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The Carrying Capacity of Nature Tourism in Salapar Hill, Bengkayang Regency, Indonesia

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Abstract. Salapar Hill is one of the leading natural tourist destinations in Bengkayang Regency. Tourist areas with an excessive number of visitors have implications for tourism activities with environmental sustainability. Identifying the carrying capacity is very important to increase visitor comfort and satisfaction. The research aims to get the value of tourism carrying capacity, physical carrying capacity, real carrying capacity, and effective carrying capacity. The research method uses a quantitative descriptive method with data analysis techniques using the calculations of Sumaraw and Sasmita. The carrying capacity of the tourism environment can determine the maximum number of visits to an area. Physical and area management conditions consider three main actions, namely physical carrying capacity, real carrying capacity, and effective carrying capacity. The results obtained the equation PCC > RCC ≥ ECC with a value is 366 > 261 ≥ 261. It means that the natural tourism area of Salapar Hill has a large carrying capacity to accommodate the number of tourists every day.

Keyword: Carrying Capacity, Environment Sustainability, Nature Tourism, Salapar Hill, Visiting Number

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1 Introduction

The carrying capacity is the ability of an area within optimal limits that must be considered to support human activities and other living things sustainably [1]. Tourism carrying capacity is the capacity of the maximum number of tourists who come per day at a certain area and unit of time from the results of an analysis of physical calculations, environmental characteristics, and management factors of attractions [2]. The excessive number of tourists visiting a tourist area, if not anticipated, can have implications for losing the balance between the number of tourists and the tourist area. Meanwhile, tourist destinations that have just opened without clear planning and following the character of the area can result in disruption to the development and development

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of a tourist destination. Tourism carrying capacity has benefited so that environmental quality does not experience a decrease or threat. Tourism carrying capacity is carried out by observing the physical carrying capacity (PCC) approach calculated based on the area of comfort in activities, actual/real carrying capacity (RCC) is limited to the level of regional tolerance, and effective carrying capacity (ECC) which is influenced by existing management capacity [1]. Excessive tourist arrivals to a tourist area can have implications for losing the balance between the number of tourists and the tourist area. New tourist destinations without planning that are not following the character of the region can result in disruption in the development of a tourist destination [3].

Bengkayang Regency is one of the areas that have a natural tourist attraction namely Salapar Hill. This tourist object was built by residents through the local tourism awareness group (POKDARWIS). Salapar Hill has very exciting natural attractions such as an expanse of areas for camping activities, clear flowing water, photo spots with a background of clouds and hilltops (Figure 1), and typical tropical flora and fauna.

Figure 1. Salapar Hill nature tourism

Based on the results of interviews with the management of Bukit Salapar tourism, the number of visits is from 20-40 visitors daily. Tourism planning should have a sustainability goal in the long term. Thus, one way is to pay attention to the carrying capacity of the existing environment [4]. Based on this description, it is important to research tourism carrying capacity including the physical, real, and effective carrying capacity of the natural tourist attraction of Bukit Salapar.

2 Research Method

The research was conducted in June 2022 at the natural tourist attraction Salapar Hill, Pungo Hamlet, Cipta Karya Village, Sungai Betung District, Bengkayang Regency, West Kalimantan Province. The research location show on the map in Figure 2. Data analysis was carried out in a

quantitative descriptive method using calculations [6] and [9]. The carrying capacity of this tourism environment tries to determine the maximum number of visits to an area based on the physical conditions and management conditions, considering three main levels: physical carrying capacity, real carrying capacity, and effective carrying capacity.

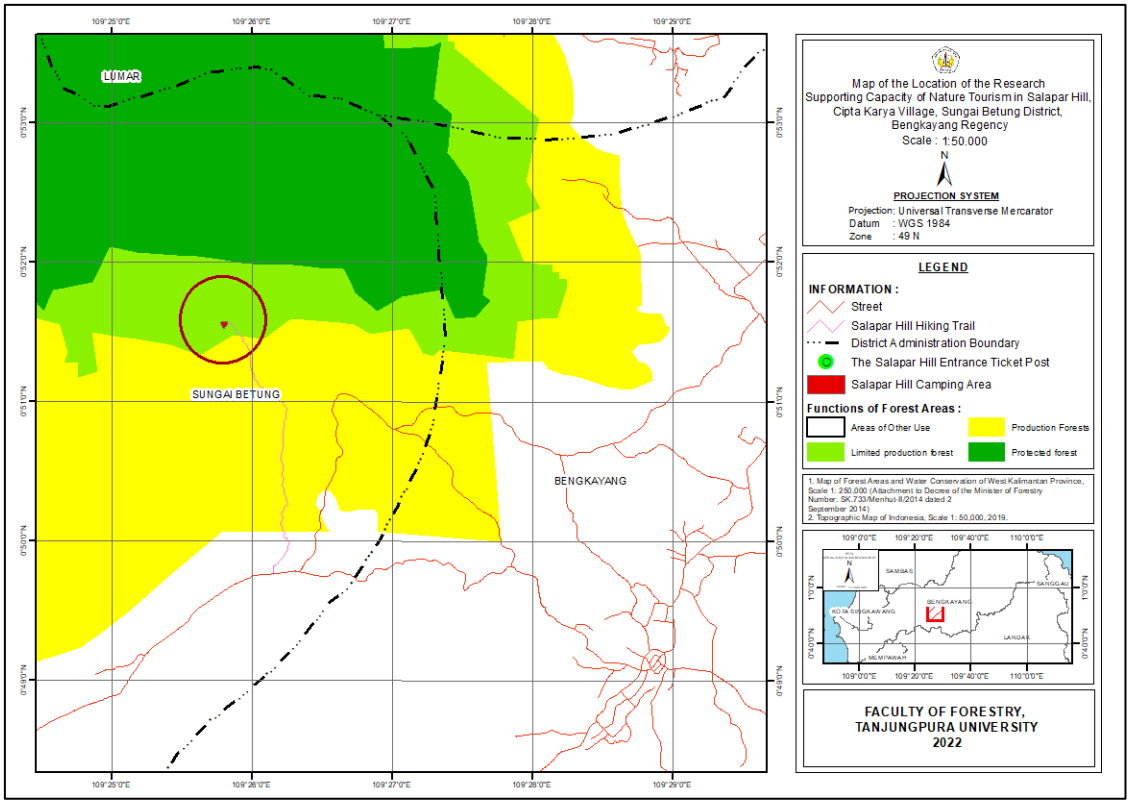

Figure 2. Map of research location in Salapar Hill at Bengkayang Regency

The data collected in this study are primary data and secondary data. Primary data collection was carried out through surveys or direct observation in the field, and open interviews with POKDARWIS the management of the Salapar Hill tourist attraction using a list of questions. The informants in this study were the managers of Bukit Salapar Tourism. Primary data in this study include; physical carrying capacity (area of the tourist area and rotation factor), real carrying capacity (vegetation index), and effective carrying capacity (area management capacity). Secondary data in this study include; physical carrying capacity (ideal area for tourism), real carrying capacity (rainfall data from Meteorology Climatology and Geophysics Agency for the nearest area, namely the Sambas area for 2020-2021, soil sensitivity erosion data from the soil type map of Bengkayang Regency, slope data from the slope map of Bengkayang Regency).

2.1. Physical Carrying Capacity (PCC)

PCC is the maximum number of tourists that can be done in one day in a certain area based on the physical area/area [5]. The formula used in calculating the physical carrying capacity based on the method [9] is:

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

Information:

PCC = Physical Carrying Capacity is the maximum limit of visits that can be made in one day

A = The area used for tourism (m^2)

B = The area required by a tourist to travel while still obtaining satisfaction, a picnic activity with a B value is 90 m^2

R*f* = Rotation factor (R*f*), Open period/average of visiting time

2.2 Real Carrying Capacity (RCC)

RCC is limited by the biophysical aspects of the environment in tourist areas, and the formula used to calculate RCC refers to [6] as follows:

$$RCC = PCC \times \frac{(100-Cf1)}{100} \times \frac{(100-Cf2)}{100} \times \ldots \times \frac{(100-Cfn)}{100} \quad (2)$$

The correction factor is determined based on the biophysical aspects of the environment in the Bukit Salapar tourist area which are identified as a limiting factor for tourism activities, priority on tourist satisfaction and comfort in carrying out tourism activities. The calculation of this correction factor is based on the formula used in the research on the carrying capacity of the tourist environment [7]. The correction factors for Bukit Salapar tourism include rainfall (Cf1), slope (Cf2), soil sensitivity to erosion (Cf3), and vegetation (Cf4).

a. Rainfall correction factor (Cf_1)

The calculation of the rainfall correction factor is based on the Rainfall index for the last ten years by comparing the wet and dry months using the formula [13]:

$$Cf_1 = \frac{\sum \text{dry month}}{\sum \text{wet month}} \quad (3)$$

b. Slope correction factor (Cf2)

The slope correction factor requires several data including the length of the steep track, the overall length of the track, the steep area of the tourist area, and the area of the tourist area. The data collection method was obtained by field survey method using GPS. Then the results of the observations were overlaid on the slope map of the Bengkayang Regency Regional Spatial Plan (RSP).

Tabel 1 Tally Sheet of Salapar Hill Nature Tourism

No	Track	Track Lenght (m)	Steep Track Lenght (m)
1	The main gate to the entry ticket collection point		

2	Entrance ticket collection point to the Salapar Hill camping area	
	Total	

$$Cf_{2a} = \frac{\text{Steep track lenght (m)}}{\text{Total of track lenght (m)}} x\ 100\% \quad (4)$$

$$Cf_{2b} = \frac{\text{steep area } (m^2)}{\text{Total of used area } (m^2)} x\ 100\% \quad (5)$$

Information :

Cf_{2a} = Slope correction factor in hiking track

Cf_{2b} = Slope correction factor in camping area

Then Cf_2 is calculated using formula below [6];

$$\mathbf{Cf_2} = \frac{\mathbf{Cf2a+Cf2b}}{\mathbf{2}} \quad (6)$$

Slope assessment is carried out using a scoring system on the slope class criteria according to [14] as follows:

Tabel 2 Classification of slope class

Slope class	Classification of slope class (%)	Information
1	0 – 8	Flat
2	8-15	Undulating
3	15 – 25	Rather steep
4	25 – 40	Steep
5	> 40	Very steep

c. Correction factor of soil susceptibility to erosion (Cf3)

The soil sensitivity correction factor is assessed based on the type of soil as stated in [14].

Tabel 3 Classification of soil type

Soil Class	Classification of soil type	Information	Value
1	Alluvial, Gley land, Panasol, Hydromorf grey, Lateria groundwater	Not sensitive	15
2	Latosol	Rather sensitive	30
3	Brown Forest Soil, Non Calcic	Less sensitive	45
4	Andosol, Lateric, Gromosol, Podzolic	Sensitive	60
5	Regosol, Lithosol, Organosol, Renzina	Very sensitive	75

Information : Not sensitive = resistant to erosion (low erodibility); Rather sensitive = rather sensitive to erosion (medium erodibility); Less sensitive = less sensitive to erosion

(rather high erodibility); Sensitive = easy to be erosion (high erodability); Very sensitive = very easy to be erosion (very high erodability).

d. Correction factor of vegetation (Cf4)

The calculation of the correction factor for flora diversity in Salapar Hill uses the Simpson Diversity Index (SDI) equation [6]. The range of values on the Simpson index is 0-1. The closer to zero to λ' a community means lower the diversion.

$$\boldsymbol{\lambda' = \frac{\sum_{i=1}^{S} ni(ni-1)}{n(n-1)}} \quad (8)$$

$$\mathbf{ID = 1 - \lambda'} \quad (9)$$

Information :

λ' = Simpson Diversity Index

S = Number of species

ni = Number of individual species to-*i*

ID = Correction factor of flora diversity

n = Individual number of all species

2.3 Effective Carrying Capacity (ECC)

ECC is the maximum number of tourists with a combination of RCC tourism areas and tourism management factors [3];

$$ECC = RCC \times MC \quad (3)$$

Tourism management capacity is calculated by the following formula [5]:

$$MC = \frac{Rn}{Rt} \times 100\% \quad (4)$$

Information:

MC = Management capacity

Rn = Number of available management officers

Rt = Number of available management officers in peak season

The method used to gain management capacity is to conduct interviews with tourism awareness groups (POKDARWIS) at the Bukit Salapar tourist attraction. Furthermore, the final stage is to determine the carrying capacity value, namely comparing PCC, RCC, and ECC with the number of tourist visits per day [6] with the following conditions:

$$\mathbf{PCC > RCC \text{ and } RCC \geq ECC} \quad (5)$$

a). If the value is PCC > RCC and RCC ≥ ECC, it means high carrying capacity

b). If the value is ECC > RCC > PCC, it means number of tourist exceed the carrying capacity

c). If the value is PCC = RCC = ECC, it means optimum carrying capacity

3 Results and Discussion

3.1 Physical Carrying Capacity (PCC)

The PCC calculation results show that the Bukit Salapar tourist area is able to physically accommodate 366 people/day. It is as follows:

Based on interview result of 43 visitors

Average daily visiting = ((0.5 hour x 0) + (1.5 hours x 0) + (2.5 hours x 10) + (3.5 hours x 33))/43

= 3.27 hours

Rotation factor (Rf) = 24 hours/3.27 hours = 7.3

Physical Carrying Capacity:

A = 4,511 m^2

B = 90 m^2 (the real need of camping tourism) [1]

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

$= 4{,}511 \times \frac{1}{90} \times 7.3$

= 366 people/day

The value of the physical carrying capacity of Salapar Hill when it is associated with the average number of tourist visits per day at this time, namely 0-40 tourists, then the PCC of Salapar Hill has been fulfilled, and tourists can still get satisfaction in tourism activities. The value of 366 indicates that the PCC's carrying capacity takes into account the physical environmental factors that can visit the Bukit Salapar tourist attraction for a time limit per day. As stated [9], if the number of visitors who come to a tourist attraction for one day is less than the actual physical carrying capacity of the tour, this will reduce the damage level to the environment and its supporting facilities. PCC is the basic value in the next calculation, namely RCC [7].

3.2 Real Carrying Capacity (RCC)

RCC is 261 people/day. It can be explained below;

Cf_1 = 0.153; Cf_2 = 9.092; Cf_3 = 60; and Cf_4 = 0.88

$$RCC = PCC \times \frac{(100-Cf1)}{100} \times \frac{(100-Cf2)}{100} \times \frac{(100-Cf3)}{100} \times \frac{(100-Cf4)}{100}$$

$$= 366 \times \frac{(100-0{,}153)}{100} \times \frac{(100-9{,}092)}{100} \times \frac{(100-60)}{100} \times \frac{(100-0{,}88)}{100}$$

=366 x (0.99 x 0.90 x 0.4 x 0.99) = 261 people/day

It shows that the real carrying capacity is still large compared to the average number of tourist per day. The correction factor in the real carrying capacity of the Salapar Hill nature tourism is adjusted to the character of the tourist area's land. According to several studies from [6] and [10]

related to carrying capacity for hill areas, the correction factor (*Cf*) for hill tourism includes rainfall, slope, soil sensitivity to erosion, and vegetation.

a. Correction factor of rainfall (Cf_1)

Calculation of the rainfall correction factor for Salapar Hill was obtained from BMKG rainfall data for Sambas Regency (BMKG for the closest area to Bengkayang Regency) from 2012-2021. The rainfall index assessment is a comparison between the number of dry months (rainfall <60 mm) to wet months (rainfall >100 mm) [3]. The results for the dry months for the last ten years were 15 months, and the wet months for previous ten years were 98 months, so for the rainfall correction factor for Salapar Hill, Cipta Karya Village, Sungai Betung District, Bengkayang Regency, it was 0.153.

b. Correction factor of slope (Cf_2)

The slope correction factor is based on the results of measuring the length of the tourist track on Salapar Hill. It is 2,360 meters from the main gate to the entry ticket collection point. The area is included in the category of flat to sloping slopes. The track length from the entry ticket collection post to the Salapar Hill campsite is 1,578 meters. Thus, the total track length is 3,938 meters. The area includes undulating till steep slopes. The data of the Salapar Hill tourist track can be seen more clearly in Table 5.

Tabel 5. Track on Bukit Salapar

No	Track	Track length (m)	Steep track length (m)
1	The main gate to the entry ticket collection point	2.360	0
2	Entrance ticket collection point to the Salapar Hill camping area	1.578	34
	Total	3.938	34

The calculation result of the correction factor for the slope of Salapar Hill was 9.092%. According to the slope class classification table, the Salapar Hill tour is in slope class 2, namely the sloping category. The steep track of Salapar Hill only has 34 meters long. It is shown in Figure 3.

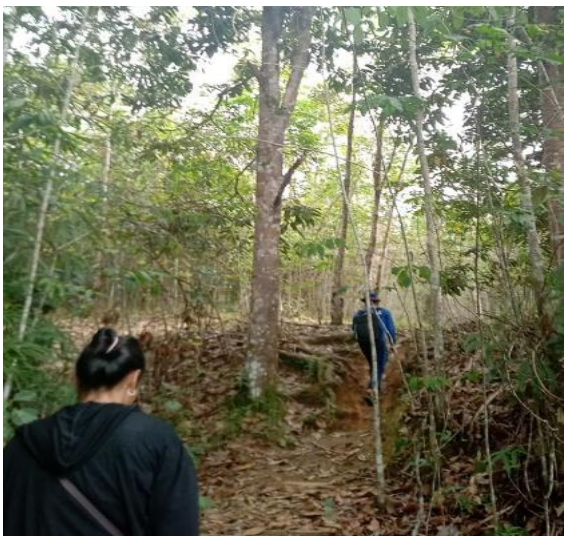

Figure 3. Steep track in Bukit Salapar

Overall, the track to Salapar Hill has an undulating till steep slope. It is a steep slope (25% -40%) of 34 meters. Figure 3 shows the steep tracks on the Salapar Hill route.

c. Correction factor of soil susceptibility to erosion *(*Cf_3)

The correction factor for soil susceptibility to erosion is based on the Bengkayang Regency Soil Type Map (Figure 4). It is from the Bengkayang Regency Regional Regulation number 7 in 2014 concerning the Bengkayang Regency Spatial Planning (RSP/RTRW) 2014-2034. The results of the polygon overlay on the soil type map of Bengkayang Regency is a podzolic soil. Podzolic soil is sensitive or has high soil sensitivity. Podzolic soil has a yellow color, clay texture, sticky consistency, lumpy soil structure, and low base saturation, with strong aggregate stability [11]. Based on the soil type classification table, podzolic soil is a sensitive or easily eroded soil (high erodibility) with a correction factor for soil sensitivity to erosion of 60.

The greater the erodibility, the higher the potential for erosion/slide. However, efforts are needed from the manager to minimize the potential for landslides. They are terracing (especially in steep areas) and maintaining or increasing the number of plants with strong root systems.

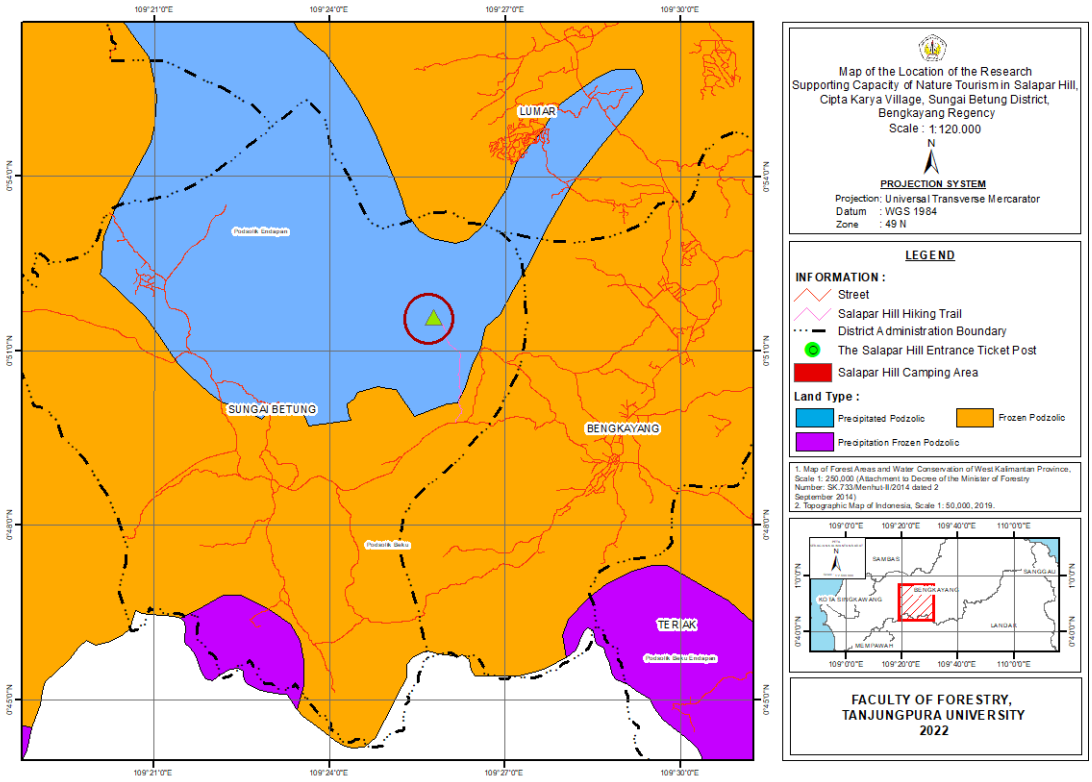

Figure 4. Soil type map of Salapar Hill

d. Correction factor of vegetation (Cf_4)

The vegetation correction factor based on the SDI calculation results obtained the value of the vegetation correction factor (Cf4) at Salapar Hill is 0.88. The results of direct field observations in the Salapar Hill tourist area found 19 types of flora (239 individuals total). The dominant vegetations in the Salapar Hill camping area are Torap, jengkol, and bamboo plants (Figure 5). The diversity of flora at tourist sites in the Salapar Hill camping area is stable, with natural forest conditions and clean water sources.

Figure 5. Vegetation on Salapar Hill; (a) Torap (*Artocarpus elasticus*), (b) Jengkol (*Archidendron pauciflorum*), (c) Bambu (*Bambusa* sp.)

The real carrying capacity in determining biophysical variables in each area is not always the same or different according to the area condition. Based on research [12] conducted at Pisang Island Ecotourism, taking biophysical variables, namely slope, rainy season, water body cover,

forest cover, and month of high wave occurrence as limiting factors. In contrast to research conducted by [13] in the marine tourism area of East Luwu Regency which considered seven parameters including water brightness, live coral cover, lifeform type, reef fish species, current velocity, and waterbed depth as limiting factors. The known RCC value can be used as material for consideration to maintain the environmental conditions of the tour according to the number of visitors who come to the Salapar Hill nature tourism.

3.3 Effective Carrying Capacity (ECC)

Based on the results of the ECC calculation, the Salapar Hill tour is 261 people/day. The ECC value is sufficient when compared to the current average number of visits. The ECC calculation is as follows:

$$MC = \frac{13}{13} \times 100\%$$

$$= 1 \times 100\%$$

$$= 100\ \%$$

ECC of Salapar Hill:

ECC = RCC x MC

ECC = 261 x 100%

ECC = 261 people/day

The results of calculating the physical carrying capacity (PCC), real carrying capacity (RCC), and effective carrying capacity (ECC) at the Bukit Salapar tourist attraction are the results of the equation: PCC > RCC (366 > 261) and RCC ≥ ECC (261≥ 261) which means that the carrying capacity of natural tourism in Salapar Hill is high (Figure 6).

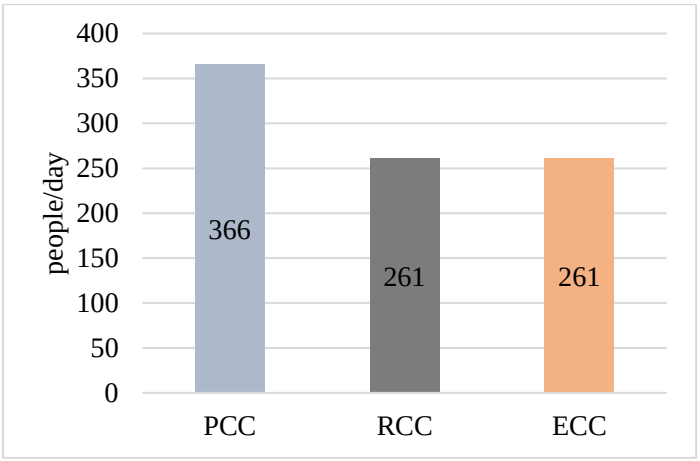

Figure 6. Graph of PCC, RCC and ECC in Salapar Hill

The results show that the tourism carrying capacity of Bukit Salapar has a high value or does not exceed the limit. It means Bukit Salapar tourism can still accommodate tourists with all proper activities as long as they do not exceed the maximum carrying capacity.

Optimizing the carrying capacity in tourism activities can increase the quality of life and add value to natural resources [12]. It has the benefit of natural resources that are utilized for tourism development can be maintained in balance and continue to be sustainable, have a positive impact on nature itself, and maintain the satisfaction quality of tourists who come to visit.

4 Conclusion

The carrying capacity values analyzed consisted of 3 factors found to be carrying capacity values including; PCC of 366 people/day, RCC of 261 people/day, and ECC of 261 people/day. Based on these values, Bukit Salapar tourism can still accommodate tourists with all tourism activities. The number of visits on the Salapar Hill tour is currently 20-40 people/day. It means that the current number of visits is still far below the carrying capacity of Salapar Hill nature tourism. Based on the value of the effective carrying capacity that has considered environmental biophysical factors and management capacity, the development of the Bukit Salapar tourism object can still be optimized by 84.67% (261 people/day). It can be done so that tourism activities from the physical, biophysical, management and socio-economic aspects of the Bukit Salapar natural tourism object can run well and optimally by considering the existing carrying capacity.

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