Carrying capacity estimations to support tourism coastal management in Ungapan Beach Indonesia

N Insani\(^1\)*, Y Ariani \(^1\), F R Arachman\(^2\), and D A Wibowo \(^1\)

\(^1\)Departement of Geography, Faculty of Social Science, Universitas Negeri Malang, Indonesia
\(^2\)Departement of Geography Education, Faculty of Social Science, Universitas Negeri Jakarta, Indonesia

*nlul.insani.fis@um.ac.id

Abstract. The development of tourism in Malang Regency can be seen from the increase in the number of visitors and new tourist destinations that have emerged. Especially tourist attractions that utilize coastal and marine resources on the southern coast of Malang Regency. One of them is Ungapan beach tourism area in Gedangan District. An increase in the number of tourist visits has become an advantage while providing challenges in coastal management. The purpose of this study was to determine the estimated carrying capacity of Ungapan beach tourism. The method used in this study is a descriptive-quantitative method that assesses tourism carrying capacity to support coastal management. Components that we assessed are: first, Physical carrying capacity (PCC); second, Real Carrying Capacity (RCC); and also third, Effective Carrying Capacity (ECC). Results calculation show that the study are the PCC is 12,960 tourists per/day, RCC is 1,993 people/day and the current ECC is 1,533 per/day. The Conclusion is the Ungapan Beach is good place for recreational activities but still has some aspect to improve without causing disruption to the coastal ecosystem and the comfort of the tourists themselves.

1. Introduction
Since the last few decades, many countries have begun to look at the tourism sector as a source of foreign exchange income due to the weakening competitiveness of their flagship commodities. BPS (National Statistic Department in Indonesia) and Indonesian Ministry of Industry in 2017 show that the tourism sector is in the top two as the country's foreign exchange contributor. The threat of the global economic crisis has also increasingly encouraged them to prioritize the development of the tourism sector as an effort to recover the economy. Tourism is a pillar of the development process [1] because it is one of the dominant economic activities within the framework of economic development [2]. In subsequent developments, tourism has made each country connected in the international tourism industry network, thus making tourism an international business that provides significant benefits in various countries [3].

Malang Regency is one of the regions in Indonesia that has many tourist attractions, especially natural tourism. These natural attractions include Coban Rondo waterfall, Wonosari tea garden, Maron source tourism, jenon source, Bromo Tengger Semeru National Park (TNBTS), and coastal tourism objects such as Balekambanga, Ungapan, Clungup located along in the southern of Malang Regency coastal area. The existence of Tourism Attraction Objects which can quite improve people's welfare if it can be managed properly. Tourism can be a significant aspect to develop to enhance community prosperity and also national development [4].

As time goes on, the number of tourist objects that are more and more and the number of tourist visits to enjoy natural tourism is increasing. In 2015 Malang Tourism and Culture Office (DISPARBUD) recorded 3,251,367 tourists, the number increased to 5,719,881 tourists in 2016. Therefore, the Malang District Government seriously boosted tourism visits, one of which was by creating Branding ‘The Heart of East Java’ as a tourism promotion effort. There is an impression to be conveyed, namely Malang Regency is the heart of East Java, a strategic region and has abundant tourism potential. The government's partisanship in encouraging the development of the tourism
industry has an essential role in increasing community self-confidence in developing tourism potential in their regions.

Ungapan Beach is one of the leading beach tourism objects in Malang Regency. This beach is unique because it is close to the river estuary. The enchantment of the Ungapan beach includes the beauty of different watercolors, the water in the river estuary is greenish, while the water on the Ungapan beach is blue. Ungapan Beach has large waves, especially in the morning. Besides that, in Ungapan Beach, it has not been touched by tourists so there is a need for a strategy to develop the coastal area so that tourists know this beach. Geographically, the Ungapan beach is located on the southern coast of Malang Regency. If accessed from the city of Malang, it takes 2 hours with the travel distance of Malang ± 64 km. Ungapan Beach is located in Garahejo Village, Gedangan District, Malang Regency. Some of the tourism activities that are the main attraction at Ungapan beach include duck boat riding, swimming, outbound activities, and campsites.

In general, the process of developing tourist attraction takes place spontaneously and naturally without going through careful planning, through several stages as stated by Foster and Greenwood [5], namely the discovery, local response, and institutionalized stages. The development of spontaneous and natural tourism attractiveness as described above often creates many difficulties in its arrangement, both physical and institutional arrangement, and often has the potential for conflict of interest. To understand tourism as a whole, tourism should be recognized as a multi-dimensional phenomenon that includes economic, socio-cultural, ecological, and so on.

The development of nature-based tourism is often not balanced with adequate technical management in tourist attractions. The establishment of natural tourism tends to prioritize the quality of tourist attractions and services to growth traveler attention and satisfaction to increase the amount of visits [6]. However, it often ignores the protection and preservation of tourist areas from biophysical aspects of the environment [7]. Three valuable assets which are the natural environment, biologically diverse habitats, and indigenous culture are the key attractions, and sometimes help to create mass tourism. But an overload of tourism intensity ultimately can cause impact into these critical assets for tourism, and also loss of revenues. The tourism carrying capacity is often found to be discussed, though, calculated to avoid this impact[8].

The environmental conditions need to contemplate because of the disruption of the environmental grade of attractions will also affect tourism activities [9]. The problem of carrying capacity in ecotourism is principal because it is nearly connected to environmental destruction [10]. So that in the development of a tourist attraction not through good planning, the number of visitors who come to this tourist area can exceed the carrying capacity of the environment. According to Douglass [11] certain tourist areas have certain abilities in accommodating tourists[12]. The environmental carrying capacity of the natural tourism attraction are the capability of one area to receive visiting state in the number of tourists per unit area per unit of the time [13]. Based on the Ministry of Culture and Tourism, the feature of carrying capacity at ecotourism areas to reflectis the amount of tourists in a year; length of the tourist stayed; how repeatedly the ecologically "vulnerable" sites be visited, and many more.

Constructed by the explanation, this paper aim to evaluate the maximum number of tourists who can visit the Ungapan Beach attractions. So the tourism activity will not have a harmful impact on indigenous environmental circumstances. This study aims to analyze the carrying capacity of the tourism environment based on the biophysical features of the environment and management capacity in the Ungapan Beach tourist area using a method developed by Cifuentes [14] with some adjustments from Fandeli, (2009).

2. Methods
This research was conducted in the Ungapan Beach Area, Gedangan Sub-District, Malang Regency (Fig. 1). This study uses the descriptive-quantitative method. The descriptive method is a method that literally a study that intends to make a description of the situation, condition or event in the area that is the object of research studies[15]. The study also uses quantitative analysis, namely the valuation of the carrying capacity of the tourism situation. Data that collected at this study are both primary and secondary data. The primary data is collected from the field with direct measurement techniques, while secondary data were collected with literature studies and information related to the assessment of the carrying capacity of the tourism environment.
The environmental carrying capacity assessment framework for tourist object zones attempts to establish the maximum amount of visits in an area constructed on the physical, biological and organization conditions in the research area, considering three focal levels, which are the Physical Carrying Capacity (PCC), then the Real Carrying Capacity (RCC) and also the Effective Carrying Capacity (ECC) [16]. The submission of this method takings into several significant elements including the movement of tourists (tourist flows), area dimension, the extreme amount of space that available for each visitor to free-moving and the length of the time visit [16].

The formula used in calculating carrying capacity on the tourism environment is based on the modified Cifuentes [14] method with Douglass [11] research by Fandeli [10]. The formulas used in calculating the carrying capacity on the tourism environment are as follows:

**Physical Carrying Capacity** which is the maximum quantity of tourists who are actually sufficient by the space provided at a definite time. Here’s the formulation:

\[
PCC = A \times \frac{v}{a} \times Rf
\]

Where A is area to travel, V / a = visitor area per m², and Rf is rotation factor or number of repeat visits per day. Factors of rotation or restoration of the environment of each person for swimming activities = 1, picnic = 1 [10]. The rotation factor can be increased by increasing the number of visits. Or according to Fandeli and Muhammad (2009) can be modified to be:

\[
PCC = A \times \frac{v}{b} \times Rf
\]

Where B is the area required by a tourist to travel although still having satisfaction (B-value for picnic activity is 65 m²).

**Real Carrying Capacity (RCC)** is the number of visitors who are allowed to visit a tourist attraction with a correction factor (Correction Factor / CF) taken from the features of the object applied to PCC. The real carrying capacity in [17] as follows:

\[
RCC = PCC \times Cf1 \times Cf2 \times ... \times Cfn
\]

Cf is the correction factor of the environmental biophysical parameters of a tourist area. To calculate the Cfn correction factor using the following formula [17]:

\[
Cfn = 1 - \left(\frac{Mn}{Mt}\right)
\]
Where Mn is the actual state in variable fn calculated, and Mt is the maximum perimeter on the variable fn. The correction factors of the biophysical aspects of the environment in the tourist area recognized as a restrictive factor for tourism actions, particularly for tourist areas and the fulfilment and comfort of the tourists to move freely.

Some environmental biophysical factors that can be used are biotic and abiotic factors. Biotic factors are flora and fauna, such as the diversity of specific flora and fauna which is an attraction for tourism objects. Abiotic factors include potential landscape or landscape, slope, sensitivity to soil erosion and rainfall.

Effective Carrying Capacity is the maximum amount of visits in which the object remains maintainable on the Management Capacity (MC) provided that adequate carrying capacity is a consequence of the mixture of real carrying capacity and management capacity of the tourist in particular area. Here's the formulation:

\[
ECC = PCC \times MC
\]

MC is approached through several variables such as the juridical background, policies and regulations, equipment, personnel, funding, infrastructure, and facilities. The output of the calculation of carrying capacity values, both physical carrying capacity (PCC), real carrying capacity (RCC) and effective carrying capacity (ECC) is the number of tourists/day so that to obtain the condition of ability must be compared with the number of real visits (JKr) tourists per day. If data on the number of tourists/day is greater than the carrying capacity, then this indicates that the carrying capacity has been exceeded. Conversely, if the number is still below the carrying capacity it has not been exceeded so that the opportunity to be developed further. Briefly, it can be formulated as follows:

The formula used in calculating the carrying capacity of the tourism environment is based on the modified [14] the tourism environment is as follows:

### Table 1. Classification and Recommended Tourism Carrying Capacity

| Type of Tourism Carrying Capacity | Carrying Capacity Classification | Recommendation          |
|----------------------------------|---------------------------------|--------------------------|
| PCC>JKr RCC>JKr ECC>JKr         | Big Opportunity                | Can be developed         |
| PCC<JKr RCC<JKr ECC<JKr         | Overuse                        | Controlled and styled    |
| PCC=JKr RCC=JKr ECC=JKr         | Optimal                        | Effective and Efficient  |

3. Results and Discussion

The environmental carrying capacity of natural tourism objects is the ability of natural tourism objects to be able to accommodate the number of tourists in a given area and unit of time [13]. The tourism carrying capacity is also a biogeophysical, socio-economic and socio-cultural carrying capacity of a location or tourism site in supporting tourism activities without causing a decrease in environmental quality and tourist satisfaction in enjoying the location and tourist sites [18]. Calculation results (1) Physical carrying capacity (PCC); (2) Real Carrying Capacity (RCC); and (3) Effective Carrying Capacity (ECC) is as follows:

#### 3.1. Physical Carrying Capacity (PCC)

From the results of measurements on the area used for tourism activities using Google Earth Pro, it is projected the area of the Ungapan around the beach tourist destination. From the results of observations on the paths used for public tourism activities around 19.2 Ha. Assumed to be the same as the space for picnics, which is 65 m² [10]. Based on observations in the Ungapan Beach tourist destination, the visit time is around 3 hours, so that the average time spent on one visit cycle = (4 hours) / 2 = 2 hours. Ungapan Beach tourist area is opened at 08.00 - 17.00 WIB (± 9 hours per day).

From these data the rotation factor value (RF) = 9 hours / 2 hours = 4.5 hours is obtained.

The results of the PCC calculation show that the area projected as a tourist activity area in the Ungapan Beach tourist destination is able to accommodate 12,960 people/day. Value B is determined based on research from Douglass (1975) which calculates the area needed by a tourist to still obtain satisfaction [10]. The B value used in the calculation of the value of physical carrying capacity is for the type of picnic tourist activity which is equal to 65 m². This PCC value still ignores biophysical factors in the field, meaning that consideration of the environment of Pantai Ungapan tourism is still
not used in the calculation of tourism carrying capacity. Whereas according to [13] that the carrying capacity of the tourism environment is influenced one of which is the biophysical environmental factors of tourist sites that influence the strength or fragility of an ecosystem. The value of physical carrying capacity is fairly important in planning tourism development.

3.2. Real Carrying Capacity (RCC)
The various biophysical parameters are used by several researchers in calculating the real carrying capacity based on local conditions. [19] in his research in the Termessos National Park area of Turkey identified parameters of excessive sunlight, rainfall, storms, erosion, accessibility, and wildlife disturbance as a correction factor that limits the number of real visits of tourists to the region. Ortega [20] in calculating the value of the real carrying capacity of Marietas Island tourism in the Gulf of California that has been designated as a National Park uses environmental limiting factors namely erodibility, accessibility, rainfall, floods, biology, and vegetation. Whereas [16] determine the limiting factor in the Praia de Faro beach tourist area, Portugal based on local biophysical conditions including rainfall, wind speed, sunlight, coastal erosion, and temporary closure. In contrast to [21] in her research on physical factors that limit the number of tourists to get comfortable traveling in the Semarang Gedong Songo Temple complex, it is influenced by climatological conditions, the state of flora and fauna, soil conditions, water conditions, geological and geomorphological conditions. [22] in his research at Sibolangit TWA in Deli Serdang Regency included correction factors such as excessive sunlight, rainfall, wind speed, erosion, the presence of mud, disturbances in wildlife (primates) and the extent of outreach locations in their calculations.

Observations in the Ungapan Beach tourist area show that biophysical aspects that are considered as limiting factors for environmental carrying capacity include slope (Cf1), fishing area (Cf2) and vegetation (Cf3). The calculation results are as follows:

3.2.1. Real Carrying Capacity (RCC)
From the results of measurements in the field, topographic conditions, in general, are relatively gentle. The Ungapan Beach tourist area has a slope of 8% - 10% so that it includes the slope classification. The value of the slope area is 40 and the maximum slope value is 100 so that the correction factor value is obtained for
\[
\frac{100 - \text{Cf}}{100} = \frac{100 - 40}{100} = 0.4
\]

3.2.2. The fishing area correction factor
The surrounding community uses around the Bajulamati River which is located on Ungapan Beach for fishing activities. Based on the results of checking the potential of fish in Bajulmati River, it is quite promising so that it becomes an attraction for people who want to wander. In addition, providing boat rental is also a supporting facility for fishing activities. The area used as a fishing area is around 0.1 Ha. Then the correction factor for the fishing area is 0.48.

3.2.3. The fishing area correction factor
Ungapan Beach has several vegetation such as Ketapang, Waru, Coconut, Pahan, Sea Pandanus and Sea Mahogany. Based on the calculation of the Shanon index obtained the value of vegetation diversity 0.8007. So that the correction factor for Ungapan vegetation is 0.8007.

The calculation of real carrying capacity (RCC) uses the formula Zacarias [17] which refers to the Cifuentes formula [14], namely as follows:

\[
\text{RCC} = \text{PCC} \times \text{Cf1} \times \text{Cf2} \times \text{Cf3}
\]

\[
\text{PCC} = 12.960 \text{ people/day}
\]

\[
\text{Cf1} = \text{slope correction} = 0.4
\]

\[
\text{Cf2} = \text{Fishing area correction} = 0.48
\]

\[
\text{Cf3} = \text{vegetation correction} = 0.8007
\]

\[
\text{RCC} = 12.960 \times 0.4 \times 0.48 \times 0.8007 = 1.992 \text{ people/day}
\]
3.3. Effective Carrying Capacity (ECC)

The effective carrying capacity is the maximum number of visits where objects remain sustainable at the available management level. Most of the management capacity Indonesia is limited by criteria: number of management officers and management systems [23,24]. But Cifuentes[14] said that to measure management capacity it is essential to talk numerous variables such as the juridical circumstantial, policies, and protocols, apparatus, peoples, capital, infrastructure and facilities. In table 2, we classified that variable into three classes which are Good (3), Moderate (2), and Bad (1). We found that the management capacity in Ungapan Beach was 77%. After that, we use Equation (5) to find the effective carrying capacity, and the result was calculated as 1.533 people per day.

| Variable                          | Value |
|-----------------------------------|-------|
| JuridicalCircumstantial           | 3     |
| Policies and Protocols            | 2     |
| Apparatus                        | 2     |
| Peoples                           | 2     |
| Capital                           | 1     |
| Infrastructure and Facilities     | 3     |

3.4. Support for Ungapan Beach Tourism

Referring to the results of the PCC, the capacity of visitors to Ungapan Beach is 12,960 people/day, while based on the outcomes of the RCC, the capacity of visitors to Ungapan Beach is 1,992.39 people/day. ECC calculations is 1,533 people/day. However, the real daily visit in Ungapan just only hundreds. This is mean there still some aspect to improve the visitor. According to Pak Subari, the coastal management system in Ungapan is still not well coordinated. The Ungapan Beach area was opened starting 4 years ago. Most of the tourist management officers are from Gajahrejo Village. According to him there will also be planning from the Malang Regency government to install Wi-Fi in the Ungapan Beach tourist area.

Increasing the capacity of management officers in serving visitors requirements to be maintained by management capacity constructed on management capacity variables. It is too important to improve the capabilities and anticipate a decline in a management capacity, especially in the peak season of tourist visits (highest-season) where the amount of visitors surpasses the effective carrying capacity. Based on the results of comments in the field, there are fairly striking differences in the service quality of officers to visitors throughout the highest season of visits, probably due to the lack of optimum management capacity of other management aspects, namely the condition of facilities, facilities, and the number of personnel.

4. Conclusions

Ungapan Beach has a high tourist attraction value and also promising tourism carrying capacity where the Ungapan Beach area has a wide range and this area can be developed. Therefore, before managing it should be determined in advance the value of the carrying capacity of the environment that is the target. In determining the carrying capacity of an area, it needs to be considered at least three main aspects, namely ecological, economic and social. This is important considering that the interaction between management activities with the ecosystem of the area will be very complicated, so it requires a multidimensional approach. The process of development planning with the concept of carrying capacity implies the ability of nature and artificial environmental systems to support needs that involve natural limitations that exceed their capabilities, which indirectly can cause degradation or damage to the environment. Physical limitations of the environment can be tolerated if there is compensation for costs to avoid the risks or hazards that occur.

Acknowledgments

The authors express their gratitude to the anonymous reviewers for their insightful comments and advice, which helped to improve the quality of this manuscript considerably.
References
[1] C. R. Goeldner and J. R. B. Ritchie, *Tourism principles, practices, philosophies*. John Wiley & Sons, 2007.
[2] A. Wijayanti, “Analisis Dampak Pengembangan Desa Wisata Kembang Arum Terhadap Perekonomian Masyarakat Lokal,” *Sarj. Wiyata Tamansiswa Yogyakarta*, 2017.
[3] R. C. Mill, *Tourism: the international business*. Prentice-Hall International, Inc., 2000.
[4] A. Y. Oka, *Perencanaan dan Pengembangan Pariwisata*. Jakarta: Pradnya Paramita, 2008.
[5] I. Pujaastawa, *Antropologi Pariwisata*. Denpasar: Universitas Udayana, 2013.
[6] C. P. Sari and S. Rahayu, “Carrying Capacity of Gancik Hill Top for Ecotourism Development in Boyolali District,” in *E3S Web of Conferences*, 2018, vol. 73, p. 2008.
[7] S. Lucyanti, “Penilaian Daya Dukung Wisata Obyek Wisata Bumi Perkemahan Palutungan Taman Nasional Gunung Ciremai Propinsi Jawa Barat,” 2013.
[8] S. R. Hasan, M. K. Hassan, and M. S. Islam, “Tourist-Group Consideration in Tourism Carrying Capacity Assessment: a New Approach for Saint Martin’s Island, Bangladesh,” *J. Econ. Sustain. Dev.*, vol. 5, no. 19, pp. 150–158, 2014.
[9] C. Fandeli, *Perencanaan kepariwisataan alam*. Fakultas Kehutanan, Universitas Gajah Mada, 2002.
[10] C. Fandeli, *Prinsip-prinsip Dasar Mengkonversi Lanskap*. Yogyakarta: Gadjah mada University Press, 2009.
[11] D. G. Pearce, “Tourism and regional development a genetic approach,” *Ann. Tour. Res.*, vol. 7, no. 1, pp. 69–82, 1980.
[12] H. Luchman, *Dasar-dasar Ekowisata*. Malang: Bayumediapublishing, 2004.
[13] O. Soemarwoto, *Ekologi, lingkungan hidup dan pembangunan*. Djambatan, 2016.
[14] M. Cifuentes, *Determinación de capacidad de carga turística en áreas protegidas*, no. 194. Bib. Orton IICA/CATIE, 1992.
[15] H. Nugraha, A. Indarjo, and M. Helmi, “Studi Kesesuaian Dan Daya Dukung Kawasan Untuk Rekreasi Pantai Di Pantai Panjang Kota Bengkulu,” *Diponegoro J. Mar. Res.*, vol. 2, no. 2, pp. 130–139, 2013.
[16] D. A. Zacarias, A. T. Williams, and A. Newton, “Recreation carrying capacity estimations to support beach management at Praia de Faro, Portugal,” *Appl. Geogr.*, vol. 31, no. 3, pp. 1075–1081, 2011.
[17] D. A. Zacarias, A. T. Williams, and A. Newton, “Recreation carrying capacity estimations to support beach management at Praia de Faro, Portugal,” *Appl. Geogr.*, vol. 31, no. 3, pp. 1075–1081, 2011.
[18] C. P. Da Silva, “Beach carrying capacity assessment: how important is it?,” *J. Coast. Res.*, vol. 36, no. sp1, pp. 190–198, 2002.
[19] M. S. Sayan and M. Atik, “Recreation carrying capacity estimates for protected areas: a study of Termessos National Park,” *Ekolaji*, vol. 20, no. 78, pp. 66–74, 2011.
[20] J. L. C. Ortega, R. M. C. Dagostino, and A. L. C. Magaña, “Estimating carrying capacity in a natural protected area as a conservation strategy,” 2011.
[21] R. Hayati, “Model Ambang Batas Fisik dalam Perencanaan Kapasitas Area Wisata Berwawasan Konservasi di Kompleks Candi Gedong Songo Kabupaten Semarang,” *J. Geogr. Media Inf. Pengemb. dan Profesi Kegeografian*, vol. 10, no. 2, pp. 85–95, 2013.
[22] U. Khair, “Kapasitas Daya Dukung Fisik Kawasan Ekowisata Di Taman Wisata Alam (TWA) Sibolangit Kabupaten Deli Serdang.” 2006.
[23] Karimah, S., & Hastuti, H. 2019. The Development Strategy of Lake Kelimutu Tourist Attraction in Ende Regency. *Geosfera Indonesia*, 4(2), 188-200. doi:10.19184/geosi.v4i2.9222
[24] S. Purwanto, L. Syaufina, and A. Gunawan, “Kajian potensi dan daya dukung Taman Wisata Alam Bukit Kelam untuk strategi pengembangan ekowisata,” *J. Pengelolaan Sumberd. Alam dan Lingkung. (Journal Nat. Resour. Environ. Manag.* , vol. 4, no. 2, p. 119, 2014.