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Recreational Carrying Capacity Assessment in a Turkish National Park

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Introduction

National parks and protected areas are favorite places for recreation activities. They are originally established to provide people with places for inspiration, recreation and spiritual renewal. Public visits to parks and protected areas continue to increase and may threaten the integrity of natural and cultural resources and the quality of the visitor experience (Lawson et al. 2003); consequently planning, management, and monitoring are developed as the steps of a system to establish a balanced level between conservation and recreational use.

Carrying capacity analysis in the wilderness provides a basis for recreational planning and management of protected areas in the visitor management context. Extensive human use and high visitor numbers could be a problem for such areas. The result is usually deterioration of natural and cultural resources and diminished visitor satisfaction. Carrying capacity analysis is the part of a framework which aims to protect the natural and cultural resources under human use and provides best social conditions for visitor experience.

Determination of carrying capacity for an outdoor recreation area requires information or data related with the resource, the visitor characteristics and the provided infrastructure which is specific to each protected area because of its unique natural and cultural characteristics, location, state of the public use and climatic conditions. Hence methods and parameters could change in different cases according to the concept and priorities of the framework.

The aim of this work is to estimate the recreational carrying capacity of Termessos National Park which is one of the important protected areas in the Mediterranean Region of Turkey. It is also aimed to provide a basis for the better management of visitors; consequently better protection of the biophysical and historical characteristics of the area in a sustainable way.

As being one of the five national parks in the Province of Antalya, Termessos is highly appreciated by foreign tourists. The Park is located 34 km to the northwest of Antalya City (figure 1). The surface area of the park is 6702 ha and situated in the altitude ranges from 250 to 1663 m from the sea level. Termessos is the name of ancient Roman city which once had been located within the national park borders.

Termessos National Park is a unique site to visit because of its richness both for natural and cultural resources. Cultural resources of the site focus on Termessos, the ancient Roman city itself. Flora and fauna of the Park are of high value. 680 plant species representing 92 families belonging

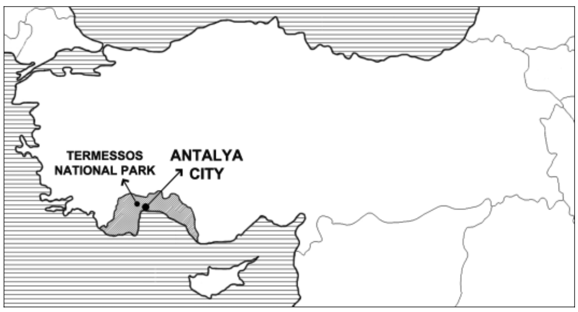

Figure 1: Location of Termessos National Park.

to 5 vegetation types namely maquis, forest, rock, hydrophilous and culture plants were identified in the Park area (Alçıtepe 1998).

Among the major mammals in the National Park area are *Canis vulpes* (common fox), *Canis aures* (jackal), *Ursus arctos* (grizzly bear), *Capra aegagrus* (wild goat), *Mustela foina* (beech marten), *Meles meles* (Eurasian badger), *Sus scrofa* (wild boar), *Lepus europaeus* (European hare), *Dama dama* (dama gazelle), *Felis silvestris* (wild cat), *Lynx lynx* (European Lynx) and *Lutra lutra* (common otter). 113 bird species representing 32 families some of which are endangered live in Termessos. Protection of the habitats of following species is of particular importance: *Circateus gallicus* (short-toed eagle), *Strix aluco* (eurasian tawny owl), *Bubo bubo* (eurorasian eagle owl), *Accipiter nisus* (sparrow hawk), *Falco peregrinus* (pelegrine falcon), *Falco biarmicus* (lanner falcon), *Asio otus* (long-eared owl).

Methods

Recreational carrying capacity of Termessos National Park was determined with the combination of two different methods. The Methodology for Estimating Protected Area Carrying Capacity by Cifuentes (1992), and the Carrying Capacity Assessment Process (C-CAP) by Shelby and Heberlein (1986) were used. Basically the first method provides the calculation of physical, real and effective carrying capacities by using environmental, ecological, climatic and managerial parameters in a formulation. The logic of this method depends on the factors which reduce the level of visitation for making carrying capacity estimations. The second method (C-CAP) provides the calculation of social carrying capacity. It makes possible to determine social norms and preferences of people (visitors) and provides to collect empirical data for the evaluative dimension of carrying capacity.

Three different types of carrying capacities are identified in the Methodology for Estimating Protected Area Carrying Capacity (Cifuentes, 1992). Physical carrying capacity (PCC) is the maximum number of visitors that can physically fit into a defined space, over a particular time, and expressed according to the following formula:

PCC = A x V/a x Rf

where A is the available area for public use, V/a is Visitor/area occupied, and Rf is the rotation factor (number of permissible visits per day). Rf is calculated as follows:

Rf = opening period / average time of one visit

Real carrying capacity (RCC) is the maximum permissible number of visits to a site, once the corrective (i.e. reductive) factors derived from the particular characteristics of the site have been applied to the PCC. These corrective factors are obtained by considering bio-physical, environmental, ecological, social and management variables. RCC is expressed by the following general formula where Cf is a corrective factor expressed as a percentage:

RCC = PCC – Cf1 – Cf2 –……… – Cfn

Thus, the formula for measuring RCC is:

RCC = PCC x (100 – Cf1 / 100) x (100 – Cf2 / 100) x ……… x (100 – Cfn / 100)

Corrective factors are closely linked to the specific conditions and characteristics of each site. They are expressed in percentage terms, using the following formula:

Cf = Ml / Mt x 100

Where, Cf is the corrective factor, Ml is the limiting magnitude of the variable, and Mt is the total magnitude of the variable.

Effective (or permissible) carrying capacity (ECC) is the maximum number of visits that a site can sustain, considering the management capacity (MC) of the site. ECC is obtained by comparing RCC with the MC of the corresponding protected area administration. It is expressed with the following formula:

ECC = RCC x MC

Social carrying capacity (SCC) involves descriptive and evaluative components (Shelby and Heberlein, 1986). Descriptive data focuses on objective characteristics of recreation systems where the evaluative component critically considers the different objective impacts produced by management parameters in an effort to determine their relative merits. The C-CAP method does not contain formulas; it employs some methods to make estimations for the social capacity for example previous

Table 1: Characteristics of Trails in Termessos National Park.

Trail	Use level	Aspect	Trail section (m)			Trail length (m)
			Slope < 10 %	Slope 10–20 %	Slope > 20 %	
1	High	West	552	90	338	980
2	High–medium	South–east	60	183	600	843
3	Medium	East	140	238	95	473
4	Medium–low	South	134	280	282	696
5	Low	West	100	44	–	144
Total length of each slope category (m)			986	835	1315	
Grand total of trail lengths (m)						3136

data analysis, literature work, field work (counting, questionnaire surveys, observations, interviews, etc.). A formula is developed in accordance with the Methodology for Estimating Protected Area Carrying Capacity as follows:

SCC = Gs x GPn x Rf

Where, Gs is the group size (mean value), GPn is the group and/or number of people preferred to have been encountered by visitors (mean value), and Rf is the rotation factor (number of permissible visits per day). The unit of SCC is also accepted as “visitor/day”, because the concept is closely related with the people themselves.

Results

Trails, main visitor points and the road from the main entrance to the parking area were taken with Global Positioning System (GPS) receiver. Five trails were classified based on their use levels. Characteristics of the trails were summarized in table 1.

Data related with visitors were collected through a questionnaire survey done in the randomly selected days of 2003 fall and 2004 spring seasons. The questionnaires were administrated on-site to a sample of 500 visitors with face-to-face interview method, after finishing their hike.

Four different types of carrying capacities were calculated with the use of parameters. PCC was calculated as follows:

Rf = opening period / average time of one visit = 9/3 = 3

31 groups each consisting of 50 visitors can fit into the Park’s 3136 m total trail length with 50 m distance between each group [(31x50) + (30x50) = 3050 m]. In PCC, theoretically, it is supposed that these 31 groups are simultaneously visiting the site. Therefore, available area for the public use becomes 1550 m (31x50 = 1550 m). Thus PCC is:

PCC = A x V/a x Rf = 1550 x 1 x 3 = 4650 visitors/day

Factors affecting the RCC of Termessos National Park are mainly based on the climatic data for 21 year period data (1980-2000) for Antalya. Concerning the RCC a number of corrective factors are identified for the Park.

Excessive sunshine

Particularly in the summer season excessive sunshine affects trekking on and climbing to the steep slope sections of trails. The number of days in which the temperature is equal or more than 25°C was considered and that is 168.4 days. Daily excessive sunny period is 4.5 hours in the 12 hours of total sunny period. Thus limiting magnitude (Ml) and total magnitude (Mt) of excessive sunshine were calculated as 757.8 hours/year (168.4x4.5) and 2020.8 hours/year (168.4x12), respectively. With these values, excessive sunshine corrective factor (Cfes) was calculated as: Cfes = Ml / Mt x 100 = 757.8 / 2020.8 x 100 = 37.5 (37.5 %)

Rainfall

In some sections of the trails of Termessos National Park are lots of broken ancient stones and ruins which are eroded by heavy use and can be slippery even in a light rain, so trekking can be dangerous. Also visibility decreases; pictures and films taken by camera and video camera are affected. Number of days in which rainfall is equal or more than 0.1 mm was taken as the climatic data and that is 74.8 days. Average rainfall period is 3.0

hours. Limiting magnitude of rainfall was calculated as 224.4 hours/year (74.8x3). Total magnitude of rainfall is related with the visiting hours of the park. Daily opening period is 9 hours and it is calculated as 3285 hours/year (9x365). Rainfall correction factor (Cfr) was calculated as: Cfr = Ml / Mt x 100 = 224.4 / 3285 x 100 = 7.0 (7 %)

Storm
Winds with a speed of equal or more than 17.2 m/s are defined as “storms” (Anonymous 2004). Storms are effective on the recreational activities, thus considered as a corrective factor. Average number of stormy days is 12.5 and effective period is 7 hours. Limiting magnitude of storm was calculated as 87.5 hours (12.5x7) and total magnitude is the same as calculated in rainfall; 3285 hours/year. So, storm corrective factor (Cfs) is calculated as: Cfs = Ml / Mt x 100 = 87.5 / 3285 x 100 = 3.0 (3.0 %)

Erosion
Intensive use of the trails causes erosion; therefore erosion was considered as a corrective factor. The relationship between slope ranges and soil types shown in the table 2 indicates the erodibility of any place under visitor use. Gravel, sand and clay soils on slopes of between 10 and 20 %, present a medium risk of erosion; lime soils on slopes between 10 and 20 %, present a high risk of erosion, as do all the soil types on slopes exceeding 20 %. Recreational activities in Termessos National Park are performed in the linear segments. Trails in the park have sections with medium and high erosion risk related with the slope range, and soil type is generally lime to sand. Total length of the trails is 3136 m of which 835 m present medium and 1315 high erosion risk. Limiting magnitude of erosion is 2150 m (835+1315) and total magnitude 3136 m. Hence erosion corrective factor (Cfe) is calculated as: Cfe = Ml / Mt x 100 = 2150 / 3136 x 100 = 68.5 (68.5 %)

Accessibility
Accessibility is related with the degree of difficulty, due to the slope of the trail, experienced by visitors. Termessos National Park is situated generally a rough area having steep slopes. According to the table 1, first and second trail slope categories (categories: 10% and 10-20%) form the majority (58%) of the total trail length. So, a site-specific evaluative standard was considered for Termessos National Park for the trail slope. Trails with slopes less than 20 % were considered suitable for visitors. Slope range more than 20 % was used as the limiting magnitude (1315 m) for the accessibility correction factor. Thus accessibility corrective factor (Cfa) was calculated as: Cfa = Ml / Mt x 100 = 1315 / 3136 x 100 = 42.0 (42 %)

Disturbance to Wildlife
Among the mammals *Capra aegagrus* (wild goat) has of particular importance for the Park. Also 7 birds of pray are endangered in the area. Therefore disturbance to wildlife was considered as a limiting factor in Termessos. Mating season for wild goat is between October 15 and November 15 (1 month) and for bird species April and May (2 months). Thus, limiting magnitude is 3 (1+2), and the total magnitude is 12 (12 months). Disturbance to wildlife corrective factor (Cfw) was calculated as: Cfw = Ml / Mt x 100 = 3 / 12 x 100 = 25.0 (25 %)
After having calculated all corrective factors for Termessos National Park, RCC was calculated by converting the corrective factors in percents into coefficients. Thus RCC was calculated as follows:

Table 2: Erosion risks of soils in different slopes (Cifuentes 1992).

Soil type	Slope		
	< 10 %	10 % - 20 %	> 20 %
Gravel or Sand	low	medium	high
Lime	low	high	high
Clay	low	medium	high

RCC = PCC x (100 – Cfes / 100) x (100 – Cfr / 100) x (100 – Cfs / 100 x (100 – Cfe / 100) x (100 – Cfa / 100) x (100 – Cfw / 100)
RCC = 4650 x (100 – 37.5 / 100) x (100 – 7.0 / 100) x (100 – 3.0 / 100 x (100 – 68.5 / 100) x (100 – 42.0 / 100) x (100 – 25.0 / 100)
RCC = 4650 x 0.625 x 0.93 x 0.97 x 0.315 x 0.58 x 0.75 = 359 visitors/day

Management capacity of Termessos National Park is derived from its administrative status. Facility conditions are thought to be sufficient. Long-term Management Plan (Anonymous 1969) considered the need for 26 personnel. However only 7 personnel (1 manager, 1 clerk, 1 forest ranger, 1 driver and 3 workers) are in charge at the moment. The management capacity (MC) for Termessos National Park was calculated as 27 % (7/26x100). Thus ECC was calculated as:
ECC = RCC x MC = 359 x 0.27 = 97 visitors/day

Social Carrying Capacity (SCC)

SCC was calculated using the data obtained by questionnaire surveys. 67.8 % of the visitors come to Termessos National Park in groups. Rotation factor had been calculated as 3 before; thus SCC was calculated as:
SCC = Gs x GPn x Rf = 12 x 2.5 x 3 = 90 visitors/day
This value is the daily capacity. Theoretically SCC at one time has to be one third of this value because of the three rotations which was calculated for one day.

Discussion and Conclusion

Termessos National Park is a place to be the home of an ancient Roman city and unspoiled habitat for most species of Mediterranean flora and fauna. In this study physical, real and effective carrying capacities of the Park were calculated through the formulas in the methodology by Cifuentes (1992).

Six corrective factors related with the bio-physical characteristics of the area were applied. Historical background could be another corrective factor on the recreational use of Termessos. However, inclusion of the visitor capacity regarding the ruins itself as a corrective factor needs comprehensive research. Determining a reasonable number of visits which aims the sustainability of the cultural resource needs the use of professional instruments to measure the effects on the ruins; therefore ruins themselves were not considered as a corrective factor.

Species in the natural vegetation could also be another corrective factor. However no endemic species were encountered in the trails and nearby areas used by the visitors. Therefore a correction factor for the plant species was not applied.

ECC was calculated as 97 visitors per day which means 35.405 visitors per year. Total visitor number in the period 1995-2005 was 328.654 visitors which means an average of 29.878 visitors per year, and 82 visitors per day. So, actual visiting state of the Park is below the capacity that was calculated in this research. SCC which was integrated into the research was calculated separately from the previous three levels of carrying capacity. It was calculated 90 visitors per day which means an average of 32.400 visitors per year. It is interesting that the results of ECC and SCC are very close to each other although they were calculated separately. This is the original finding of this study, not been found in the previous studies.

Final numbers for recreational carrying capacity is 97 visitors/day, and for social carrying capacity 90 visitors/day. In the case of Termessos, it seems easier to establish a recreational carrying capacity for the National Park. Both visitor numbers are very close to each other and lower than the actual average visitor numbers; thus any of them can be used as the maximum visitor number. Actual visitor numbers are suitable for the site and current visitation conditions should be maintained. If the management system is improved, the recreational carrying capacity may be increased. Therefore a balanced management system is of importance for the sustainability of the natural resources; for the protection of cultural heritage and for the quality of recreation experience.

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