Carrying Capacity Assessment for Tourism Management in Peninsula Area

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1. Introduction

1.1. Background

The peninsula areas are generally characterized by high cultural, environmental and landscape values, and consequently these territories are important and desirable tourist and recreational destinations. Depending on a more convenient public transportation, the peninsula areas get a chance to acquire better accessibility from surrounding cities. Tourism Nation Promotion Basic Law[6] was established in 2006 in Japan. And it's expected to revitalize the regions and to increase employment opportunities by capturing the rapidly growing demand for tourism in Asia and other parts of the world.

However, as we all know, every coin has two sides. Every developmental activity leads to environmental changes (positive or negative) and tourism is no exception to this (Buckley, 2009). Tourism often has the potential to contribute in a positive manner to local development but at the same time, its fast and sometimes uncontrolled growth could be the major cause of environmental degradation and loss of local identity and traditional culture (Syamlal, 2008). The environment of the destination is negatively influenced by the increase of tourism (Gossling, 2002; Ramdas and Badaruddin, 2014), whereas the growth of tourism depends on the quality and characteristics of the environment. As tourism activities become more widespread, there tend to be marked changes in the environment (Smith, 1989), the capacity to absorb large number of people would be challenged (WTO, 1990[8]). On the other hand, the aimless growth of tourism could cause a waste of tourism resources. In order to develop sustainable tourism by making great use of existing tourism stocks, it's essential to figure out the use intensity of different tourism activities.

1.2. Purpose

In 1981, the World Tourism Organization (WTO, 1981) proposed a definition of tourism carrying capacity as: "The maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic, socio-cultural environment and an unacceptable decrease in the quality of visitors' satisfaction." (UNEP/MAP/PAP, 1997[7]). Consequently, the concept of carrying capacity that covers all these aspects is often used to develop sustainable tourism in order to protect the destination physically, socially, culturally and ecologically (Rodella et al., 2017; Saveriades, 2000; Syed Rashidul et al., 2014; Zacarias et al., 2011). In order to respond to a surge in tourists and to achieve a better sustainable tourism management for peninsula areas, this paper aims to clarify the changes in tourism intensity of the whole peninsula area, to clarify the use intensity of different types of tourism facilities, and to propose suggestions for realizing better sustainable tourism from the perspective of the whole peninsula region, different types of tourism activities and single tourism facility.

1.3. Literature Review

A considerable amount of research has investigated Tourism Carrying Capacity Assessment from various perspectives and made significant progress. Previous researches on tourism carrying capacity mainly focused on ecological or physical aspects (Tang et al., 2018[4]; Elisa et al., 2016; Anthony, 2017), psychological and sociocultural aspects (Dogan et al., 2019; Charles et al., 2018) and economic aspect (Amin, 2018; Li, 2019). While initial research focused on investigating the tourism carrying capacity for some types of destinations, such as protected areas, natural parks, archaeological sites, small beaches, etc., the interpretation of capacity could be related to crowding, that is the number of people present at a given period of time (Elisabetta et al., 2015; Corinne et al., 2019; Zhang et al., 2017, Takahashi, 2015[5]). Although there are plenty of researches have tried to measure the Tourism Carrying Capacity from different perspectives, it failed to reach an agreement on the method of Tourism Carrying Capacity Assessment until the advent of Cifuentes method (Cifuentes, 1992; Papageorgiou and Brotherton, 1999; Eagles et al., 2002; Corinne et al., 2019[1]).

The previous studies have advanced the understanding of tourism carrying capacity from various aspects. However, regarding the evaluation of tourism carrying capacity, these researches neglect the heterogeneity of various tourism activities which correspond to different indicators for the carrying capacity assessment. And for peninsula area containing complicated elements, this paper has applied proper methods on different objectives. This study is not going to figure out an accurate number or a threshold of tourists. A comparison between tourism carrying capacity and actual number of tourists would illustrate the use intensity of different types of tourism activities.

2. Study Area & Data Sources

2.1. Study Area

Since it's believed that a certain number of residents is necessary to support the local tourism development, in this paper, 35 peninsulas with a population of over 50,000 and area below 2,000 km^2 are selected as the target peninsulas in the preliminary analysis (Figure 1). And due to a lack of available tourism statistics data in some peninsulas from 2008 to 2017, 20 peninsulas are selected in the first step of this paper.

But not all of them are faced with the problems mentioned previously. Considering the significance of research on Tourism Carrying Capacity, the study method could be applied on peninsula areas with certain characteristics as follows:

(1) A rising tendency in number of tourists;
(2) High accessibility by public transportation;
(3) A decline in Tourism Carrying Capacity Index.

Peninsula areas with these characteristics are considered suffering from environmental, social and economic problems caused by overmuch tourists.

2.2. Data Sources

The data sources used in this paper could be available from official websites which means this study method could be highly verifiable and easily applied to other tourist destinations which is faced with the same problems. And on the other hand, this paper illustrates a new perspective from taking good use of government open data and provides great feedback for local tourism management (Figure 2). Firstly, peninsulas with a rising tendency in number of tourists and high accessibility by public transportation are selected for TCCI analysis by three indices. And then TCCA has been figured out in Itoshima peninsula and Tsuruga peninsula based on Cifuentes method.

3. Methodology

3.1. Tourism Carrying Capacity Index

A considerable amount of research has investigated Tourism Carrying Capacity Index (TCCI) so far. And the definition of Tourism Carrying Capacity Index is proposed as:" The maximum dimensionless quantity of tourism intensity in a tourism area, without causing destruction of the physical, economic, socio-cultural environment and an unacceptable decrease in the quality of local people's life" (Pearce, 1989; Cui, 1998[2)]).

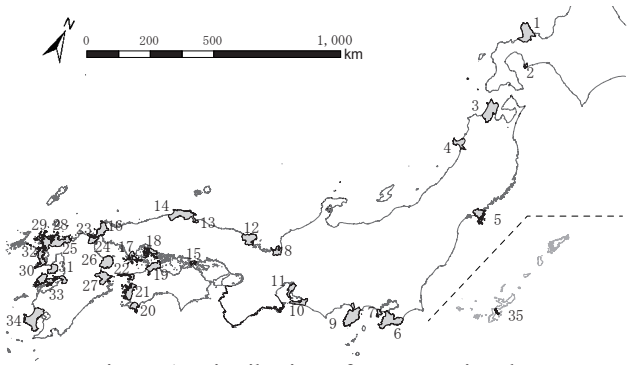

Figure 1. Distribution of target peninsulas

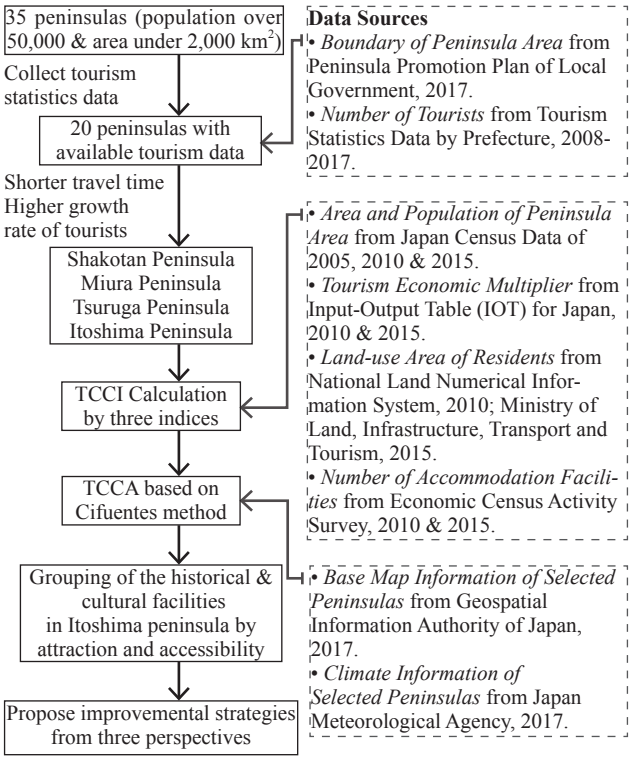

Figure 2. Research Flow

According to the methods applied in previous researches (Cui,1998[2)]; Misui, 2006), the TCCI could be defined by three impact indices.

3.1.1. Socio-cultural Index—Tourist Density Index (TDI)

It's believed that socio-cultural impact of tourists on local residents grows stronger when the tourist density becomes higher (Cui & Liu, 1998). The Tourist Density Index is used as the description of socio-cultural impact (Equation 1).

$$TDI = D_T / D_R = N_T / N_R \quad (1)$$

Where: D_T= tourist density; D_R= resident density; N_T= number of tourists; N_R= number of residents.

3.1.2. Economic Index— Economic Income Index (EII)

In order to have a comprehensive description of the economic impact, the Keynesian Multiplier is used as Economic Income Index in this paper (Equation 2).

$$EII = M = 1/(1\text{-}MPC) = 1/L = \Delta Y/\Delta C \quad (2)$$

Where: M= Keynesian Multiplier; MPC= marginal propensity to consume; L= leakage; ΔY= increment of tourism income; ΔC= increment of tourism investment.

3.1.3. Environmental Index— Land-use Intensity Index (LII)

As the tourism land-use area grows, it could exert pressure on residential land-use area and cause environmental impact on local tourism carrying capacity (Equation 3).

$$LII = LA_T / LA_R \quad (3)$$

Where: LA_T= land-use area of tourism; LA_R= land-use area of residents.

3.2. Tourism Carrying Capacity Assessment Based on Cifuentes Method

Cifuentes method has been successfully applied in several areas and indicated by different authors as a useful method to provide information on the interactions between the human activities and the environment, and represents a quantitative analysis with a degree of verifiability (Cifuentes, 1992; Papageorgiou and Brotherton, 1999; Eagles et al., 2002; Corinne et al., 2019[1)]).

The carrying capacity could be defined by three indices, linked to each other:

- the physical carrying capacity – PCC,
- the real carrying capacity – RCC,
- the effective carrying capacity – ECC.

Each of the three indices could be derived from the correction of the previous one. Only PCC and RCC are calculated in this paper. In particular, they would follow the relationship as following:

$PCC > RCC \geq ECC$

3.2.1. The Physical Carrying Capacity – PCC

PCC is the maximum number of tourists who could physically fit into a specific area over a determined period. The available area may be limited by physical factors and by limitations due to security reasons or weakness of the ecosystem (Equation 4).

$$PCC = (T/T_A) \cdot (S/S_A) \quad (4)$$

Where: T= Daily open period; T_A= Average time of visit or occupancy; S= Available area or length for tourist use; S_A= Average area or length required per tourist.

3.2.2. The Real Carrying Capacity – RCC

RCC is the maximum permissible number of tourists, once the Correction factors (CF) derived from the particular characteristics of the site have been applied to the PCC (Equation 5).

$$RCC = PCC \times (Cf_1 \times Cf_2 \times Cf_3 \times \ldots Cf_n)$$
$$Cf_x = 1 - Lm_x / Tm_x \quad (5)$$

Where: Cf_x= Correction factors of variable x; Lm_x= Limiting magnitude of variable x; Tm_x= Total magnitude of variable x.

There are two correction factors used in this chapter as following:

• Rainfall (Cf_1): this factor is probably the most important correction factor because it largely influences the outdoor activities.

• Wind (Cf_2): strong wind prevents the arrival of the boats and influences other outdoor activities, especially when its velocity exceeds 5.5 m/s.

4. Results

4.1. Changes in Number of Tourists

13 peninsulas with a rising tendency in number of tourists are selected from the 20 peninsulas with available tourism data (Figure 3). And the travel time from the 5 metropolitan areas (Tokyo, Kansai, Nagoya, Hokkaido, and Kyushu) by public transportation (subway, train or bus) is used in this paper as accessibility evaluation (Figure 4). Peninsula with a shorter travel time from the 5 metropolitan areas and a higher growth rate of tourists could have a priority in study area selection. At last, Shakotan Peninsula, Miura Peninsula, Tsuruga Peninsula and Itoshima Peninsula are selected for TCCI calculation.

4.2. Tourism Carrying Capacity Index (TCCI)

4.2.1. Functional Relationship between TCCI and the Three Impact Indices

There is an inverse proportional relationship between TCCI and TDI & LII. And TCCI would increase with the increment of EII which means TCCI is directly proportional to EII. Due to a lack of land-use area of tourism, it could be replaced by the amount of accommodation facilities based on the assumption that the average area remains unchanged in 5 years. In a word, the TCCI could be expressed by the following equation (Equation 6).

$$TCCI = K \bullet (N_R / N_T) \bullet (1 / L) \bullet (LA_R / N_A) \quad (6)$$

Where: K= constant; N_T= number of tourists; N_R= number of residents; L= leakage; LA_T= land-use area of tourism; N_A= number of accommodation facilities.

4.2.2. Changes in TCCI from 2010 to 2015

TCCI of Shakotan Peninsula (-6.3%) and Itoshima Peninsula (-5.1%) keep decreasing while TCCI of Tsuruga Peninsula (+2.5%) keeps increasing. And TCCI of Miura Peninsula (+0.2%) remains almost unchanged (Table 1). The decrease in TCCI of Shakotan peninsula and Itoshima peninsula could be closely related to a sharp increase in number of tourists and a decrease in number of local residents. Otherwise, the increase in TCCI of Tsuruga peninsula could be related to a decrease in number of accommodation facilities.

4.3. Tourism Carrying Capacity Assessment (TCCA)

Considering the availability of tourism data and the rate of change in TCCI, Itoshima Peninsula and Tsuruga Peninsula are selected for TCCA. And there are five types of tourism facilities which are shared in two peninsulas and independent of the daily use of local residents. They are Natural, Historical & Cultural, SPA & Healthy, Sports & Recreational, Festival & Events.

According to the Equation 4 and Equation 5, the PCC and the RCC of each tourism facility has been measured (Table 2, Table 3). The use intensity of each type of tourism facility could be defined as the number of tourists divided by the TCC. The use intensity of historical & cultural facilities keeps at a very low level (7.6%) in

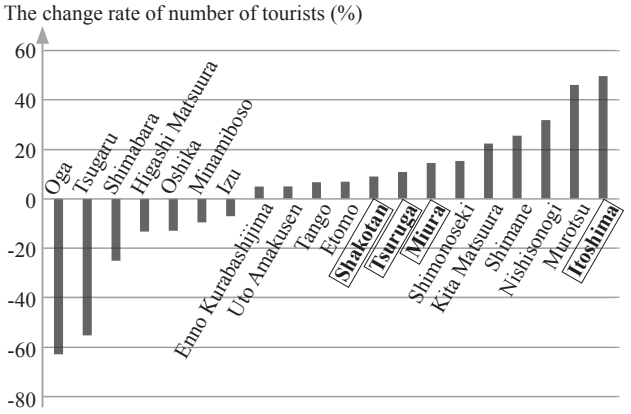

Figure 3. Change rate of number of tourists (2008-2017)

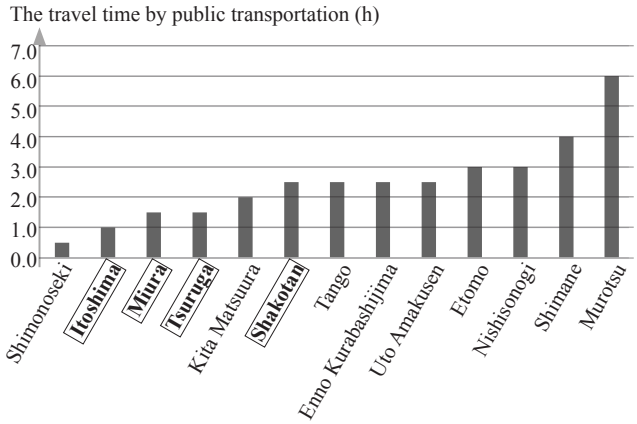

Figure 4. The accessibility from the 5 metropolitan areas

Table 1. The changes in TCCI of the four peninsulas

Variables	Shakotan Peninsula			Miura Peninsula			Tsuruga Peninsula			Itoshima Peninsula		
	2010	2015	Multiple	2010	2015	Multiple	2010	2015	Multiple	2010	2015	Multiple
K	Unchanged		1.00	Unchanged		1.00	Unchanged		1.00	Unchanged		1.00
N_R (thousand persons)	55.1	50.4	0.91	557.7	541.4	0.97	78.3	76.1	0.97	291.7	303.3	1.04
N_T (thousand persons)	3,052.4	3,898.0	1.28	14,636.1	16,141.0	1.10	2,862.0	2,938.0	1.03	4,504.0	6,137.0	1.36
L	0.733	0.728	0.99	0.774	0.788	1.02	0.767	0.761	0.99	0.711	0.751	1.06
LA_R (km^2)	10.58	10.35	0.98	65.37	65.52	1.00	10.02	9.86	0.98	28.53	28.21	0.99
N_A	100	103	1.03	141	121	0.86	180	150	0.83	46	44	0.96
$TCCI_{2015}$/ $TCCI_{2010}$	68.50%			100.98%			112.68%			74.68%		
Rate of Change in TCCI per year	-6.3%			+0.2%			+2.5%			-5.1%		

Table 2. Samples of Physical Carrying Capacity in Itoshima

* ○ : Outdoor facility ▲ : Indoor facility

Classification	Number	Name	T	T_A	Yearly Open Period (day)	Indoor or Outdoor	S_A	S		PCC (person)
			Daily Open Period (h)	Average Time of Visit (h)			Area or Length Required per Tourist (m^2 or m)	Area (m^2)	Length (m)	
Natural	1	Shiraito Falls	8	2.5	343	○	9.0	8,206		2,918
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
Festival & Events	88	Itoshima Handmade Carnival	8	2.5	3	○	1.0	3,833		12,266

Itoshima Peninsula. And the use intensity of SPA & healthy facilities keeps at a lowest level (2.1%) in Tsuruga Peninsula. While the use intensity of festival & event facilities reaches to 156.2% (Table 4).

4.4. Grouping the Tourism Facilities by Attraction and Accessibility

It's find that the accessibility and attraction of tourism facilities strongly affect the number of tourists (Oda, 1986[3]). In order to solve the problem which the historical & cultural facilities in Itoshima peninsula are faced with, these tourism facilities are divided into four groups by the average value of travel time and the number of retrievals as following (Figure 5):

Group Ⅰ : Low accessibility and low attraction.
Group Ⅱ : Low accessibility and high attraction.
Group Ⅲ : High accessibility and low attraction.
Group Ⅳ : High accessibility and high attraction.

According to the characteristics of the four groups, some suggestion could be made. Group Ⅳ should keep up the good accessibility and attraction. While Group Ⅰ shows lower priority in tourism improvement comparing with Group Ⅱ & Ⅲ, because they would get better quickly after making improvements on only one side.

5. Conclusions

This paper has studied the TCC in peninsula areas on three different scales and some conclusions could be drawn as following:

(1) The decrease in TCCI of Shakotan peninsula (-6.3%) and Itoshima peninsula (-5.1%) could be closely related to a sharp increase in number of tourists and a decrease in number of local residents. Considering the functional relationship between the three impact indices and TCCI, in order to prevent the TCCI from uncontrolled decrease, the local government should increase investment on tourism facilities. And the local government should maintain no reduction in residential land-use area and no increase in number of accommodation facilities in the case of meeting the demands of tourists.

(2) An uneven spatial and temporal distribution of tourists in the two target peninsula areas could be seen from the results. The use intensity of historical & cultural facilities keeps at a very low level (7.6%) in Itoshima Peninsula. And the use intensity of SPA & healthy facilities keeps at a lowest level (2.1%) in Tsuruga Peninsula. While the use intensity of festival & event facilities reaches to 156.2%. A mismatch between the use intensity and carrying capacity of some tourism facilities would cause overload or waste of tourism resources. For festival & event facilities, the organizer should extend the open period of festival and event to increase the carrying capacity. Otherwise, more area for festival and event could be beneficial to the increase in carrying capacity. Finally, the increase in management capacity could make the flow of people more efficient and reduce the risk of congestion.

Table 3. Samples of Real Carrying Capacity in Itoshima

Classification	Number	Name	PCC (person)	Cf_1	Cf_2	RCC (person)
				Rainfall	Wind	
Natural	1	Shiraito Falls	2,918	0.693	0.997	2,017
⋮	⋮	⋮	⋮	⋮	⋮	⋮
Festival & Events	88	Itoshima Handmade Carnival	12,266	1.000	1.000	12,266

Table 4. TCC and number of tourists (thousand person)

Classification	Itoshima Peninsula			Tsuruga Peninsula		
	TCC	Number of Tourists	Multiple	TCC	Number of Tourists	Multiple
Natural	3,249	401	12.3%	3,135	385	12.3%
Historical & Cultural	6,258	474	7.6%	3,811	1,428	37.5%
SPA & Healthy	2,462	727	29.5%	3,521	73	2.1%
Sports & Recreational	2,466	1,014	41.1%	3,980	486	12.2%
Festival & Event	332	108	32.5%	325	507	156.2%

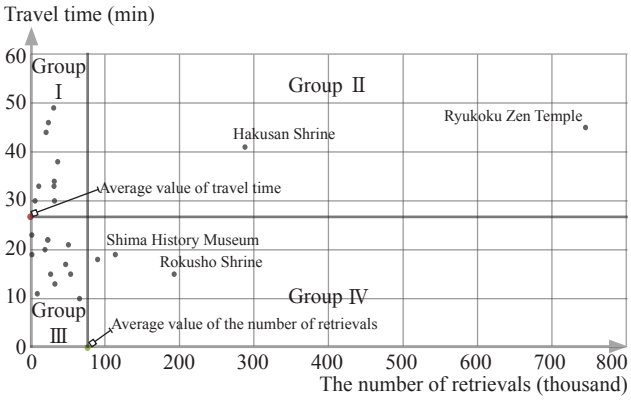

Figure 5. Grouping of historical & cultural facilities

(3) The historical & cultural facilities in Itoshima Peninsula are divided into four groups by attraction and accessiblity. Group Ⅳ should keep up its good accessibility and attraction. Group Ⅱ is characterized by its low accessibility and high attraction. Since it's caused by a lack of direct bus route, it's suggested to improve its accessibility by extending current sightseeing bus route to there. While Group Ⅲ is characterized by its high accessibility and low attraction. It's suggested to improve its attraction by increasing publicity of these historical & cultural tourism facilities.

REFERENCES

[1] Corinne, C., Graziella, B., Pietro, P. C., Umberto, S., Donatella, C., 2019. *Tourism analysis at Asinara Island (Italy): Carrying capacity and web evaluations in two pocket beaches.* Ocean & Coastal Management, Volume 169, 1, March 2019, Pages 27-36.
[2] Cui, F. J., Liu, J. M., 1998. *The theory of tourism environmental carrying capacity and its practical significance.* Geographical Research. Vol. 17, No. 1, Mar., 1998.
[3] Oda, Yasuo., Nishitani, Kenji., Ishizuka, Koji., Watanabe, Hitoshi., 1986. A study on outdoor recreation planning of Noto Peninsula– Methology of demand forecast outdoor recreation–. Summary of academic lectures of Architectural Institute of Japan, 1986-07, 667-668.
[4] Tang, C. C., Wu, X. F., Zheng, Q. Q., & Lyu, N., 2018. *Ecological security evaluations of the tourism industry in Ecological Conservation Development Areas: A case study of Beijing's ECDA.* Journal of Cleaner Production, Volume 197, Part 1, 1 October 2018, Pages 999-1010.
[5] Takahashi, K., 2015. *A Study on the Relationship between Tourism Characteristics and Demographic, Industrial Characteristics in the Island Regions of Japan.* Tourism Science Research (8), 133-140, 2015-03.
[6] Tourism Nation Promotion Basic Plan, 2017. *Goals for Tourism Nation Promotion.* Tourism Nation Promotion Basic Plan, 12pp.
[7] UNEP/MAP/PAP, 1997. *Guidelines for Carrying Capacity Assessment for Tourism in Mediterranean Coastal Areas.* Priority Actions Programme Regional Activity Centre (Split), Turkey.
[8] WTO. 1990. *Tourism to the year 2000: Qualitative aspects affecting global growth.* Madrid.