
Visitor Management Concept Through Carrying Capacity Analysis In Forest Recreation

Aziean Jamin¹, Fitri Rahmafritria²

ajamin@bournemouth.ac.uk, rahmafritria@upi.edu

¹Bournemouth University Business School (BUBS), Bournemouth University, United Kingdom,

²Study Program of Management Resort & Leisure. Faculty of Social Science, Universitas Pendidikan Indonesia, Indonesia

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Abstract

Kawah Putih Forest Recreation (KPFR) is a tourism area with beautiful and unique scenery, functioning as biodiversity conservation and protection of Presbylis comata, an endemic primate of West Java. Because of its complex function, the use of the area for tourism should consider carrying capacity aspect. Carrying capacity is identified from three factors; those are physical carrying capacity (PCC), real carrying capacity (RCC) and effective carrying capacity (ECC). The calculation resulted from these three factors are then compared to the actual condition in KPFR. This research showed that physically the crater area of KPFR could accommodate 986 visitor/day (PCC). The result also showed that according to the specific characteristic of the area KPFR could accommodate 255 visitors/ day (RCC), while in its management capacity, the mode of local transportation in KPFR only able to carry 98 visitors/ day (ECC).

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Abstrak

Hutan Rekreasi Kawah Putih (KPFR) merupakan kawasan wisata dengan pemandangan yang indah dan unik, berfungsi sebagai konservasi keanekaragaman hayati dan perlindungan Presbylis comata, primata endemik Jawa Barat. Karena fungsinya yang kompleks, maka pemanfaatan kawasan untuk pariwisata harus memperhatikan aspek daya dukung. Daya dukung diidentifikasi dari tiga faktor; yaitu daya dukung fisik (PCC), daya dukung nyata (RCC) dan daya dukung efektif (ECC). Hasil perhitungan dari ketiga faktor tersebut kemudian dibandingkan dengan kondisi sebenarnya di KPFR. Hasil penelitian menunjukkan bahwa secara fisik kawasan kawah KPFR mampu menampung 986 pengunjung/hari (PCC). Hasil penelitian juga menunjukkan bahwa sesuai dengan karakteristik spesifik kawasan KPFR mampu menampung 255 pengunjung/hari (RCC), sedangkan dalam kapasitas pengelolaannya, moda transportasi lokal di KPFR hanya mampu mengangkut 98 pengunjung/hari (ECC).

INTRODUCTION

Kawah Putih Forest Recreation (KPFR), a nature-based tourism area in West Java, invites many visitors with its beautiful and unique attractions. These appealing attractions constitute natural forest, artificial forest ecosystem (*Eucalyptus* sp), endemic habitat of *Presbylis comata* (an endangered species of primate) and beautiful as well as unique volcano crater. In line with this, the number of visitors in KPFR reach 300.000 per year. In the peak season, this high number is centered on the crater's area, which has defined as protected area because of its elevation that above 2000 m asl

Carrying capacity analysis in KPFR is very important to conduct, particularly to determine the maximum number of visitors allowed to be in the crater's area per unit of time. Research conducted by [Rahmafitria and Nanin \(2013\)](#) suggested that KPFR is located in an area susceptible to landslide. The basic objections of this research are to identify the physical, real and effective carrying capacity of KPFR. Then this carrying capacity analysis can be used as the basis both to determine a concept/ program to manage visitors, determine tourists' activity and to decide the organizer policy to establish the zoning concept.

[Rahmafitria et al \(2019\)](#), [Hall & Boyd \(2005\)](#); [Manning, R.E. \(2002\)](#); [Douglass, W.R \(2016:84\)](#), stated that the overuse of natural tourism site will cause low quality in tourism activity and can generally cause damages to the surrounding areas as well the landscapes widely. Therefore, the management should apply the concept of environment carrying capacity in the planning process ([Butler, 2019](#)). Natural tourism site development requires comprehensive planning so that the use of the natural resources, facility management and

required room as recreation demand, now and the future, can be attained ([Fennel, D. 2008](#)); [Cifuentes \(1992\)](#) has developed the calculation for carrying capacity of one conservation area. The application of this carrying capacity analysis can be used in order to find out effectively acceptable number of visitors without damaging the conservation area. Therefore, this research is conducted to analyze the tourism carrying capacity of Kawah Putih, as the basic data in managing visitors in protected area.

LITERATURE REVIEW

1. Carrying Capacity in Mountainous Destination

The idea of carrying capacity is to represent the need to keep up with development and activities at a level that is both naturally and socially economical and exercises past which ecological corruption happens. The travel industry carrying capacity will evaluate the visiting capacity of each destination ([Faiz and Komalasari, 2020](#)).

Carrying capacity can be measured either at the extent of a tourist destination as a whole, with all its associated contents or at the capacity of individual, specific services and facilities. In both cases, capacity is categorized by physical, social and economic attributes which will be measured. Each type of capacity could considerably vary from one destination to another, depending on the natural-ecological characteristics of a given area, the manner of its use, and developmental goals to be achieved ([Sari and Rahayu, 2018](#)).

The availability of data on the sector in mountain areas is generally scarce, which poses many challenges in benchmarking destinations and opens opportunities for further research on tourism development, demand and impact in mountain regions.

Based on conditions and other factors of mountainous destination, the carrying capacity could be different from other destination (Romeo et al, 2021).

2. Debate in Carrying Capacity Method

An alternative to using tourism carrying capacity as a tourism management strategy is setting “limits of acceptable change (LAC). These are not interchangeable approaches, as tourism carrying capacity establishes capacity and then devises policies to counter excess visitation. One of the purposes of LAC approach is to come up with a better solution, where we could improve the quality of tourism by monitoring carrying capacity, community building, planning implementation and promotion by applying collaboration with local stakeholders to maintain on local level (Hargrove, C.M., 2017).

With LAC framework more focus on appropriate and acceptable condition for visitors rather than just counting the limit number of visitors (Hargrove, C.M., 2017). However, in terms of protected areas, it is not enough to take into account acceptance from the visitor's side. It is necessary to take into account the acceptance from the environmental side. This is done to balance visitor satisfaction and environmental damage control (Sari and Rahayu, 2018). Calculation of carrying capacity is something that needs to be done to continue the next development, especially in natural and protected areas where infrastructure facilities are comparatively less and tourists' flow is high (Sati, 2018).

3. The Importance of Calculating Tourism Carrying Capacity in Protected Area

By calculating tourism carrying capacity, we could avoid over-tourism in protected area. In which can create damage, such devalue of protected area

but also can damaging the quality life of locals around the area. Calculating the right tourism carrying capacity also help the area to avoid negative experiences for

the tourist, stakeholders, also the locals who lives around the area (Sari and Rahayu, 2018; Mandie and Petric, 2021).

RESEARCH METHOD

This research was conducted by using carrying capacity analysis suggested by Cifuentes (1992). Carrying capacity analysis was calculated in two tourism zone in KPFR, which are the core zone and the intensive recreation zone. The core zone is the crater area with specific and unique character (Extensive zone). The crater area also pointed as the main attraction and pull factor for tourists. The intensive zone is located near the main gate, can be utilized and modified for tourism facilities. The calculation of tourism carrying capacity analysis is defided into 3 steps:

1. Physical Carrying Capacity Analysis (PCC)

Physical Carrying Capacity makes up the maximum number of visitors that can be physically fulfilled per certain unit of time. It is calculated by using the formula as follows.

$$PCC = A \times V/a \times Rf$$

In which, A : the available area width
V/a : the area width used for the activity (m²)
Rf : the Rotation Factor

Assumption:

- The available area width makes up the entire area width used for the facility as the center of tourism activity.
- Rotation factor (Rf) is daily number of visitors allowed in one location and is calculated by using the following formula:

$$Rf = \frac{\text{Open Time}}{\text{Average time per visit}}$$

2. Real Carrying Capacity Analysis (RCC)

Real Carrying Capacity is the actual carrying capacity indicated by the maximum number of visitors allowed to one location, after calculating correction factor relevant with landscape character in

that area. This can be done after the PCC is calculated. The correction factors used in the research covered rain fall (Cf^1) land slope (Cf^2), soil types (Cf^3), sulfuric gas concentrate (Cf^4) disturbance to the wild primates, (Cf^5), disturbance to vegetation endemic to the area (Cf^6), and location shutdown temporarily (Cf^7).

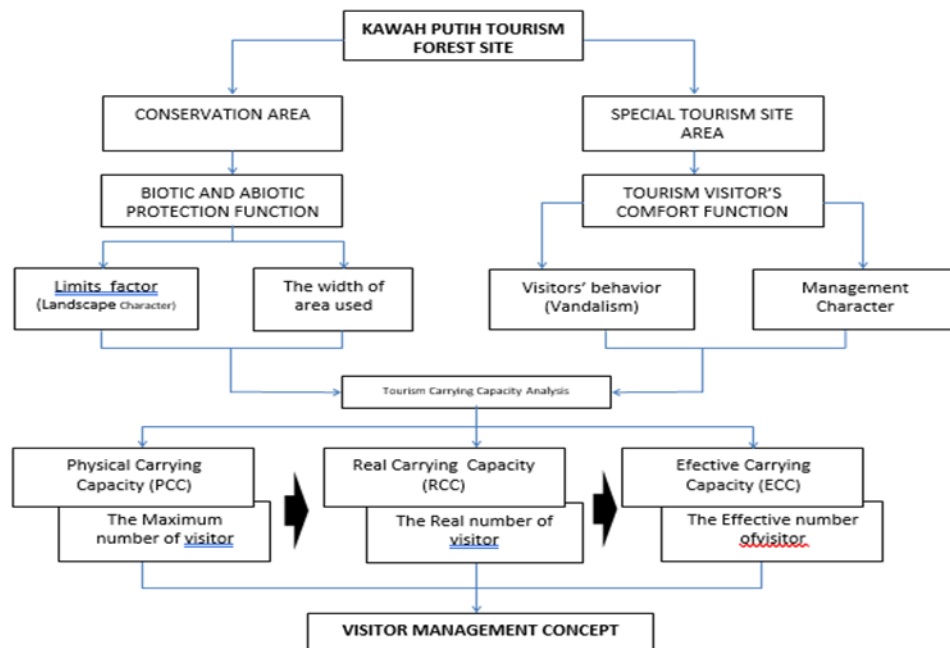


Fig.1. Research Framework

The formula used to measure RCC is as follows.

$$RCC = PCC - Cf_1 - Cf_2 - Cf_n$$

Further, in order to measure real carrying capacity, the below formula is used.

$$RCC = PCC \times \frac{100 - Cf_1}{100} \times \frac{100 - Cf_2}{100} \times \frac{100 - Cf_n}{100}$$

1. Effective Carrying Capacity Analysis (ECC)

Effective Carrying Capacity (ECC) allowed is the maximum number of visitors accommodated by one place due to certain management capacity factor (MC).

RCC : real carrying capacity

ECC is calculated by using the following formula.

$$ECC = \frac{\text{Infrastructure Capacity} \times MC}{RCC} \times 100\%$$

$$\frac{(\text{Infrastructure Capacity} \times MC)}{RCC} \times 100\%$$

In which

ECC : allowed effective carrying capacity

MC : management capacity based on the number of the staff and the allocation of budget

4. Tourism Carrying Capacity Analysis

This analysis is conducted by comparing the data resulted from the

previous analyses including PCC, RCC and ECC. The rule is below stated.

$$PCC > RCC \text{ dan } RCC \geq ECC$$

The result of analysis is used as a standard in determining the tourism carrying capacity in KPFR. If ECC is bigger than RCC and RCC is bigger than PCC, it shows that visitors number has exceeded tourism carrying capacity and it leads to the determination of visitors management concept to preserve area.

RESULTS AND DISCUSSION

KPFR extends 1.087 H and its crater's area is located in the steepy slope from the highest peak of Mount Patuha. KPFR is the main tourist destination in the South of Bandung. The total visitors of KPFR are never less than 200.000. In 2011, the total visitors were 206.713, while in 2012 the number of total visitors increased to 25 % from the year before into 259.178. Meanwhile, from 2013 up to its second trimester, the total number of visitors has reached 195.890.

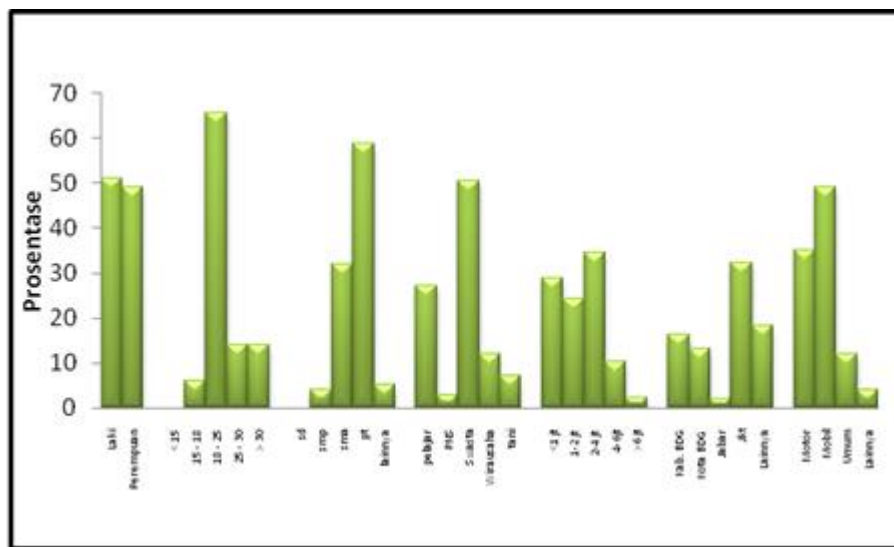


Fig.2. Visitors Characteristics in KPFR

A. Carrying Capacity Analysis of KPFR

1. Physical Carrying Capacity

In this research, PCC is the maximum number of visitors that can be accommodated physically by KPFR. The

value of PCC is obtained by multiplied the width of tourism area with the constants that indicate the area needed for picnic activity.

Table1. Kawah Putih Tourism Forest Site Physical Carrying Capacity

Type	The width of the area (m ²)	The width of the area needed (person/m ²)	Rotation Factor			PCC (visit/day)
			Duration of visit	Opening time	Visiting period Per day	
Ekstensive Area	16.412	0,01	1 hour	09.00 – 15.00	6	984
Intensive Area	21.450	0,01	1 hour	09.00 – 17.00	8	1.716

2. Real Carrying Capacity

Real Carrying Capacity is used in order to find out the actual carrying capacity, that

the maximum number of visitors allowed can be attained. The analysis of RCC is

considering some corrections factors, base on special characteristics of the area. The assumptions used in the calculation of RCC are as follow.

- a. Correction factor determined based on specific condition of the area
- b. Correction factors related to environment biophysics variable and management

Area	Rainfal Cf1(%)	Land slope Cf2 (%)	Soil types Cf3 (%)	Sulfuric gas concentrate Cf4 (%)	Disturbance to wild animals Cf5 (%)	Management factor Cf6 (%)	RCC of Extensive zone (visit/day)	RCC of Intensive zone (visit/day)
Extensive	42,49	78,78	0	0	16,67	0	255	683
Intensive	42,49	60,72	0	0	25	0		

Table 2. Percentage of Physical Carrying Capacity

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3. Effective Carrying Capacity

Based on the result of ECC calculation, it was found that ECC value of KPFR was 43 %. By having the value of RCC in the extensive area as 255 visitors, it was concluded that number of visitors accommodated effectively was 110. This number constitutes the maximum number in the peak season, that could be carried by all transportation mode for return in one day, both local and private. According to [Chang, M and Hans G \(2012\)](#), MC should consider the need of infrastructure, available equipment, staff's managerial skill to supply tourists need. Effective carrying capacity in intensive area aren't calculated because there is no transportation mode required by the management.

Through the PCC, RCC and ECC calculation, showed that in the extensive area, $PCC > RCC > ECC$, in which $984 > 255 > 98$. And in the intensive area, $PCC > RCC$ in which $1798 > 683$. This research showed that physically the crater area of KPFR could accommodate 986 visitor/day (PCC). The result also showed that according to the specific characteristic of the area KPFR could accommodate 255 visitors/ day (RCC), while in its management capacity, the mode of local transportation in KPFR only able to carry 98 visitors/ day (ECC). It implied that 157 visitors could be carried and accommodated in crater's area by using personal vehicles. To put on average, if one vehicle accommodates 5 passengers, 30 vehicles could then be accommodated in the crater's area

4. The Carrying Capacity of Kawah Putih Forest Recreation Site

Table 3. The Result of Carrying Capacity Analysis Comparing to the Actual Condition of Visitors number in KPFR

Extensive Area (Crater's Area)					Intensive Area (Bottom Area)				Visitor Number Within last 5 years				
PCC		RCC		ECC		PCC		RCC		The Highest		The Lowest	
Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year	Visitor//da Visito y r/ year
984	359.160	255	93.075	98	35.770	1.798	656.270	683	249.295	5.877	259.178	40	119.425

The comparison between the result of carrying capacity analysis with the highest and lowest number of daily visitors in

KPFR shown in the table 4. Focused on extensive area as the main attraction for tourists, in the peak season, visitor number

within a day reaches 5.877 visitors/day. This value is very high, above the standard of carrying capacity calculation (maximum capacity are 255 visitors/day). It illustrates that management of the area should manage and organize visiting rule program, especially when the number of visitors reaches the highest value.

Based on the interview with the organizer, it was found that the highest number of visitors occurred on the weekend, on the school holiday (June-July), the national holiday, the religion holiday such as *Idul Fitri's* day, and New Year's holiday. This is in line with Schirpke et al, (2021) that pressure factor to the area depends on seasonal visitor, transport model and a number of disturbances resulted from either a group of people or individual. Visitor management considered to be applied will be relevant with several aforementioned factors.

Basically, tourism carrying capacity is not fixed, it depends on the changes occurred, that are resulted from pattern of visits, visitors experience, climate, management and organizer policy, company and society economy aspect influencing area physical carrying capacity (Leung et al, 2018). This data also implies that Kawah Putih Tourism Forest site is also struck from the compression due to density and tourism activity in certain time in the peak season and thus the anticipation can be done in the low season by doing recovery to the areas used as visitor center area.

Carrying capacity analysis showed that KPFR required specific visitor management program without reducing visitor satisfaction in enjoying natural attraction resides in the area. If the organizer disregards this management program, the preservation of the area is threatened. This could be viewed from the comparison of carrying capacity calculation result to the actual numbers of

daily visitors showing that carrying capacity value was exceeded. According to Kastolani & Rahmafitria (2015), some factors that should be consider in visitor management program are resources efficiency, monitoring the program effectively, analyzing its positive and negative contribution and equity.

B. Visitors Management Concept based on Carrying Capacity Analysis in KPFR

The analysis result of carrying capacity in KPFR showed that in the peak season, the area was exceeded it carrying capacity. However, in the low season, the number of visitors was still below the standard, so that it was possible to improve the area naturally in order to normalized the physical condition after being struck intensively from tourism activity. This result certainly illustrated the importance of visitor management to be done seriously. They are several program in developing visitor management concept of KPFR, which are:

1. Zoning Concept

Zone is an effort to divide the space in one area to preserve the area and to keep the comfort of the user as well as to avoid conflict among spaces so that environment damage can be prevented. Zoning will be a key tool in managing medium-sized and large sites, and also enables the site manager to divide the site into relatively homogenous units where specific objectives and standards can be addressed (Grinyuk, Damianenko & Kupach, 2021; Novikov et al, 2020). The zone developed in the area was resulted from the interpretation result on the map of area congruity for natural sites based on the condition and limitation of local natural resources. The zoning concept was used to determine the function of the space for protection and other benefits. Kawah Putih Tourism Forest site can be divided

into several zones. Generally, those zones are below explained.

a. Core Zone

This is the core of tourism area that becomes the main attractions as it has unique natural resources in the forms of a particular blue-green lake and a crater resulted from volcano eruption. Despite of being the core of tourism attraction, it is also the protected areas that is highly fragile and susceptible. The development of facilities in the area is conducted as minimum as possible and should be semi permanent construction. The attraction of tourism is focused on natural attractions without developing other man made attractions, so that duration of the visitor in the crater's area can be limited.

b. Protection Zone.

This zone is natural area that needed for natural protection, due to its susceptibility and low carrying capacity. The activities done in the area are very limited, only to focus on rehabilitation and preservation of wild life, especially *Presbylis comata* which is the endemic species of primates in West Java. Tourism activity can be done particularly through training activity and special interest tourism.

c. Intensive Recreation Zone

This zone constitutes greets and serves area (tourism services area). This is where the intensive tourism activities are centered. This zone provides the best area congruity for facility and infrastructure placement. The intensive recreation zone must be placed in a distance from the core and protection zones. The development on this zone is directed to ecotourism activity and provided with natural supporting activities. [Novikov et al \(2020\)](#) stated that the relationship between tourism and the environment must be managed so that the environment is sustainable in a long term. Tourism activities and development should respect the scale, nature and

character of the place in which they are sited.

d. Exstensive Recreation Zone

The extensive recreation zone is a specific tourism activity area, which developed as an effort to reduce the compression to the core zone. This zone is developed intentionally in line with visitor comfort. However, the activities are created to be the passive ones as well as the limitation of the resources. It must be low development of infrastructure to avoid the land form change. The development of structure and infrastructure in this extensive zone are takes into account with the existing land formation and its semi preservation function. The activities that accommodate in this zone are outbond, adventure game, nature tracking, canopy trail and so on.

e. Exstensive Recreation Zone

Preservation zone is a green area, functioning as a buffer zone that acts as a boundary between the protection and recreation zones. This boundary is aimed for preventing damages to protection zone from recreational activity as the central area of activities. The greenery concept of this area is covered by shrubs and bushes, which also could be the physical and visual barriers for recreation space.

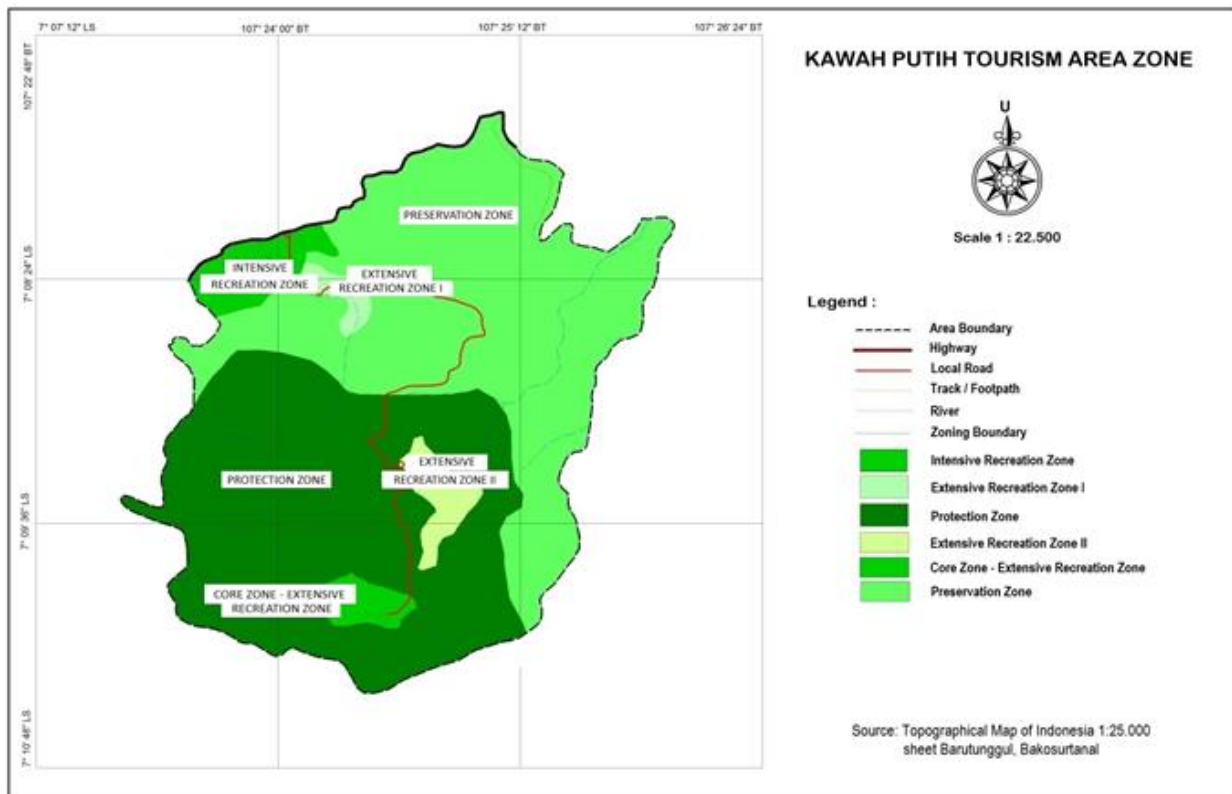


Fig 3. Kawah Putih Tourism Area Zone

2. Visitor Limitation and Group Size

Primary and secondary observation results showed that the number of visitors visiting Kawah Putih Tourism Forest Site was fluctuated depending on the season. The peak season occurred in June, August, December and January and reaches 4000-5000 visitors within a day. While in the low season, the number of visitors tended to decrease and it was usually below allowed carrying capacity standard. Area management should certainly consider visit season aspects because the compression to the area was centered on the day where number of visitors is 40 % of the total number within a year (Leung et al, 2018). According to Douglass, W.R (2016) and Shackley, M. (2001), visitor management aimed to direct and serve visitors to expand their experiences, in line with the main objective of the area.

Despite that, visitor management also ‘manipulated’ the visitor activities directly or indirectly to be parallel with management’s objectives, including providing recreational service that in line with visitor expectation, protecting them from any kinds of danger, and preserving natural resources.

The management could apply the policy of visitor limitation through three ways as follow.

- a. Increasing ticket price in the peak season
- b. The limitation system of visitor number who is permitted for entering the crater’s area
- c. Visitors’ diversion from extensive zone to another area as alternative locations to prevent the main core zone from the visitor activities pressure. The research conclude that tourism carrying

capacity in Kawah Putih Tourism Forest Site has been exceeded the ideal number on certain days in the peak season. On the contrary, in the low season, carrying capacity of the area is sufficient. It shows that visitors management program and visitors management number are required so that the environment in the area can be well preserved. Several programs suggested are area zone management, tourism activity program management, visitor limitation and size group, visit duration limit, price decision policy, temporarily area shutdown and ecosystem interpretation. The natural attraction of KPFR is more rising today as the shift of tourism trend to virtual revolution in the nature of wildlife attractions. Nature and wildlife will continue to be a great attraction for tourists and the nature of wildlife attraction will evolve and develop in new ways. That's why creating new attraction to diversified attractions should be done in KPFR, to spread the pressure of tourist's activities.

Monitoring and controlling number of visit and visitors' activity in Kawah Putih Tourism Forest site conducted by the management are also required. By implementing this role, the environmental damage can be minimized. Further, monitoring station for mountain liveliness is required, particularly in terms of sulfuric gas concentrate supervision that can disturb visitor comfort and health. Educative tourism program and conservation can be developed by involving local society, especially that relevant with *Presbylis comata* conservation as primate endemic to West Java. Socialization to local society should also be conducted intensively so that cooperation can be built to preserve the environment.

CONCLUSION

The research conclude that tourism carrying capacity in Kawah Putih Tourism Forest Site has been exceeded the ideal number on certain days in the peak season. On the contrary, in the low season, carrying capacity of the area is sufficient. It shows that visitors management program and visitors management number are required so that the environment in the area can be well preserved. Several programs suggested are area zone management, tourism activity program management, visitor limitation and size group, visit duration limit, price decision policy, temporarily area shutdown and ecosystem interpretation. The natural attraction of KPFR is more rising today as the shift of tourism trend to virtual revolution in the nature of wildlife attractions. Nature and wildlife will continue to be a great attraction for tourists and the nature of wildlife attraction will evolve and develop in new ways. That's why creating new attraction to diversified attractions should be done in KPFR, to spread the pressure of tourist's activities.

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