

## <Abstract>

# A study on comprehensive carrying capacity of Jeju Island

## 1. Research Background

- Over 15.8 million tourists visited Jeju Island in 2016 and this size is about 10 times more than tourists in 30 years before
- Tourism is a fast growing industry and a valuable sector, contributing significantly to the Jeju economy and society. Tourism has the potential to generate employment opportunities, create regional and local investment, provide local people with trade opportunities and support other economic sectors especially in Jeju Island
- Despite the dramatic increase in tourism demand for Jeju Island, the overall social problems and discomforts of residents have increased the need for research on the overall carrying capacity of Jeju Island
  - Serious traffic congestion in downtown of Jeju Island as well as famous sightseeing spots is deteriorating the quality of residential life and making serious damages to tourist resources and facilities
  - Especially the problems of water supply and sewage, energy and waste capacity due to the constant increase of the resident population triggered common interests about regional carrying capacity of Jeju island
- Considering the latest fruits of domestic and international tourism capacity (or carrying capacity) researches, tourism capacity was defined as "the maximum acceptable limit of a certain regional unit (such as tourist site, scenic spot) for the influence of tourism development without damage to the resources in the regional unit"
- Conceptual framework of carrying capacity includes tourism psychological capacity, physical (or resource) capacity, ecological capacity, economic capacity, social capacity and tourism management capacity, each of them includes concrete capacity components

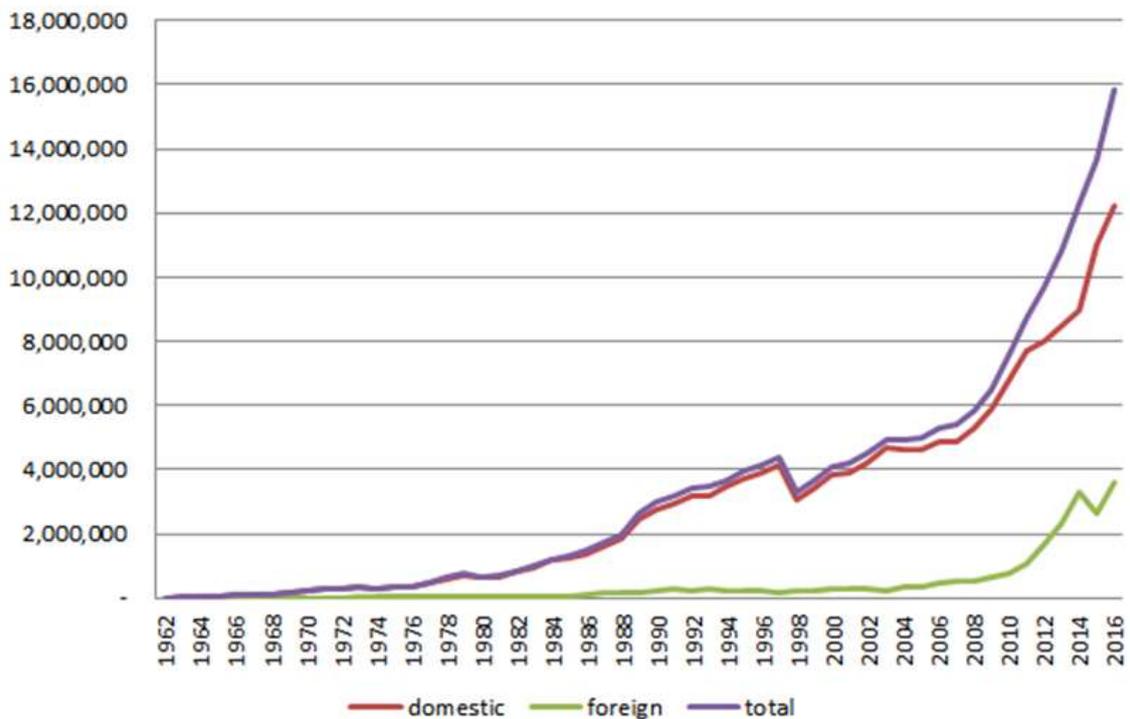
- Physical carrying capacity refers to the largest tourist amount that sightseeing activity spaces and facilities of the tourist site can accommodate under certain basic spatial standards
  - Ecological carrying capacity refers to the largest tourist amount that the tourist site can accommodate when ecological environment and tourist resources are not destroyed permanently
  - Economic carrying capacity refers to the largest tourist amount that the tourist site can accommodate by not exceeding supply capacity of tourism economic development elements
  - Psychological carrying capacity refers to the psychologically acceptable tourist amount of the locals and the acceptable congestion degree of visitors
  - Social carrying capacity refers to the largest tourist amount that tourist site can accommodate without repelling the locals
  - Tourism management capacity refers to the tourist amount that areal system of the tourist site supports for normal tourist activities under the mandatory control of the established management objectives
- Objective of this study has two folds; 1) to derive statistical estimation results of future demand of tourism for Jeju Island, 2) to derive the estimates of carrying capacity of each domains (physical, psychological, and economic) for Jeju Island
  - In this study, tourism carrying capacity of the Jeju Island was studied, by measuring its physical capacity, psychological capacity, and economic capacity and the future demand of tourism was studied by time series estimation with statistical techniques such as ARIMA and GAM

## 2. Research Result

### 1) Estimation of future tourism demand

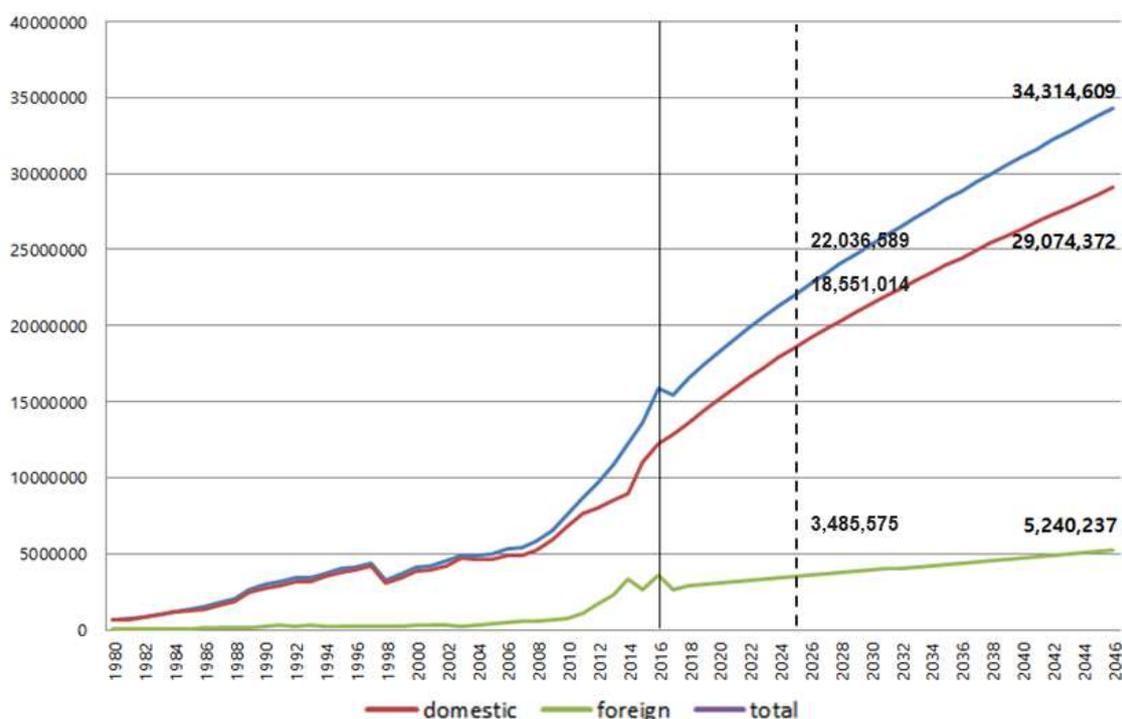
- Among the forecasting techniques we used quantitative forecasting approach because it is free from subjectivity and we have sufficient time series data of the number of tourists by monthly-base.

〈Figure 7-1〉 Number of tourists visiting Jeju Island from 1967 to 2016



- We introduced ARIMA approach among the quantitative forecasting methods to derive estimation of future demand
  - We used ARIMA(1,1,1) for the domestic tourists by developing optimal time differences for AR and MR processes with AIC and BIC
  - And we used ARIMA(1,1,1 2) for the foreign tourists by developing optimal time differences for AR and MR processes with AIC and BIC
  - We aggregated those estimation results to derive the total number of future demand

〈Figure 7-2〉 Estimation Result of future demand with ARIMA (1980 – 2046)



- Using ARIMA method we derived statistical estimation for the future demand of tourism; total number of tourists in 2020 is 18,261,976 and the estimated number exceeds 20,000,000 of tourists in 2023

〈Table 7-1〉 Estimation Result with data from 1980 to 2016 (2017–2046)

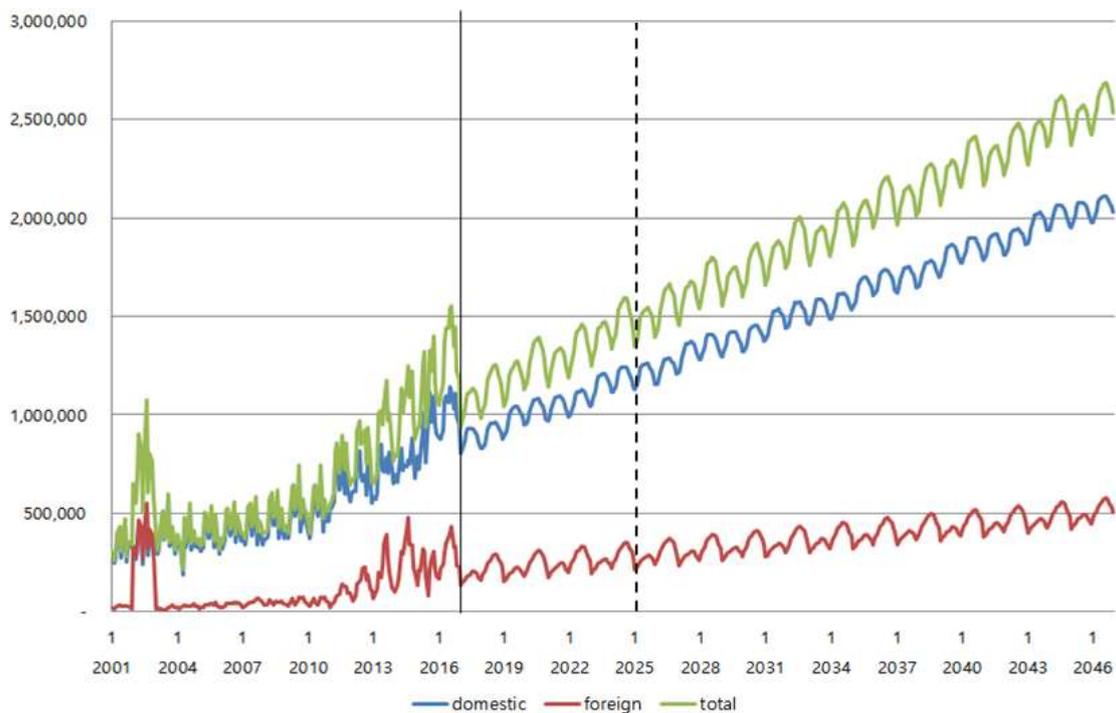
(unit : person)

Year	Domestic Tourists	Foreign Tourists	Total
2017	12,821,995	2,661,105	15,483,100
2018	13,648,516	2,939,149	16,587,665
2019	14,437,310	2,974,767	17,412,077
2020	15,191,838	3,070,138	18,261,976
2021	15,915,247	3,150,781	19,066,028
2022	16,610,392	3,235,054	19,845,446

Year	Domestic Tourists	Foreign Tourists	Total
2023	17,279,866	3,318,432	20,598,298
2024	17,926,026	3,402,031	21,328,057
2025	18,551,014	3,485,575	22,036,589
2026	19,156,768	3,569,133	22,725,901
2027	19,745,058	3,652,688	23,397,746
2028	20,317,484	3,736,243	24,053,727
2029	20,875,504	3,819,798	24,695,302
2030	21,420,440	3,903,354	25,323,794
2031	21,953,490	3,986,909	25,940,399
2032	22,475,748	4,070,464	26,546,212
2033	22,988,202	4,154,019	27,142,221
2034	23,491,754	4,237,575	27,729,329
2035	23,987,220	4,321,130	28,308,350
2036	24,475,344	4,404,685	28,880,029
2037	24,956,796	4,488,240	29,445,036
2038	25,432,190	4,571,796	30,003,986
2039	25,902,084	4,655,351	30,557,435
2040	26,366,980	4,738,906	31,105,886
2041	26,827,340	4,822,461	31,649,801
2042	27,283,576	4,906,017	32,189,593
2043	27,736,070	4,989,572	32,725,642
2044	28,185,164	5,073,127	33,258,291
2045	28,631,170	5,156,682	33,787,852
2046	29,074,372	5,240,237	34,314,609

We used GAM as an alternative approach to account for the nonlinear characteristics and seasonality of the monthly data

〈Figure 7-3〉 Estimation Result of future demand with GAM



〈Table 7-2〉 Estimation Result with GAM

(unit : person)

Year	Domestic Tourists	Foreign Tourists	Total
2017	10,619,696	2,117,791	12,737,487
2018	11,009,979	2,993,767	14,003,745
2019	11,908,656	2,363,894	14,272,550
2020	12,411,336	3,239,870	15,651,206
2021	12,589,631	2,609,997	15,199,628
2022	12,979,914	3,485,973	16,465,886
2023	13,878,591	2,856,100	16,734,691
2024	14,381,272	3,732,076	18,113,347
2025	14,559,567	3,102,203	17,661,769
2026	14,949,849	3,978,178	18,928,028
2027	15,848,527	3,348,306	19,196,832
2028	16,351,207	4,224,281	20,575,488
2029	16,529,502	3,594,408	20,123,910

Year	Domestic Tourists	Foreign Tourists	Total
2030	16,919,784	4,470,384	21,390,169
2031	17,818,462	3,840,511	21,658,973
2032	18,321,142	4,716,487	23,037,629
2033	18,499,437	4,086,614	22,586,051
2034	18,889,719	4,962,590	23,852,310
2035	19,788,397	4,332,717	24,121,114
2036	20,291,077	5,208,693	25,499,770
2037	20,469,372	4,578,820	25,048,192
2038	20,859,655	5,454,796	26,314,451
2039	21,758,332	4,824,923	26,583,255
2040	22,261,012	5,700,899	27,961,911
2041	22,439,307	5,071,026	27,510,333
2042	22,829,590	5,947,002	28,776,592
2043	23,728,267	5,317,129	29,045,396
2044	24,230,947	6,193,105	30,424,052
2045	24,409,242	5,563,232	29,972,474
2046	24,799,525	6,439,208	31,238,733

## 2) Carrying Capacity of Jeju Island

- Carrying capacity of Jeju Island is defined as "the maximum acceptable limit of tourists for Jeju Island maintaining favorability for the tourism perceived by local residents, also maintaining the appropriate level of tourism quality perceived by tourists, and without deteriorating sociocultural and ecological environment" in this study
- In this study, tourism carrying capacity of the Jeju Island was studied by measuring its physical capacity, psychological capacity and economic capacity
  - Physical carrying capacity : the largest tourist amount that spaces and facilities of Jeju Island can accommodate under certain basic spatial standards
  - Psychological carrying capacity : the psychologically acceptable tourist amount of Jeju Island maintaining favorability for the tourism perceived by local residents with the elements of traffic congestion, waste disposal and sewage treatment

- Economic carrying capacity : the largest tourist amount that Jeju Island can accommodate by absorbing functions of tourism without shrinking local economic activities. It is estimated by income factor of tourism and cost factor of it such as traffic congestion, waste disposal and sewage treatment

a) Physical Carrying Capacity of Jeju Island

- We reviewed overall elements of physical resources related to the physical carrying capacity of Jeju Island and

<Table 7-3> Overall elements of physical carrying capacity

Category		Elements	Result of preliminary review	Opinions
Physical space		Density per area	23 persons per 1km <sup>2</sup> (/day)	Further consideration is not required
Facilities	Accommodation	Toilets	Not available	Further consideration is not required
		Rest area		
		Parking lots	Parking lots: 328,423 Acquiring rate: 93.4%, lack of 23,083 lots	Further consideration is not required
	Accommodation	Guest rooms	Key factors of facility capacity	total accommodation 67,999 guest rooms
Transport	Maximum number of tourists that can access the inbound transportation	Jeju Int'l Airport: 26.23 million passengers in 2015 and this number exceeds the facility limit of 25.47 million	(Airplane) 14.85 million + (Ship) 2.015 million = 16.855 million (2016)	

- We excluded the spacial density of tourists across the whole island, number of toilets and rest areas in account for the primary objectives of this study.
- Upper limit of aircraft transportation was already exceeded with the number of inbound passengers 14.85 million persons in 2015 and derived the physical carrying capacity number as 16.85 million

persons not considering the second international airport plan under discussion and Gung-jung Harbor which was newly constructed

- Considering accommodation capacity, we calculated total 67,999 guest rooms across the whole island and this result shows sufficient rooms for accommodation with the 3.12 days of average date of stay

b) Psychological carrying capacity

- Psychological carrying capacity is defined as;
  - Psychological carrying capacity : the psychologically acceptable tourist amount of Jeju Island maintaining favorability for the tourism perceived by local residents with the elements of traffic congestion, waste disposal and sewage treatment
- We adopted contingent value method to identify the status of psychological carrying capacity perceived by local residents
  - The contingent valuation method (CVM) is used to estimate economic values for all kinds of ecosystem and environmental services. It can be used to estimate both use and non use values, and it is the most widely used method for estimating non-use values. It is also the most controversial of the non-market valuation methods
  - The contingent valuation method involves directly asking people, in a survey, how much they would be willing to pay for specific environmental services. In some cases, people are asked for the amount of compensation they would be willing to accept to give up specific environmental services or benefits. It is called “contingent” valuation, because people are asked to state their willingness to pay, contingent on a specific hypothetical scenario and description of the environmental service
- With 1,000 samples we carried out statistical approach to derive contingent value of improving discomfort (traffic congestion, waste disposal, sewage treatment) originated from tourism
- The result of CVM for each categories are listed below
  - Psychological cost for traffic congestion: 20,990 KRW (per year)
  - Psychological cost for waste disposal: 23,110 KRW (per year)
  - Psychological cost for sewage treatment: 23,071 KRW (per year)
- The rate of willingness to pay is about 15 percent (15.9%, 14.8%, 16.4% respectively), and those who didn't want to pay for those service said that government should pay for that with tax or even

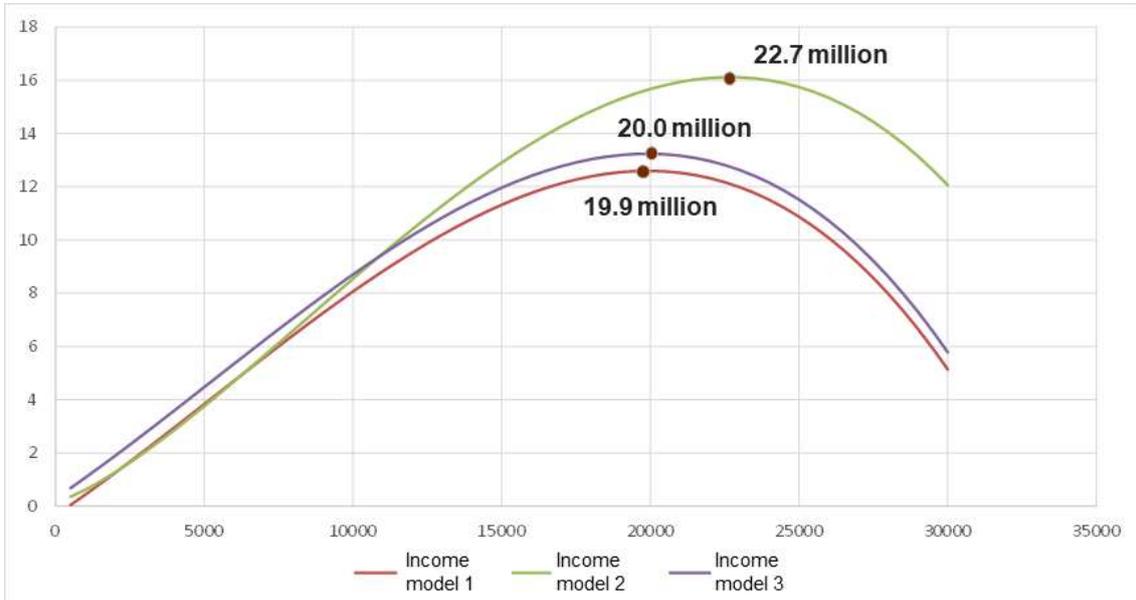
tourists should defray because they are the cause of those discomforts

- Total amount of psychological cost can be calculated as below with a condition of total number of local residents as 670,000 person in Jeju Island
  - Psychological cost of traffic congestion : 14,063,300,000 KRW (per year)
  - Psychological cost of waste disposal : 15,483,700,000 KRW (per year)
  - Psychological cost of sewage treatment : 15,457,570,000 KRW (per year)
  - Total amount : 45,004,570,000 KRW (per year)
  
- Total amount which local resident are willing to pay was calculated as below
  - Psychological cost of traffic congestion : 2,236,064,700 KRW (per year)
  - Psychological cost of waste disposal : 2,291,587,600 KRW (per year)
  - Psychological cost of sewage treatment : 2,535,041,480 KRW (per year)
  - Total amount : 7,062,693,780 KRW (per year)

c) Economic Carrying Capacity

- Economic carrying capacity is defined as;
  - Economic carrying capacity : the largest tourist amount that Jeju Island can accommodate by absorbing functions of tourism without shrinking local economic activities. It is estimated by income factor of tourism and cost factor of it such as traffic congestion, waste disposal and sewage treatment
  
- We derived estimation of social surplus with income from tourism, cost of traffic congestion, cost of waste disposal, and financial cost of sewage disposal with given number of tourists. We adopted 3 different models of economic benefits: Model 1 (linear), Model 2(Log-Log), Model 3(Linear, but domestic and foreign tourists are divided)

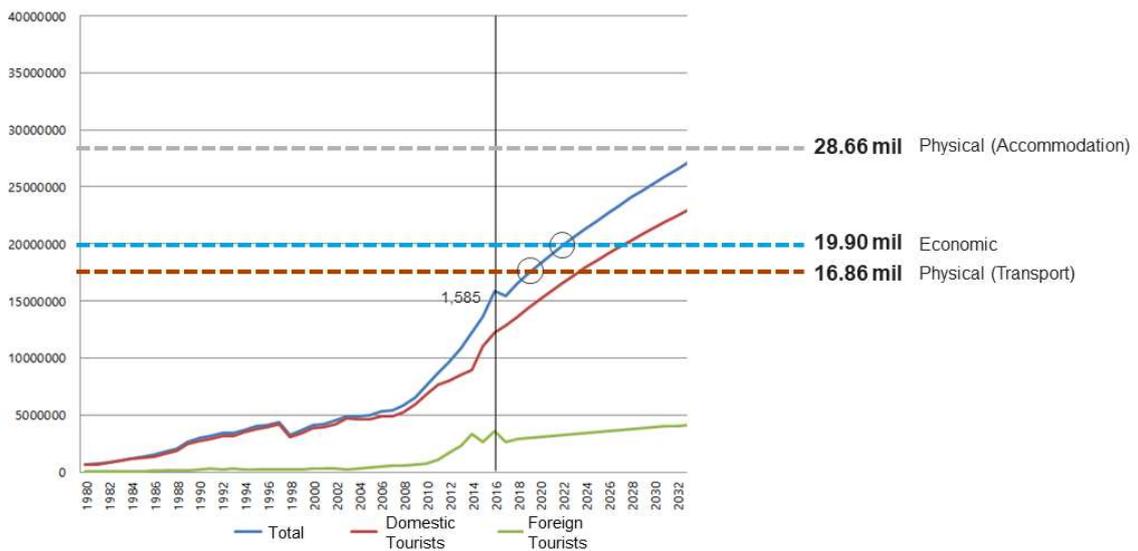
<Figure 7-4> Economic Carrying Capacity (Benefit/Cost Efficiency Line)



- The maximum equilibrium point is acquired at 19.90 million tourists at Model 1 and 22.70 million at Model 2. Conservative speaking, economic inefficiency will occur when the numbers tourists exceed 19.90 million

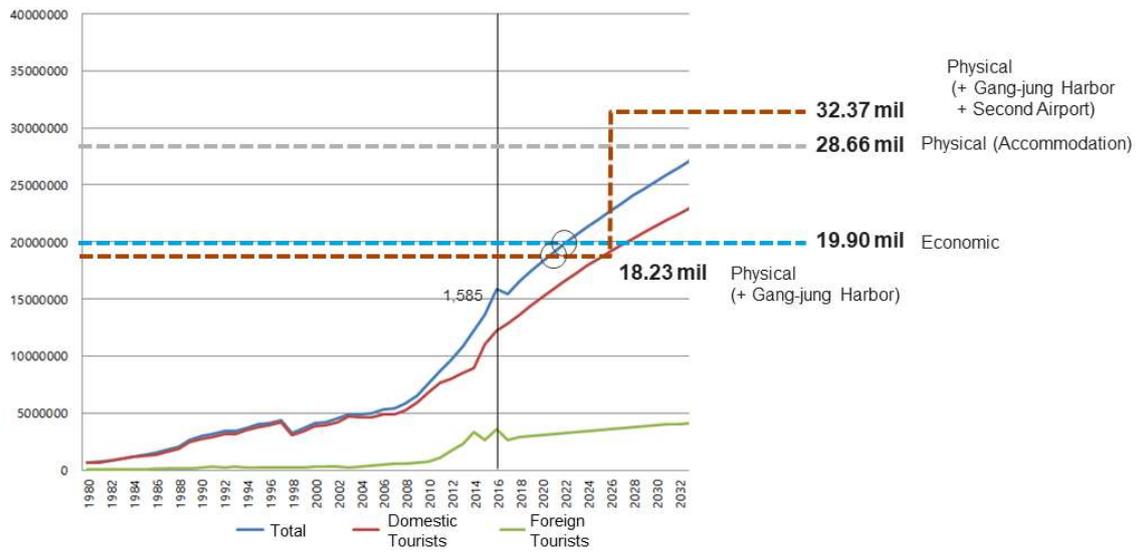
d) Comprehensive Result of Carrying Capacity of Jeju Island

<Figure 7-5> Overall Carrying Capacity of Jeju Island (current state)



- Maximum capacity of Gung-jung harbor is about 1.36 million persons per year and we aggregated this into the result

〈Figure 7-6〉 Overall Carrying Capacity of Jeju Island (expected state of infrastructure)



### 3. Conclusion and Suggestion

- This research has theoretical and practical implications from the perspective that it is the first research which dealt in the carrying capacity across the whole Jeju Island and it can suggest the practical guidelines for managing tourism policy
- However, this research has some major limitations and we proposed some future research subjects and practical alternative for the tourism policy of Jeju Island
  - Since the "THAAD" crisis still goes on as of 2017, there are discrepancy between estimation and real number of tourists
  - Although the level of congestion is located in the middle of carrying capacity concept, we could not measure the direct status of congestion because this research is not focused on a certain site or spot.