

STUDY OF THE RECREATIONAL CARRYING CAPACITY OF THE CAÍDA DO MORRO TRAIL (ILHA GRANDE, PIAUÍ STATE, BRAZIL)

Rodrigo de Sousa Melo¹
Charles da Costa Silva²
Brunhilde Passos Horta³
Solano de Souza Braga⁴

ABSTRACT

This paper sought to reflect on the methodologies of the carrying capacity assessment in ecotourism trails. After analyzing and defining the methodology presented by Cifuentes (1992) it was possible to estimate the Recreational Carrying Capacity for the “Caída do Morro Trail” in the Tatus community, in the Ilha Grande municipality, state of Piauí, in the Brazilian northeast. For the evaluation of the Recreational Carrying Capacity the specific characteristics of the limiting or correction factors (dune height, trail length and temperature) applied to the control and data collection were used. The method used showed that once an adequate management plan has been implemented with the construction of more support points and acquisition of more equipment by the agencies involved in this activity, the number of visits may increase, but it is also important that visits do not exceed the rate stipulated by the Real Carrying Capacity.

Keywords: Recreational Carrying Capacity, Ecotourism Trail, Tourism, Recreation, Caída do Morro Trail (PI).

JEL Classification: Z32

1. INTRODUCTION

Different motivations lead people to practice diversified forms of ecotourism and recreational activities, especially in natural environments, which have a greater number of followers. According to the World Tourism Organization (UNWTO, 2011), ecotourism presents a growth rate of 20% a year, while other segments presents a rate of 7.5% a year (Araújo & Silva, 2006). According to Teixeira & Oliveira (2015), these data, associated with the science of the fragility of natural ecosystems, encourage the care in relation to the practice of this segment of tourism, since this and other anthropic actions are, in many cases, responsible for the degradation of the natural environments.

Tourism, as an economic activity, can generate employment and income for certain localities. With the structuring of new tourism products and services, it tends to increase the number of jobs and, consequently, to leverage the generation of income. Beyond the economic aspect “tourism is an international human activity that serves as a means of communication and as a link between peoples both inside and outside a country” (Trigo,

¹ Universidade Federal do Piauí, Brazil (rodrigomelo@ufpi.edu.br)

² Universidade Federal do Piauí, Brazil (charles.costaphb@gmail.com)

³ Universidade Federal do Piauí, Brazil (brunehildy@yahoo.com.br)

⁴ Universidade Federal do Piauí, Brazil (solanobraga@yahoo.com.br)

2004: 12). In this way, tourism is a complex activity that unites several actors and sectors of society.

In this context, one of the possible activities to be developed in the Parnaíba Delta region is Ecotourism. This activity seeks a greater involvement of man with the environment, considering environmental and economic sustainability in a place that has a biological importance and, at the same time, it is fragile. According to Swarbooke (2000), "Ecotourism" is a widely used term by scholars, but is rarely defined. It is often used interchangeably with other terms such as "soft" tourism, alternative tourism, responsible tourism and nature tourism.

There is a great demand for people interested in visiting natural areas and Conservation Units (CU) to carry out tourism and recreational activities with a wide range of purposes such as the contact with nature on ecological trails. In this way, public use in the areas with trails must be observed and calculated to avoid, or at least minimize, the impacts of the visitation. That is, analyze the flow of visitors their practices so as not to harm the environment. Passos & Costa (2018) highlight that authors such as Sinay, Sinay & Pena (2014), Silva, Melo & Lucena (2017) and Pistorello, Conto & Zaro (2015), already address in their studies the environmental issue in the tourist activity.

As an example of an emerging tourist attraction and suitable for actions to control the impacts of the visitation, there is the Caída do Morro Trail, the target point of this research, located in the municipality of Ilha Grande, in the state of Piauí, in the Tatus community. It is an area where it is possible to observe several animal species, such as birds and primates, as well as a beautiful landscape. This trail was used only by natives as a route to fishing areas and it was used for the first time as a tourist attraction in the year of 2012, in one of the editions of the event named Walks in Nature (ANDA BRASIL, 2012).

To this end, there are several methods to propose a strategy for managing the impacts of visitation. Among them is the study of the Recreational Carrying Capacity (RECCC) of a tourist attraction. According to Sardinha et al. (2007) the use of methods to evaluate and quantify the impacts of tourism activities on natural attractions and cites started in the 1970s, as references: "LAC - Limits of Acceptable Change (Stankey et al. (1998), VIM - Visitor Impact Management (Graefe et al., 1990), Carrying Capacity (Cifuentes, 1992), Pressure-State-Response (OECD, 1994) and VERP - Visitor Experience and Resource Protection (NPS, 1995)" (Sardinha et al., 2007: 162).

From the cited methods, the most applied in Brazil is the study of carrying capacity (Sardinha et al., 2007). The greatest exponent of this method was Cifuentes (1992), who proposed a method composed of six sequential and interrelated steps, namely: analysis of policies on tourism and management of protected areas; analysis of the objectives of protected areas; analysis of the situations of the places destined to visit; definitions, strengthening and changes of policies and decisions regarding the category of management and zoning; identification of the factors/characteristics that influence in each place of public use and the determination of the carrying capacity for each place of public use. In addition, Cifuentes defined that the parameters for calculating the RECCC are the following: trail length, area occupied by each person, time for site visit, time required for those visits, and accessibility.

In this way, this work sought to understand how the Recreational Carrying Capacity can contribute to the ecotourism planning in the Caída do Morro Trail. Faced with this questioning, this research proposes that the adoption of a recreational carrying capacity rate will reconcile the tourist use with the conservation of the environmental heritage of the Caída do Morro Trail. The choice of this investigation theme was based on the perception of the fragility of the ecosystems existing in the path of the Caída do Morro Ecological Trail. It was proposed in this work the need to measure the carrying capacity in order to have a greater control of the activity.

For the theoretical basis of this study it was used the ideas of some relevant authors that conducted investigations in the research area of ecotourism, such as: Cifuentes (1992), being one of the main theoreticians to study the tourism carrying capacity in protected areas; Ruschmann (1997), who addresses the planning and tourism sustainability in Environmental Protection Areas; Guzzi (2012), that deals with the various ecosystems and biodiversity of the Parnaíba Delta, as well as local fauna and flora; Drumm (2003), who conducts studies on the development of ecotourism as well as its sustainable planning; and Lindberg & Hawkins (2002), who address principles and bases for planning linking environmental education and ecotourism. In this perspective, this article aims to estimate the recreational carrying capacity for an ecological trail in the municipality of Ilha Grande (Piauí), and its contribution to the promotion of the sustainable use of local natural resources.

2. RECREATIONAL CARRYING CAPACITY IN ECOLOGICAL TRAILS

Ecological trails have become one of the most sought-after tourist products by ecotourists. Trails that used to be used only for cargo transport or hunting activities are now important elements of tourism, promoting economic and cultural development, according to Carvalho & Bóçon (2004) and Maciei et al. (2011). In this sense, Campos and Filletto (2011) reinforce that ecological trails are fundamental elements to develop a sustainable tourism concept. This kind of trail has central importance to develop the ecotourism practices, leading to the preservation of the environment and, thus, to minimizing future impacts. In this way, a greater study and preparation of tour guides and visitors conductors are necessary, for the development of sustainable and lasting environmental practice.

Since the Caída do Morro Trail is located in a permanent preservation area the displacement of large numbers of people could directly impact the environment, deteriorating the trails and, consequently, affect the local fauna and flora. Because of this scenario it is necessary to plan and control the activities and people that use the trail, that is, determine its carrying capacity. The term “carrying capacity” had its first concept applied in the 1920s and was directed to agricultural issues (Newsome et al., 2002; Limberger & Pires, 2014). In 1992, the same concept was remodeled for tourism purposes by the Center for Environmental and Political Studies of the Costa Rican Neotropics Foundation (Seabra, 1999; Lazzarotto et al., 2006). In this sense, carrying capacity is a method for the preservation and minimization of the environmental impacts caused by the visitation. However, often these impacts are not the result of the excess of visitors, but of the activities developed by them (Zilioli, 2008 apud Teixeira et al., 2015).

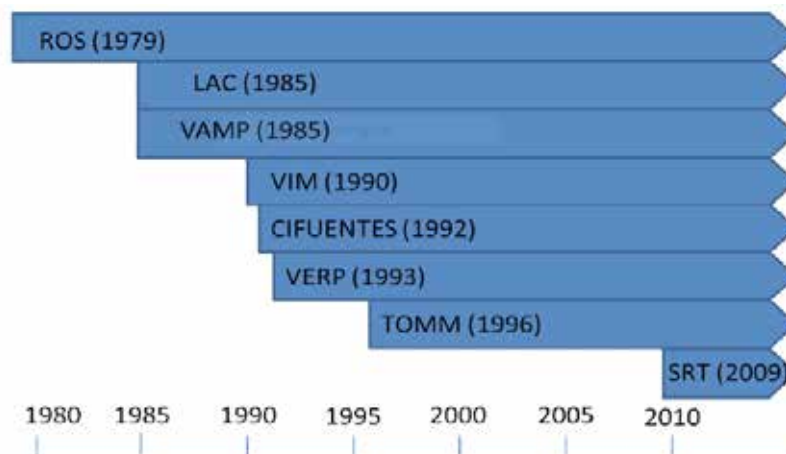
According to Ruschmann (1997), the concept of carrying capacity must be applied to tourism planning, since both natural and man-made resources have a limit to absorb visitors and this limit, when overcome, causes deterioration. Developing activities in a natural environment without previous planning can cause impacts in the region where the activity is being carried out, since the massification of the tourist activity requires an increase in the use of the tourist product, and with this, also comes the need to create new ventures aimed at greater comfort to tourists.

In general, the measurement and adoption of the carrying capacity seeks to minimize these impacts by pursuing a way to harmonize all these areas aiming at a balance, even knowing the existing limitations. However, this technique has its critical points, because it cannot present a specific number of visitors in a natural area. The carrying capacity is a highly criticized method, being described as “unrealistic” and “non-scientific” (Stigliano, 2004, apud Delgado, 2007). Several authors affirm that it is not possible to establish a number, which expresses the limit from which the impacts caused by the visitation would

degrade the area that receives the visitation. The Recreational Carrying Capacity defines the maximum number of users that a given recreational site can support without significant impacts being generated in the natural environment (Stankey & Manning, 1986).

The approaches of the carrying capacity method can be very different, being able to receive the following theoretical classification: ecological; perceptive/psychological/social; landscaped; materials; physicists; economic; and environmental (Pires, 2005). The method introduced by Miguel Cifuentes is one of the most known and widespread one for working the carrying capacity in protected areas aiming at a greater applicability of the methods directing the diverse resources of the locality in the practices of recreation putting in charge the reduction of impacts to the environment. The three fundamental aspects that are the basis of the Cifuentes methodology are: physical carrying capacity (PCC), real carrying capacity (RCC) and effective carrying capacity (ECC). According to Limberger & Pires (2014), the main models of recreation planning and management in natural areas are: Recreational Opportunity Spectrum (ROS); Limits of Acceptable Change (LAC); Visitor Impact Management (VIM); Visitor Activity Management Process (VAMP); Tourism Optimization Management Model (TOMM); Visitor Experience and Resource Protection (VERP); Cifuentes method; and Sustainable Recreation and Tourism (SRT) (Cifuentes, 1992, Newsom et al., 2002, Pires, 2005 and Slider, 2009). Thus, a methodological synthesis of the carrying capacity was formulated through the several models presented, since ROS in 1979 coming up to 2009 with SRT, in a chronological scale presented in the Figure 1 below.

Figure 1. Chronology of Methods for Managing the Impacts of Visitation



Source: Adapted from Cifuentes (1992), Limberger and Pires (2014)

The following text is a summary of the main characteristics of the various systems used:

Recreation Opportunity Spectrum (ROS) (1979), the recreational opportunities spectrum was developed by the United States Forest Service and the United States Territorial Agency, designed at the time as a way to identify and determine the various recreational opportunities, with the aim of diversifying their offerings and giving tourists and visitors the opportunity to choose the activities best suited to their desires. Because of its flexibility, the ROS has a planning process divided into six stages where the strong point is a guarantee of greater opportunity to take advantage of the areas in use for both tourist and recreational purposes, as well as for activities other than these.

Limits of Acceptable Change (LAC) (1985), was created from the analyzes and improvements of the initial concept of carrying capacity initially used in grazing cattle management. It was also developed by the United States Forest Service and is an extension of the ROS. This model specifically addresses the conditions and changes acceptable in the

biophysical environment as well as in ecosystems, and thus differs from the older models that cared about the amount of people that could use a particular recreational area without causing damage. The LAC is divided into ten planning stages and, like the ROS, is very flexible, with its main strength being the norms of the amount of changes acceptable for a specific area.

Visitor Activity Management Process (VAMP) (1985), was a model developed in Canada, in the field of the Parks Planning and Management System (Pires, 2005). This system seeks to integrate the wishes of the visitors with the opportunities provided in certain areas, through marketing approaches. As a positive point, this system identifies both the producers and the demand for natural areas. Its downside lies in its inability to identify and determine changes in the natural environment and its impacts.

Visitor Impact Management (VIM) (1990), originated from the principles of the LAC. Its applicability becomes simpler when used as an alternative to carrying capacity management. It was used and developed in the United States National Parks Service, by the conservation associations. In its process, the VIM follows eight steps divided into two monitoring phases. The main differential of this model is the precision based on the trust in judging the scientific and subjective facts, being used in small natural areas. Its limiting point is linked to the non-use of the ROS and the lack of vision of the potential impacts through visits.

Cifuentes (1992), the method proposed by Cifuentes is divided into six steps in a related sequence: policy analyzes on tourism and protected areas at national, regional and local level; analyze the objectives of the protected areas in question which have close links with management categories; analyze the conditions of the places of public use, and their zoning; definition, strengthening and changes of policies and decisions regarding the management and zoning categories of the area; identification of factors/characteristics that influence in each place of public use; determination of the carrying capacity and the use of a certain place of public use. For the determination of the carrying capacity and the use of a certain place of public use we can cite the three levels of carrying capacity proposed by Cifuentes, which are: physical carrying capacity (PCC), real carrying capacity (RCC) and effective carrying capacity (ECC).

Visitor Experience and Resource Protection (VERP) (1993), is another model developed by the United States National Parks Service. Its main use was to provide a set of experiences to the visitors, taking into account the different areas to receive them. Its purpose is to zonate the existing natural resources in a given area of visitation. Its versatility is linked in a model where there is an existing management. Its limit point is the dependence of monitoring on the determination of impacts.

Tourism Optimization Mode (TOMM) (1996), was created in Australia by a consulting firm and its employment is directed not only to the national parks service, but to any nature tourism destination. This model took as reference the LAC, especially when it comes to monitoring steps. Its main focus is economic sustainability and only secondarily the carrying capacity. Its main feature is the use of stakeholders in great diversity of areas for its planning process. Its great differential lies in the explicit inclusion in the spheres of economics and politics through projects involving stakeholders. Its limitation lies in the fact that it needs a lot of information coming from data manipulation and management, thus requiring large investments.

Sustainable Recreation and Tourism (STR) (2009), this new concept has been suggested by Slider (2009). In a joint vision, he recognizes that there are multiple values and perspectives for the various systems, which entails cautious use of social, environmental, and economic influences on management processes. It seeks opportunities for recreation and tourism that can be achieved by all society. Thus, this new vision becomes more a principle than an operational model itself.

3. METHODOLOGY

3.1 Study Area Characterization

The Caída do Morro Trail is located in the community of the Tatus, inserted in the Delta of the Parnaíba Environment Protection Area, located in the city of Ilha Grande of Piauí. The city has an area of 130.08 km² and a population of approximately 8914 inhabitants and it is 349 km away from Teresina, which is the state capital (Figure 2).

Figure 2. Location of the Ilha Grande Municipality, State of Piauí, Brazil



Source: Borges, 2017, p. 200

The trail begins in the Tatus community, latitude -2.8311975114, longitude -41.8266895786 and altitude of 4460 m. It takes a 6.7 km route between the place of departure and arrival. The first part of the trail passes through a set of mobile dunes, which means that you always have a new landscape with each tour. The dunes at the beginning of the trail are between 7 and 9 meters high, followed by others between 20 and 80 meters high. The highest altitude sand dunes are used for the practice of sandboarding, a very popular sport in adventure tourism in this region (Figure 3). While sandboarding the tourists have a greater contact with nature and can understand the need to preserve the natural environment for future practices.

Figure 3. Dunes where People can Practice Sandboarding



Source: Silva, 2016

During the rainy season it is possible to stop in the lagoons formed amidst the dunes and thus enjoy the scenic beauty (Figure 4). The second part of the trail is done almost entirely on flat terrain amidst native vegetation, where the trail narrows further and participants will have greater contact with the local flora and fauna (Figure 5). They can thus contemplate the various species of animals, such as birds and reptiles, which seek these places for reproduction.

Figure 4. Swimming Spots



Source: Silva, 2016

Figure 5. Group in the Midst of Native Vegetation



Source: Silva, 2016

3.2 Methodological Procedures

In order to analyze the possible direct impacts, the methodology of Cifuentes (1992) that addresses the calculations of the Recreational Carrying Capacity (RECCC) was adopted. This calculation is divided into three stages: Physical Carrying Capacity (PCC), Real Carrying Capacity (RCC) and Effective Carrying Capacity (ECC), and mathematical formulas are used to calculate each step.

The Physical Carrying Capacity (PCC) will be defined based on the maximum number of visits made, based on the relation between the space available for visitation and the time. For this calculation the following formula is used:

$$PCC = S/s.v \times T/t.v$$

Where:

PCC= Physical Carrying Capacity

S= Total surface area of the attractive, used for public use.

s.v.= surface area occupied by a visitor.

T= Total period of time in which the recreational area is open for public visitation.

t.v.= time needed to visit the place.

The Real Carrying Capacity (RCC) is defined starting from the maximum permissible number of visits of a locality, observing limiting or correction factors originating from particular characteristics applied to each location. For this calculation the following formula is used:

$$RCC = PCC \times LF_1 \times LF_2 \times LF_n$$

Where:

RCC= Real Carrying Capacity

PCC = Physical Carrying Capacity

LF_1 to LF_n = Limiting or correcting factors of PCC, that is, factors that will limit the number of people who will have access to a certain recreational area. In order to calculate the limiting or attractive correction factors, the following formula is used:

$$LF_n = 1 - l.a./T.A.$$

Where:

l.a.= Limiting amount of factor considered.

T.A.= Total amount in which the limiting factor is considered.

The Effective Carrying Capacity (ECC) uses factors related to human resources, infrastructure and equipment available locally to support visitation and achieve management objectives. In this way, it reduces the RCC according to the local management capacity. Therefore, it is calculated:

$$ECC = RCC \times MC/100$$

Where:

ECC= Effective Carrying Capacity

RCC= Real Carrying Capacity

MC = Management capacity of the area. This number is obtained through the elaboration of two specific checklists: the first is directly related to human resources, equipment used in the existing local infrastructure and infrastructure to support the visitation and activities carried out, the so called installed capacity; the second is related to the resources needed to better serve visitors, the so called adequate capacity. The MC shall be defined according to the percentage of installed capacity in relation to the appropriate capacity, according to this formula:

$$MC = \text{installed capacity (IC)} / \text{adequate capacity (AC)} \times 100$$

4. RESULTS

As previously described, the process for defining the Caída do Morro Trail RECCC was derived from data collection regarding the physical and environmental characteristics of the route currently performed by tour operators to compose the calculation proposed by Cifuentes (1992). Therefore, the RECCC was defined in the Caída do Morro Trail as it follows:

Physical Carrying Capacity (PCC)

$$PCC = S/s.v \times T/t.v$$

Where:

$$S = 6,7 \text{ km}$$

$$s.v. = 1 \text{ m}^2 \text{ (UNWTO standart)}$$

$$T = 7 \text{ h (from 7 AM to noon and 4 PM to 6 PM)}$$

$$t.v. = 5 \text{ h}$$

$$PCC = 6700\text{m}/1 \times 7/5 = 9380$$

$$PCC = 6700 \times 1.4 = 9380$$

Real Carrying Capacity (RCC)

$$RCC = PCC \times LF1 \times LF2 \times LF3$$

LF1 – It was considered the drought period of the region, from July to December, when all the temporary lagoons are dry, making the course of the trail more rigorous because of the dry sand.

$$LF1 = 1 - l.a./T.A.$$

$$l.a. = 180 \text{ days}$$

$$T.A. = 365 \text{ days}$$

$$LF1 = 1 - 180 \text{ days} / 365 \text{ days} = 0,49$$

LF2 – In this correction factor we can mention accessibility, taking into account that the trail is mostly considered of medium and high difficulty due to the height of the dunes that can vary from 7 to 9 meters (the lowest) and from 20 to 80 meters (the highest).

$$LF2 = 1 - l.a./T.A.$$

$$l.a. = 3500 \text{ m}^2$$

$$T.A. = 6700 \text{ m}^2$$

$$LF2 = 1 - 3500/6700 = 0,48 \text{ m}^2$$

LF3 – From 11 AM temperatures can vary between 38° to 40°C, making the walk more exhausting. Therefore, it is not feasible to walk the trail after 12 o'clock, especially during the summer.

$$LF3 = 1 - l.a./T.A.$$

$$l.a. = 5 \text{ h}$$

$$T.A. = 7\text{h}$$

$$LF3 = 1 - 5\text{h} / 7\text{h} = 0,29$$

$$RCC = 9380 \times 0,49 \times 0,48 \times 0,29 = 639 \text{ visits/day}$$

Effective Carrying Capacity (ECC)

$$ECC = RCC \times MC/100$$

Based on the limit established in the calculation of the Real Carrying Capacity (RCC), which was 639 visits per day, the calculation of the Effective Carrying Capacity was sought

to answer if there are real conditions to receive the established number of visits. From this result it is possible to identify the number of visits that can occur with safety and quality, professional support and recreational excellence, aiming at minimizing environmental impacts.

Due to the lack of adequate infrastructure and few equipment, and because it was a new trail to support visitation, the MC was estimated using the reports of the local guides on what they had and what was desirable to have regarding security, comfort and an also other aspects to improve the visitors experience. Thus, a list was created with the main components installed and the adequate capacity for the best use of the Caída do Morro Trail, as can be seen in Table 1.

Table 1. General Description of the Installed Capacity (IC) and the Adequate Capacity (AC) for the Caída do Morro Trail

Installed Capacity (IC)	Adequate Capacity (AC)
Staff = 4	Staff = 10
Equipments = 11	Equipments = 241
Facilities = 1	Facilities = 4
TOTAL = 16	TOTAL = 255

Source: Own Elaboration

Staff = here defined as the guides who conduct the visitation. For 639 visits/day, defined in the RCC, an average of 1 guide per group of 12 people was calculated. Visits will take place in the morning from 7 AM to 12 PM. There will be 53 visits (groups) with the need of approximately 54 guides. The fifty-fourth guide would be responsible for a sweep to determine if no person or equipment was missing at the end of the trail course.

Equipment = trekking poles, ropes, Sandboarding boards, first aid kits and GPS receptor were listed as needed equipment. Table 2 lists the items distributed in the Installed Capacity (IC) and Adequate Capacity (AC) categories.

Facilities = it was considered the construction of three more support points where the local community could market artisanal products, coconut and mineral water, as well as food produced from fruits and vegetables found in the region. In addition, there is a need for the implementation of a tourist signaling system indicating the distance traveled, as well as information about the local fauna and flora. With this, there will be four facilities in total to better serve and receive the visitor, since the existing conditions are precarious.

Table 2. Description of the Equipment in the Installed Capacity (IC) and the Adequate Capacity (AC) Categories for the Caída do Morro Trail

Equipment	Installed Capacity (IC)	Adequate Capacity (AC)
Trekking poles	1	128(per group)
Ropes	5	10
Sandboarding boards	4	50
First aid kits	1	53(per group)
Total	11	241

Source: Own Elaboration

After taking in consideration all the factors above, the MC and the ECC were calculated:

MC = installed capacity (IC)/ adequate capacity (AC) x 100

MC = 16/ 255 x 100 = 6,2%

ECC = 639 x 6,2/100 = 39,6 visits/day (approximately 39 visits per day).

Each visit lasts 5 hours on average with a stop for bathing in the lagoons and in the river, in addition to time for photos. The total opening hours of the attraction is 7 hours. It could be stipulated the visit of 4 groups of 12 people, that must be accompanied by 1 guide or local conductor. Given the installed capacity in place and according to the calculations above, it is possible to occur only 39 visits per day, however, once implemented the necessary improvements, the number of visitors could be increased (Table 3). It is important to emphasize that the limit established by the RCC is 639 visits/day, aiming at the harmony between the visitors and the environment, so that there is no imbalance in the local ecosystems. Thus, the recreational carrying capacity of the Caída do Morro Trail was estimated at 39 visits/day or 7020 visits/year, in which 180 days per year were considered, excluding the dry season.

Table 3. Variations in the Effective Carrying Capacity (ECC) as a Result of Improvements in the Management Capacity (MC) in the Caída do Morro Trail

Management Capacity (MC) (%)	Effective Carrying Capacity (ECC) (visits/day)
6,2% (Present)	39
25%	159
50%	319
75%	479
100%	639

Source: Own Elaboration

For a better visualization of the trail path, the map below is shown (Figure 6). According to the legend, it is possible to locate the starting point, where is the concentration of the dunes called Lençóis Piauienses; the return trail that passes through the Vereda Grande stream, where native vegetation is exploited for environmental interpretation practices; besides the main points of support and the stops made for resting and bathing in the lagoons and in the river Parnaíba.

Figure 6. Map of the Caída do Morro Trail



Source: Google Earth Adapted by Silva & Nascimento, 2017

According to Cooper et al. (2011), at the moment that the tourist activity happens, the environment is inevitably modified. In the region where the trail is located there are several animal species, especially birds that use the place during the breeding season. In the period between January and June the vegetation becomes denser and the process of inflorescence begins, and it is exactly this period the one with the greatest flow of visitors. Disordered visitation causes major impacts on the ecosystem, damaging local flora and fauna, such as solid waste accumulation along the trail discarded by visitors as well as constructions that cause visual pollution (Figure 7).

Figure 7. Accumulation of Solid Waste and Constructions along the Trail



Source: Silva, 2016

5. CONCLUSION

This article sought to estimate the Recreational Carrying Capacity aiming at the sustainable use of the Caída do Morro Trail, located in the Ilha Grande municipality, in the state of Piauí, Brazil. For this calculation the methodology proposed by Cifuentes (1992) was used, which showed a Real Carrying Capacity of 639 visits per day, taking into account three limiting factors: the dry season, dune height and averages temperatures. After analyzing the installed capacity on site, it was defined that the Effective Carrying Capacity is 39 visits per day, representing 6.2% of the actual capacity. However, based on the methodology used, the indexes showed that after applying an adequate management plan with the construction of more points of support and acquisition of a greater number of equipment the number of visits could increase without, however, harming the local ecosystem.

During the years of use of the trail some initiatives have already been taken to reduce the impacts caused by the tourist activity, such as the attempt to direct visitors to a single path, from the installation of cement columns and barbed wire, which caused great visual pollution. However, due to the natural movement of the dunes, the fence was covered by sand, generating a greater visual impact and increasing the risk for local residents and visitors who may be injured with the vestigial materials.

In order to guarantee the Recreational Carrying Capacity in the Caída do Morro Trail, it is necessary to understand the results obtained from the methodology adopted. For this, tourists, guides and conductors of tourism must keep control of their activities, from the development of environmental education actions and equity awareness of the other actors involved and local community. In this way, it is expected that this work may contribute as a research source for future studies, both in the process of environmental and sustainable development of the trails of the region, as well as in the elaboration of a management plan, with a view to promoting local tourism and economy.

REFERENCES

- Anda Brasil (2012). *Confederação Brasileira de Caminhadas, atividades esportivas não competitivas e inclusão social*. Retrieved from <http://www.andabrasil.com.br/>
- Araújo, S. M. & Silva, E. L. (2006). Ecoturismo, desenvolvimento sustentável e planejamento: política brasileira e potencialidades do Sertão Paraibano. *Caderno Virtual de Turismo*. 6(3), 64-72. Retrieved from <http://www.ivt.coppe.ufrj.br/caderno/index.php?journal=caderno&page=article&op=view&path%5B5D=131>
- Borges, V. (2017). Felicidade, políticas públicas e desenvolvimento turístico: Uma proposta para o Polo Costa do Delta. *Revista Turismo & Desenvolvimento (RT&D)/Journal of Tourism & Development*.
- Brasil (2000). Lei Nº 9.985, de 18 de julho de 2000. Sistema Nacional de Unidades de Conservação (SNUC).
- Cifuentes, M. (1992). *Determinacion de Capacidad de Carga Turistica en areas Protegidas*. Centro Agronomico Tropical de investigacion y enseñanza Catie. Turrialba, Costa Rica. Retrieved from <http://www.ulpgc.es/hege/almacen/download/23/23388/articulocifuentes.pdf>
- Campos, R. F. & Filleto, F. (2011). Análise do perfil, da percepção ambiental e da qualidade da experiência dos visitantes da Serra do Cipó (MG). *Revista Brasileira de Ecoturismo*, 4, 69-94. Retrieved from <http://www.unicap.br/simcbio/wp-content/uploads/2014/09/PERCEP%C3%87%C3%83O-AMBIENTAL-DOS-VISITANTES-DOS-PARQUES-URBANOS-DE-TERESINA-%E2%80%93-PI.pdf>

- Carvalho, J. & Bóçon, R. (2004). Planejamento do traçado de uma trilha interpretativa através da caracterização florística. *Revista Floresta*, 34, 23-32. Retrieved from <http://revistas.ufpr.br/floresta/article/view/2372>
- Cooper, C., Fletcher, J., Wanhill, S., Gilbert, D. & Shepherd, R. (2001). *Turismo, princípios e práticas*. Porto Alegre: Bookman.
- Delgado, M. (2007). Análise da Metodologia criada por Miguel Cifuentes Referente à Capacidade de Carga Turística. *Revista Turismo em Análise*, 18(1), 73-93.
- Graefe, A., Kuss, F. R., & Vaske, J. (1990). *Visitor Impact Management (VIM): the planning framework*. Washington. National Parks and Conservation Association.
- Guzzi, A. (2012). *Biodiversidade do Delta do Parnaíba: litoral piauiense*. Parnaíba: EDUFPI. Retrieved from <http://www.ebah.com.br/content/ABAAAFsQcAF/biodiversidade-delta-parnaiba-litoral-piauiense-versao-compacta>.
- Lazzarotto, A. D. S., Soldateli, M., & Pimenta, L. H. F. (2006). *Estudo e aplicação da metodologia de capacidade de carga na Trilha Interpretativa da Restinga do Maciambú, no Parque Estadual da Serra do Tabuleiro, SC, Brasil*. In: Congresso Nacional de Planejamento e Manejo de Trilhas, 1. 2006, Rio de Janeiro. Anais. Rio de Janeiro: Universidade Estadual do Rio de Janeiro. CD Room (completo). Retrieved from http://www.caipora.org.br/wp-content/uploads/2012/12/Capacidade_de_carga_trilha_restinga_Lazzarotto_Soldateli_Pimenta.pdf, on 01/25/2016.
- Lindberg, K., & Hawkins, D. E. (2002). *Ecoturismo: Um Guia para Planejamento e Gestão*. 4 ed. São Paulo: SENAC.
- Lindbenrg & Pires (2014). A Aplicação das Metodologias de Capacidade de Carga Turística e dos Modelos de Gestão da Visitação no Brasil. *Revista de Turismo Contemporânea*. RTC, Natal, 2(1), 27-48. Retrieved from <https://periodicos.ufrn.br/turismocontemporaneo/article/download/5473/4452>.
- Maciel, N. A. L., Paolucci, L., & Ruschmann, D. V. M. (2008). Capacidade de carga no planejamento turístico: estudo de caso da Praia Brava - Itajaí frente à implantação do Complexo Turístico Habitacional Canto da Brava. *Revista Brasileira de Pesquisa em Turismo*. 2(2), 41-63.
- Melo, R. S. (2006). *Planejamento Turístico-recreativo dos Ambientes Recifais das praias do Seixas, Penha e Arraial (PB)*. 159f. Dissertação de Mestrado – PRODEMA, Universidade Federal da Paraíba, Universidade Estadual da Paraíba, João Pessoa – PB.
- Neiman, Z. (2016). *Ecoturismo em Unidades de conservação como Estratégia para a Educação Ambiental*. Retrieved from http://www.anppas.org.br/encontro_anual/encontro2/GT/GT15/zysman_neiman.pdf.
- Newsome, D., Moore, S. A., & Dowling, R. K. (2002). *Natural area tourism: ecology, impacts and management*. Clevedon, Grã-Bretanha: Channel View Publications.
- Nps - National Park Service. (1992). *Visitor Experience and Resource Protection Process (VERP)*. Denver: Denver Service Center.
- Passos, F. V. A., & Costa, R. B. (2018). Percepção dos Gestores de Meios de Hospedagem sobre Sistema de Gestão Ambiental e sua Aplicabilidade. *Marketing & Tourism Review*, 3(2), Belo Horizonte - MG - Brasil.
- Pires, P. S. (2005). “Capacidade de carga” como paradigma de gestão dos impactos da recreação e do turismo em áreas naturais. *Turismo em Análise*, 16(1), 5-28. Retrieved from <http://docplayer.com.br/14284148-Capacidade-de-carga-como-paradigma-de-gestao-dos-i-m-pactos-da-recreacao-e-do-turismo-em-areas-naturais.html>.

- Pistorello, J., Conto, S. M., & Zaro, M. (2015). Geração de resíduos sólidos em um restaurante de um Hotel da Serra Gaúcha, Rio Grande do Sul, Brasil. *Eng. sanit. ambient*, 20(3), 337-346.
- Ruschmann, D. V. M. (1997). *Turismo e planejamento sustentável: A Proteção e Meio Ambiente*. Campinas, São Paulo: Papirus.
- Silva, E. L. (2005). *Metodologia da pesquisa e elaboração de dissertação*. Edna Lúcia da Silva, Estera Muszkat Menezes. – 4. ed. rev. atual. – Florianópolis: UFSC.
- Silva, A. L., Melo, I. V., & Lucena, D. R. (2017). *Auditoria interna de sistema de gestão ambiental: estudo de caso no Verdegreen Hotel*.
- Slider, T. C. (2009). Concepts & Tools - Inspired By the Past, Built For the Future. In: VI Congresso Brasileiro de Unidades de Conservação. Anais. Curitiba, PR: Rede Nacional Pró-Unidades de Conservação. Fundação O Boticário de Proteção à Natureza.
- Swarbrooke, J. (2000). *Turismo Sustentável*, 5. Aleph.
- Sardinha, D. S. et al. (2007). Impactos do uso público em atrativos turísticos naturais no município de Altinópolis (SP). *Geociências*, 161-172.
- Stankey, G., & Manning, R. (1986). *Carrying capacity of recreation settings. A Literature Review: The President's Commission on Americans Outdoors*. Washington: Us //Government Printing office, p. 4757 Retrieved from <https://pdfs.semanticscholar.org/c0ee/fbfb8f88fd5b20686dd773ae72d26a7c47a.pdf>.
- Teixeira, P. R., & Oliveira, L. T. (2015). O Método de Cifuentes e a Avaliação da Capacidade de carga na Trilha na “Serrinha” São João da Baliza, Roraima. *Revista Rosa dos Ventos – Turismo e Hospitalidade*, 7(jan-março), 120-132. Retrieved from <http://www.ucs.br/etc/revistas/index.php/rosadosventos/article/view/2667>.
- Trigo, L. G. G. (2004). *Turismo Básico*. 7ªed. São Paulo: Senac São Paulo.
- Unidades de Conservação no Brasil (2016). *Sistema de Unidades de Conservação*. Instituto Socioambiental. Retrieved from <http://uc.socioambiental.org/uso-sustent%C3%A1vel/%C3%A1rea-de-prote%C3%A7%C3%A3o-ambiental>.
- UNWTO - United Nations World Tourism Organization. (2011). *Practical guide for the development of biodiversity-based tourism products*. (2nd Ed.). Madrid: WTO, pp. 64.