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CARRYING CAPACITY ASSESSMENT OF CIBEUREUM WATERFALL TOURISM IN GUNUNG GEDE PANGRANGO NATIONAL PARK

ANINDIKA PUTRI LAKSPRIYANTI[1*)], METI EKAYANI[2)], AND ARZYANA SUNKAR[3)]

1) Study Program of Natural Resources and Environmental Management, Baranangsiang IPB Campus, Bogor 16129, Indonesia
2) Department of Economics of Natural Resources and Environment, Faculty of Economics and Management, Dramaga IPB Campus, Bogor 16680, Indonesia
3) Department of Conservation of Forest Resources and Ecotourism, Faculty of Forestry, Dramaga IPB Campus, Bogor 16680, Indonesia

**Email: anindikapl@gmail.com*

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ABSTRACT

Cibeureum Waterfall has long been a popular tourist attraction with increasing number of visitors. High visitations would increase the risk of environmental damage, especially if the location of the tourism object is in a protected area that is still intact and rich in resources. One strategy to reduce the impact of recreational and nature tourism activities is by conducting a carrying capacity (CC) analysis. This study aims to 1) analyse the CC of Cibeureum Waterfall and 2) to formulate a CC-based waterfall tourism management strategy. The research was conducted on October 2018 in Cibeureum Waterfall of Gunung Gede Pangrango National Park (GGPNP) of West Java. The CC was estimated using the Cifuentes (1992) approach, referring to the permissible number of tourists. Three parameters were calculated: physical carrying capacity (PCC), real carrying capacity (RCC), and effective carrying capacity (ECC), by considering various correction factors. Interviews were conducted with 100 visitors of Cibeureum Waterfall. In addition, interviews were also conducted with 5 key informants from the management authority. The results showed that the daily PCC value was 800, exceeding the RCC (173) and ECC (86) values, indicating overcrowding. However, the number of visitors is lower than the RCC on weekdays. These results indicated a potential disturbance in Cibeureum Waterfall and its environment during the holidays. The CC-based management alternatives that were recommended included increasing ticket prices on holidays and implementing early booking system.

Keywords: carrying capacity, national park, waterfall tourism.

INTRODUCTION

Nature tourism and protected area are mutually interrelated. Protected area management aims at protecting the unique values of an area, at the same time allowing visitors to optimise their visitor experiences (Leung *et al*. 2014). Nature tourism is understood as a strategy for conservation and a tool for economic development (Setijawan 2018), while tourism can become a strategy in fostering the relationship between visitors and the area (Leung *et al*. 2018). Sustainable nature tourism not only gives positive impacts to the community but also the environment since the utilisation is not exploitative (Ekayani 2014).

Long-term nature tourism depends on the environmental quality, as it is the main capital of its attractiveness, hence environmental protection plays a great role in developing sustainable tourism (Duzgunes and Demirel 2016). Among the components of a landscape, the most reactive and sensitive elements to tourist disturbances are soil, water, and vegetation as indicated by soil compaction (Sitania *et al*. 2018), reduced number of flora and fauna (Nofriya *et al*. 2019), and ground water balance (Sezgin and Yildirim 2017). These indicate the impacts of tourism to the ecosystem (Bin *et al*. 2016). Therefore, if left unmanaged, toursim can become a threat to the integrity of protected area and thus decreasing the quality of visitors' experiences.

Tourism development usually prioritises the number of visitors, while the protection and preservation of the area are often ignored by managers. Ignoring sustainability can lead to environmental degradation, loss of biocultural diversity, and important income sources, due to uncontrolled visitors (Leung *et al*. 2014; Szczęsna and Wojtanowicz 2014). Therefore, the presence of visitors should become a significant part of the objective of management of protected areas (Candrea and Ispas 2009; Zelenka and Kacetl 2013). In other words, visitor management is an inseparable part of nature tourism management in a protected area (Candrea and Ispas 2009; Duzgunes and Demirel 2016).

Regarding the large number of impacts of tourism activities, carrying capacity (CC) is a useful concept in environmental management (Nugroho 2018; Sari and Rahayu 2018). World Tourism Organisation (UNWTO 2018) and Chamberlain (1997) defines CC of tourism as the maximum number of people that may visit a tourism destination at the same time, without causing degradation

to the physical, economic, sociocultural and environmental conditions in an unacceptable decrease in the quality of visitors' satisfaction. Determination of environmental CC can assist the management authority to minimise the adverse effects of tourism on the environment (Mak 2004).

Cibeureum Waterfall in GGPNP is one of a popular tourism attractions in West Java. In 2017, Cibeureum Waterfall had been visited by 39,441 people (BBGGPNP 2018) and currently the numbers is thought to be beyond control. This could decrease the quality of the GGPNP environment, which will not only damaging the surrounding ecosystem, but also reducing visitors' satisfactions. Based on these problems, the research objectives are to 1) analyse the CC of Cibeureum Waterfall and 2) determine the strategic alternatives to manage waterfall tourism based on carrying capacity.

RESEARCH METHOD

The research was conducted in Gunung Gede Pangrango National Park on October 2018, specifically in Cibeureum Waterfall area of Cibodas Resort. Data were collected through field observation and interviews using questionnaires. Interviews with the management authority of the Cibodas Resort as the manager of Cibeureum Waterfall, were conducted with five informants, namely the Head of Cianjur Area Department, Head of Cibodas Resort, Forest Ecosystem Controllers (PEH), Forest Ranger (Polhut), and Community-based Forest Rangers (MMP). Interviews were also conducted with the visitors who came in groups and above 17 years old. Within each group, one respondent was selected, with a total of 100 people. Other data used in this research were the area maps (topography, soil types, and working maps of the Cibodas Resort) obtained from GGPNP Office, and precipitation data for Cianjur District within the period of 2012-2017 obtained from the Meteorological, Climatological, and Geophysical Agency (BMKG). Literature study was also conducted related to the research topic.

The environmental CC of Cibeureum Waterfall was calculated using the formula developed by Cifuentes (1992). This approach calculates the maximum number of visits in an area based on physical, biological, and management conditions at the three CC levels: physical carrying capacity (PCC), real carrying capacity (RCC), and effective carrying capacity (ECC). The implementation of this approach considers the crucial elements such as tourist flow, area, maximum space available for each visitor to move freely, and time of visit (Zacarias *et al*. 2011).

Physical carrying capacity is the maximum limit of daily visit that an area is able to support, according to the available area and time (Cifuentes 1992; Sari and Rahayu 2018).

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

Description:

PCC = Physical Carrying Capacity (people/day)
A = Available area for use (m^2)
B = Area needed by a tourist to achieve satisfaction (m^2)
Rf = Rotation factor
Rf value is obtained from the following formula:

$$Rf = \frac{\text{Open hours}}{\text{Average time visitors spent}} \ldots. (2)$$

Real carrying capacity is the maximum number of visits to an area by taking into account its biophysical characteristics (Cifuentes 1992; Sari and Rahayu 2018).

$$RCC = PCC \times Cf_1 \times \ldots. \times Cf_5 \ldots.(3),$$
$$\text{with } Cf = 1 - {}^{Mn}/_{Mt} \cdots (4)$$

Description:
RCC = Real carrying capacity (people/day)
Cf = Correction factor
Mn = Limiting magnitude of variable
Mt = Total magnitude of variable

Given that the tourism object is in an open space, it is influenced by several natural limitation factors (correction factors). The biophysical characteristics as the correction factors in calculating the RCC are rainfall (Cf_1), soil erodibility (Cf_2), slope (Cf_3), landscape potential (Cf_4), and disturbance to wildlife (Cf_5).

a. Rainfall (Cf_1)

Rainy season may influence tourism activities and number of visits. Rain will disturb convenience in enjoying tourism (Lucyanti *et al*. 2013). Calculation of the rainfall correction factor was based on a rainfall index over the past 5 years by comparing the dry and wet months.

$$\text{Precipitation Index} = \frac{\sum \text{dry month}}{\sum \text{rainy month}} x100\% \ldots (5)$$

b. Slope (Cf_2)

Slope will influence the number of visits to a site (Lucyanti *et al.* 2013). Slope index assessment used the scoring of criteria for slope classes on an active area accessed by visitors. Data of slope gradient were obtained from GGPNP Office, which were then classified and scored according to the slope condition of the Cibeureum Waterfall. Scoring followed the Minister of Agriculture Decree No. 837/KPTS/UM/11/1980 on Criteria and Procedures for Determining Protection Forest with slope classification as follows: 1) flat = 20; 2) lower slope = 40; 3) middle slope = 60; 4) steep = 80; 5) upper steep = 100. Slope gradient score of the Cibeureum Waterfall area is the limiting magnitude variable (Mn), while the highest score (100) is the total magnitude variable (Mt). By using equation (4), slope correction factor (Cf_2) was obtained.

c. Soil erodibility (Cf_3)

Soil erodibility will influence the sensitivity of an area to the risk of disaster, hence the number of visitors. The more sensitive is the soil, the higher the chances of erosion or landslide would be. Data on soil were obtained from GGPNP Office, which were then classified and assessed based on the types of soil as stated in the Minister

of Agriculture Decree No. 837/KPTS/UM/11/1980 on Criteria and Procedures for Determining Protection Forest. The classification of soil erodibility is as follows: 1) insensitive = 15; 2) slightly sensitive = 30; 3) moderately sensitive = 45; 4) sensitive= 60; 5) highly sensitive = 75. The soil types of Cibeureum Waterfall area are the limiting magnitude variable (Mn), while the highest score (75) was the total magnitude variable (Mt). By using equation (4), soil erodibility correction factor (Cf_3) was obtained.

d. Index of Landscape Potential (Cf_4)

Landscape is one of significant correction factor in determining the CC of an area, as it is related to the available physical space. Index of landscape potential was calculated following the guidelines provided by the *Bureau of Land Management* (Fandeli and Muhammad 2009) and assessed based on the criteria score for each landscape element comprising of landform, vegetation, colour, scenery, scarcity, and structural modification. Each element has its own score, which together constitute the limiting magnitude variable (Mn), while the total score (27) was the total magnitude variable (Mt). By using equation (4), soil erodibility correction factor (Cf_4) can be formulated.

e. Disturbance to wildlife (Cf_5)

Visitors may disturb the wildlife particularly during reproduction or mating season (Cifuentes 1992). Wildlife is sensitive to human existence. Therefore it is assumed that wildlife would be disturbed during reproductive period, giving results in the following wildlife disturbance index.

$$\mathrm{Cf_n} = \frac{\mathrm{G_n}}{\mathrm{G_t}} \times 100\% \ldots (6)$$

Description:

Cf_n = Wildlife disturbance index correction factor (%)
Gn = Mating season (month)
Gt = Month in a year (month)

Effective carrying capacity is the maximum number of visits to a site taking into account the management capacity (Cifuentes 1992; Sari and Rahayu 2018). The parameter of management capacity was using approach of the number of the staff attending the tourism area.

$$\mathrm{ECC} = \mathrm{RCC} \times \mathrm{MC} \ldots (7), \text{ with}$$

$$\mathrm{MC} = \frac{\mathrm{Rn}}{\mathrm{Rt}} \times 100\% .. (8)$$

Description:

ECC = Effective Carrying Capacity (people/time)
RCC = Real Carrying Capacity (people/day)
MC = Management Capacity
Rn = Active resource at location (people)
Rt = Fixed resource of management (people)

Tourism management strategy based on CC is a form of management that can regulate the number of visitors according to the CC. The formulation was combining literature review and interview with the visitors of Cibeureum Waterfall. The strategy for regulating the number of visitors was adapted from Mak's (2004), by implementing policies based on price and non-price, supported by IUCN guidelines related to nature tourism management in protected areas (Eagles *et al*. 2002). The number of visitors can be reduced by increasing prices and or limiting the quotas based on *first come first serve* approach (Mak 2004). The results of the literature review were applied into the questionnaire, which were then selected by the respondents by giving their perceptions to agree or disagree. In addition, interviews were also conducted with Cibodas Resort or Cibeureum Waterfall management authority to obtain additional information regarding the management of Cibeureum Waterfall tourism.

Interview results from the visitors and key informants were analysed using descriptive-qualitative analysis. The function of this analysis is to describe the conditions, symptoms, or problems obtained from data collection. The conclusion was then drawn based on the existing data collection (Madaidy and Juwana 2019).

RESULTS AND DISCUSSION

Cibeureum Waterfall is located within the GGPNP area at 106º 51' - 107º 02' EL and 6º 41' - 6º 51' SL. It is administratively situated in Cianjur Regency. Located in the highland, this tourism area has a high rainfall with type A, based on climate classification by Schmidt-Ferguson (BBGGPNP 2012). Cibodas Resort is also the habitat of three flagship species, that is Javan gibbon (*Hylobates moloch*), Javan leopard (*Panthera pardus*), and Javan hawk-eagle (*Nisaetus bartelsi*), hence the preservation of these species in the management of Cibeureum Waterfall tourism is very important.

The number of visitors to Cibeureum Waterfall in 2017 was 39,441 people, with a daily average of 108 visitors (BBGGPNP 2018). One of the criteria for sustainable nature tourism is the limitation of visitors in accordance with the CC (Nugroho 2018). The measurement of CC within a nature tourism area would prevent damage or degradation of natural resources so the sustainability and function of the nature tourism are enhanced.

1. CC Analysis of Cibeureum Waterfall Tourism

a. Physical Carrying Capacity

The area of Cibeureum Waterfall accessible by the visitors is about 200 m^2 (BBGGPNP 2012). According to Cifuentes (1992), the area needed for a tourist to enjoy tourism activities is 1 m^2. The results of the interview showed that on average, visitors spent 2 hours at the location, thus if it is assumed that the site is open for 8 hours (working hours), the rotation factor is four times. It means that during the opening hours, there were four visitor rotations. Using formula (1), the obtained PCC value of Cibeureum Waterfall of 800 visitors/day. It can be defined that with the available area, Cibeureum

Waterfall can receives a maximum of 800 visitors/day to avoid overcrowding.

In 2017, the average daily visit (regardless weekdays and holidays) is 108. If this number is compared to the PCC value, it is far below the CC. The obtained PCC is the basic value for calculating the RCC.

b. Real Carrying Capacity (RCC)

The limitation in calculating RCC is the biophysical condition of the area, resulting in the lower value of RCC below the PCC (Sari and Rahayu 2018). Such limiting factor is important given that Cibeureum Waterfall is located within a national park that must be preserved. Moreover, Cibeureum Waterfall is located in the highland area, which is prone to disaster. The area is exposed to the risk of earthquake, landslide, flood, flash flood, extreme weather, forest fire, and volcanic eruption (BNPB 2019).

Biophysical aspects as the correction factor parameters were determined based on field observation and literature study. The parameters of correction factor in Cibeureum Waterfall were rainfall (Cf_1), slope (Cf_2), soil erodibility (Cf_3), landscape potential (Cf_4), and disturbance to wildlife (Cf_5).

b.1 Rainfall *(Cf_1)*

Correction factor value was obtained from the precipitation data in the past 5 years (2014-2018). Based on the BMKG data (2019), the numbers of the wettest months and driest months for Cianjur Regency amounted to 49 months of rainy season and 10 months of dry season. By using formula (5), the rainfall index value of 0.20 was obtained. This value was set as Mn and Mt was set at 7 (the highest index value in Schmidt-Ferguson classification), thus the correction factor of the rainfall was 0.97.

b.2 Slope *(Cf_2)*

According to the topographic map of the Cibodas Resort area, Cibeureum Waterfall has a moderately steep topography. Based on the criteria for slope classes, this resulted in the slope score of 40 (Mn), while the maximum variable of slope class or Mt was 100, resulting in the correction factor of slope valued at 0.6.

b.3 Soil erodibility *(Cf_3)*

Cibeureum Waterfall area is dominated by greyish brown alluvial soil, which is classified as non-erosive soil, thus the score was 15 (Mn), while the Mt score was 75. The correction factor of soil erodibility in the Cibeureum Waterfall area was 0.8.

b.4 Index of landscape potential *(Cf_4)*

Development of a nature tourism area that exceeds its CC would disturb the landscape elements of the area (Fandeli and Muhammad 2009). Based on the calculation of the index of landscape potential in Cibeureum Waterfall using the guidelines provided by the *Bureau of Land Management* in Fandeli and Muhammad (2009), the obtained index of landscape potential (Mn) was 21, while the Mt was 27, giving a correction factor 0.22.

b.5 Disturbance to wildlife *(Cf_5)*

Based on the statement of an MMP (9 October 2018, private communication) and also BBGGPNP (2018), Cibeureum Waterfall area is also the home range areas for several protected species, such as Javan gibbon (*Hylobates moloch*), Javan hawk-eagle (*Nisaetus bartelsi*), and Javan leopard (*Panthera pardus melas*). In line with its role as a national park, GGPNP serves to protect and preserve wildlife populations and their habitats (BBGGPNP 2018). The presence of tourists might disturbed the wildlife, especially during mating seasons, since they are sensitive to humans and would stay away from the area (Eagles *et al.* 2002). Considering this condition, it was assumed that wildlife would be disturbed during mating season (Table 1). Result of the RCC calculation based on all of the above correction factors and using formula (3) is presented in Table 2.

As seen from Table 2, the maximum permissible number of visitors to the Cibeureum Waterfall area, taking into account the biophysical factors is 173 people/day. Compared with the average number of visitors during holidays (269 people), this figure has exceeded the RCC. The huge gap between PCC (800) and RCC (173) indicated the fragility of the biophysical conditions of Cibeureum Waterfall. Consequenstly, if the number of visitors cannot be managed properly, it will give great pressures in the environment (Lucyanti *et al.* 2013).

Table 1. Wildlife disturbance correction factors

Types of Animal	Mn (month)	Mt (month)	Cf_n
Javan gibbon	4	12	0.67
Javan hawk-eagle	5	12	0.58
Leopard	2	12	0.83
	Cf_5		2.08

Table 2 RCC of Cibeureum Waterfall area

Correction factors					PCC (visitors/day)	RCC (visitors/day)
Cf_1	Cf_2	Cf_3	Cf_4	Cf_5		
0.97	0.60	0.80	0.22	2.08	800	173

NOte: Cf = Correction factor, PCC = physical carrying capacity , RCC = real carrying capacity

c. Effective CC (ECC)

Cibeureum Waterfall is located in a protected area with high sensitivity, thus management factors becomes the key factor in the successful management of a national park (Kastolani and Rahmafitria 2015). ECC is the maximum permissible number of visitors to a tourism object to maintain its preservation based on the managerial ability of the manager. ECC calculation in this research used the number of available field officers. It is known that Cibodas Resort has ten officers, consisted of Forest Ecosystem Controller, Forest Ranger (Polhut), and Community-based Forest Rangers (MMP). However, only five officers were actively stationed at Cibeureum Waterfall. Based on the calculation using formula (7), the ECC was obtained at 86 visitors/day, which indicated that the capacity of the officers (5 people) could only serve 86 visitors/day. It means, if the number of visitors exceeded 86 visitors/day, visitors would feel overcrowded. According to Rambaldi (2000), the ratio of security personnel per area is one person per 1,000 hectares. This ratio was the result of a case study on the efficiency of the number of security personnels in eight protected areas in the Philippines. If such ratio was to be applied to GGPNP, results showed that most of the resorts has a ratio nearly 1:1,000 (people: total area in hectares). If the number is used as a benchmark, then the total of five officers stationed at Cibeureum Waterfall area of 200 m^2 is more than adequate. However, in tourism management, it is a different matter, since there is a need for a sufficient number of officers stationed at site to provide an optimum service to the visitors, especially in maintaining visitors' safety and ensuring that visitors did not cause any damages to the environment.

If compared to the average number of daily visitors (Table 3), it could be concluded that the CC of Cibeureum Waterfall is below the threshold. However, Table 3 also showed that on holidays, the number of visitors (269 people) is over the RCC (OCC) which may might lead to overcrowding.

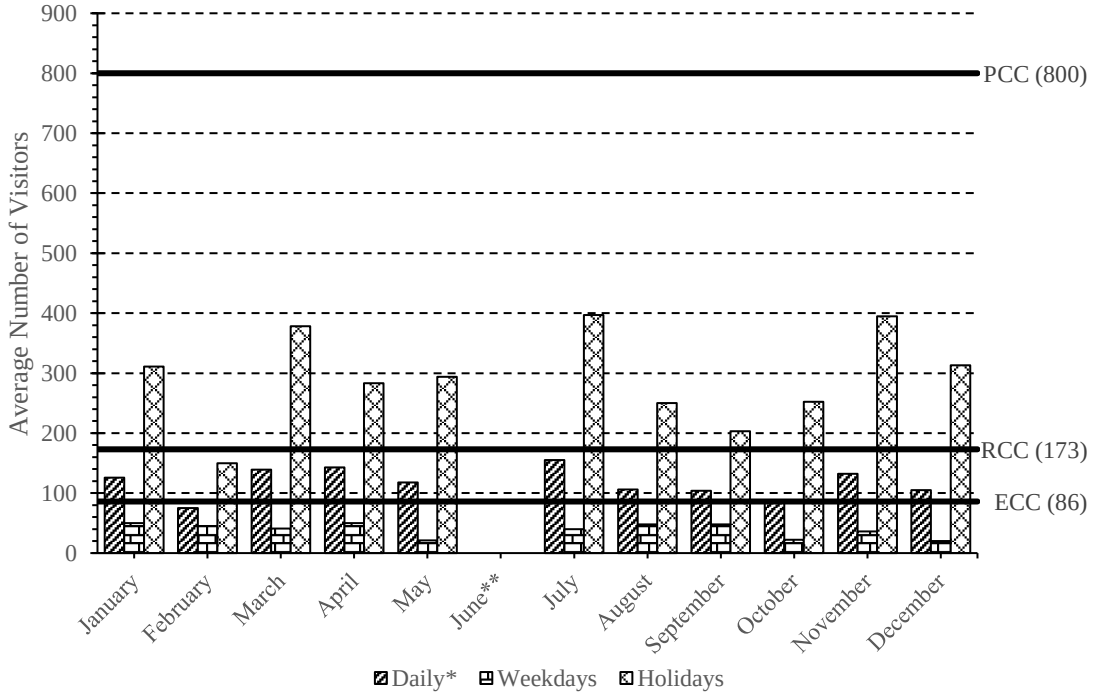
2. Suitability of Carrying Capacity with the Number of Visitors

Despite the difference or similar numbers of visitors between weekdays and holidays, the number of visitors to Cibeureum Waterfall is below the PCC and RCC, but exceeded the ECC, except in February (Figure 1). In February, the number of visitors was lower that the other months due to high rainfall and frequent downpours, so that the access to Cibeureum Waterfall was closed for the visitors' safety.

Table 3 Number of visitors to Cibeureum Waterfall

Month	Number of visitors (people/month)	Average number of daily visitors (people/day)		
		Daily*	Weekdays	Holidays
January	3,900	126	50	311
February	2,100	75	45	150
March	4,300	139	41	378
April	4,300	143	50	283
May	3,649	118	21	294
June**	0	0	0	0
July	4,806	155	40	397
August	3,299	106	48	250
September	3,133	104	48	203
October	2,742	88	22	252
November	3,962	132	36	395
December	3,250	105	20	313
Average		108	35	269

*: Number of visitors per day, regardless weekdays or holidays
**: No visitor (Ramadhan)
Source: BBGGPNP (2018)



Description: * = Number of visitors, on weekdays and holidays, ** = No visitation
Figure 1 Comparison of the number of visitors with CC.

As illustrated in Figure 1, if the number of visitors was determined based on weekdays and holidays, the average number of visitors on weekdays would be below the PCC, RCC, and ECC. Although visitors' number on holidays has not exceeded the PCC, but it has exceeded the RCC and ECC. Lower visitors' number compared to RCC, implied that the tourists' activities are safe for the environment, and vice versa (Sasmita *et al.* 2014). The number of visits exceeding the RCC should be paid close attention, as this CC indicated the capacity to receive visits based on environmental capacity. Therefore, if the number of visitors exceeded the RCC, this could bring negative impacts on the tourists site.

3. Alternative Management Strategies for Cibeureum Waterfall Tourism Based on Carrying Capacity

The negative impacts of tourism activities in protected areas could damage the existing natural resources and would greatly affect the economic activities of the surrounding community (Rabbany *et al.* 2013). In addition to its prone to disaster location, Cibeureum Waterfall is also the habitat of three priorities and protected species of GGPNP (BBGGPNP 2012). Therefore, this waterfall tourism should be managed in a sustainable manner according to its tourism CC. Moreover, this tourism object attracted mass visitors and results of this research indicated that the number of visits has exceeded the CC during peak season on holidays. Therefore, visitor management is the key to sustainable nature tourism management in the area, as visitor activity cannot be separated from the management of protected areas.

Figure 1 shows that the number of visitors to Cibeureum Waterfall in GGPNP during holidays has exceeded the RCC, yet there was no limit determined for the number of visitors on holidays. It is quite a concern that this might be potentially damaging to the environment, which will have implications for the sustainability of the natural resources and the environment within a tourism site (Vibriyanto *et al*. 2015). Nature tourism is said to be sustainable if it can sustain its ecological, economic and sociocultural conditions (Setijawan 2018). From the ecological aspect, the determination of the CC for the area should reduce the negative impact of visitors on the environment. Therefore, an alternative strategy is needed to keep the number of visitors below the CC, especially during peak seasons such as on holidays.

Empowering the community to become Community-based Forest Rangers (MMP), as has been carried out by the GGPNP management, is a strategy that could help achieve the CC-based tourism management following the ECC. Besides adding or involving the number of personnels or MMPs, efforts were also required to manage the impacts of visitors, one of which could be carried out by reducing the number of visitors. Reducing the number of visitations on holidays, could be regulated through price and non-price-based policies. Mak (2004)

states that to regulate the number of visitors in a tourism site with a high number of visits, using price and non-price-based policies can be effective. A price-based policy means increasing the ticket prices, while the non-price policy is a quota-based policy through early booking system or reservation in which the amount is adjusted to the number of permissible visitors following the CC of the area.

a. Increasing Ticket Prices on Holidays

As many as 53% respondents disagreed should the entrance ticket price be increased on holidays. If the disagreed respondents were assumed to not visiting Cibeureum Waterfall on holidays, then the visitors on holidays would decrease by 53% or about 126 visitors/day. Although the number exceeded the ECC, but below the RCC, thus can be categorized as safe for the environment (Sasmita *et al*. 2014). Those whom were not willing to pay higher ticket price, were expected to come on weekdays and paid the original price. Results of this research (Figure 1) showed that the number of visitors could still be increased up to the RCC, as long as it is accompanied by an increased in the management capacity. It is thus necessary to study the magnitude of the increase of ticket price that could provide revenues to cover management expenditures with reduced visitations.

Price segmentation could be a way to reduce visitors' density, by setting a lower price on weekdays and charging higher price on holidays. This strategy might reduce the density of tourist objects and help encouraging certain types of visitors that the managers are trying to reach, as stated by Leung *et al.* (2018).

GGPNP management has differentiated the ticket price for weekdays at IDR16,000 and holidays at IDR18,500, but in reality, this difference was not able to reduce the number of visits on holidays. Therefore, the management could consider increasing the ticket price on holidays according to the willingness of the tourists to pay according to the CC. It indicated an undervaluation, so that further studies on visitors' willingness to pay (WTP) are required. Through proper calculation, the increases in ticket price would still be profitable to the management even with reduced number of visitors (Isnan 2016).

The increase in ticket price should be balanced with the quality of experiences of the visitors as stated by the repondents who were willing to pay higher ticket price. Such would include improvement of facilities, education tourism programmes, and increased area safety.

b. Implementing Early Booking or Reservation System

Limiting the utilisation of tourism objects that exceeded the CC, could be carried out by implementing an early booking or online reservation system. Based on the survey, 43% of the respondents disagreed if reservation is applied. Through reservation, the management authority could develop a quota system to limit the number of visitors in accordance with ECC (86 visitors/day) or RCC (173 visitors/day).

GGPNP manager has implemented an online reservation to control the number of visitors who wanted to hike to the top of Mount Gede and Mount Pangrango. This method has succeeded in controlling the number of hikers adjusted to the quota to avoid accumulation of hikers. Similar system can also be applied to Cibeureum Waterfall tourism activities. Quota system will be very beneficial in keeping the national park free from huge mass tourism, preserving the natural beauty and enhancing visitor experience (Ferreira and Harmse 2014).

The implementation of the reservation system is in line with the current government policy in dealing with the Covid-19 pandemic which requires social distancing. The Decree of the Minister of Health of the Republic of Indonesia Number HK 01.07/Menkes/382/2020 on Health Protocols for Communities in Public Places and Facilities in the Context of Prevention and Control of Covid-19 regulates the health protocols at tourist sites. This regulation urges the tourism managers to implement social distancing, for instance by limiting the number of visitors. Online reservation minimises direct contact between visitors, as well as between visitors and officers. Moreover, it can assure potential visitors that they will feel safe and comfortable performing their activities because of the limited number of visitors, and it will be easier for the managers to control the tourist flow and making preparation before receiving visitors.

CONCLUSION

Based on the CC, the number of visitors to Cibeureum Waterfall within one year has exceeded the ECC, while on weekdays it could still be maintained below the CC at PCC, RCC, and ECC levels. However, on holidays, it has exceeded the CC at RCC and ECC levels.

The alternative strategic management for Cibeureum Waterfall based on CC were to control the number of visitors on holidays in accordance with the recommended CC. These would include increasing the ticket price on holidays and implementing an early booking or reservation system. These two strategies would be able to reduce the number of visitors to meet the RCC.

REFERENCES

[BMKG] Badan Meteorologi dan Geofisika. 2019. *Data Curah Hujan SMPK Pacet.* Bogor: BMKG.

[BNPB] Badan Nasional Penanggulangan Bencana. 2018. *Kajian Risiko Bencana Kabupaten Bogor Provinsi Jawa Barat 2019-2023*. Jakarta: BNPB.

[BBGGPNP] Balai Besar Taman Nasional Gunung Gede Pangrango. 2012. *Revisi Rencana Pengelolaan Taman Nasional Gunung Gede Pangrango 2011 - 2020*. Bogor: Balai Taman Nasional Gunung Gede Pangrango.

[BBGGPNP] Balai Besar Taman Nasional Gunung Gede Pangrango. 2018. *Statistik Balai Besar Taman*

Nasional Gunung Gede Pangrango. Bogor: Balai Besar Taman Nasional Gunung Gede Pangrango.

Bin W, Xiaolei Z, Zhaoping Y, Heigang X, Yang Q. 2016. Influence of tourist disturbance on soil properties, plant communities, and surface water quality in the Tianchi scenic area of Xinjiang, China. *J Arid Land*. 8(2):304–313. doi:10.1007/s40333-015-0140-y.

Candrea AN, Ispas A. 2009. Visitor management, a tool for sustainable tourism development in protected areas. *Bull Transilv Univ Brasov Ser V Econ Sci*. 2(51):131–136.

Chamberlain K. 1997. *Carrying Capacity in UNEP Industry and Environment 8 (January-June 1997)*. Paris: UNEP.

Cifuentes M. 1992. *Determinacion De Capacidad De Carga Turistica En Areas Protegidas.* Costa Rica: Centro Agronomico Tropical De Investigation Y Ensenanza Catie.

Duzgunes E, Demirel O. 2016. Importance of visitor management in national park planning. *J Environ Prot Ecol*. 680(2): 675–680.

Eagles P, McCool S, Haynes C. 2002. *Sustainable Tourism in Protected Areas: Guidelines for Planning and Management*. Gland, Switerland, Cambridge: IUCN.

Ekayani M. 2014. Wisata alam sebagai jembatan ekonomi dan ekologi di Taman Nasional Gunung Halimun Salak. *Risalah Kebijakan Pertanian dan Lingkungan*. 1(1): 40–45.

Fandeli C, Muhammad. 2009. *Prinsip-prinsip Dasar Mengkonservasi Lanskap*. Yogyakarta: Gadjah Mada University Press.

Ferreira S, Harmse A. 2014. Kruger National Park: Tourism development and issues around the management of large numbers of tourists. *J Ecotourism*. doi:10.1080/14724049.2014.925907.

Isnan W. 2016. Harga optimal tiket masuk wisata alam Bantimurung, Sulawesi Selatan. *J Penelitian Sosial dan Ekonomi Kehutanan*. 13(3): 155-163. doi:10.20886/jpsek.2016.13.3.155-163.

Kastolani W, Rahmafitria F. 2015. Model pengaturan pengunjung pada kawasan wisata alam pegunungan dengan fungsi lindung dan intensitas wisata tinggi di kawasan wisata kluster Gunung Patuha Kabupaten Bandung. *Spatial: Wahana Komunikasi dan Info Geografi*. 14(2):21–29.

Leung YF, Spenceley A, Hvenegaard G, Buckley R. 2014. *Tourism and Visitor Management in Protected Areas*. Switzerland: IUCN.

Leung YF, Spenceley A, Hvenegaard G, Buckley R. 2018. *Tourism and Visitor Management in Protected Areas : Guidelines for Sustainability.* Switzerland: IUCN.

Lucyanti S, Hendrarto B, Izzati M. 2013. Penilaian daya dukung wisata di obyek wisata Bumi Perkemahan Palutungan Taman Nasional Gunung Ciremai Propinsi Jawa Barat. *Jurnal Ekosains.* 4(1): 33-46.

Madaidy AAl, Juwana I. 2019. Penentuan nilai ekonomi Taman Nasional Gunung Ciremai dengan metode contingen valuation method. *J Rekayasa Hijau*. 3(2):147–156. doi:10.26760/jrh.v3i2.3147.

Mak J. 2004. *Tourism and The Economy: Understanding the Economiv of Tourism.* Hawaii: University of Hawaii Press.

Nofriya, Arbain A, Lenggogeni S. 2019. Dampak lingkungan akibat kegiatan pariwisata di Kota Bukittinggi. *J Tek Lingkung Univ Andalas*. 16(2):86–94. doi:10.25077/dampak.16.2.86-94.2019.

Nugroho AW. 2018. Implementasi dan tantangan ekowisata dalam upaya konservasi sumberdaya hutan: apakah sudah memenuhi konsep kelestarian?. *Swara Samboja*. 7(1):8–15.

Rabbany G, Afrin S, Rahman A, Islam F, Hoque F. 2013. Envinronmental effects of tourism. *American Journal of Environment, Energy and Power Research.* 1(7): 117-130.

Rambaldi G. 2000. *Staffing Protected Area: Defining Criteria Based on Case Study of Protected Area, Special Report*. Philippine: Departement of Environment and natural Resources

Sari CP, Rahayu S. 2018. Carrying capacity of Gancik Hill Top for ecotourism development in Boyolali District capacity of an area. *E3S Web Conf*. 73:02008.

Sasmita E, Darsiharjo, Rahmafitria F. 2014. Analisis daya dukung wisata sebagai upaya mendukung fungsi konservasi dan wisata di Kebun Raya Cibodas Kabupaten Cianjur. *J Manajemen Resort Leisure*. 11(2):71-84.

Setijawan A. 2018. Pembangunan pariwisata berkelanjutan dalam perspektif sosial ekonomi. *J Planoearth*. 3(1):7-11. doi:10.31764/jpe.v3i1.213.

Sezgin M, Yildirim G. 2017. The environmental impacts of tourism and recreation activities the environmental impacts of tourism and recreation activities on Kaçkar Mountains National Park, Rize/ Turkey. *Australas J Business, Social Science Information Technology*. 3(2):71–77.

Sitania SY, Avenzora R, Sunarminto T. 2018. Kajian dampak injakan wisatawan di Kawasan Wisata Ciwidey. *Media Konservasi*. 23(2):114–121.

Szczęsna J, Wojtanowicz P. 2014. The role of national parks in promoting sustainable and responsible tourism. *Barom Reg*. 12(4):19-25.

UNWTO. 2018. *'Overtourism'? Understanding and Managing Urban Tourism Growth beyond Perceptions*. Madrid: UNWTO

Vibriyanto N, Ismail A, Ekayani M. 2015. Manfaat ekonomi dan daya dukung kawasan pantai Lombang Kabupaten Sumenep Provinsi Jawa Timur. *Risalah Kebijakan Pertanian dan Lingkungan.* 2(2):152–159.

Zacarias DA, Williams AT, Newton A. 2011. Recreation carrying capacity estimations to support beach

management at Praia de Faro, Portugal. *Application Geogr*aphy. 31(3):1075–1081. doi:10.1016/j.apgeog.2011.01.020.

Zelenka J, Kacetl J. 2013. Visitor management in protected areas. *Czech J Tourism*. 2(1):5–18. doi:10.2478/cjot-2013-0001.