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Management of recreational sites and observance of environmental law considerations through carrying capacity determination

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Abstract
The purpose of this study is to determine the number of tourists permitted for the mountainous areas of northern Shahroud. The research method is analytical -survey. Initially, by registering ground points, the study was precisely determined. The area of the study area is 430 hectares. Standard relationships were used to identify zones and recreation classes. A researcher -made questionnaire and 384 questionnaires were used to measure management restrictions. The results showed that the study area has two types of extensive and intensive recreation and 6 classes. The study site scored 2.22 out of 5 based on user and local community votes. Therefore; the region has 44.4% of the minimum capabilities required to achieve the desired goals. Also, the capacity of the physical, real and effective carrying capacity is 2859500, 632235 and 278183, respectively. In general, determining the carrying capacity is one of the important managerial and legal parameters in the protection of natural ecosystems.

Keywords: Carrying capacity, Mountain tourism, Recreational site, Shahroud.

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1. Introduction

Environmental rights have always been cited as a means of protecting natural environments and preventing the destruction of ecosystems. It is clear that the development of recreational activities can lead to the destruction of natural ecosystems (Barghjelveh et al., 2013). It should be noted that short-term economic and social benefits should not be used as an excuse to put too much pressure on nature. Recreational activities are also known as one of the common uses in resorts (Sayan et al., 2011). Due to the vulnerability of natural areas, it is important to investigate and determine the recreational carrying capacity. Therefore, establishing the desired balance between the recreational capability of a site and the rate of client use of them is a very important issue and forms the basis of planning related to recreational areas (Martire et al., 2015).

In a general sense, carrying capacity is defined as the extent to which an environmental process or variable within an ecosystem can change without the structure and function of that ecosystem exceeding certain limits (Duarte et al., 2003: 124).

The practical concept of carrying capacity is "the maximum number of people visiting a natural sports or recreation area at a given time without changing the environment and without creating an unacceptable reduction in the quality of user satisfaction" (UNWTO, 2016). In other words, carrying capacity determines the extent to which resources are destroyed or irreparable damage is done to the ecosystem (Hosseinzadeh & Erfanian, 2015: 8). Crossing this level and threshold will lead to destruction and damage on various scales or reduce the level of satisfaction of users and visitors (Brown, 2011:23). This concept is recognized as a tool for planning for sustainable development (Santos Lobo, 2013:88). Determining "recreational and sports carrying capacity" (STCC) is an essential planning policy that is usually based on site feature analysis (James et al., 2015).

2. Literature review

Environmental carrying capacity (physical - ecological); It is the maximum number of people that can be supported by a habitat without compromising the sustainability and performance of sustainable destructive life support systems (Meadows, 1992). In social range capacity, tolerance and congestion are met from the perspective of

indigenous peoples and user satisfaction (Lawson et al., 2003). Economic capacity is a level of economic activity that takes place without harming key local economic activities. This means that tourism activities should not interfere with other economic sectors or reduce local people's income (Reghunatan, 2016).

To estimate the carrying capacity of tourism, it is necessary to calculate 3 parameters: Physical Carrying Capacity (PCC), Real Carrying Capacity (RCC) and effective capacity (Taheri Hosseinabadi et al., 2019:(

•Physical or potential carrying capacity; is the maximum number of users that can be physically present at a given location and time. This capacity can by no means be the basis of planning; rather, it shows the capacity of the physical environment of the region without considering limiting elements (Moradi et al., 2019).

•Real carrying capacity; is the maximum number of visitors to a recreational area that, due to limiting factors (Cf), are allowed to visit or operate there (Busby et al., 1996).

•Effective carrying capacity; refers to the maximum number of users in a place that the existing management has the ability to manage it in a sustainable manner (Taheri Hosseinabadi et al., 2019).

The purpose of this study is to determine the range capacity of tourist sites to ensure the sustainable use of users. For this purpose, the mountains north of Shahroud city have been selected.

So far, many studies have been done on carrying capacity. Including the studies of Taheri et al. (2019), which examined the range capacity of the mountainous region north of Tehran, or the study of Moradi et al. (2019), which examined the carrying capacity of the tourist area in the city of Mashhad ?

Also, In 2017, Mexa and Coccossis, reviewed and analyzed all aspects of the theory related to carrying capacity in tourism in a book titled Tourism Carrying Capacity: A Theoretical Overview. And, in 2020, Willial Butler mentioned in a review article the issues related to tourism and the determination of range capacity. This paper aims to review research on carrying capacity over two periods and provide a future perspective. This paper is a brief review of literature and commentary. A subject of potential major importance with significant implications has been relatively ignored by researchers over the past few decades. Bertocchi et

al., (2020) Studid on Over-tourism in Venice. Over-tourism problems, anti-tourist movements and negative externalities of tourism are popular research approaches and are key concepts to better understand the sustainable development of tourism destinations. In many of the over-tourism narratives, Venice is considered to be one of the most relevant cases of over-tourism and therefore has become a laboratory for studying the different conflicts that emerge when tourism numbers continue to grow and the quality of the tourism flow continues to decline. This article is therefore focusing on Venice and on one of the possible solutions to mitigate the negative impacts of tourism represented by the concept of a tourist carrying capacity (TCC) in an urban destination. The aim of this paper is to discuss alternative methodologies regarding the calculation of the TCC, and to apply a fuzzy instead of a 'crisp' linear programming model to determine the scenarios of a sustainable number of tourists in the cultural destination of Venice, looking for the optimal compromise between, on the one hand, the wish of maximizing the monetary gain by the local tourism sectors and, on the other, the desire to control the undesirable effects that tourism exerts on a destination by the local population. To solve the problems related to tourism statistics and data availability, some uncertainty in the parameters has been included using fuzzy numbers. Guo & Chang (2019), studied on Using Tourism Carrying Capacity to Strengthen UNESCO Global Geopark Management in Hong Kong. Tourism carrying capacity (TCC) is a measure of the optimum use level of visitors who can use a site without creating environmental degradation. This study demonstrates how this concept can be used to strengthen the management of the only United Nations Educational, Scientific and Cultural Organization (UNESCO) Global Geopark in Hong Kong. A research model is proposed based on the criteria of the Global Geoparks Network (GGN). A confirmatory factor analysis and a structural equation modelling (SEM) procedure are performed on the case study of Hong Kong UNESCO Global Geopark (HKGP). The validity of the TCC research model is confirmed. The results further demonstrate that TCC has been achieved in HKGP; the local community highly agrees with the three management principles of the Global Geopark; and the three dimensions of sustainable geotourism (i.e. environmental carrying capacity (ECC), socio-demographic carrying capacity (SCC), and political-economic carrying capacity (PCC)) have

strong positive inter-relationships with each other. This study demonstrates a novel way to use the TCC web of elements to evaluate sustainable tourism practices in a UNESCO Global Geopark. A study Santos Lobo (2013) and Duarte et al (2003) on the number of tourists allowed entering tourist areas.

3. Research Method

In the first stage, the study area was determined accurately using GPS. To prepare the required maps, the data were entered into the GIS software (Figure 1). The area of the study area is 860 hectares, but by examining the land use map, only the sections that have the possibility of recreational and sports activities were selected as the study site. Accordingly, 50% of the initial area has suitable conditions for recreation. Because parts of the study area have residential use, livestock, agriculture, industry and... . Makhdoom (2008) method was used to classify wide and concentrated recreation and classification of zones. Intensive tourism includes a type of tourism that requires special facilities and infrastructure (Darvishi et al., 2019). On the other hand, in extensive tourism, due to the fragility of the natural ecosystem, construction is not allowed and not much change should be made in nature.

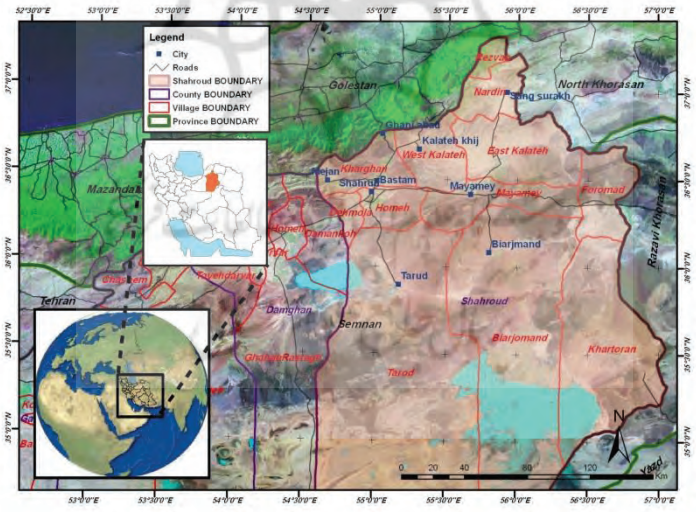

Figure 1. Map of the study area

In the next step, all the factors affecting the public operation of the site (including physical, biological, social, economic and cultural factors) were identified and evaluated. In the following, the method of

estimating each of the carrying capacities is described separately. Equation 1 is used to calculate the physical board capacity (Elahichoren et al., 2019).

$$PCC = A \times (v/a) \times Rf \qquad \text{(Eq.1)}$$

A: Area of suitable areas for recreation
(v⁄a): is the ratio of the number of users (visitors) allowed per unit area.
v: Equivalent to one visitor or tourist
a; the amount of space each visitor needs to be able to move around easily. This amount is considered according to the characteristics of the region and with the opinion of experts based on consensus. In various researches, this number has been considered from 1 square meter to 12 square meters (Mashayekhan et al., 2019).
Rf: The ratio of the usability time of the area to the average duration of a visit. This time is considered from 6 to 18 hours in similar studies. According to the background and opinion of users and the local community, the usability time of this site was considered 16 hours. Equation 2 is also used to calculate the real carrying capacity (McCool & Lime, 2010):

$$RCC = PCC \times \frac{100-Cf1}{100} \times \frac{100-Cf2}{100} \times \frac{100-Cf3}{100} \qquad \text{(Eq. 2)}$$

Cf: Corrective factors or limiting factors are due to the specific conditions of the place. Each limiting factor is calculated from the following formula (UNWHO, 2016):

$$Cf = \frac{M1}{M2} \times 100 \qquad \text{(Eq. 3)}$$

M_1 **:**A limited amount of the size of a variable
M_2: The total size of a variable

In this study, 3 factors and 8 related parameters were considered as factors limiting the area for recreation. Table 1 shows these parameters.

Table 1. Limiting factors and parameters in the mountainous region of Shahroud

Row	Factor	Parameter	Describe
1	Weather	Frosty days	According to recent 40-year statistics, 35 days of frost have been recorded.
		Extreme heat	Due to the fact that the maximum recorded temperature in the region was equal to 41 degrees Celsius, there is thermal stress. On the other hand, according to meteorological data, 12 days with high temperatures (more than 35 degrees Celsius) have been recorded.
		Severe cold weather	Cold means cold below 4 degrees Celsius, which will be annoying and harmful to the human body system. According to statistical data, 42 days per year have been recorded.
		Strong wind	12 days a year
		heavy raining	The number of days of heavy rain and torrential floods was recorded as 18 days.
2	Slope	50-0٪	70% of the average area with 301,000 square meters (acceptable for sports and leisure)
		50≥	30% of the area equivalent to 1290000 square meters (not acceptable for recreation and amateur sports)
3	Biodiversity	Vegetation density	About 25% of the area (equivalent to 1075,000 square meters) has valuable vegetation.
		Animal habitat	12% of the area (equivalent to 516,000 square meters) is the habitat of valuable or dangerous animal species.

The following equation has been used to calculate the effective carrying capacity (Parvaresh et al., 2010):

$$ECC = RCC \times \frac{100-FM}{100} \quad \textbf{(}\text{Eq. 4}\textbf{)}$$

FM: or management adjustment coefficient; It includes the set of conditions that the management of an area needs to achieve the desired goals and actions (Busby et al., 1996). In any case, it should be noted that the effective carrying capacity never exceeds the real carrying capacity. Management capabilities can lead to the use of a zone up to the capacity of the actual range and not above it. The

management adjustment coefficient is obtained by multiplying the ideal management capacity (Imc) and the actual or existing management capacity (Amc).

$$FM = \frac{Imc-Amc}{Imc} \times 100 \qquad \text{(Eq. 5)}$$

Imc: The number of ideal facilities for sustainable management of recreation and sports.
Amc: Number of available features

To calculate the effective range capacity of the site, from management parameters such as: design and improvement of access route, facilities and facilities (parking, camping, grocery store, sanitation, drinking water, sanitation, security, relief system, service, monitoring Function), local calm and silence is used. In order to obtain reliable and accurate information about the management capabilities of the study site, a researcher-made (spectral likert) questionnaire was provided to experienced users. To determine the sample size, the following formula is used:

$$n = \left(\frac{zs}{d}\right)^2 \qquad \text{(Eq. 6)}$$

With 95% confidence, standard deviation of 0.5 and margin of error of 5% - / + sample size was determined as follows (Sajjadi & Karimpour, 2016):

$$n = \left(\frac{(1.96)(0.5)}{0.05}\right)^2 = \frac{0.9604}{0.0025} = 384.16 \qquad \text{(Eq. 7)}$$

Accordingly, the sample size was 384 people. The sampling method was a purposeful choice.
Flowchart method is shown in fig. 2.

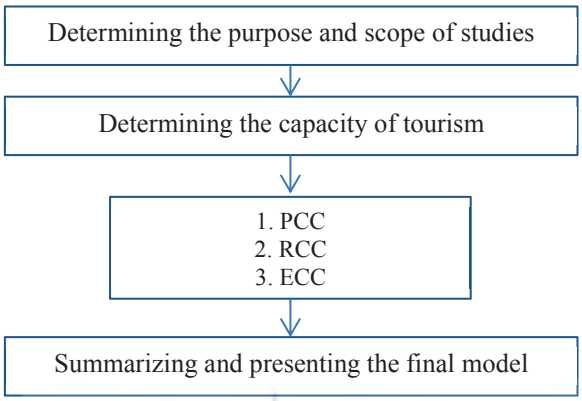

Figure 2. Flowchart of method

4. Results

After screening and determining land use in the study area, 430 hectares of the area was selected as the study site. Two types of intensive and extensive recreation were identified in the area and each of them includes 3 classes (Figure 3).

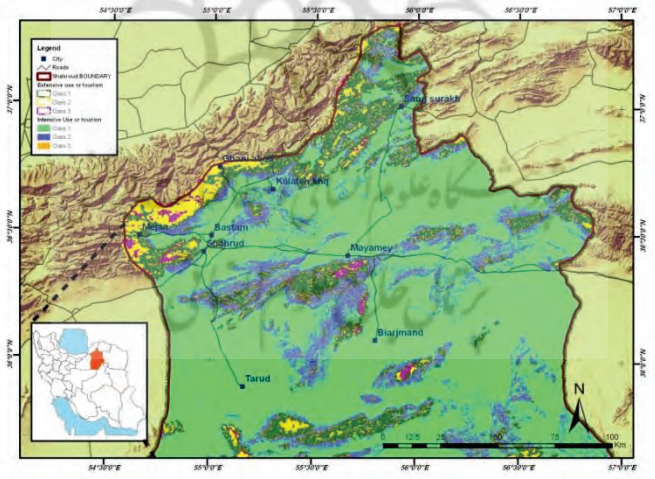

Figure 3. Types of recreation and classes classified in each zone in the study area

Depending on the area of the site under study, the amount of space per visit and the duration of usability, the physical carrying capacity of the site can be calculated (Table 2).

Table 2. Calculation of physical carrying capacity

Region	Area (m^2)	The amount of space per visit (v/a)	Duration of use (hours)	Average length of use (hours)	Daily usage rate (Rf)	Physical Board Capacity (PCC) (People per day)
Shahroud Mountain	4300000	0.25	16	6	2.66	2859500

To calculate the actual range capacity, the factors and parameters of Table 1 were used.

$$Cf1 = \frac{\text{Number of days of heavy rain + Number of days of wind + Number of days of frost + Number of days of extreme cold + Number of days of extreme heat}}{\text{All days of the year}} \times 100$$

$$Cf1 = \frac{18 + 12 + 12 + 42 + 35}{365} \times 100 = 32.60\ \%$$

In the following, constraint parameters related to slope; vegetation and habitat were also obtained:

$$Cf2 = \frac{\text{Restrictive slope area + Wildlife habitat area + Valuable vegetation area}}{\text{Total area}} \times 100$$

$$Cf2 = \frac{129000 + 1075000 + 516000}{4300000} \times 100 = 67\%$$

After calculating the limit coefficients, the actual range capacity of the study site was obtained:

$$RCC = 2859500 \times \frac{100 - 32.60}{100} \times \frac{100 - 67}{100}$$

$$RCC = 632235$$

To obtain the percentage of managerial capabilities, weighted averages were calculated that were calculated for each of the parameters of the mountainous region, and then proportionality was used to convert it into a percentage. Finally, effective multiplication capacity was obtained by multiplying the real carrying capacity by the percentage of calculated managerial capabilities.

Table 3. Investigation of the status of management capabilities of the study site based on the percentage of frequency of parameters from the perspective of users

Parameters examined	Average score based on Likert scale
Design and improve the access route	2.9
Parking	0.7
Camping facilities	1.8
Variety of sports uses	3.3
Variety of recreational uses	3.9
Market	0.3
Toilet	1.5
Drinking water	2.4
Hygiene and cleanliness	3.6
Security	1.2
Relief system	1.4
Service	2
Monitoring	2.3
Local silence	3.8
Average	**2.22**

As shown in Table 3, the study site scored 2.22 out of 5 based on user and local community votes. Therefore; the region has 44.4% of the minimum capabilities required to achieve the desired goals. Finally, the effective range capacity of the study site (in terms of people per day) was calculated as follows:

ECC = 632235 × 0.44 = 278183

5. Discussions and Conclusion

Considering that Shahroud Mountain and Resort, all day of the year, and especially on holidays, welcomes a significant amount of users, in this article, it was attempted to determine the three types of physical, real and effective physical carrying capacity, a reliable basis for planning in Sustainable development should be provided to planners and designers. It is important to note that in this study, a wider range of hiking has been selected, as the area has high potential for recreational and sports use. The physical board capacity of the study site was estimated at 2859500 people per day. 3 limiting factor and 8 parameters were used as the coefficient of calculating the actual board capacity of the study site, the result of 632235 per day. In order to calculate effective board capacity, management parameters were also used to determine managerial capabilities. In the meantime, the lowest rating belonged to "parking" (0.7). Accordingly, the effective board capacity for the study site was determined by 278183 people per day. One of the most important aspects of nature conservation is the legal requirements that are considered as a management tool for decision makers.

6. Conclusion

In general, Shahroud's mountainous and resort area can accept the number of considerable users for recreational and sports activities. On the other hand, the area has pristine and special spaces for biodiversity. But environmental and environmental priorities should also be considered. Lack of attention to the capacity of the board in determining the number of user entry into the area and the entry of tourists exceeds the capacity of the area causes many problems, Including: environmental damage and the quality of services and amenities. Therefore; the management of the area must do the planning in a way that, in addition to the use of current applications, also ensures sustainable exploitation. Obviously, the capacity of each area is specific to the same area and cannot be generalized to other areas.

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