

# Carrying Capacity of Gancik Hill Top for Ecotourism Development in Boyolali District

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**Abstract.** Gancik Hill Top is one of the popular destinations in Boyolali District. Gancik Hill Top tourist destination is located at the foot of Mount Merbabu with an altitude between 1850 m above sea level that presents the concept of mountain resorts in the form of a view of Mount Merapi and is an alternative path to climb Mount Merbabu. Tourist visits from the Selo climbing route are the highest compared to the three climbing routes opened by the Gunung Merbabu National Park. Stretching tourist interest through the Selo line due to other supporting factors such as the traditions and culture of the local community. Selo is included in landslide prone areas in the area of Gunung Merbabu National Park. Soil conditions with a level of 4-70% slope does not make consideration for the community in the processing of the land because it is still dependent on the agricultural sector. Assessment of carrying capacity to illustrate the concept of ecotourism development. This study aims to analyze the carrying capacity of ecotourism development. This research is done with quantitative approach. This study used a modified Cifuentes formula that is Physical Carrying Capacity (PCC), Real Carrying Capacity and Effective Carrying Capacity (ECC).

Keywords: **carrying capacity; ecotourism; gancik hill top.**

## 1 Introduction

The development of tourist destination areas is often not adapted to appropriate processing in the utilization of tourist attraction. Tourism development usually prioritizes tourist attractions and services in order to increase interest and satisfaction to boost the number of tourist visits. Efforts to protect and conserve tourist destinations from the biophysical aspect are sometimes ignored by the management. The carrying capacity problem in ecotourism is quite important because it is closely related to environmental damage [1]. However, environmental conditions need to be considered because if there is disruption of environmental quality of one tourist attraction, it can be ascertained that the attraction will be disturbed or decreased [2]. If in the development of a tourist destination area does not go through the planning properly then the number of tourist visits can exceed the carrying capacity of the environment.

Management of tourist destination areas is implemented in an integrated manner and prioritized on the adjustment of facilities with the carrying capacity. This concept affects the restriction of space and intensity of visitors and ultimately aims to maintain sustainability. The paradigm of sustainable nature tourism is at the core of ecological, economic and social factors in which each factor contributes positively to other factors [3]. Sustainable development is formulated as a development

that meets the needs of the present without compromising the right to meet the needs of future generations while still integrating the implementation of the three pillars of development, namely economic, social and environmental [4]. Sustainable tourism development aims to maintain a balance between nature and humans which in turn is in line with the concept of low carbon development.

## 2 Meaning and Definitions of Carrying Capacity

Carrying capacity of the environment participate in influencing the quality of satisfaction and comfort of tourists in enjoying the tourist destination [5]. The carrying capacity of the tourist destination is closely related to the number of tourists visiting. This condition is important to know the maximum threshold of the number of tourists who are in the area of the tourist destination at the same time so it can be a warning for the manager in planning the development of tourist destinations. The high number of tourists visiting will have an impact on the environment as it puts more pressure on the environment. Richardson & Fluker (2004) added that the impact of tourism on the environment is due to the use of transportation, the construction of tourism facilities, the pressure on natural

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resources, the destruction of wild habitats, and pollution [6].

### 3 Factors Affecting The Carrying Capacity of An Area

There are two aspects of tourism utilization that are integrally related to carrying capacity, among others is to protect the resources and quality of travel experience [7]. In general understanding, the carrying capacity is related to the amount and type of utilization acceptable to protected areas and associated areas without negatively impacting the area and the quality of the tour [8].

Carrying capacity also includes the carrying capacity of geobio-physical, socio-cultural and socio-economic of a tourist destination in supporting tourism activities without reducing the quality of the environment and the satisfaction of tourists. Soemarwoto (2004) states that geobio-physical factors in a natural tourism area influence the strong vulnerability of an ecosystem to the carrying capacity of natural tourism. A strong ecosystem will have a strong carrying capacity as well, this is evidenced by being able to receive the amount of tourists because it will recover in spite of damage [9].

Concept of carrying capacity is a concept that is not difficult but not easy to be calculated. This concept varies greatly with time, climate and characteristics according to tourist destinations such as coastal areas, protected areas, rural, mountains, and historical areas. Douglas (1979) defines the carrying capacity of the tourist environment as the number of tourists using an area for travel that can still be supported by the area marked without any change in the quality of tourism [5].

Cifuentes (1992) adds that Physical Carrying Capacity (PCC) refers to the maximum number of visits, which physically can be done in one day. Furthermore, it is necessary to consider the real carrying capacity (RCC) value of physical carrying capacity that has been corrected by environmental limiting factors (physical, biological aspects) that affect the maximum number of visitors who are physically acceptable to the environment. The role of the manager also affects the real carrying capacity in providing maximum service so as to increase the effective carrying capacity (Effective Carrying Capacity/ ECC). The value of this effective carrying capacity represents the maximum number of visitors allowed to be on a public area tourist site where the real carrying capacity is associated with management capacity [7]. This ECC concept uses RCC calculation as PCC which is influenced by ecosystem variable that is biotic and abiotic variable. Both variables are correction factor of PCC. The correction factor as a limiting factor for the effective carrying capacity.

Environmental carrying capacity is also a consideration in an effort to maintain environmental quality, visitor safety and quality experience of tourist locations [10]. There are several components to be able to calculate the carrying capacity:

#### 1. Physical carrying capacity.

This carrying capacity relates to environmental capabilities that depend on the capacity of natural resources, systems and environmental capabilities to

assimilate impacts. Examples are the ecological capabilities of the land, climates such as the influence of frequency and precipitation.

#### 2. Biological carrying capacity.

This carrying capacity is related to the ecosystem and its use ecologically. Examples are flora fauna, natural habitat and landscape.

#### 3. Socio-cultural support capacity of the community.

This carrying capacity is mainly related to the recipient community of tourists in the form of cultural diversity and customs of the inhabitants.

Output from the calculation of effective carrying capacity (ECC) is the number of tourist visits per day. This condition is next to be compared with the number of real tourist visits per day in Gancik Hill Top obtained from local area data manager. Both conditions are conducted to test the hypothesis of whether the effective carrying capacity (ECC) has exceeded the number or not.

### 4 Methods

The assessment framework of the carrying capacity of the tourist environment in the protected area refers to the power calculation formula support tourism developed by Cifuentes (1992). This template tries to set the number of visits the maximum of an area which is based on the physical, biological and management conditions of the area, consider three main levels: Physical Carrying Capacity (PCC), Real Carrying Capacity (RCC) and Effective Carrying Capacity (ECC). Application this method takes into account several important elements such as the flow of tourists (tourist flows), size of area, amount maximum space available for each of the free-moving travelers and time of visit [11].

The formula used in the calculation of carrying capacity of the tourist environment based on Cifuentes method (1992) the result of modification with research by Douglass (1975) [1]:

$$PCC = A \times \frac{1}{B} \times Rf \quad (1)$$

PCC is the physical carrying capacity that is the maximum limit of visits that can be made in one day; A is the area used for tourism; B is the area needed by a tourist to travel with still get satisfaction (activity picnic value B is 65 m<sup>2</sup>); Rf is the rotation factor. While the real carrying capacity refers to the formula Cifuentes (1992) by [11].

$$RCC = PCC \times Cf_1 \times Cf_2 \times \dots \times Cfn \quad (2)$$

RCC is the real carrying capacity that is the maximum number of visitors that can visit certain tourist area sites based on correction factors according to local biophysical character; PCC is physical carrying capacity; Cf ..... Cfn are correction factors of biophysical parameters the environment of a tourist area. To calculate the Cfn correction factor using the following formula [11]:

$$Cfn = 1 - (Mn/Mt) \quad (3)$$

Cfn is the n-correction factor associated with the n-component data; Mn is the real condition in the variable fn counted; Mt is the maximum limit on the variable fn. The correction factor of the biophysical aspect environment in Gancik Hill Top tourist area that is identified as a limiting factor on tourism activities especially towards tourist visits to the tourist areas as well as the satisfaction and convenience of tourists moving.

The calculation of this correction factor is based on the formula used in the assessment of carrying capacity tourist environment in the tourist area of Grojogan Sewu (with author modifications) [12]. As for the attractions of Gancik Hill Top, biophysical factors identified as limiting factors in the calculation of carrying capacity of the tourist environment:

1. Rainfall (Cf<sub>1</sub>)

The rainy season is quite affecting tourism activities in Gancik Hill Top which is where in the months with high rainfall intensity and many tend to influence the number of tourist arrivals coming. Calculation the rainfall correction factor according to Sustris (2009) is based on the Rainfall Index over the past 10 years with compare the dry and wet months using the equations [6]:

$$Index\ CH = \Sigma\ Wet\ Month : \Sigma\ Dry\ Month \quad (4)$$

2. Soil Erosivity (Cf<sub>3</sub>)

Land sensitivity of a tourist area is very influential on tourism activities. A tourist area whose land sensitivity high means to have the rate of erosion or landslide also become big. Correction factor calculation erosivity assessed in the form of sensitivity of soil erosion based on soil type using Erosion Rate Index) [12].

The effective carrying capacity is a result of a combination of real carrying capacity with the capacity of tourism area management, such as described by the following formula:

$$ECC = PCC \times MC \quad (5)$$

ECC is the effective carrying capacity; PCC is the physical carrying capacity; MC is the area management capacity. This last parameter is approached through the officer's capacity managers in the tourist area, using the formula [12]:

$$MC = \frac{Rn}{Rt} \times 100\% \quad (6)$$

Rn is the number of existing management officers; Rt is the number of required management personnel.

## 5 Results

Problems that arise with the absence of ecotourism management based on the carrying capacity of the environment causing the interruption of the form garbage, vandalism and the use of areas that are not appropriately designated. Besides it's a condition where visitors exceed the carrying capacity feared will reducing

the quality of travel experience / satisfaction. No visitor satisfaction become the main limits in ecotourism management but there are limits environments such as area and time of visit [13]. So it becomes important to know the carrying capacity of the environment inside ecotourism activities.

### 5.1 Physical Carrying Capacity

Visitors of Gancik Hill Top in June amounted to 12,571 people, an average daily visitor of 419 people. The calculation of the physical carrying capacity in the Gancik Hill Top tourist area used the values established by management and standard / criteria of previous study results include:

1. The area used for tourism (A) is differentiated by division each room/ sub-space at the Gancik Hill Top tourist site that is 15.000 m<sup>2</sup>.
2. The breadth needed by one tourist for activity (B) is set of 65 m<sup>2</sup> for picnic activity refers to Douglass's research (1975) [1].
3. The value of the rotation factor (Rf) of the calculation is 4 means that in one day tours and opening hours Gancik Hill Top attractions over 12 hours (05.00 - 17.00) receive visits 4 times per day with visit duration is 3 hours per visit.

Based on 3 (three) main components above then can be calculated Physical Carrying Capacity according to the calculation formula PCC in each of the tourist spaces as well as the entire tourist area and obtained results as presented in Table 1.

**Table 1.** Physical Carrying Capacity (PCC)

A (m2)	B (m2)	Rf	PCC (days)	PCC (months)
19.000	65	4	1.169	35.070

Based on the above table it can be said that satisfaction visitors will still be increase if in 1 (one) day Gancik Hill Top tourist sites visited or accommodate as many as 1.169 people. Value the physical carrying capacity only sees the physical (broad) area and not consider other environmental factors.

PCC Gancik Hill Top if associated with the number of actual visitors in June that is 419 visitor per day still below the value of physical carrying capacity calculation result that is 1.169 visitor/ day. This assumption does not take into account peak seasons as well as off-season. While the characteristics of visits to Gancik Hill Top attractions can be distinguished based on the time of the visit is the quiet season of visitors and the season crowded visitors. PCC is the basic value used to calculate the carrying capacity of the next tour [7]. PCC value is used to calculate the real carrying capacity (RCC) value limited by the biophysical conditions of the local tourist area, so the final value of the RCC is lower than the value of its physical carrying capacity. The biophysical aspect used as the correction factor parameters is determined by observation in the field and

literature studies as well as limited interviews on tourism managers.

### 5.2 Real Carrying Capacity

Real carrying capacity is the maximum number of visitors allowed to visit the tourist destination by correction factor (Cf) obtained from the regional characteristics applied to the PCC. The correction factor is obtained through various considerations of biophysical variables, environmental variables, ecological variables and management variables. The calculation of real carrying capacity is obtained by including the limiting factor of correction. Value of above correction factor on bulk components rain and soil erosivity are used in power assessment real support. Results of calculation of real carrying capacity are shown in Table 2.

**Table 2.** Real Carrying Capacity (RCC)

FH	FL	FE	Cf1	Cf2	Cf3	RCC (days)	RCC (months)
5,67	79,76	80	0,94	0,20	0,20	221	6.630

Value of real bearing capacity of Gancik Hill Top is 813 visitors/ day so that estimation the number of visits per month that can be received is 6.630 visitors/ month. This value is still above the actual value of the number of visitors in June so the number of visitors still can optimized up to 5% (6.300 visitors). Consideration of real carrying capacity helps to maintain equilibrium between environmental conditions of tourism with the number of visitors Gancik Hill Top. In line with Butler's thinking (1999) which states that carrying capacity is a limit of space usage tourism prior to the significant decline in the quality of the foundation of tourism resources or tourist experience [14].

### 5.3 Effective Carrying Capacity

The effective carrying capacity is the maximum number of travelers allowed by environmental conditions and management capacity without affecting tourist demand in tourism activities [15]. Tourism management capacity is the sum of all conditions in protected areas that can be functioned objectively and in accordance with the objectives of the management of the area. The management capacity is limited by the criteria: the management system, the number of existing management staff/ present serve the visitor against the ideal number of managers on tourism activities in a location. The greater the value of management capacity manager then the value of effective bearing capacity will be greater.

Management of Gancik Hill Top tourist attraction is currently done by the villagers of Selo who are members of the *Kelompok Sadar Wisata* (Pokdawis). Based on observations and results interview to Pokdawis management chairman as manager met twenty officer who did the service of every visitor from a total of thirty persons scheduled according to the following table.

**Table 3.** Actual Amount of Managing Staff

Position	Job Description	Staff
Ticket officer	Staff serving tickets	4
Parking attendant	Staff who organize parking vehicles	6
Janitor	Staff cleaning the location	8
Supervisor	Staff who oversee the tourism activities	2
		20

In accordance with the number of officers scheduled each day within visitor service activities have their respective duties, therefore if any officer is not present it will affect the management activities tourism and tourist satisfaction in tourist visits. Condition as this will affect and decrease the value of the managerial capacity. The composition of the manager of Gancik Hill Top tourist attraction is as follows.

**Table 4.** Ideal Amount of Managing Staff

Position	Job Description	Staff
Ticket officer	Staff serving tickets	6
Parking attendant	Staff who organize parking vehicles	5
Janitor	Staff cleaning the location	15
Supervisor	Staff who oversee the tourism activities	4
		30

Based on that, the management capacity of managers is calculated as follows:

$$MC = \frac{20}{30} \times 100\% = 66,67\%$$

Furthermore, the calculation of management capacity (MC) and effective carrying capacity value can be seen in Table 5.

**Table 5.** Effective Carrying Capacity

RCC (days)	RCC (months)	MC Value	ECC (days)	ECC (months)
221	6.630	66,67%	147	4.410

Referring to the calculation of the effective carrying capacity (ECC) in the area of Gancik Hill Top attractions then the amount tourist visits should be reduced by 42%. With the number of officers currently unable to serve the number of visitors who come every day with an average number of visitors at present, there are 210 visitors. But the optimization of the number of visitors is good by value real carrying capacity and effective carrying capacity shall be accompanied by optimizing the capacity of the management officers to with 100%. According to Cifuentes (1992), management capacity

can be indicated from some variables such as legal basis, policies and regulations, equipment, personnel, financing, infrastructure and amenities [11]. So in improving the capacity of the manager in serving the visitor needs to be supported with management capacity based on these variables. This is to anticipate the decline management capacity especially during peak season where the number of visitors exceeds the carrying capacity. Based on observations in the field shows there are differences quite striking on the quality of service officers to visitors during the peak season of the visit is likely due to the lack of optimal management capacity from other aspects of management, among others, facilities condition infrastructure, facilities, and personnel.

## 6 Conclusion

Result of assessment of environmental tourism support capacity in Gancik Hill Top based on Cifuentes method (1992) modified results, that the value of physical carrying capacity (PCC) of 1.169 visitor per day; Real Carrying Capacity (RCC) of 211 visitors per day; and Effective Carrying Capacity (ECC) of 147 visitors per day. PCC and RCC values are still below the average number of visitors in June, which are 210 visitors per day. But the ECC value is above the average number of visits by 42%. This needs to be a consideration for managers of tourism because the number of tourist visits exceeds the carrying capacity of an area. The ability of an area to be balanced with activities carried out so that sustainable tourism is maintained.

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