Development of a Carrying Capacity Assessment System for the Chi-Ri National Park

Woo-Kyun Lee[1]*, Min-Ho Son, Doo Ahn Kwak****

*Division of Environmental Science & Ecological Eng., Prof. of Korea Univ.

**Dept. of Environmental & Ecological Eng., Graduate school of Korea Univ.

Abstract

A GIS application for assessment of carrying capacity for national parks was developed and presented in this study. Three criteria--ecological factors, facilities, and institutions--were employed as determining factors for assessing the carrying capacity. Using the GIS-based approach, the site-specific carrying capacity for the Chi-Ri National Park was assessed and a carrying capacity map was prepared. This carrying capacity map can be helpful in making policies for decentralizing visitors and keeping the park environmentally stable.

Keywords : Carrying Capacity, National Park, Carrying Capacity Assessment System

1.Introduction

According to IUCN (International Union for the Conservation of Nature), the objective of a national park is mainly the conservation of nature and it shall be managed by a top organization in a pertinent authority and visitors' use is allowed only when the use is not violating the objective of nature conservation, that is, a national park is the most stringent legal tool protecting relatively broad area in a country where population density is high (National park Institute, 1995). However, a national park in South Korea is an area with a representative beautiful scenery of the country, and designated and operated to protect and preserve regional and cultural resources and to provide a nation relaxation and emotional life (Lee, 1996). Meanwhile, because the original concept of a national park system is to protect nature which is destructed or vulnerable to destruction, it's sometimes misunderstood as kind of No trespassing area limiting people's visiting due to too much weight on protection, misunderstanding of the concept of protection, or too much limit. Therefore, the concept of capacity was emerged for efficient park management. The concept of capacity came from population growth theory by ecologists, in which equilibrium state is maintained with specific upper limit achieved by environmental resistance when the population of animals or plants increase in a certain habitat environment. That is, this concept is defined as a upper limit of maximum population form of a certain species which can be maintained without any unrecoverable damages of an ecosystem or habitat (Park, 1995). The capacity features of a park are formed and determined according to artificial conditions like visitors' accessibility, convenience, and satisfaction, etc. and natural conditions like resource type, location and topography, and weather, etc. In addition, the features of parks shall be taken into account to classify them into a park with cultural assets, a mountain national park including summit or valley, etc, a costal national park including coast or island, etc. In calculating capacity, many prior studies calculated appropriate individual capacity through individual study using physical, ecological, psychological, and

[1] Tel : +82-011-759-8050; Fax : 08-02-953-0737.
E-mail : leewk@korea.ac.kr.

economical approach (Getz, 1982; Canestrelli & Costa, 1991). However, this study implemented unified capacity calculation to resolve the problem of individual capacity calculation in an actual field. We believe this will be very efficient and helpful to the management of a national park and systematic capacity calculation model based on system access method will be very helpful to decision making.

2. Methodology

2.1. Study area

The target area of this study is the first national park in South Korea and it's adjacent to 5 counties in southern inland and it has total area of 440.17 km^2 with its ridgeline of 45.0 km^2 from east to west and 1,915m above the sea level. It has the most broad area among national mountain parks(Fig. 1).

2.2. Carrying capacity

When we focus on the capacity of tourism for a national park, the tourism carrying capacity means capability to continuously satisfy and attract tourists (O'Reilly, 1986). In addition, the capacity can be defined assuming there is a potential limit, that is, threshold in the growth and development natural environment can afford (Godshalk and Parker, 1975) and the threshold can be identified (Schneider, et al., 1978) and it can be increased or decreased by external conditions. Therefore, this study defines the concept of capacity as "the maximum number of visitors a tourist site can afford with which optimized satisfaction to tourists without damages to natural ecosystem can be achieved" and calculate the capacity by identifying potential limit through external conditions.

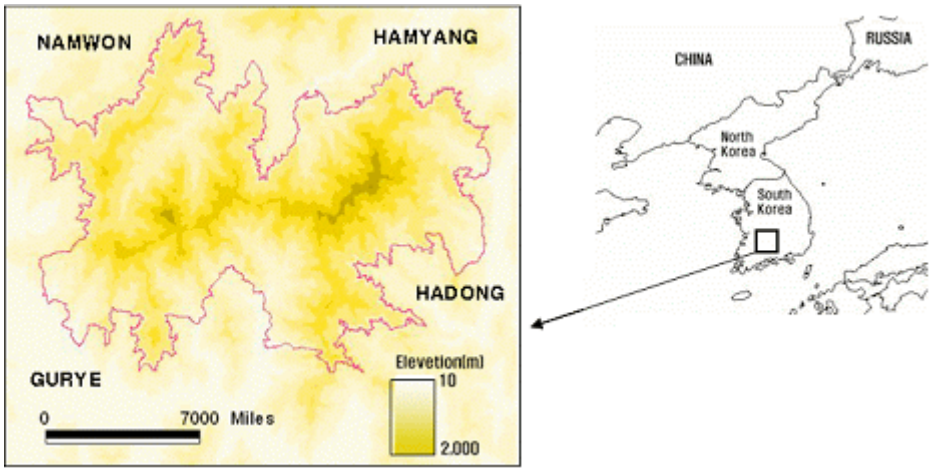

Figure 1. Digital elevation model(DEM) of Chi-ri National Park in South Korea

2.3. Determining factors of National park carrying capacity

The prior studies, about factors used to calculate capacity, used the amount of park resources, the tolerance of park resources to use, the number of visitors, the type of use, the design and management of visitor facilities, and the behavior and attitude of visitors as factors (Lindsay, 1986). In addition, Glasson, Goddfrey, Goodey (1995) proposed capacity calculation equation which includes ecosystem, tourism facilities, economical features, and policy capability by modifying previous equations. Therefore, this study defines and applies the capacity of facility (physical capacity), the capacity of natural

environment (environmental and ecological capacity), regulatory capacity (social and regulatory capacity) to mountain-type national park based on the type of capacity introduced in prior studies. The capacity factors for each type is shown in Table 1.

2.4. Development of Carrying Capacity Assessment System

Prior studies calculated individual capacity, but this study calculated the capacity of target area by integrating each individual capacity. In addition, a feedback system was established for the results of individual capacity calculation to enable continuous park management. Therefore, the capacity of entire park is consistently maintained at the same level while each individual capacity is adjusted if necessary.

The Carrying Capacity Assessment System includes File, Input and Assessment (Individual, Integrated). The Carrying Capacity assessment process performs defining factors, grading factors, and calculating individual carrying capacity and compares the results with park management plan. If the results satisfy the objective of park management, it calculates integrated capacity. If not, it defines factors again under grade for determining factors which modify causing factors. This process allows calculation of consistent capacity. The carrying capacity assessment system was programmed with Visual Basic 6.0 and MapObject 2.1.(Fig. 3).

Table 1. Determining factors of National park carrying capacity

Carrying Capacity Types		**Factors**
Facility	Physical	Facility Map(Parking area, Camping area etc..)
Environmental	Environmental	DEM(Digital Elevation Map), Ecological Map (Forest , Geological , Natural protect area etc..)
	Ecology	
Law	Social	Public law (National land used & plan law etc..)

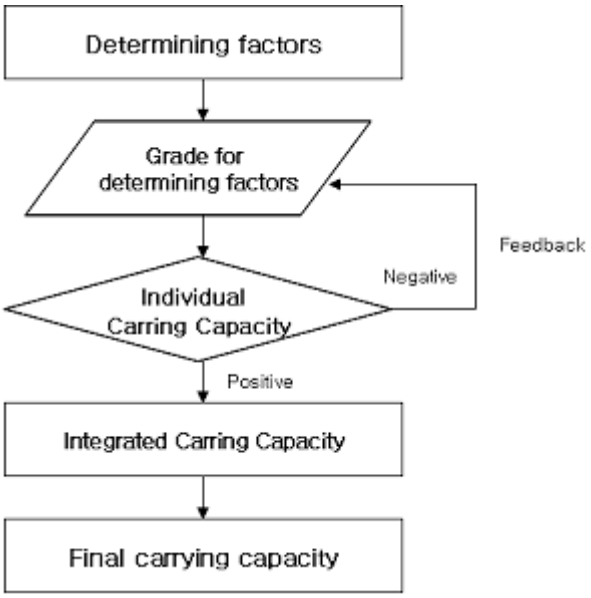

Figure 2. Carrying Capacity assessment process

3. Results

3.1. Facility carrying capacity assessment

The facility capacity is calculated based on facility management map of a park and the area of each facility to obtain each regional capacity. These capacities are added to get the capacity of entire park. Therefore, the facility distribution or intensiveness of a park determines regional capacity and the calculation by using parking lot and camping site which has the most effect on the capacity calculation leads to the capacity result of 12.3 km^2 3,500 people/day.

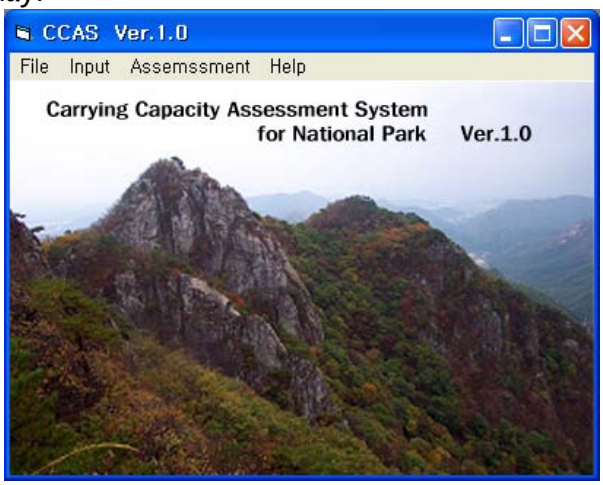

Figure 3. Main picture

3.2. Environmental carrying capacity assessment

The environmental capacity is the highest capacity among three elements for capacity calculation. By grading natural environmental factors and ecological factors and then using minimum index method, we applied the system in which the lowest grade was chosen for corresponding capacity among many features. Slope, water system, and road were important natural environmental factors, and a forest reserve, a natural monument, an ecological area, etc. were important ecological factors. The capacity calculation based on natural environmental factors and ecological factors leads to the result of 58.45 km^2 9,764 people/day.

3.3. Law carrying capacity assessment

The lawful capacity was calculated based on the law about the lan use and the plan for land development. The calculation equation for regional building-to-land ratio is equation 1.

$$BPAR = (RB / 100 * LR / 100) / 10000 \quad (1)$$

$$BPA = A * BPAR \quad (2)$$

$$CC = BPA / PDNA(16.5\,m^2) \quad (3)$$

BPAR : build possibility area ratio, RB : regional building, LR: land ratio, A : area
BPA : build possibility area, PDNA : person per dwelling necessity area

The calculated lawful capacity was 440.17 km^2 2,343 people. This is the maximum number for the capacity, so it doesn't represent appropriate capacity. Therefore, it shall be considered as lawful capacity limit when calculating integrated capacity.

3.4. Integrated carrying capacity assessment

The integrated capacity calculated from facility, environmental, and law capacities is

58.45 km^2 9,764 people/day. This final capacity means the capacity which can implement visitors' satisfaction without damages to natural ecosystem. This number is close to 1,845 people/day which is actual number of visitors in 2005.

4. Discussion

This study simplified previous complex survey process and equation derivation process used in calculating capacity by developing GIS-based capacity calculation system and discovered the followings. First, the change of facility capacity shall be taken into account to increase capacity. When a capacity is too high, environmental capacity shall be taken into account. Third, the integrated capacity unifying individually calculated capacities is a realistic capacity.

While this study calculated capacity based on general factors of a park, there are a variety of features for each park, so it will be more realistic capacity calculation when those characteristics are taken into account.

References

National park Institute, “National park in West Europe”, pp.24~25.

Hang Gue, Lee, 1996, “Introduction of Tourism law”, pp.485.

Canestrelli, Elio & Costa, Paolo, Tourist carrying capacity : A fussy approach, Annals of Tourism Research, Vol.18, pp.295-311.

Getz, D.,1982, A rational and methodology for assessing capacity to absorb tourism, Ontario Geographic, No. 19.92-102.

Getz, D.,1983, Capacity to absorb tourism : Concepts and Implications for strategic planning. Annals of Tourism Research, Vol, 10. 239-263.

Godschalk, D.R., Parker, F.H., 1975. Carrying capacity: a key to environmental planning. J. Soil Water Conserv. 30, 160-165.

O'Reilly,A. and Wall, G. 1982, "Tourism Carrying Capacity", Tourism Management, Dec..