

Ecological Carrying Capacity Analysis of Ecotourism Objects in *Salak II* Resort Area, *Halimun Salak* National Park

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Abstract. *Salak II* Resort Area, *Halimun Salak* National Park (HSNP) covers an utilization zone with an area of 760.36 ha which is designated as an ecotourist zone, located within a specific zone. There are some ecotourism objects namely: 1) *pemandian air panas*; 2) *curug cigamea*; 3) *curug seribu*; 4) *curug muara*; 5) *curug kondang*; 6) *curug pangeran*; 7) *curug ngumpet*; 8) *curug cihurang*; 9) *curug alami*. In addition, there are *bumi perkemahan* which contained the business zone and *kawah ratu* in the natural forest area. This study aims to analyze the ecological carrying capacity of ecotourism areas. This research uses quantitative descriptive method and done through two stages: 1) calculation of physical carrying capacity and 2) calculation of real carrying capacity. Based on the results of the analysis, all objects have great potential to be developed as an ecotourist destination because the current visit still has not exceeded the carrying capacity of existing ecological. *Kawah Ratu* has a very high potential to be developed because of its very high of carrying capacity. The value of carrying capacity of *Kawah Ratu* is still very high, that is able to accommodate 13.256 people per day which is a huge income potential.

1. Introduction

Tourism is one sector that is continuously pursued and can influence and encourage the development of other sectors. It can also provide the benefits of expanding employment, business opportunities, and poverty alleviation [1-4]. One form of tourism activity is ecotourism. In essence, ecotourism is an activity that is responsible for the preservation of natural areas [5-9]. Nature preservation is one of the important principles in ecotourism. One of the concepts used in maintaining natural sustainability to support the activities undertaken thereon is the carrying capacity. The carrying capacity problem in ecotourism is very important because it is closely related to environmental damage [10].

Salak II Resort Area, *Halimun Salak* National Park (HSNP) have 9 ecotourism objects that located in a specific zone that is *pemandian air panas*, *curug cigamea*, *curug seribu*, *curug muara*, *curug kondang*, *curug pangeran*, *curug ngumpet*, *curug cihurang*, and *kawah ratu* [11,12]. The location of the *bumi perkemahan* in which there are business zones and ecotourism objects of the *kawah ratu* is located within natural forest areas. The existence of *Salak II* Resort Area located in the natural environment requires an assessment of its ecological carrying capacity.

The concept of environmental carrying capacity of ecotourism objects is closely related to the number of tourists who come to visit the ecotourism object. This concept is related to the quality of satisfaction and visitors comfort in enjoying tourism activities in ecotourism locations. Environmental carrying capacity of ecotourism objects that exceeded can reduce the comfort and satisfaction of tourists.



The framework of assessing the carrying capacity of the tourist environment in protected areas refers to the calculation formula of tourism carrying capacity developed by [13].

This study aims to analyze the ecological carrying capacity of ecotourism areas obtained through 2 (two) stages, namely the calculation of physical carrying capacity (PCC) and the calculation phase of real carrying capacity (RCC).

2. Methods

The research location was in *Salak II* Resort Area, HSNP, Bogor, Indonesia. This research was conducted in October 2015 until January 2016. This research uses quantitative descriptive method. This study was conducted through two stages: 1) calculation of physical carrying capacity and 2) calculation of real carrying capacity that drives on Cifuentes formula [14].

This method attempts to determine the maximum number of visits an area is based on the physical, biological conditions and management conditions in the area, considering three main levels: 1) Physical Carrying Capacity (PCC); 2) Real Carrying Capacity (RCC) and 3) Effective Carrying Capacity (ECC) [15]. The application of this method takes into account several important elements such as the flow of tourists (tourist flows), the size of the area, the maximum amount of space available for each of the free-moving travelers and the time of visit [15]. CC is the estimation of the number of tourists who can physically enter into the area. This carrying capacity can be predicted by knowing several parameters, i.e. the area of the object, the wide use of space required for travel by tourists, as well as the area rotation factor. The formula used is as follows:

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

Where *PCC*: Physical Carrying Capacity; *A*: effective area available for ecotourism utilization; *V/a*: the area used per tourist/m²; *Rf*: area rotation factor.

RCC is the estimated value of the maximum number of tourists that the object can receive after considering the ecological correction factor. The ecological carrying capacity formula is as follows:

$$RCC = PCC \times \frac{100 - Cf1}{100} \times \frac{100 - Cf2}{100} \times \frac{100 - Cf3}{100} \times \frac{100 - Cf4}{100} \quad (2)$$

Where *RCC*: Real Carrying Capacity; *Cf1*: excessive sunshine correction factor; *Cf2*: rainfall correction factor; *Cf3*: erosion correction factor; *Cf4*: accessibility correction factor.

3. Results and Discussion

3.1. General condition

The region of located at: longitude 106° 36 '30' ' - 106° 45' 55 " E and latitude 6° 31 '0' - 6° 47' 15 " N. This research administrative area was in *Pamijahan* district that passed by three major rivers, namely *Cikuluwung* River tipped in *Kawah Ratu*, *Cigamea* River tipped from the buffer area of the foot of *Salak* Mountain, and *Ciapus* River.

3.2. Physical Carrying Capacity (PCC)

Resort Area *Salak II*, HSNP has several objects that can be developed as an ecotourism destination. The area of each ecotourism objects are as follows: 1) *pemandian air panas* 7,199.18 m²; 2) *curug cigamea* 4,421,31 m²; 3) *curug kondang* 330.39 m²; 4) *curug alami* 102.25 m²; 5) *curug pangeran* 410.65 m²; 6) *curug ngumpet* 210.13 m²; 7) *curug cihurang* 1,004.13 m²; 8) *curug seribu* 831.96 m²; 9) *bumi perkemahan* 1,672.36 m²; 10) *kawah ratu* 83.742,62 m². The area is on the calculation of carrying capacity is also referred to as "A".

The use of space area is closely related to the adaptability of tourists to the availability of space on site. Based on the results of field observations, three kinds of recreational activities that can be done in *Salak II* resort area, namely play activities, gathering, and taking pictures. The calculation of the space used by tourists can be seen in table 1.

Table 1. Proportion of space area used ecotourist.

No	The Activities	Frequency	Proportion (%)	Area (m ²)
1	Playing	51	15%	1.53
2	Gathering	56	17%	1.23
3	Taking Pictures	230	68%	1.65
The Average area of ecotourist				1.56

It is necessary to estimate the value of physical carrying capacity that is the rotation factor of each object. This rotation factor can be obtained from the length of stay of tourists within the object and the duration of the object's open time. Based on the distribution of questionnaires to tourists, the following is the length of stay of tourists in each object (table 2).

Table 2. Ecotourist long stay in ecotourism objects.

No	Ecotourism objects	Ecotourist long stay	Rf (8 hours: ecotourist long stay)
1.	<i>Pemandian Air Panas</i>	3.00	2.67
2.	<i>Curug Cigamea</i>	3.29	2.43
3.	<i>Curug Kondang</i>	2.57	3.11
4.	<i>Curug Alami</i>	3.11	2.57
5.	<i>Curug Pangeran</i>	5.89	1.36
6.	<i>Curug Ngumpet</i>	5.60	1.43
7.	<i>Curug Cihurang</i>	5.14	1.56
8.	<i>Curug Seribu</i>	3.38	2.37
9.	<i>Bumi Perkemahan</i>	1.93	4.15
10.	<i>Kawah Ratu</i>	5.57	1.44

Based on the parameters data that have been obtained, then the next PCC value can be calculated of each object. The result of calculating PCC/ecotourism objects can be seen in table 3.

Table 3. The PCC value calculated per ecotourism objects.

No	Ecotourism objects	Area (m ²)	Area per ecotourist (m ²)	Rf	PCC (people/days)
1	<i>Pemandian Air Panas</i>	7,199.18	1.56	2.67	12,306
2	<i>Curug Cigamea</i>	4,421.31	1.56	2.43	6,900
3	<i>Curug Kondang</i>	330.39	1.56	3.11	658
4	<i>Curug Alami</i>	102.25	1.56	2.57	168
5	<i>Curug Pangeran</i>	410.65	1.56	1.36	357
6	<i>Curug Ngumpet</i>	210.13	1.56	1.43	192
7	<i>Curug Cihurang</i>	1,004.13	1.56	1.56	1,001
8	<i>Curug Seribu</i>	831.96	1.56	2.37	1,264
9	<i>Bumi Perkemahan</i>	1,672.36	1.56	4.15	4,446
10	<i>Kawah Ratu</i>	83,742.62	1.56	1.44	77,080

3.3. Real Carrying Capacity (RCC)

The correction factors of carrying capacity used for RCC are excessive sunshine correction factor, rainfall, erosion, accessibility (wildlife disturbance), and wildlife disturbance (in this case Using a disturbance index in the long tail monkey mating season).

Based on data obtained from the Indonesia Meteorology, Climatology and Geophysics Agency (BMKG) related to the strong sun exposure received by *Salak II* Resort Area, it is known that strong

sun exposure is only a few in this area. This is related to climate and temperature conditions in Bogor Region itself which is also known as the rain city. Moreover, the forest area is very rarely penetrated by the hot sun. But when viewed from the annual data, exposure to sunlight is increasingly increasing every year. Global warming conditions are also continuing to cause sun exposure in this area is small enough, only affect 10.84% to be used as a correction factor $Cf1$. The data can be seen in table 4.

Table 4. Excessive sunshine correction factor data.

Year	<i>Excessive Sunshine</i> ($Cf1$) (%)
2010	7.59%
2011	9.24%
2012	9.72%
2013	12.48%
2014	12.81%
2015	13.20%
Average	10.84%

Based on rainfall and rainy day data from 2010-2015, the number of dry days (days with rainfall <60mm), 60.63%, and the number of wet days (days with rainfall > 100 mm) is 39.37%. The value index of rainfall correction factor is a comparison of wet days in a year for the last 5 years. The magnitude of the correction factor $Cf2$ was 39.37% (table 5).

Table 5. Rainfall correction factor data.

Year	<i>Rainfall</i> ($Cf2$) (%)
2010	76.16
2011	25.75
2012	30.41
2013	36.44
2014	33.7
2015	33.76
Average	39.37

Based on field observations, the topography of ecotourism areas visited intensive by ecotourist can be grouped in five segments. The five segments are assessed based on the steepness of the slope rate in general based on The Ministry of agriculture Decree No. 837/Kpts/Um/11/80. The erosion correction factor calculated in estimating the RCC can be seen in Table 6. As for the data, the $Cf3$ correction factor is based on the slope level of each ecotourism objects (table 6 and 7).

Table 6. Erosion correction factor data.

Slopes	Categories	The Assessment Criteria
0-8 %	Level	Level = 20
8-15 %	Sloping	Sloping = 40
15-30 %	Rather steep	Rather steep = 60
30-40 %	Steep	Steep = 80
>40 %	Very steep	Very steep = 100

Table 7. Slope level correction factor data.

Slope level	Area (m ²)	Cf_3
<i>Bumi Perkemahan</i>	1,672.356972	80%
30-40 %	1,672.356972	
<i>Curug Seribu</i>	831.961159	80%
30-40 %	831.961159	
<i>Curug Alami</i>	102.249291	60%
15-30 %	102.249291	
<i>Curug Cigamea</i>	4,421.30712	60%
15-30 %	4,421.30712	
<i>Curug Cihurang</i>	2,008.264962	50%
15-30 %	1,004.132481	
8-15 %	1,004.132481	
<i>Curug Kondang</i>	330.390749	40%
8-15 %	330.390749	
<i>Curug Muara</i>	4,850.498472	70%
15-30 %	2,425.249236	
30-40 %	2,425.249236	
<i>Curug Ngumpet</i>	210.12552	60%
15-30 %	210.12552	
<i>Curug Pangeran</i>	410.65371	60%
15-30 %	410.65371	
<i>Kawah Ratu</i>	167,485.2469	50%
15-30 %	83,742.62347	
8-15 %	83,742.62347	
<i>Pemandian Air Panas</i>	7,199.182843	80%
30-40 %	7,199.182843	

Accessibility that can still be considered not burdensome ecotourists is if still can be reached within 200 meters [13]. The distance data of the entrance into each object in the resort area of *Salak II* Resort Area, HSNP so that it can be expected the accessibility correction factor on each object (table 8).

Table 8. Entrance distance data to in each object.

Accessibility	The Distance (meters)	Accessibility correction factor (Cf_4) (%)
<i>Pemandian Air Panas</i>	404	2.04
<i>Curug Cigamea</i>	410	2.10
<i>Curug Kondang</i>	243	0.43
<i>Curug Alami</i>	218	0.18
<i>Curug Pangeran</i>	256	0.56
<i>Curug Ngumpet</i>	69	-
<i>Curug Cihurang</i>	185	-
<i>Curug Seribu</i>	1,294	10.94
<i>Bumi Perkemahan</i>	75	-
<i>Kawah Ratu</i>	3,776	35.76

Based on filed observations, it is estimated that the mating season occurs throughout the year, 12 months per year. There is no specific time period for long tailed monkeys (*Macaca fascicularis*) to mate [16]. This means that for monkeys, the presence of visitors is not a distraction for him to perform the process of reproduction. Therefore, the wildlife correction factor becomes 0 'zero'. After all parameters are

known, the next is the calculation of ecological carrying capacity the ecological carrying capacity (RCC) of each ecotourism objects (table 9).

Table 9. The value of ecological carrying capacity (RCC) of each ecotourism objects.

No.	Objects	PCC (people/day)	100% – %Cf (%)				RCC (people/day)	Current destination (people/day)
			Cf1	Cf2	Cf3	Cf4		
1	<i>Pemandian Air Panas</i>	12,306	89.16	60.63	20.00	97.96	1,303	26
2	<i>Curug Cigamea</i>	6,900	89.16	60.63	40.00	97.90	1,461	6
3	<i>Curug Kondang</i>	658	89.16	60.63	60.00	99.57	212	*
4	<i>Curug Alami</i>	168	89.16	60.63	40.00	99.82	36	*
5	<i>Curug Pangeran</i>	357	89.16	60.63	40.00	99.44	77	*
6	<i>Curug Ngumpet</i>	192	89.16	60.63	40.00	100	42	22
7	<i>Curug Cihurang</i>	1,001	89.16	60.63	50.00	100	271	*
8	<i>Curug Seribu</i>	1,264	89.16	60.63	20.00	89.06	122	13
9	<i>Bumi Perkemahan</i>	4,446	89.16	60.63	20.00	100	481	*
10	<i>Kawah Ratu</i>	77,080	89.16	60.63	50.00	64.24	13,384	123/year*

* : no data

Based on the results of the estimation calculation, it can be seen that all objects have great potential to be developed as ecotourism destination area because the current destination still has not exceeded the value of ecological carrying capacity. Among all the objects, *Kawah Ratu* has a very high potential to be developed as a tourist destination because of its very high carrying capacity. Currently, visitors to *Kawah Ratu* only reaches 123 people per year. With the addition of tourism facilities and utilities, as well as accessibility improvements, it is possible to attract a number of ecotourists, especially when viewed the carrying capacity of *Kawah Ratu* is still very high, which is able to accommodate 13,256 people per day which is a huge income potential.

4. Conclusions

Salak II Resort Area, HSNP has several objects that can be developed as an ecotourism destination. Based on the results of field observations, three kinds of recreational activities that can be done in *Salak II* resort area, namely play activities, gathering, and taking pictures.

Based on the parameter data that have been obtained, it can be obtained the value of physical carrying capacity (PCC) for *pemandian air panas* 12,306 people/day, *curug cigamea* 6,900 people/ day, *curug kondang* 658 people/day, *curug alami* 168 people/day, *curug pangeran* 357 people/day, *curug ngumpet* 192 people / day, *curug cihurang* 1,001 people/day, *curug seribu* 1,264 people/day, *bumi perkemahan* 4,446 people/day, and *kawah ratu* 77,080 people/day.

The value of ecological carrying capacity (RCC) ecotourism object of *pemandian air panas* 1,303 people/day, *curug cigamea* 1.461 people/day, *curug kondang* 212 person/day, *curug alami* 36 people/ day, *curug pangeran* 77 people/day, *curug ngumpet* 42 people/day, *curug cihurang* 271 people/day, *curug seribu* 122 people/day, *bumi perkemahan* 481 people/day, and *kawah ratu* 13,384 person/day. Value of carrying capacity of ecotourism object of *kawah ratu* is still very high, that is able to accommodate 13,256 people/day which is a huge income potential.

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