Carrying capacity of small island for tourism development

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Abstract. This study aims to analyze the carrying capacity of the environment on small islands to develop marine tourism. Research carried out in the Thousand Islands Indonesia includes Bidadari Island, Untung Jawa, Pramuka, Karya, Ayer Besar, Rambut, Cipir, Moringa, and Onrust. The methodology used in this study is the environmental carrying capacity class. The carrying capacity of the beach to receive tourists on Bidadari Island, Untung Jawa, Pramuka, Karya, Ayer Besar, Rambut, Cipir, Moringa, and Onrust, are as follows: 50, 40, 40, 30, 30, 30, 30, 26, 26 and 10 tourists per day for low class. Tourists who visit have already exceeded the carrying capacity of the environment while on vacation on the island of Untung Jawa, Pramuka, Bidadari, Ayer Besar, and Onrust; there are 60-200 tourists. The island's carrying capacity for accommodation is 11,200, 5,166, 7,700, 28,070, 4,221, 4,550, 8,400, 1,120, 1,400 and 14,000 beds for each island on Pramuka Island, Karya, Panggang, Untung Jawa, Bidadari, Ayer Besar, Onrust, Cipir, Kelor, and Rambut. While the environment carrying capacity for diving activities is between 5000-6000 divers, the interview results found out that, in reality, 9600 divers do diving activities around Pramuka Island's waters. The government should limit the number of visitors according to the allotment of the island; for example, for Rambut island tourism development should be closed because it is a conservation area. For housing islands such as in Java Untung Island, Pramuka island should limit the tourism development, while for Angel Island and Big Ayer, tourism development committed intensively.

1. Introduction
On the one hand, the development of the tourism sector in the Seribu Islands has made this sector becoming one of the backbones of the economy. On the other hand, tourism development does not pay much attention to the carrying capacity of the environment. The resorts, hotels, and other tourism built as support facilities by ignoring the local area's physical carrying capacity. If this continues, the preservation of tourist attraction objects treated, which ultimately, tourism itself will not be able to develop further. While it suspected that it is because four islands are now dirty and rarely visited by tourists, namely Matahari Island, Pelangi Island, Bira Island, and Pantara Island.

Market demand has shifted the tourism products to prioritize the environmental factors as their main attraction and the comparative advantage of tourism products. According to [1], four factors cause changes in tourist interest. One of them is that there has been an increase in environmental awareness and cultural sensitivity in society. High environmental awareness from visitors mainly comes from developed countries. Besides seeing tourism potential, the visitors also see whether the attractions offered to pay attention to the carrying capacity of the environment.
The carrying capacity of the region for tourism activities will determine the sustainability of tourism activity. If the carrying capacity of the area is not possible for tourism activities, thus the activities can not be carried out or can be done with limited specific periods. This carrying capacity might be different from one region to another. Tourism development must pay attention to the carrying capacity of the environment, especially for small islands such as those in the Thousand Islands, because they are very vulnerable to environmental change [2].

The environmental carrying capacities are related to humans and the use of the environment. [3] have applied the definition of environmental carrying capacity (DDL) in human activities. In tourism activities, DDL closely related to the density of visitors in a tourist place. This study questions the environmental carrying capacity of the small islands in the north and south of the Thousand Islands for tourism activities development.

2. Material and methods
2.1. Theory studies
The first important question in the concept of environmental carrying capacity is whether the environmental carrying capacity is only a concept of knowledge or a tool for environmental management [4]. [5] argue that the carrying capacity of the environment is not a concept of knowledge but a tool for environmental management because of its usefulness in integrating an area under pressure because of human activity. This concept often used by scientists in the field of geography and ecology. The second important question is related to the qualitative aspect; for example, the impact of tourism development on environmental conditions affected by the level of tourist visits. A complete arrangement must be build to answer those questions, while the implementation is an evolutive management policy, such as a spatial system. This policy is essential to evaluate the vulnerability and environmental damage caused by tourist visits. [4] added that the third question was the definition of environmental carrying capacity, where a concept related to the limits of change could accept from the impact of tourist visits. The carrying capacity of the environment is related to environmental insecurity and visitor satisfaction also the balance between physical capacity and the level of tourist visits.

According to [6] tourism development would create pressure on the environment. Tourism development can modify the environment, regional economic activity, local culture, land use, and social structure. The carrying capacity of the environment must have a measure related to the region's uniqueness, where the tourism development that respects local capacity. Thus, it is reflected in the tourism management that uses planning in the development where the local people participate as one of the characteristics in sustainable development.

The carrying capacity of the environment (DDL) does measure not only the number of tourists, or the maximum level of visitor density but also measures the minimum level of tourism development, which is the minimum level of support from the local community. It is due to the limited carrying capacity of the environment consisting of three aspects, namely physical-ecological, socio-demographic, and political-economic. The definition divided into the form of descriptive and evaluative. In the descriptive section, it is identifying obstacles and impacts of tourism. The concept of DDL must have aspects of the constraints of tourism development, but also these limits are natural to manage by regulating the level of visits and types of utilization. Managers in the evaluation section must define as the management objectives, then the evaluation of alternative actions, and the elaboration of tourism development strategy.

The basic idea from the tourism development that must pay attention to the carrying capacity of the environment is the consequence of sustainable tourism development. The development must align between the preservation of natural resources and the development of tourism potential because tourism development intended to improve the economy of a region. [7] states the importance of sustainable tourism development given the non-renewable natural resources, therefore the use of resources for tourism development without permanent damage to the environment. Permanent damage to the environment is a trigger factor in why it is essential to evaluate the carrying capacity of the environment.
[8] conducted a study in 2001 on the carrying capacity of the environment associated and its support to the tourism activities. [8] stated that it is crucial to study the room needed for every tourist because it is very varied according to the cultural context. The need for space determined by the size of the infrastructure needed to meet each tourist's needs. There are no standards to define the size of tourism development infrastructure for the Asian region.

The definition of DDL is comprehensive and varied; quantitatively is a calculation of density or ratio. Qualitatively DDL is a normative dimension that is much related to the appreciation of resource management [9]. Klaric also added to the density level should not be exceeding the DDL limit to preserve the environment. The application of DDL in the archipelagic analysis is in the tourist activities, where [10] estimates that an ecosystem of islands such as coral reefs and mangroves are very complex and prone to human activities.

The definition of DDL often used in tourism activities. According to [11], the definition can see from two points of view, namely the ratio between the number of tourists and their perception of the environment and the damage caused by tourism activities. According to the World Tourism organization, the definition of environmental carrying capacity is the optimum number of tourists visiting a tourist site without causing physical, biological, economic and social damage, which means this is related to the environmental damage and visitor satisfaction. Visitor satisfaction is an estimate of the impact of tourist density and natural quality. Optimal satisfaction is related closely between visitor density and natural potential.

2.2. Data analysis techniques and research locations
The carrying capacity analysis used to see whether the area supports the development of activity in this case for tourism activities in the coastal area, including beach tourism and marine tourism.

Carrying capacity for tourism development that exists intensively, some is limited, and some are closed. The definition of intensive is about an area on an island is being used for tourism activities, it will limit if only part of it used for tourism activities and the rest for other purposes. While closed, one interpreted as actors in tourism development may not carry out physical development in these places but are allowed to become tourist attractions object for its natural beauty.

According to [12] the availability of reasonable lodging and demand by tourists for its strategic location will affect the increase in tourist visits and long-lasting. Accommodation or lodging must provide a sense of security, close to attractions, free and clean air, beautiful, comfortable, fresh, and easy to access with public facilities. The standard of space requirements related to the beach carrying capacity and land carrying capacity in this study is the island area in this study using [13] standard, which uses the experience of American and European tourists in traveling to the Asia and Pacific region. It is due there are no criteria at the preset concerning the need for space for Asian tourists.

This research carried out several small islands in the Thousand Islands, such as Angel Island, Ayer Island, Onrust Island, Pramuka Island, and other islands.

3. Results and discussions
3.1. General description of research location
Thousand Islands Southern parts such as the islands of Bidadari, Ayer Besar, Onrust, Cipir, Kelor, Untung Jawa, and Rambut island have potential for coastal tourism. Tourists can carry out beach tourism activities such as enjoying the sea view, playing on the beach, swimming, and other beach activities. The condition of the southern part of Seribu Island is less clear than the northern part of Thousand Island, because it is located in Jakarta Bay. The islands located in Jakarta Bay have a high level of sedimentation. Jakarta is the capital of the country and 80 percent of economic activity is carried out here. Many residents of Jakarta and around Jakarta dispose of their domestic waste into rivers. Tourists cannot do underwater activities on the southern thousand islands, firstly because high sedimentation rates prevent divers from seeing the underwater beauty. In addition, there is an island has the level of damage to coral reefs reached 97.8 percent. In fact, the level of coral cover is an important factor for underwater tourism activities.
Table 1. Supporting parameter existing condition for beach tourism

| Parameter                      | Untung Jawa Island | Bidadari Island | Ayer Besar Island | Onrust Island | Cipir Island | Kelor Island | Rambutan Island |
|-------------------------------|-------------------|-----------------|-------------------|---------------|--------------|--------------|-----------------|
| Basic water material          | Sand and coral reef fragments | Sand | Sand and coral reef fragments | Sand | Sand and coral reef fragments | Sand | Sand |
| Type of Beach                 | Sand and coral reef fragments | Sloping sand | Sloping sand | Sand with steep coral | Sloping sand | Sand and coral reef fragments | Sloping sand |
| Coastal land cover Settlement | Open field | Open field | Open field and historic wake | Open field and historic wake | Open field and historic wake | Open field and historic wake | Bush |
| Distance from freshwater sources | 21 (Km) | 13 (Km) | 14 (Km) | 14 (Km) | 14 (Km) | 14 (Km) | 22 (Km) |

The Northern Thousand Islands, in research locations such as Pramuka Island, Karya Island, and Panggang Island, has tourism potential for underwater activities. Tourists can dive around these islands, because the underwater ecosystem conditions are better than the southern thousand islands. In addition, these three islands have lodging facilities, restaurants, and diving equipment rental. On Pramuka Island and Karya Island, the water transparency level is very high, namely around 15.25 and 16.15. This means that these two islands for the parameter of water transparency level are not a limiting factor for underwater tourism activities. It is different with Panggang Island which has a low water transparency level (3.25), so that the water transparency level parameter is a limiting factor for underwater activities. The low level of water transparency in Panggang Island is due to the high level of sedimentation that comes from household domestic activities.

3.2. Carrying capacity of the accommodation environment
The availability of suitable accommodation facilities must support tourism activities in the Thousand Islands. Accommodation facilities should be built in strategic locations and not damage ecological conditions to change the natural conditions too much and are easily accessed by visitors [14]. The accommodation facilities construction besides providing a sense of security, close to attractions, having fresh air, beautiful, comfortable, and relaxed air, but also easy for access to other public facilities [15].

The islands with the most extensive land for the accommodation construction based on Table 2 are Untung Jawa Island, Pramuka Island, Onrust Island, and Panggang Island. These islands can be used for economy class to accommodate 28,070, 11,200, 8,400, and 7,700 beds per day. The land area for the accommodation based on the consideration of Law No. 26 of 2007 regarding the provisions on spatial planning, but in reality in the Panggang Island cannot build anymore because there is no room left anymore. Due to the island having a very dense population, even the beach is partly the result of the reclamation process. The population is always increasing every year, forcing the people of Panggang Island to do the reclamation process to add residential land.

Other residential islands, such as Untung Jawa Island, Pramuka, and Karya, the land can be used as accommodation. It means that, in reality, the islands of Untung Jawa, Pramuka, and Karya Island can
provide accommodation of 1,604, 2,807, and 1,120 beds. Pramuka Island is very potential for tourism development due to the complete infrastructure owned, such as lodging, restaurants, diving equipment rental shops.

### Tabel 2. Broad area of small islands in the research location

| Island           | AreaIsland(hektar) | Area for accommodation based on UU No.26/2007 |
|------------------|--------------------|---------------------------------------------|
| Pramuka Island   | 16                 | 112,000.00                                  |
| Karya Island     | 7.38               | 51,660.00                                   |
| Panggang Island  | 11                 | 77,000.00                                   |
| Untung Jawa Island | 40.1             | 280,700.00                                  |
| Bidadar Island   | 6.03               | 42,210.00                                   |
| Ayer Besar Island| 6.5                | 44,500.00                                   |
| Onrust Island    | 12                 | 84,000.00                                   |
| Cipir Island     | 1.6                | 11,200.00                                   |
| Kelor Island     | 2                  | 14,000.00                                   |
| Rambut Island    | 20                 | 140,000.00                                  |

### Table 2. Comparison carrying capacity for accommodation and the number of beds

| Pulau            | Estimated DDL in the low category | DDL estimation in the middle category | DDL estimation in the upperclass category | the number of beds available for tourists on each island |
|------------------|-----------------------------------|--------------------------------------|------------------------------------------|------------------------------------------------------|
| Pramuka Island   | 11,200                            | 5,895                                | 3,733                                    | 240                                                  |
| Karya Island     | 5,166                             | 2,719                                | 1,722                                    | 100                                                  |
| Panggang Island  | 7,700                             | 4,053                                | 2,567                                    | N.A.                                                 |
| Untung Jawa Island | 28,070                      | 14,774                               | 9,357                                    | 175                                                  |
| Bidadar Island   | 4,221                             | 2,222                                | 1,407                                    | 150                                                  |
| Ayer Besar Island| 4,550                             | 2,395                                | 1,517                                    | 170                                                  |
| Onrust Island    | 8,400                             | 4,421                                | 2,800                                    | 0                                                    |
| Cipir Island     | 1,120                             | 589                                  | 373                                      | 0                                                    |
| Kelor Island     | 1,400                             | 737                                  | 467                                      | 0                                                    |
| Rambut Island    | 14,000                            | 7,368                                | 4,667                                    | 0                                                    |

Rambut Island, if viewed from the land area, can provide a lot of accommodation (80,000 beds). However, since this island is a conservation area, the accommodation construction is closed; it means that the tourism development actors may not carry out physical development in that place. However, they are allowed to sell it as tourism objects for nature’s beauty.

In residential areas (Panggang Island, Pramuka Island, and Untung Jawa Island), a development that conducted was limited (part of the land used for tourism activities and the rest for other activities). Intensive tourism development can be done on Angel Island and Ayer Island, meaning that the island’s
entire mainland used for tourism activities. However, this island's environmental carrying capacity is small (Angel Island and Big Ayer Island), because the land has limited space. Each island (Bidadari and Ayer Besar) can only have 4,221 and 4,550 beds for tourist accommodation. On the other hand, the accommodations available on Pramuka Island, Karya Island, Untung Jawa Island, Bidadari Island, Ayer Besar Island, Onrust Island, Cipir Island, and Kelor Island are 240 beds, 100 beds, 175 beds, 150 beds, 170 beds, 0 bed, 0 bed, 0 bed, and 0 bed.

The shortage in the number of accommodations for tourists is due to shorter distance between the islands from Jakarta. Thus, so many tourists do not stay overnight, especially considering the many cheap transportation options, especially when we visit residential islands. In contrast, Pramuka Island, Karya Island, and Panggang Island, tourists stay around two days, because the distance is quite far from Jakarta. Also, the activities carried out for tours (diving) require quite a long time.

Cipir Island and Kelor Island have the smallest land area, so if they want to build accommodation, the rest area that can utilize is in a small portion (Open system). Ayer Besar islands and Bidadari islands are quite reliable for tourists because they are not residential areas and have a relatively large area (Extensive system). Onrust Island from the land's side is quite extensive, but there is a historical building on this island so that the visitors limited by not building facilities on this island (close system). Islands that have historical buildings such as Onrust Islands, Cipir Islands, and Kelor Islands were not built homestays even for Moringa Islands and Cipir Islands with damaged bridges.

### 3.3. Environmental carrying capacity (DDL) for beach tourism activities

Based on the table below, ten islands in the Thousand Islands have sandy beaches. However, the most potential beach with its beaches length (quantity) is Bidadari Island, Ayer Island, Pramuka Island, and Untung Jawa Island, because they have long and extensive beaches. Quality islands are Angel Island, Ayer Besar Island, and Cipir Island because they have spotless white sand.

**Table 3.** Comparison carrying capacity for beach activities and the number of tourists

| Islands           | CC for low category | CC for middle category | CC for lux category | CC for special category | The number of tourists |
|-------------------|---------------------|------------------------|---------------------|-------------------------|------------------------|
| Pramuka Island    | 40                  | 27                     | 20                  | 17                      | 100                    |
| Karya Island      | 30                  | 20                     | 15                  | 10                      | There is information   |
| Panggang Island   | 26                  | 17                     | 13                  | 8                       | There is no information|
| Untung Jawa Island| 40                  | 33                     | 25                  | 17                      | 200                    |
| Bidadari Island   | 50                  | 40                     | 30                  | 20                      | 100-200                |
| Ayer Besar Island | 30                  | 20                     | 15                  | 10                      | 100-200                |
| Onrust Island     | 10                  | 7                      | 5                   | 3                       | 60                     |
| Cipir Island      | 26                  | 17                     | 13                  | 8                       | 20                     |
| Kelor Island      | 26                  | 17                     | 13                  | 8                       | 10                     |
| Rambut Island     | 30                  | 20                     | 15                  | 10                      | -                      |

Pramuka Island, Panggang Island, and Untung Jawa Island, although they have quite long beaches, since they are residential islands, the beaches are not clean enough. Panggang Island has a beach that
partly produced by the reclamation process. The reason is that the population is always increasing every year, so the people there do the reclamation. Onrust Island and Moringa Island mixed with coral, so visitors must walk carefully. Pulau Karya has perfect quality sand, white sand, but its size is too small.

The environmental carrying capacity of Bidadari Island, Untung Jawa Island, Pramuka Island, Karya Island, Ayer Besar Island and Rambut Island can accommodate around 50 tourists, 40 tourists, 40 tourists, 30 tourists, 30 tourists, and 30 tourists respectively. Rambut Island cannot accommodate visitors according to the carrying capacity of the environment because it functions as a nature reserve. Thus, the number of visitors will be less than 30 tourists. Managers of hair Island will usually select their visitors based on the activities that will carry out. Only tourists who will conduct research can visit this island or those who have received permission from the Thousand Islands National Park.

Islands that can only receive visitors less than 30 people per day are Panggang Island, Cipir Island, Kelor Island, and Onrust Island. Each of these islands can only receive visitors are 26 people, 26 people, 26 people, and ten people for the low category. It is because some beaches are the result of the reclamation process, coupled with the character of Panggang Island, a residential island that makes the island conditions not too clean.

In special classes, Bidadari Island, Pramuka Island, and Untung Jawa Island can only accommodate tourists for about 20 people, 17 peoples, and 17 peoples per day. In reality, the number of tourists visiting to play the beach in Untung Jawa Island, Bidadari Island, Ayer Besar Island, Onrust Island, Cipir Island, and Kelor Island, are 200, 100, 100, 60, 20, and 10 people respectively. It means that the number of tourists visiting has exceeded its environment carrying capacity.

3.4. Environmental carrying capacity (DDL) for marine tourism activities

The environment carrying capacity for diving, such as diving activities around Pramuka Island, Karya Island, and Bake Island, cannot damage the coral reef ecosystem. The recommended number of divers/location/year is 5,000-6,000 people. This recommendation used to estimate the environmental carrying capacity of a diving spot. Researchers propose a threshold of 4,000-6,000 divers/location/year so as not to damage the coral reef ecosystem. The level of tourist visits exceeds the carrying capacity. In the future condition, the coral reefs damaged because the nature of coral reefs is susceptible to environmental changes. Increasing the number of tourist visits to the Thousand Islands (was almost 7% from 2008 to 2009), the visitors’ activity who did diving activities is increasing.

Based on field interviews, about 100 visitors per week come to Pramuka Island to do diving activities because tourists usually visit this island to dive. They dive around two times on the average divers around the diving area. Thus, it concluded that there are about 9,600 divers per year. It said that Pramuka Island had exceeded the recommended carrying capacity if referring to the environmental carrying capacity recommendation at one point per diver each year. The number of people set as the diving threshold set so that the divers do not damage is only 5,000-6,000 divers.

4. Conclusions

The study’s weakness is that this study did not calculate the environment carrying capacity from the availability of fresh water due to the limitations of research data. The availability of freshwater limits the factor in the tourism development of small islands, especially small islands consist of atolls such as at our study site. Based on the carrying capacity of beach tourism, the carrying capacity to play on the beach on Angel Site, Untung Java Island, Pramuka Island, Karya Island, Big Ayer Island, Rambut Island, Cipir Island, Kelor Island and Onrust Island is 50, 40, 40, 30, 30, 26, 26, 26 and 10 tourists per day for low class respectively. In reality, the number of tourists visiting to play on the beach in Untung Jawa Island, Bidadari Island, Ayer Besar Island, Onrust Island, Cipir Island, and Kelor Island are 200, 100, 100, 60, 20, and 10 people respectively. It means that the number of tourists visiting has exceeded the environment carrying capacity.

The accommodation carrying capacity of Untung Island, Pramuka, Onrust, Bake, Hair, Angel, Ayer Besar, Onrust, Cipir, Karya and Kelor, each able to provide 16,040, 6,400, 4,800, 4,400, 80,000, 2,412,
2,600, 680, 2,952 and 400 beds for tourists respectively. On the other hand, the accommodations available on Pramuka Island, Karya Island, Untung Jawa Island, Bidadari Island, Ayer Besar Island, Onrust Island, Cipir Island, Kelor Island, and Bidadari Island are as follows 240, 100, 175, 150, 170, 0, 0, 0, and 0 beds. The distance between these islands with Jakarta is so close to make it lack of accommodation for tourists. Thus, many tourists do not stay overnight, considering the many cheap transportation options. Another problem in developing tourist activities in the Thousand Islands is diving activities that exceed the environmental carrying capacity. The land provision for accommodation must be adjusted to the allotment of the island, such as Pulau Rambut, as a nature reserve, so the construction of accommodation prohibited. In residential areas (Panggang Island, Pramuka, and Untung Jawa), the development is also limited. The intensive tourism development can be elaborate on Angel Island and Ayer Island. At the same time, 9600 divers do diving activities around the Pramuka Island, Karya Island, Pulau Rambut, as a nature reserve, so the construction of accommodation prohibited. In residential areas (Panggang Island, Pramuka, and Untung Jawa), the development is also limited. The intensive tourism development can be elaborate on Angel Island and Ayer Island. At the same time, 9600 divers do diving activities around the Pramuka Island waters, which is over the environment carrying capacity.

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**Acknowledgement**

Thanks for Statistique Bereua, Information office of Seribu Island Regency, for the data and the information about tourism and fisheries development of Seribu Island Regency.