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Estimating the carrying capacity of tourism and the necessity of forest stands management (Case study: Darkesh forest, North Khorasan, Iran)

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ABSTRACT

This study focuses on the carrying capacity estimation for Darkesh forest in Northeast Iran. Four factors were used for estimating the carrying capacity including tourist flows, size of the area, optimum space available for each tourist, and visiting time. Results showed that the physical carrying capacity was 2727 ha or 165 visitors day^{-1}, while the real carrying capacity was 2719 ha or 132 visitors day^{-1}. An average of 200 tourists per day visited the park during 2015, which was much higher than the estimated carrying capacity. Development of recreational uses in the study area would also affect the forest production and other benefits in long term. This study suggested that to prevent intense use of the forest area, a plan must be developed. On the other hand, the number of visitors has to be precisely calculated in order to maintain healthy forest stands and to secure the ecological benefits for future generations.

Key words: Estimation, Carrying capacity, Management, Darkesh forest, Iran

INTRODUCTION

Forests are increasingly becoming important in Iran due to the quality of life by providing a chance for recreation. Darkesh watershed with an area of 22,500 ha is located in the southern part of Mane city and Samlghan, North Khorasan Province. In general, 80% of this area is occupied by forest ecosystems, while the rest by pasture, gardens and agriculture (Mashayekhan 2016). This area is a popular recreational destination because it is close to the main road. According to field surveys, the number of households in Darkesh village is 218 encompassing over 1000 people (Mashayekhan 2016). Studies showed that the highest demographic category was between 15 and 64 year – olds including 66% men and 67% women. Darkesh forest attracts approximately 1,000,000 visitors each year, who spend 2 million US dollars in this area. Over the last 10 years, tourism had been increased over 50%. Increasing the number of visitors could have negative effects on forest ecosystems including loss of vegetation, soil compaction, and fires. The capability of the resources and the recreation settings for supplying recreational uses had raised the concept of carrying capacity (Pigram & Jenksins 1999). In most cases, utilization of forest area has exceeded its carrying capacity (Mitchell 1994; Wilkinson 1995). The carrying capacity was first suggested in 1930s as a concept of area management in the context of national forests (Sumner 1936); however, systematic applications did not emerge until 1960s. In those days, the early focus was on

ecological issues. This concept was developed from the population growth theory by ecologists defined as the maximum allowable population for an individual species which can be kept without any unacceptable changes in an ecosystem. Lee *et al*. (2005) and Munar (2002) suggested that the carrying capacity shows the optimum level of resource uses which can irreversibly damage the ecosystems. By providing a mathematical formula, the authors suggested that the maximum number of visitors in the area can be estimated. Mexa & Coccossis (2004) pointed out that assessment of carrying capacity is a powerful concept, which can be used for planning and managing sustainable tourism programs. Many studies calculated carrying capacity using physical, ecological, psychological, and economical approaches (Getz 1982; Canestrelli & Costa 1991). It was showed by Zacarias *et al*. (2011), because carrying capacity as one of the affective methods has to be precisely defined. The concept of carrying capacity was argued once since it is not only related to the degradation of environmental resources, but also to the social investment. These social views were based on the theory defined as more people make huge social impacts (Eker 2008). Thus, the carrying capacity has two elements: environmental capacity and social capacity (Stankey *et al*. 1985 Hendee 1990; Manning *et al*. 1996; Nash 2001; Harshaw & Meitner 2005).

In order to employ an appropriate forest management, to increase the users' experiences and to preserve natural forests, the aim of this study was to calculate the carrying capacity (estimating the threshold of usage) as a tool for forest management in Northeast Iran, which is based on the framework introduced by Cifuentes (1992) and IUCN (Ceballos-Lascurain 1996). Estimating the carrying capacity is necessary in forest areas planning, it has been neglected in most forest management plans in Iran. This tool attempts to estimate the maximum number of visits without any unacceptable changes to the physical condition. Therefore, this study was conducted to find a balance between number of visits and potential restrictions in Darkesh forest by focusing on the carrying capacity estimation.

MATERIALS AND METHODS

This research was conducted in Darkesh forest, north of Khorasan Province, Iran, located between 37° 21' 55″ and 37° 31' 28″N and 56° 30' 04″ and 56° 58' 12″ E (Fig. 1) in September 2015. The total area is 22,500 ha and the elevation ranges from 900 to more than 2030 m.

The study area is a popular recreational destination and a particular diversity of deciduous species can be seen there. This area is close to the main road (Gorgan-Bojnurd) and it has a permanent river with fishery resources and beautiful landscapes, which attracts tourists. Forest covers about 80% of this area, which 20% of it is assigned to shrub lands and herbaceous vegetation.

The tree types are as follows: *Quercus castaneifolia, Juniprus polycarpus, Acer ibericum, Acer cappadosicum,* and *Acer velutinum.* This area has a population of more than 1200 inhabitants.

The annual visits, geographical and physic-ecological characteristics of the area were investigated.

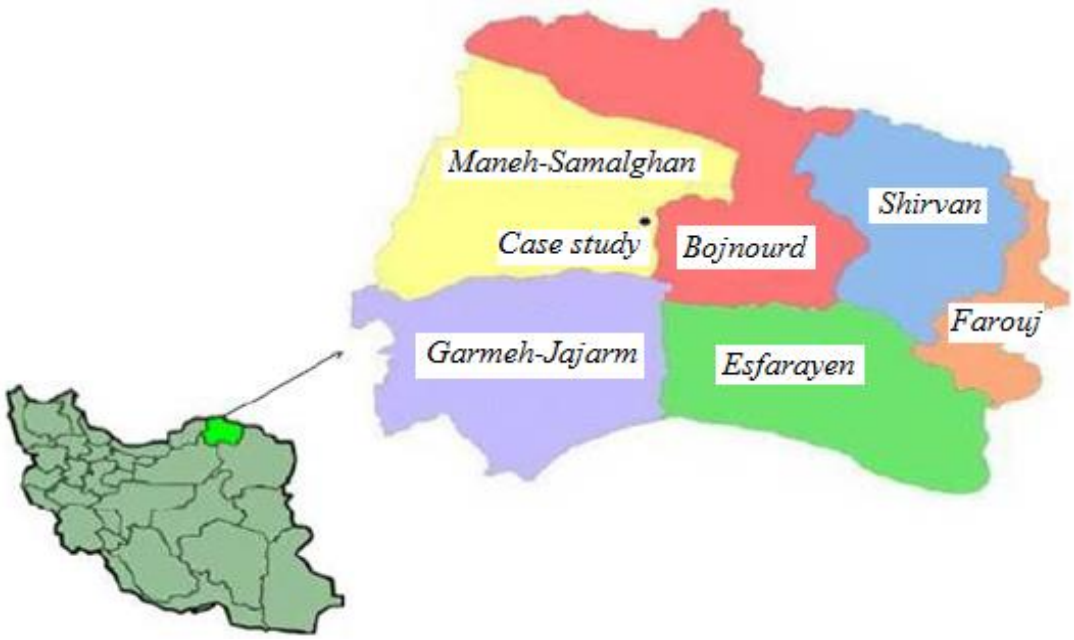

Fig. 1. Geographic location of Darkesh forest in North Khorasan, Iran.

Carrying capacity

The concept of recreational carrying capacity has been studied since 1930s (Sumner 1936). The concept includes both the subject of academic studies (Wagar 1964) and the basis for management decisions (Haas 2002). In this study, carrying capacity is the maximum number of people who can use a forest park with optimized enjoyment without causing any degradation. The carrying capacity method used here was the approach known as the method of carrying capacity estimation for protected areas. Physical and real carrying capacities were evaluated by using Countess's methodology (Cifuentes 1992), which was suggested by IUCN (Ceballos-Lascuarin 1996). This method involves physical carrying capacity (the maximum number of visits that can physically fit into a defined site over a particular time) and the real carrying capacity (the maximum permissible number of visits to a site, once the corrective factor derived from the particular characteristics of the site have been applied to the PCC) (Cifuentes 1992; Ceballos-lascurain, 1996; Cifuentes *et al*. 1999). In this method, tourist flows, size of the area, optimum space available for each tourist, and visiting time were the main parameters (Cifuentes 1992). In this study, physical and real carrying capacities were considered to estimate the tourism carrying capacity.

The required data was collected using questionnaire, while weather data was collected from Darkash meteorological station. Given that the population of the study is 1200 people and according to Morgan Table, 278 would be an appropriate sample size, which was considered to collect information. In order to assess the tourism demand and collecting the needed information to estimate the carrying capacity, the questionnaire was distributed randomly among visitors. Physical and real carrying capacity was determined based on equations 1 - 3.

$$PCC = A/Au \times Rf \qquad \text{Eq. 1}$$

Where PCC is the physical carrying capacity; A is the available area for public use; Au is the area required per user (16.5 m^2); and Rf is the number of permissible daily visits to a forest park (dividing the time of place availability by average time of a visit).

The real carrying capacity was determined using equation 2.

$$RCC = PCC \times (Cf1 \times Cf2 \times Cf3 \times \ldots \times Cfn) \qquad \text{Eq. 2}$$

Where RCC is the real carrying capacity; PCC is the physical Carrying Capacity; and Cf1…Cfn are the correction factors, which are determined using equation 3.

$$Cfx = 1 - Lmx / Tmx \quad \text{Eq. 3}$$

Where Cfx is the correction factor for variable X; Lmx is the limiting magnitude of variable X; and Tmx is the total magnitude of variable X (Zacarias *et al*. 2011). Since climate variables affect the tourism, three factors including rainfall, strong winds and frost were used as variables (X) in equation 3.

Based on the average climate of Darkesh weather station in the period 2000-2015, the average number of days with heavy rain was 10 days; the average number of days with strong wind was 27 days, while the average number of frost days was 34 days.

Due to the fact that the entire year is considered 365 days, limitation factors of heavy rain, strong wind and frost were 97%, 92% and 90%, respectively according to the equations 2 and 3. Therefore, the actual carrying capacity of Darkesh village was 2190 ha and 132 person per day.

RESULTS AND DISCUSSION

Physical carrying capacity is important because of the increasing recreational use of forest stands, which has to be maintained. Over 20 species have been identified in Darkesh forest including *Quercus castanifolia, Juniprus polycarpus, Acer ibericum, Acer cappadosicum, Acer velutinum*, and *Crataegus Crataeg usembigua*. A new management system such as carrying capacity assessment is necessary for Darkesh forests due to having medicinal trees, rare birds and etc.

Given that the recreational uses have adverse effects to an area, the number of visits that a forest park can tolerate without negative effects can be determined by the physical carrying capacity. Darkesh forest covers 22,500 ha and receives most of its visitors during summer. The results indicated that the optimum area available per user (Lee *et al*., 2005: 16.5 m^2) and based on the duration of visitors' stay in Darkesh village through questionnaires, the average length of visit was 12 hours. Finally according to these data, the physical carrying capacity was 2727 ha and 165 visits day^{-1}, respectively.

In this study to calculate the true carrying capacity, the limitations affecting the visiting duration,such as rainfall, strong winds and frost, should be exclude from the physical carrying capacity which were 97%, 92% and 90%, according to equations 2 and 3 respectively. So, based on correction factors and by applying equations 2 and 3, the real carrying capacity was 2190 ha, 132 visits day^{-1}. The average number of visitors of the park in 2015 was 200 people per day exhibiting overpopulation compared to the carrying capacity, while no precaution has been taken to decrease the number of visitors yet. It is possible to develop some allocation systems, which would only allow a certain number of daily visits to a site in order to protect the area from heavy usage (Eker 2008). In practice, the risk of overload carrying capacity mainly happens during the spring and summer.

The physical carrying capacity has been defined and used for forest park management and decreasing the effects of overutilization. The physical carrying capacity estimates the number of permissible visitors in Darkesh forest in one time, which could serve as a significant indicator of the service quality in the area.

This study calculated this capacity based on tourist flows, the size of area, the optimum space available for each tourist and visiting time (based on Cifuentes 1992; Zacarias *et al*. 2011). Such measurements with the development of the allocation system are capable of maintaining the park from external threats and degradation. Once an allocation system has been defined, care must be taken to assign the number of visitors to the pre-defined areas, which the natural reserves or other important parts of the forest must not be involved. In order to increase the number of visitors (in the vicinity of the Sari-Mashhad

main road), we need developing several recreational activities (such as hiking, cycling, fishing, education) and facilities (like parking lots, restrooms, waste treatment, etc.). In Darkesh forest, old stands of *Q. castanifolia, J. polycarpusand* and the river running through the forest are the main fascinating aspects of the park for visitors and might be served as tools for educational excursions.

CONCLUSION

Estimating the number of visitors to an area should be accomplished in order to minimize the effects of forest overuse. Preserving the natural properties of a site, securing user's ability to move freely and to fully enjoy the natural environment without degrading it, as well as preventing the overcrowding, are the most necessary items in all environmental management plans. Parks have been always popular and the number of visitors looking for outdoor recreation is increasingly exceeding. These areas receive large number of visitors during the holidays. Thus, carrying capacity as a new management system can be studied to preserve forest stands by decreasing the number of visitors. Among several methods, the carrying capacity assessment is one of the beneficial and practical methods to ensure the conservation of an area. In addition, the balance between preserving natural resources, visitors' experience and economic stability can be established using the carrying capacity concept. This study has presented how this method is applied to parks and protected areas, with a special attention to Darkesh forest park. For Darkesh forest, the physical carrying capacity was 2727 ha or 165 visits day^{-1}. Higher visits flow was observed during summer with a distance of 16.5 m^2 between each group. This study was the first to apply the concept of carrying capacity for forest parks in Iran, and hence further studies is highly recommended. In addition to the physical carrying capacity, other applicable techniques and factors such as socio-economic factors should be studied in the modeling. More researches are required to investigate the effects of overuse on soil properties, like bulk density. The present study showed that the current management plan for Darkesh forest is poorly planned and needs to be improved and adjusted with the park capacity before arising major problems. The main theoretical aspect of this study was an attempt to develop a tool for forest management which provides the capability of accessing forest resources for recreational purposes while preserving its properties. This new tool is an example of how theoretical concept and ideas can be expanded and how a study can benefit from managing outdoor recreational resources. We believe that this method can serve as a reference for further management plans in Darkesh forest and other similar outdoor recreational areas.

REFERENCES

Canestrelli, Elio & Costa, Paolo 1991, Tourist carrying capacity: A fussy approach, *Annals of Tourism Research*, 18: 295-311.

Cifuentes, MA 1992, Determinación de capacidad de cargaturísticaenáreasprotegidas. Costa Rica: *Biblioteca Orton IICA/CATIE,* (In France).

Eker, O 2008, Recreational Carrying Capacity of Belgrad Forest. *KSU Journal of Science and Engineering,* 11: 77-80.

Getz, D 1982, A rational and methodology for assessing capacity to absorb tourism, *Ontario Geographic*, 19: 92-102.

Harshaw, HW& Meitner, MJ 2006, Chapter 8: Recreation Management. In S Watts (Ed.), Forestry Handbook for British Columbia (5th ed.), Vancouver, 293p.

Hendee, JC 1990, Principles of wilderness management. In J CHendee, G HStankey & RC Lucas (Eds.), *Wilderness Management* (2th ed., pp. 181-193). Golden, CO: North American Press.

Lee, Wk, Son, MH, & Kwak, DA 2005, Development of a Carrying Capacity Assessment System for the Chi-Ri National Park. 5 p.

Manning, R, Lime, D & Hof, M 1996, Social Carrying capacity of natural Areas:

Theory and application in the US national parks. *Natural Areas Journal*, 16: 118-127.

Mexa, A & Coccossis, H 2004, Tourism carrying capacity: a theoretical overview. In H Coccossis & A Mexa (Eds.), The challenge of tourism carrying capacity assessment: Theory and practice. England: Ashgate.

Mitchell, J.G, 1995, Our national parks. *National Geographic*, 186: 1-55.

Munar, FXR 2002, Análisis de capacidad de cargaen los espacioslitorales, calas e playas, situadosenáreasnaturales de especial interés de la Isla de Menorca. Spain: Universidad de Almería. 11 p. (In France).

Nash, R 2001, *Wilderness and the American Mind* (4th ed.). New Haven CT: Yale University Press. pp. 433-446.

Stankey, GH, Cole, DN, Lucas, RC, Peterson, ME, Frissell, SS & Washburne, RF 1985, The limits of acceptable change (LAC) system for wilderness planning. USDA Forest Service General Technical Report INT-176. 43 p.

Sumner, E 1936, Special report on a wild life study in the High Sierra in Sequoia and Yosemite National Parks and adjacent territory. Washington, DC: U.S. *National Park* Service Records, National Archives.

Wilkinson, T 1995, Crowd Control. National Parks, 69: 36-41.

Zacarias, DA, Williams, AT& Newton, A 2011, Recreation carrying capacity estimations to support beach management at Praia de Faro, Portugal. Applied Geography, 31: 1075-1081.

برآورد ظرفیت حمل و نقل گردشگری و ضرورت مدیریت توده‌های جنگل (مطالعه موردی: جنگل دارکش، خراسان شمالی، ایران)

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چکیده

این تحقیق بر برآورد ظرفیت حمل و نقل در جنگل دارکش در شمال شرقی ایران تمرکز دارد. چهار فاکتور شامل جریان گردشگری، اندازه منطقه، فضای مطلوب در دسترس برای هر گردشگر و زمان بازدید برای برآورد ظرفیت حمل و نقل استفاده شد. نتایج نشان داد که ظرفیت حمل و نقل فیزیکی ۲۷۲۷ هکتار یا ۱۶۵ بازدیدکننده در روز بوده و ظرفیت واقعی حمل و نقل ۲۱۹۰ هکتار یا ۱۳۲ بازدیدکننده در روز بوده است. به طور متوسط ۲۰۰ گردشگر در روز در سال ۲۰۱۵ از پارک بازدید کردند که بسیار بیشتر از ظرفیت تخمین زده شده بود. توسعه امکانات تفریحی در منطقه مورد مطالعه نیز در بلندمدت بر تولید جنگل و سایر مزایا تاثیر می‌گذارد. این مطالعه نشان می‌دهد که برای جلوگیری از استفاده فشرده از سطح جنگل، باید یک طرح توسعه داده شود. از سوی دیگر، تعداد بازدیدکنندگان باید به طور دقیق محاسبه شود تا بتوان توده‌های جنگلی سالم داشت و مزایای زیست محیطی برای نسل‌های آینده تامین شود.

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