Coastal Ecotourism of Baluran National Park, Indonesia

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Abstract. The resources of Baluran National Park have been used for marine and coastal ecotourism. The increasing number of visitors has led to the increasing of tourists and its related activities. This condition will cause the degradation of resources and the welfare of local communities. This research aims to determine the sustainability of coastal ecotourism management by calculating the effective number of tourists who can be accepted. The study uses the concept of tourism carrying capacity, consists the ecological environment, economic, social and physical carrying capacity. The results of the combined carrying capacity analysis in Baluran National Park ecotourism shows that the number of 3,288 people per day (151,248 tourists per year) is the maximum number of accepted tourists. The current number of tourist arrivals is only 241 people per day (87,990 tourists per year) which is far below the carrying capacity.

1. Introduction

One of the tourist destinations who has been and developed in Indonesia is a Baluran National Park that not only functions as a conservation for various types of plants and animals, but also have potential for ecotourism. This region has a physical landscape structure that can be used for tourism activities. Currently, many coastal tourism activities were already in progress, such as beach tourism, snorkeling, diving and mangrove tours. Various community groups such as family group, students, government and foreign tourists usually spend their long holiday to travel in Baluran National Park. In the recent two years, the number of tourist visiting to Baluran National Park has increased. In 2013, the number of tourists is 39,866 persons, and in 2014 reached to 58,169 persons. The increasing number of visitor absolutely has an impact, both positive and negative effect, especially for coastal natural resources condition in Baluran National Park. Coastal tourism activities in Baluran National Parks essentially contribute to economic growth and prosperity of local communities. On the other hand, these activities also had a negative impact on the preservation of coastal resources like coral reefs and mangroves. For this reason, restrictions on tourists’ visit are necessary in considering natural resource support in Baluran National Park.

The concept of tourism carrying capacity arises from the perception that tourism cannot grow continuously in a particular region without causing irreversible damage to the local [1]. The concept of carrying capacity in tourism has its origins in the 1960’s, when it was developed to place limits on the numbers of visitors that a tourist attraction (such as a natural reserve) or destination could cope with [1]. The concept of carrying capacity in tourism was very much in vogue in the 1970s and has encountered a fall in interest since then [2]. Many definitions of tourism carrying capacity have been proposed [3,4] but the best is the World Tourism Organization’s definition; i.e: “the maximum number of people that
may visit a tourist destination at the same time without causing destruction of the physical, economic or socio-cultural environment and an unacceptable decrease in the quality of the tourist satisfaction” [3]. This definition implies various capacities: physical, economic, perceptual, social, ecological, and political [5]. This research is aimed to determine the sustainability of coastal ecotourism management based on the carrying capacity of the ecological, economic, social and physical environment.

2. Methods
This research was conducted in Baluran National Park which is administratively located in the District Banyuputih, Situbondo, East Java, Indonesia. This area is restrained by Madura Strait in the North, Bali Strait in the East, and the River Bajulmati, Wonorejo village in South, next to the West River Klokoran, Sumberanyar village. The Baluran National Park has an area of 25,000 ha with a coastline of 42 km [6]. This study is focused on coastal areas. Baluran National Park is located in the Latitude of 7°50’10.3” and Longitude 114°24’19.4”. Figure 1 shows the map of research sites.

![Study Area Map](image)

**Figure 1. Study Area**

The data collected in the study were classified into primary data and secondary data. The object of the research is natural resources associated with the coastal tourist activities include coral reefs, mangrove forests, beaches, water quality, rating, community, tourism entrepreneurs, supporting individual infrastructure and institutions related to the management of the park. Collected data were tabulated and grouped by interest analysis to address concerns and research purposes.

2.1 Carrying capacity of ecotourism coastal ecology
The ecological carrying capacity of ecotourism is analysed by the area attractions that are susceptible to direct damage and the maximum load of waste.

2.1.1 Utilization of tourist areas.
Estimation of the carrying capacity activities for utilization conservation area is following the
government regulation (Government Regulation No. 18/1994) about the utilization of natural tourism attraction in the zone of national parks and Natural Park which is 10% of the utilization zone. Based on these considerations, a formulation to calculate the carrying capacity of the area for coastal tourism activities in conservation areas [7] is expressed as:

\[ \text{Carrying capacity} = 0.1 \left( \frac{K}{L_t W_p} \right) \]  

(1)

K is a maximum number of tourists per unit area, \( L_p \) is the area or length of the area that can be used, \( L_t \) is a unit area for particular category, \( W_t \) is the time reserved area for tourism activities per day, \( W_p \) is the time spent by a visitor to any particular activities. Space requirements for coastal tourism refers to [8], [9], [10].

**Table 1.** The value of K, \( L_t \), \( W_p \) and \( W_t \) for coastal tourism activities [5],[3],[6].

| Number | Activity          | K  | \( L_t \)  | \( W_p \) | \( W_t \) |
|--------|------------------|----|----------|----------|----------|
| 1      | Diving           | 2  | 1000 m²  | 2        | 8        |
| 2      | Snorkelling      | 1  | 300 m²   | 3        | 6        |
| 3      | Beach Tourism    | 1  | 20 m²    | 3        | 6        |
| 4      | Mangrove Excursion | 1  | 100 m²   | 2        | 8        |

2.1.2. Sea water pollution. The number of human population who move to coastal areas influence the maximum limit of allowed water usage to maintaining standard water quality for coastal tourism. Standards of coastal tourism water quality is the range of values that can sustain water quality for aquatic biota. It is assumed that tourists and residents who move in the area of the park produce waste that possibly pollute the waters.

2.2. Physical carrying capability
World tourism organization, in [11] provides a standard development of tourism facilities (resort and supporters) in coastal areas and small islands in order to limit the number of tourist visits. It is designed that natural resources in the region socially sustainable (not interfere with the local community). Physical carrying capacity indicates the amount of area that can be used for infrastructure / tourist facilities without disturbing the comfort of locals or other travelers. Standard space requirements for coastal tourist facilities can be seen in Table 2.

**Table 2.** Standard Space Requirement for Coastal Tourism Facilities.

| Number | Commentary          | Unit | Information                                      |
|--------|---------------------|------|--------------------------------------------------|
| 1      | Coast capacity      | m²   | Max.Quantity of person per 20-50 m² coast        |
|        | Low Class           | 10   | 2.0-5.0                                          |
|        | Middle Class        | 15   | 1.5-3.5                                          |
|        | High Class          | 20   | 1.0-3.0                                          |
|        | Luxurious Class     | 30   | 0.7-1.5                                          |
| 2      | Coast Facilities    |      | Hygienic Facilities : 5 unit of toilets. 2 bathrooms and 4 showers for each 500 people |
| 3      | Capacity of         | 60-100 bedroom/ha |                                             |
|        | accommodation       |      |                                                  |

2.3. Social and economic carrying capacity
The social carrying capacity express that the increment of time and the number of people, resulted in the increment of the need for human interaction and competition among human beings in the occupied area [12]. Consequently, discomfort (dissatisfaction) arise between one human being to another and disturbed (unsustainable). Some of the parameters needed to analyze the social carrying capacity are the
public perception of tourism, feelings and reactions to the arrival of tourists, lifestyle changes related to tourism, and tourists as well as local communities’ perceptions associated with comfort in interacting and conducting respectively. The method used to assess the carrying capacity is descriptive analysis and agreement [12].

Economic carrying capacity analysis in this study is approached by supply and demand, derived from the balance between supply and demand functions which generate coastal tourism product prices and the optimum number of tourists throughout the year. Based on these two values, the magnitude of the economic value of coastal ecotourism resource can be observed. Economic carrying capacity with the bidding approach is an approach used to analyze the economic potential of coastal resources developed as coastal ecotourism products. The calculation of the economic carrying capacity to micro bidding approach related to activities of travel services by companies that have consequences on production costs. The total cost (TC) issued by travel company is a function of supply whose value depends on the number of tourist arrivals (V) or mathematically written TC = f (V). Based on this, the economic capacity analysis is supported by the analysis of the costs arising marginal. Marginal cost (MC) is the ratio of change in the total production cost of coastal ecotourism to the changes in the number of tourists or can be written:

\[ MC = \frac{\partial TC}{\partial V} \quad (2) \]

Travel demand approach is an approach used to analyze the magnitude of coastal tourism product demand by tourists is limited by the cost of travel, tourist income, changes in prices and other factors. Approach this request was analyzed by measuring the magnitude of the ability to pay (Willingness to Pay, WTP) by travelers in conducting coastal tourism. The method used to measure the WTP is the method of travel expenses (Travel Cost Method TCM) in order to obtain the value of consumer surplus. The maximum amount (the carrying capacity of the economy) tourists visiting the Baluran National Park and the maximum price that can be paid is obtained by balance between function related to coastal ecotourism product demand function (Supply = Demand).

2.4. Composite carrying capability

The combined carrying capacity analysis performed to obtain the value of the carrying capacity of a standard that will be presented as the basis for the management of coastal ecotourism in the National Park Baluran. By taking into account the four dimensions of ecological, social, economic and physical [3] in [8]. Operational approach in determining the carrying capacity that integrated from the fourth dimension is optimizing the values of the technical parameters and the carrying capacity that has produced by four dimensions. The fourth optimization carrying capacity by using linear goal programming, on the basis of the following formula [8]:

\[ Z = \sum_{i=1}^{4} DU_i atau DO_i \]

\[ \sum_{i=1}^{4} a_i X + DU_i - DO_i = b_i \approx X, a_i, b_i \geq 0 \approx DU, DO = 0 \quad (4) \]

Where:
- DU and DO = bearing capacity has not been reached and exceeded the carrying capacity of the target \( b_i \)
- \( a_i \) = coefficient of each parameter function carrying capacity constraints \( i \)
- \( X \) = optimal carrying capacity (combined)
- \( b_i \) = target each parameter carrying capacity

3. Result and Discussions

Generally, environmental carrying capacity is a maximum capacity to support an organism to grow. The amounts of capacity in an area are influenced by the condition and characteristics of existing resources in an area. The capacity of the environment and resources in Baluran National Park will become a
limiting factor in determining the appropriate utilization of space. A geobiophysics factor in coastal tourism affect the fragility of an ecosystem on the carrying capacity of coastal tourism [13]. Coastal ecotourism carrying capacity comprises of physical, ecological carrying capacity, social carrying capacity and economic carrying capacity.

3.1. Ecological carrying capacity
Ecological carrying capacity analysis is based on the maximum number of visitors who physically can fit in the area provided at a certain time without disturbing the natural and society. In this research, is based on the necessary space that can be accommodated in the region is very suitable for coastal tourism at a certain time. Due to the study is in the area of conservation (Baluran National Park), tourism activities are not mass tourism and visitor space is very limited, the determination of the carrying capacity of the region should consider aspects of environmental sustainability. So, the authorized area for tourist utilization is 10% of the total area. There are several values used in the calculation of the carrying capacity to the conditions and perceptions of tourism players in Baluran National Park, such as average time of diving, snorkeling, mangrove and beach tourism. The results of the analysis of ecological carrying capacity in Baluran National Park are presented in Table 3.

| No. | Coastal tourism activities | DDK (people/day) | Condition Existing (people/day) |
|-----|---------------------------|-----------------|---------------------------------|
| 1   | Mangrove Excursion        | 1813            | 50-70                           |
| 2   | Beach tourism             | 3680            | 50-100                          |
| 3   | Snorkeling                | 756             | 10-30                           |
| 4   | Diving                    | 404             | 5-10                            |
| Total|                           | 6653            | Maximum 210                     |

Table above shows that total carrying capacity for the coastal tourism activities is 6,653 visitors a day and 306,038 annually (assuming the effective day of activities 46 travel days per year). Snorkeling and diving capacity have a smaller amount than the other, because of the limitations of rental equipment and diving guide. Considering the current utilization and enthusiast, then the possibility of snorkeling will reach to maximum carrying capacity, especially in peak season. In the area of tourism, carrying capacity of mangrove which is usually used as a tourist attraction tracking only in Resort Bama, while other areas are still undeveloped. Attempts to increase the visitor carrying capacity should be supported by the aquatic condition in the Baluran National Park. The results of the aquatic analysis compared to the quality standard for marine tourism indicate below the standards (in accordance with the Environment Decree No. 51 2004). The results of the analysis show the maximum linear proibity the number of tourists as many as 14 585 people per day.

3.2. Physical carrying capacity
Physical carrying capacity is the maximum utilization of a resource or ecosystem that can be absorbed by an area without causes a decrease in physical quality. Method to analyzing the physical carrying capacity was compared between standard requirements space [11] with the reality of the use of coastal areas to travel at this time. Some indicators used are; beach capacity, room capacity, density and the presence of boat rentals presented in Table 4.

| No. | Description | Reality in Baluran National Park | Standard Facility of coastal eco-tourism information |
|-----|-------------|---------------------------------|-----------------------------------------------------|
| 1   | Coast facility | Each room: 2 people, 1 toilet, 1 bathroom, 1 shower. There are 4 showers out room in homestay for 20 people. | Facility cleanliness: 5-unit suitable toilet, 2 bathrooms, 4 showers for 500 people |
2 Capacity of accommodation 80 bedrooms 60-100 bedroom suitable
3 Facility of traditional fishing boat 3 boats, 1 glass boat, 75 traditional fishing boat 50-200 traditional fishing boat suitable

Table 4. Shows that physically, coastal tourism facilities in each coastal tourist business location not exceed the carrying capacity (standard requirement amenities). There are some areas that still do not meet the infrastructure facilities and infrastructure. Thus, when the peak season there are several coastal tourist activities used with limited facilities. In peak season or certain activities, room needs sometimes exceed capacity (80 rooms), which reaches 160 people per day, so travelers forget reduced.

3.3. Social carrying capacity
Social carrying capacity assessment in this study is the level of public acceptance of local (host) with the arrival of the visitors (tourist) without disturbing the existing comfort. It is assumed that there is the maximum number of tourists visiting the Baluran National Park, so that local people do not feel disturbed by the arrival of tourists. Results showed 70% of local people give the perception that there is no change in the behavior of the local community since the tourists especially foreign tourists and 10% of people expressed no behavioral change in local communities. The behavioral changes regarding everything related to the activity which is always valued by money or there is a trend shift in the value of individuality (lack of help each other), and change the way they dress. In addition, the presence of tourists has not been a significant influence in the economy and changes in the quality of life of local communities so that presence to be addressed by ordinary travelers.

Associated with the convenience of local communities to the presence of tourists, the results showed that a variety of opinions and ratings of local people and tourists about the optimum ratio between tourists and local communities. Generally, local people claimed that in addition to the increase in the number of tourist visits, discomfort can be disturbed society mainly due to the way social interaction. But if people given the freedom to choose the ratio travelers with local people, then as many as 90% of respondents expressed a 1-30 rating compared to the local population (10% choose one versus 20). This shows that there is a possibility where a traveler can interfere with the 1 or the 30 local communities, depending on how the interaction and behavior among tourists with the local community. If we assume the total population Wonorejo village in 2014 was 6576 people, and the interaction between tourists and local communities, the maximum number of tourists visiting in Baluran National Park is 220 persons per day (this number is still smaller than the ecological carrying capacity 6653 people). As explained by [12], that inconvenience a person can choose to receive when someone else got to interact (Social Carrying Capacity), although ecologically (Biological Carrying Capacity) is still available space for people to interact [12].

3.4. Economical carrying capacity
Carrying capacity of the economy in this study using the approach of supply and demand, derived from the balance between supply and demand functions which generate coastal tourism product prices and the optimum number of tourists throughout the year. Based on these two can be seen also the magnitude of the economic resources of coastal ecotourism. The results of the economic analysis of the carrying capacity of tourist demand side will be obtained coastal ecotourism products consumer surplus per year amounting to Rp 189 328 thousand per traveler or USD 87.790 16 659 million per traveler. The average cost incurred by tourists today is Rp 300 thousand per day. Economic resources coastal tourism is still relatively small. This could be due to low accessibility to the coastal ecotourism locations in the park, and the lack of promotion by the central and local governments. Consumer surplus could increase if carried out improvements in support services and facilities [8].

Carrying capacity analysis in this study is a travel product on the balanced position between demand and supply of coastal ecotourism products. The results of analysis of the carrying capacity in the
The economic equilibrium position is 131,975 people per year with optimal price coastal ecotourism products that can be applied to any visitor to US $ 1,444.82 per visit. Maximum economy which can be obtained in the use of coastal tourism in Baluran National Park Rp. 34.33 billion per year. Based on the carrying capacity of this economy, the maximum number of tourists who can visit the tourist business is 2,869 people per day. The carrying capacity is smaller than the ecological carrying capacity. The economic capacity of a conservation area can be improved through effective and optimum [14] management (in terms of conservation management) and an increase in tourist knowledge. Improved knowledge of marine ecotourism activities especially snorkeling, diving tourism, distribution and rotation of each dive, setting space and time for snorkeling and underwater photographers is expected to provide a relatively small impact damage [8].

3.5. Combined analysis carrying capability
Carrying capacity can be measured in a level of tourist arrivals, which is associated with individual activities, amenities and special services [8]. Combined fourth-carrying capacity is intended to obtain an optimal value of the carrying capacity of coastal ecotourism that has considered the fourth aspect. Operationally means that the number of tourists coming into Baluran National Park by a combined carrying capacity, able to minimize the degradation of coastal resources, are economically profitable, in accordance with the capacity of lodging, tourists and people feel comfortable with the coastal ecotourism activities.

The considering the four aspects of carrying capacity, the maximum number of tourists who can go into the coastal ecotourism in Baluran National Park is 3,288 people per day (151,248 tourists per year). The combined carrying capacity is an optimal value that accommodate the interests of ecological, social, economic and physical management of coastal ecotourism. Value effectiveness of coastal ecotourism management and carrying capacity generated is expected to be used as guidance in the management of coastal ecotourism including local understanding of ecotourism. The management of ecotourism always consider the ecological, social and economic aspects [15], therefore ecologically highly vulnerable marine tourism activities will damage marine resources and socially may bring inconvenience to the local community.

4. Conclusions
The results of the combined carrying capacity analysis in ecotourism Baluran National Park shows that the number of 3,288 people per day (151,248 tourists per year) is the maximum number of accepted tourists. The current number of tourist arrivals is only 241 people per day (87,990 tourists per year) which is far below the carrying capacity. The condition shows the high possibility to increase the number for tourists. Based on the carrying capacity per dimension per day, it shows that the ecological carrying capacity is 6,653 people per day, while the maximum number of tourist which is able to be accepted considering physical carrying capacity is 160 people per day. In terms of Social carrying capacity, Baluran National Park can accept 220 people per day, and in terms of Economical aspect, 2,869 people per day can be accommodated. Based on the analysis, the carrying capacity of the area can be improved if the magnitude of the extent of coral reefs and mangrove forests is well maintained and increased its presence.

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