Revista Brasileira de Gestão e Desenvolvimento Regional
G&DR. V. 16, N. 3, P. 263-274, set-dez/2020. Taubaté, SP, Brasil.
ISSN: 1809-239X

Received: 08/14/2019
Accepted: 4/16/2020

METHODOLOGY FOR DETERMINING THE POTENTIAL TOURISTIC VALUE OF INTERPRETIVE TRAILS IN NATURAL AREAS

METODOLOGIA PARA A DETERMINAÇÃO DO VALOR DE POTENCIAL TURÍSTICO DE TRILHAS INTERPRETATIVAS EM ÁREAS NATURAIS

Emilia Alibio Oppliger[1]
Reginaldo Acylino de Moura Rodrigues[2]
Ademir Kleber Morbeck de Oliveira[3]

Abstract

The attractive potential of an interpretive trail is closely related to biodiversity and should encourage and promote environmental conservation. Therefore, it is important that it can be quantified, considering the largest number of possible elements. In order not to compromise, the determination of these potential, subjective items should be avoided. The aim of this research was to develop a methodology based on a mathematical formula that can determine the touristic potential value of interpretive trails in natural areas, relating to different environmental variables and their values. The methodology consisted of grouping elements (1-condition of trail, 2- components that increase value, 3- components that reduce value, 4- environmental quality of the trail, which increase the value of the tourism potential of the interpretive trail) relative to variables, determining criteria and setting punctuation to develop the mathematical formula. After developing the formula, a test was applied using the Tatu Trail at Prosa State Park, Campo Grande, MS. The calculation determined a score of 5.9 for the touristic potential of the trail evaluated.

Keywords: Scientific methodology. Tourism. Ecosystem services. Touristic potential. Regional development.

Resumo

O potencial atrativo de uma trilha interpretativa relaciona-se estreitamente com a biodiversidade e deve incentivar e promover a conservação ambiental. Por isso é importante que possa ser quantificado, considerando o maior número de elementos possíveis. Para não comprometer a determinação desse potencial, itens subjetivos devem ser evitados. O objetivo dessa pesquisa foi desenvolver uma metodologia baseada em uma fórmula matemática que possa determinar o valor de potencial turístico de trilhas interpretativas em áreas naturais, relacionando diferentes variáveis

[1] PhD student of the Graduate Program in Environment and Regional Development - Uniderp, Campo Grande - MS, Brazil. Email: emiliaoppliger@hotmail.com
[2] Specialist in Mathematics Teaching Methods. Municipal Secretary of Education of Campo Grande - MS, Brazil. Email: rodriguesram@hotmail.com
[3] PhD in Sciences (UFSCAR). Professor Anhanguera-Uniderp University, Campo Grande - MS, Brazil. Email: akmorbeckoliveira@gmail.com

ambientais e seus valores. A metodologia consistiu em agrupar elementos (1- condicionantes de uma trilha, 2- componentes que agregam valor, 3- componentes que desagregam valor e, 4- qualidade ambiental da trilha, que eleva o valor do potencial turístico da trilha interpretativa), relacionar variáveis, determinar critérios e definir pontuação para desenvolver a fórmula matemática. Depois do desenvolvimento da fórmula, aplicou-se um teste utilizando a Trilha do Tatu, no Parque Estadual do Prosa, Campo Grande, MS. O resultado do cálculo determinou a nota 5,9 para o potencial turístico da trilha avaliada.

Palavras-chave: Metodologia científica. Turismo. Serviços ecossistêmicos. Potencial turístico. Desenvolvimento regional.

Introduction

The research methodology is essential for the construction of science. It is through the rigorous, systematic and logical study of the different possible methods to be used in the sciences that the research will be considered valid and can be related to scientific theories. There is no science without using scientific methods. It is the method that allows, with greater security and savings of time and resources, achievement of the objective (solving a problem, whatever it is) proposed by the research.

For example, when studying tourism, geography uses its own research methods that analyse the two main types of resource, natural and artificial. In the process, the geographers adopt traditional geographic (observation, analysis and synthesis) and specific (qualitative and quantitative) methods. In the field of tourism, the research focuses on qualitative methods (interviews, focus groups and document analysis) and quantitative methods (statistical analysis, tourist flow models and territorial models), compromising the research result (CHEIA, 2010).

A study that analysed 555 articles presented in the main forum for tourism in Brazil and published in the Annals Seminar of the ANPTUR - Brazilian Association for Research and Postgraduate Studies in Tourism between the years 2006 and 2008, showed flawed scientific production of its result, mainly in relation to the criteria of validity and reliability. The research showed an essentially empirical and qualitative academic production, in addition to verifying that the published articles had little emphasis on conceptual aspects. This situation indicates that some researchers have little interest on conceptual aspects, or even that there is some selectivity by Annals Seminar (KOVACS et al., 2012).

The same research concluded that researchers' concern for validity and reliability procedures in the field of tourism is minimal, which may represent a risk to the legitimacy of the studies. This is an alarming finding, considering that the proceedings of the Annals Seminar present the results of postgraduate research, a fact directly related to the methodology defined and used, which is predominantly qualitative. This field of applied social sciences therefore receives a lot of criticism, and the credibility of the published results is questionable (KOVACS et al., 2012).

In 1988, a study had already pointed out that methodological sophistication was lacking in some areas of tourism research, after detecting that professionals from other areas showed ambivalent attitudes towards the tourism research that was presented to them. Comparing theoretical awareness and methodological sophistication in a four-quadrant model, the researchers concluded that only one quadrant demonstrated sufficient balance, wherein theoretical awareness and methodological sophistication interacted and coincided in the conceptualization phase of the research process (DANN; NASH; PEARCE, 1988).

For these reasons, quantifying the potential value of a tourist attraction can be a complex issue if the parameters used are based on subjectivity. This becomes even more complex when the attraction is in a natural environment.

In natural areas, interpretive trails are important tools for the sustainable development of tourism. The methodology for determining the value of tourism potential is defined based on the criterion that any proposed interpretive trail, planned and used for tourism activities in natural areas, must contribute to and promote environmental conservation. In addition, it is understood that tourists or visitors have different levels of interest in and knowledge about biodiversity. Thus, it is necessary to determine elements that draw the attention of the participants in the trails and that, combined, can offer an understanding and interpretation of the ecosystem involved.

The trails cover different aspects, such as the assessment of environmental characteristics to determine which have the best aesthetic qualities (SALINAS-CHÁVEZ; SERRATE, 1993); the attractiveness index of interpretive points (MAGRO; FREIXÊDAS, 1998); elements of their composition (RODOLFO; TEMPONI; CÂNDIDO JR., 2008) and the quality of these elements (FONSECA FILHO; VARJÃO; FIGUEIREDO, 2011); the interpretive potential of the trail (IKEMOTO; MORAES; COSTA, 2009); the influence on the surrounding vegetation (HIRATA; MELO; EISENLOHR, 2010); characterization of the profile of visitors and their perception (SILVA; FIGUEIREDO, 2011); and planning methods (LUNA; ROSA; MELO, 2016).

However, it is also essential to consider the context and the possible presence of communities, including the socioeconomic and cultural interference in their surroundings. The attractive potential of an interpretive trail relates closely to biodiversity and should encourage and promote environmental conservation. Therefore, it is important that it can be quantified, considering the largest number of possible elements. In order not to compromise the determination of this potential, subjective items must be avoided.

It is important that tourists or visitors understand not only the elements of nature but also the traces left by history, archaeological remains, or the presence of traditional communities around the trail, and that they can observe the possible effects caused by economic activities developed in nearby areas.

Finally, it is necessary to draw attention to risk situations such as pollution, a decrease in native species and the uncontrolled growth of exotic species, as such problems cause environmental imbalance and are responsible for the danger of extinction of many native species. The knowledge acquired from the experience of carrying out an interpretive trail (the observation, interrelationships and interpretation of different elements) must be able to sensitize participants to changes in behaviour and pro-conservation attitudes in relation to environmental practices and, in fact, promote environmental education.

Tourism—and one aspect of it, ecotourism—is an important tool for the conservation of biodiversity and for the development of environmental education activities. Thus, it is important to use appropriate methodologies in planning and using the trails as a tourist product. For these reasons, the objective here was to develop a methodology based on a mathematical formula that can be applied to determine the potential touristic value of interpretive trails in natural areas in relation to different environmental variables.

The work begins with the theoretical foundation, where we seek to reference the fragility of the scientific methodology used in research in the field of tourism. The importance of tourist activity is summarized and the interpretive trails are highlighted, as they can contribute to the sustainable development of tourism. In the methodological procedures, the criteria are defined and organized. As a result, a mathematical formula is proposed to determine the potential touristic value of interpretive trails in natural areas, and the results obtained are compared with other methods proposed in similar studies. Finally, it is concluded that the formula presented is a scientific method that can be used in research in the field of tourism. The assigned value can prove the environmental quality of the tested trail, contributing to conservation efforts in natural areas. In addition, a high score is a factor that can influence competitiveness among the various trails of this nature presented in the tourist market.

Theoretical Frame of Reference

The different areas of science (exact, biological, social, among others) direct and determine the methodology and methods that are used to conduct the research. As for nature, applied research involves local truths and interests, generating knowledge for practical application and problem-solving. The basic research, on the other hand, is concerned with building new and useful knowledge for the advancement of science and involves universal truths and interests, although it has no expected practical application (MARCONI; LAKATOS, 2003).

Regarding the approach, qualitative research focuses on deepening the understanding of a group or social phenomenon, explaining the dynamics of social relations. However, it is widely criticized for its empirical character, subjectivism, and even for the emotional involvement of the researcher. On the other hand, quantitative research is focused on objectivity. It uses mathematical language to describe the causes of a phenomenon and relationships between variables, among other methods. Thus, adoption of the qualitative-quantitative form allows more information to be collected

than could be gathered using only one of these forms, making the research more complete (MINAYO; MINAYO-GÓMEZ, 2003) and interesting from the reader's perspective.

Tourism can be seen from different perspectives. The most recurrent presents it as one of the most important economic activities in the world (LORÍA; SÁNCHEZ; SALAS, 2017). From an economic point of view, it is an investment and business capable of generating profits, responsible for the entry of resources generating a certain stability in several countries in Latin America and the Caribbean. Thus, the number of people who consume tourism products and services or the amount they pay for these products and services directly interferes with the profitability and sustainability of tourism as an economic activity. In this way, the market moves according to the competitiveness and demand requirements (CEPAL, 2014).

Tourism is also recognized as a social phenomenon widely studied by researchers who seek to understand the result of the meeting between guests and hosts, and its positive and negative impacts (SAMPAIO, 2013). Combined with environmental education, it is a powerful conservation tool that makes it possible to correlate elements of biodiversity and their importance in maintaining ecosystems (SANTOS; BERNARDES, 2019).

Different types of tourism can be carried out in natural areas, such as geotourism (MOURA-FÉ, 2015), adventure tourism (CARVACHE-FRANCO et al., 2018) and ecotourism (BACCHI; QUEIROZ; NEIMAN, 2017). In the year 1994, the document 'Guidelines for a National Ecotourism Policy' published by the Ministries of Science and Technology and the Environment in partnership with the Brazilian Institute of Tourism and the Brazilian Institute for the Environment and Renewable Natural Resources, conceptualizes ecotourism as:

a segment of the tourist activity that uses, in a sustainable way, the natural and cultural heritage, encourages its conservation and seeks the formation of an environmental awareness, through the interpretation of the environment, promoting the well-being of the populations (BRASIL, 2010:17).

Thus, one of the main components of this type of tourism is the interpretation of ecosystems presented to tourists or visitors. Ecotourism, combined with environmental education, represents a way to achieve sustainable development (NASCIMENTO et al., 2018). It is an activity that works as an instrument of approximation between human beings and the natural environment, incorporating the questioning of values, learning through experience, and the search for reformulations for everyday problems. It is therefore an educational activity, and can take advantage of the contact situation to understand the importance of nature conservation in a very contextualized way. This educational activity consists of interpretation—revealing meanings and relationships from original objects or by illustrative means, which facilitates a profound experience instead of a communication that uses only factual information (TILDEN, 2007).

Environmental education activities within the scope of the trails should provide an understanding of the ecosystem in question, allowing people to relate the elements in it, their interdependence and the degree of threat to which they are subjected, among other factors. Through environmental education, the focus on the dimensions of the visitor's experience can reveal that he is not only concerned with observing a landscape, but also with the sensation and perception of the value of something. Interpretation is guided by the visitor's cognitive and emotional state to broaden their awareness, intensify their understanding, expand their perspective and modify their attitude towards environmental conservation. In this context, the environment ceases to have only utilitarian or commercial value and starts to have existential value (FREIRE; ALMEIDA, 2018).

Thus, nature and the services it provides constitute the fundamental raw material for tourism, from 'sun and beach' tourism to the contemplation of scenic beauty and biodiversity. Some authors define ecosystem services (provided by nature) as the functions of protection and environmental quality offered by the natural environment, such as the availability of water for human consumption and production of electricity, the scenic beauty, carbon compensation in the atmosphere, and maintenance of the climate. Biodiversity and the landscape constitute an indispensable ecosystem service for tourism (MUÑOZ; FREITAS, 2017).

Tourist companies benefit when these services reflect an increase in the entry of tourists. This should be accounted (or considered) as an environmental service, i.e., what provides (makes available, offers) the resources natural. The resource can be privately or publicly owned, such as a hotel that maintains a nature reserve area and charges extra to the hosting price for this product, or

a conservation unit that offers different options of interpretive trails for different age groups, degrees of accessibility, carrying capacity, interest and levels of knowledge (CEPAL, 2004).

Conservation units contain elements of biodiversity and unique landscapes. and are considered possible tourist attractions that arouse the interest of an audience sensitive to the environment. The development of ecotourism in these areas can also minimize dissatisfaction and conflict between local communities due to the restricted use of the conservation units. Through environmental education, it is possible to sensitize those who still do not understand the urgent importance of environmental conservation (MATHEUS; RAIMUNDO, 2017).

On the other hand, it is necessary to consider the characteristics of the practitioners and limitations related to safety, environmental zoning, and the strengths and limitations imposed by the nature of the space in which the trail is located. Planning is essential for the success of the interpretive trail as a product for ecotourism and a tool for environmental education. The trails bring the visitor or tourist closer to the visited environment and are able to insert the ecotourist into a conserved natural environment in a very contextualized way (EISENLOHR et al., 2013).

It is also essential to consider the social and biophysical aspects of the place in terms of landscape, cultural and educational opportunities, access to areas for walking, presence of water resources, and support for management activities. It is necessary to consider the context of the area where the trail will be developed in terms of the maximum elements that can be used for its composition; the physical and biodiversity elements; fragile ecosystems and areas where human presence should be avoided; its design and possibilities for use by different age groups of the public with regard to respective degrees of difficulty; and the presence of endemic, rare or threatened species, among other factors (LUNA; ROSA; MELO, 2016).

Material and Methods

The procedures used to construct the mathematical formula for determining the potential touristic value of interpretive trails initially consisted of fundamental characterization of the trail, distinct grouping of the components of positive or negative punctuation, and the environmental quality in the area. In sequence, minimum criteria were defined that must be considered for each of the groups; finally, their score was assigned according to the concept of probability, which is the basis of the mathematical formula developed (Table 1).

Table 1: Procedures for determining the potential touristic value of interpretive trails

GROUP	VARIABLES	CRITERIA	PUNCTUATION
1 BASIC ELEMENTS Conditions for the existence or not of an interpretive trail	A Way (soil, rock or water) B Fauna C Flora	A, B and C Presence or absence (way, fauna and flora)	Presence 1 Absence 0
2 ELEMENTS THAT AGGREGATE Components viewed prominently along the trail (considering seasonality) with positive value in the mathematical formula	D Fauna richness E Flora richness F Water resources G Anthropic interventions	D Fauna (1) Birds (2) Mammals (3) Reptiles E Flora Diversity of plants Species with outstanding structure (height, circumference, flowers, fruits and seeds visually appealing to tourists/visitors); native species; species of medicinal plant with value (economic, cultural and/or traditional), which provide ecosystem services; abundance of species per trail size F Water resources (1) Springs (2) Streams (3) Lakes and ponds (4) Rivers (5) Mangroves G Interventions Infrastructure (1) Suspended structure for realization of the trail (2) Bridge for the conservation of water resources (3) Stopping points for observation in areas with viewpoints	D Presence 1–3 Absence 0 E Number of plant species/trail size Level 1 Not abundant: 1–3 species every 10 metres of trail. Level 2 Abundant: 4–7 species every 10 metres of trail. Level 3 Very abundant: Over 8 species every 10 metres of trail. F Presence 1–5 Absence 0 G Presence 1–11 Absence 0

		(4) Information plates Historical elements (5) Archaeological sites (6) Significant historical constructions (7) Presence of traditional communities (indigenous, quilombo, riverine, caiçaras, rural settlements and/or immigrant colony) Level of autonomy of these communities (8) Subsistence crops and subsistence animals (9) Transformation of raw materials into products for sale, such as flour, jam, peppers, breads and cakes, among others (10) Presence of cooperatives, residents' association and/or schools (11) Acting local expert guides (biology, botany, ecology, ornithology, environmental conservation, etc.)	
3 ELEMENTS THAT DISAGGREGATE With negative value in the mathematical formula	H Exotic and invasive species I Presence or traces of exploratory activities J Signs of environmental impacts	H Registration of exotic and invasive species (1) Fauna (2) Flora I Exploratory activities (1) Mining (2) Ground-clearing fires (3) Deforestation J Environmental impacts (1) Presence of solid waste (garbage) (2) Noise pollution (3) Visual pollution (4) Sedimentation	H Presence 1–2 Absence 0 I Presence 1–3 Absence 0 J Presence 1–4 Absence 0
4 ENVIRONMENTAL QUALITY OF THE TRAIL Elements that raise the value of the touristic potential of the interpretive trail	K Phytophysiognomy: vegetation strata and succession process L Local index of endemism (birds, mammals, reptiles and plants) M Certified quality of water from water resources N Certified quality of the soil along the trail	K Phytophysiognomy - Table 2 Vegetation strata (3 levels) (1) Herbaceous (2) Shrub (3) Arboreal Succession stages (2 levels) (1) Initial (colonizing, pioneer and secondary plants) (2) Advanced (climax and dynamic climax) L Index of endemism - Table 3 Matching the total species record for the trail/endemic species and the index of endemism by Brazilian biome (3 levels) M Water quality (CONAMA Resolution 357/2005) N Soil quality (CONAMA Resolution 420/2009)	K Presence 1–3 Absence 0 Presence 1–2 Absence 0 L Endemic index for the trail Level 1 Low endemism index: 50% lower than the reference index for the biome Level 2 Medium index of endemism: reference index for the biome Level 3 High index of endemism: 50% higher than the reference index for the biome; among birds, mammals, reptiles and plants, is considered the group with the best score level M Meets 1 Does not meet 0 N Meets 1 Does not meet 0

Source: Authors

For the construction of the formula, each variable was defined in terms of: (1) maximum number of possibilities of presence and no possibility of absence of elements; (2) minimum and maximum levels, according to the number of specimens of plant species per trail length; and, with the index of endemism compared to the reference index for the respective biome; (3) values that are in accordance with the parameters established in the current resolutions (National Environment

Council, CONAMA); (4) phytophysiognomic diversity (Table 2); and (5) registered and endemic species of fauna and flora in Brazilian biomes (Table 3).

Table 2: Landscape, vegetation cover and succession processes

Predominant phytophysiognomy	Vegetation strata	Level	Succession processes	Level
Field	Herbaceous	1	Colonizing	1
Mixed areas	Shrub	2	Pioneer	
			Secondary	
Forest trails	Arboreal	3	Climax	2
			Dynamic climax	

Source: Authors

Table 3: Index of endemism (IE) by Brazilian biome

Biome	Species/Endemic (IE)			
	Birds	Mammals	Reptiles	Plants
Amazônia	1094/32 (3%)	350/136 (39%)	550/341 (62%)	11945/2615 (22%)
Mata Atlântica	1072/217 (20%)	261/55 (21%)	311/60 (19%)	14970/9836 (66%)
Caatinga	607/15 (2%)	148/19 (12%)	107/23 (21%)	4676/2624 (56%)
Cerrado	1048/56 (5%)	195/18 (9%)	187/32 (17%)	12140/7328 (60%)
Pantanal	527/4 (0,7%)	132/2 (1,5%)	113/[1] (ND)	1305/165 (13%)
Pampas	529/3 (0,5%)	125/7 (6%)	43/9 (21%)	1746/247 (14%)
Marinho-Costeiro	111/3 (3%)	261/35 (13%)	6/2[2] (33%)	31/7 (23%)

Note and sources: animals (BRASIL, 2002; TÁXEUS, 2018; ICMBio, 2018a); [1]no registry (IE not determined); [2]registration only for the Fernando de Noronha archipelago; plants (ICMBio, 2018b)

It is important to highlight that, due to the dynamics of the discovery, registration and extinction of fauna and flora species, the parameters presented for this variable can and must be updated.

Results and Discussion

In similar studies, other authors have joined efforts to present research methodologies in tourism. Realizing that regions of France and Switzerland with the presence of geomorphological sites (glacial, karstic and hydrographic) were interesting resources to become tourist products, PRALONG (2005) proposed criteria to quantify and qualify their tourism and recreational potential. Thus, he assigned a score between zero and one, with calibrations of 0.25 (twenty-five hundredths). He determined the terms of the values: 1: scenic/aesthetic; 2: scientific; 3: cultural/historical; and 4: social/economic; and the potential use in terms of degree (spatial and temporal) and mode of exploration (the four values mentioned). For scientific value, PRALONG (2005) considered the criteria of: a) paleogeographic interest, b) representativeness, c) natural rarity, d) integrity, and e) ecological interest.

In Brazil, geosites located in the Serra do Rola Moça State Park, Minas Gerais, were also investigated in order to quantitatively assess the tourism potential and the risk of degradation caused by the activity, presenting an adapted methodology. For the potential for tourism use, the following criteria were established: a) vulnerability, b) accessibility, c) usage limitations, d) security, e) accommodation services, f) food services, g) exclusivity, h) association with other values, i) scenario, j) observation conditions, k) observation potential, l) economic level, and m) proximity to other geosites. To quantify, weights were assigned according to their importance and weighting criteria; to classify, a score of 100 (low potential) to 400 (high potential) was stipulated. For the risk of degradation, the criteria defined were 1: deterioration of the elements of geodiversity; 2: proximity to areas/activities potentially causing degradation; 3: legal protection; and 4: accessibility. A score between 1 (lowest risk) and 4 (highest risk) was assigned (REIS, 2019).

To make a comparison between different trails, the development of the mathematical formula is based on the concept of probability, according to MELLO (2005: 379), in which:

In an equiprobable space, the probability of occurrence of an event, indicated by $P(E)$, is the ratio between the number of elements in the event and the number of elements in the sample space (S): $P(E) = \frac{n(E)}{n(S)}$.

This concept is used only as a basis, as it is known that probability occurs in random experiments, being a measure of a trend that returns a value between zero and one (in other words, from 0 to 100%). There are no random experiments in the study and the elements are known and well defined, an adjustment in the formula allowing the result to be given on a scale from zero to ten.

Thus, the formula developed to define the potential value of the trail provides a numerical value, where zero indicates a trail with the minimum tourist attraction, and ten, one that reaches the maximum tourist attraction potential for that region.

$$\textbf{PTTV} = \frac{(\sum_{a=1}^{n_a} f_a) - (\sum_{d=1}^{n_d} f_d) + n_d}{0{,}1(n_a + n_d)}$$

Where:
PTTV = potential touristic trail value
f_a = elements that aggregate
n_a = maximum value of the score achieved by the elements that aggregate
f_d = disaggregating elements
n_d = maximum value of the score reached by the elements that disaggregate

However, some items require preliminary calculations to have their values included in the sum of the elements that aggregate, especially items K and L (Table 1).

To test the formula, the Tatu Trail was used, a linear 480-metre route located in Prosa State Park, Campo Grande, MS, part of the Cerrado biome. The number of species of fauna (birds, mammals and reptiles) and flora (vegetation) were obtained from the park's management plan (MATO GROSSO DO SUL, 2011) (Table 4).

Table 4: Testing of the formula to determine the potential touristic value of the Tatu Trail, Prosa State Park, Campo Grande, Mato Grosso do Sul, Brazil

Groups and Variables		Punctuation	
Basic elements		f_a	n_a
a	Way	1	1
b	Presence of fauna	1	1
c	Presence of flora	1	1
Elements that aggregate		f_a	n_a
d	Fauna richness	3	3
e	Flora richness	1*	3
f	Variety of water resources	2	5
g	Anthropic interventions	3	11
Disaggregating elements		f_d	n_d
h	Exotic and invasive species (fauna and flora)	2	2
i	Exploratory activities	0	3
j	Signs of environmental impacts	1	4
Environmental quality of the trail		f_a	n_a
k	Vegetation strata; succession process	3; 2	3; 2
l	Local index of endemism	1**	3
m	Water quality	1	1
n	Soil quality	1	1

Note: *Flora richness: 480 m trail/19 species = 1 species/25 m trail = Level 1
**Local index of endemism: birds (2%); mammals (0%); reptiles (0%); plants (0%) = Level 1 (IE birds of the Cerrado = 5%)

$$\textbf{PTTV} = \frac{(\sum_{a=1}^{n_a} f_a)-(\sum_{d=1}^{n_d} f_d)+n_d}{0.1(n_a+n_d)}$$

$(\sum_{a=1}^{n_a} f_a)$ = sum of the elements that aggregate (exclusively the f_a of each of the items): (a+b+c+d+e+f+g+k+l+m+n) → (1+1+1+3+1+2+3+3+2+1+1+1) = 20

$(\sum_{d=1}^{n_d} f_d)$ = sum of the elements that disaggregate (exclusively the f_d of each of the items): (h+i+j) → (2+0+1) = 3

n_a = maximum (possible) value of the score achieved by the elements that aggregate (exclusively the n_a of each of the items): (a+b+c+d+e+f+g+k+l+m+n) → (1+1+1+3+3+5+11+3+2+3+1+1) = 35

n_d = maximum (possible) value of the score achieved by the elements that disaggregate (exclusively the n_d of each of the items): (h+i+j) → (2+3+4) = 9

Substituting the values in the formula we have:

$$\textbf{PTTV} = \frac{(\sum_{a=1}^{n_a} f_a)-(\sum_{d=1}^{n_d} f_d)+n_d}{0.1(n_a+n_d)} \rightarrow \textbf{PTTV} = \frac{(20)-(3)+9}{0.1(35+9)}$$

Solution:

$$\textbf{PTTV} = \frac{(20)-(3)+9}{0.1(35+9)} \rightarrow \frac{17+9}{0.1(44)} \rightarrow \frac{26}{4.4} \rightarrow 5.9$$

Conclusion

The presented formula represents a method that can be applied to any potential trails whose objective is especially to prove the environmental quality. The methodology is based on the objectivity of quantification, presence or absence of elements, and compliance or not with determinations. In this way, discrepant scores are more difficult to occur due to the use of subjective criteria.

It is noteworthy that the main function of this formula is to contribute to the efforts of environmental conservation and, at the same time, to the quality of the tourist product in natural areas. Thus, the formula allows a differential in the sale of a tourist product, demonstrating its environmental quality. A high score is a factor that can influence competitiveness among the different trails of this nature presented in the tourist market. This can also be reflected in the tourist's greater perception of the value of the place that he is visiting.

The result of this investigation (the proposed mathematical formula) contributes to the expansion of the research methodology in tourism, especially to be used as a research method for tourism in natural areas. The limitations the researchers' time and resources only allowed application of the method to a trail whose elements had already been described and quantified previously, included in the management plan of the conservation unit in which the trail is structured. Nevertheless, the entire length of the trail was travelled.

Thus, it is possible to state that the methodology proposed in this research will be improved by all researches that use the mathematical formula as a method and that submit interpretive trails to the test to determine tourism potential. However, it is essential that the environmental conditions surrounding the trails be perceived beyond the tourist product. It is expected that the interpretive trails submitted to the determination of potential touristic value will favour, contribute to and facilitate sustainable regional development.

Acknowledgement

The authors thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for the Present Research Grant (PQ2) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for the scholarship. We would also like to thank the Universidade Anhanguera-Uniderp for funding the Interdisciplinary Research Group (GIP) project.

References

BACCHI, R.; QUEIROZ, O. T. M. M.; NEIMAN, Z. A Educação Ambiental no Ecoturismo e no Turismo de Aventura: estudo de caso do Parque Estadual da Serra do Mar, Núcleo Santa Virgínia (SP). **Revista Brasileira de Ecoturismo (RBEcotur)**, São Paulo, v. 10, n. 2, p. 498-524, 2017. https://doi.org/10.34024/rbecotur.2017.v10.6635

BRASIL. Ministério do Meio Ambiente. **Biodiversidade brasileira** - Avaliação e identificação de áreas e ações prioritárias para conservação, utilização sustentável e repartição dos benefícios da biodiversidade nos biomas brasileiros. Brasília: MMA/SBF, 2002.

BRASIL. Ministério do Turismo. **Ecoturismo: orientações básicas**. Brasília: Ministério do Turismo, 2010.

CEPAL. Comissão Econômica para a América Latina e o Caribe. Comercio de servicios ambientales vinculados al turismo y revision de la sostenibilidad del turismo en tres casos de studio. LC/MEX/L.597/Rev. 1, 2004, 72 p. Disponível em: https://repositorio.cepal.org/bitstream/handle/11362/25650/1/LCmexL597rev1_es.pdf. Acesso em 02 set. 2018.

CEPAL. Comissão Econômica para a América Latina e o Caribe. Desafios para a sustentabilidade do crescimento em um novo contexto externo. 2014, 12 p. Disponível em: https://repositorio.cepal.org/bitstream/handle/11362/37108/S1420065_pt.pdf?sequence=1. Acesso em 02 set. 2018.

CARVACHE-FRANCO, W.; CARVACHE-FRANCO, M.; CARVACHE-FRANCO, O.; RECALDE-LINO, X. Preferencias para el turismo de aventura en la elaboración de un paquete turístico: Caso Santa Elena, Ecuador. **Revista Interamericana de Ambiente y Turismo**, Talca, v. 14, n.1, p. 43-51, 2018. http://dx.doi.org/10.4067/S0718-235X2018000100043

CHEIA, G. Research Methods in Tourism. **Scientific Annals of Stefan cel Mare University**, Suceava, v. 19, n. 2, p. 81-94, 2010. http://dx.doi.org/10.4316/GEOREVIEW.2010.19.2.98

DANN, G.; NASH, D,; PEARCE, P. Methodology in tourism research. **Annals of Tourism Research**, Amsterdam, v. 15, n. 1, p. 1-28, 1988. https://doi.org/10.1016/0160-7383(88)90068-0

EISENLOHR, P. V.; MEYER, L.; MIRANDA, P. L. S.; REZENDE, V. L.; SARMENTO, C. D.; MOTA, T. J. R. C.; el al. Trilhas e seu papel ecológico: o que temos aprendido e quais as perspectivas para a restauração de ecossistemas? **Hoehnea**, São Paulo, v. 40, n. 3, p. 407-418, 2013. https://doi.org/10.1590/S2236-89062013000300002

FONSECA FILHO, R. E.; VARAJÃO, A. F. D. C.; FIGUEIREDO, M. A. Qualidade do solo como um atributo para uma metodologia de manejo de trilhas do Parque Nacional da Serra do Cipó (MG). **Revista Brasileira de Ecoturismo**, São Paulo, v. 4, n. 4, p. 508, 2011. https://doi.org/10.34024/rbecotur.2011.v4.5942

FREIRE, P. M. O.; ALMEIDA, F. A. B. Ecoturismo, educação ambiental crítica e formação de sujeitos ecológicos: convergências e desafios. **Revista Brasileira de Ecoturismo**, São Paulo, v.11, n. 4, p. 561-587, 2018. https://doi.org/10.34024/rbecotur.2018.v11.6697

HIRATA, J. K. R.; MELO, M. M. R. F.; EISENLOHR, P. V. Padrões florísticos do componente arbóreo sob interferência de trilhas em um trecho de Floresta Ombrófila Densa de Transição em São Paulo, SP, Brasil. **Hoehnea**, São Paulo, v. 37, p. 555-570, 2010.

ICMBio. Instituto Chico Mendes de Conservação da Biodiversidade. **Biomas brasileiros**, 2018a. Disponível em: http://www.icmbio.gov.br/portal/unidadesdeconservacao/biomas-brasileiros. Acesso em 06 jun. 2018.

ICMBio. Instituto Chico Mendes de Conservação da Biodiversidade. **Portal da Biodiversidade**, 2018b. Disponível em: https://portaldabiodiversidade.icmbio.gov.br/portal/. Acesso em 06 jun. 2018.

IKEMOTO, S. M., MORAES, V. C.; COSTA, V. C. Avaliação do potencial interpretativo da Trilha do Jequitibá, Parque Estadual dos Três Picos, Rio de Janeiro. **Sociedade & Natureza**, Rio de Janeiro, v. 21, p. 271-287, 2009. https://doi.org/10.1590/S1982-45132009000300004

KOVACS, M. H.; BARBOSA, M. L. A.; SOUZA, A. G.; MESQUITA, A. E. P. Pesquisa em Turismo: uma avaliação das metodologias empregadas nos artigos publicados nos anais do triênio do seminário anual da Associação Brasileira de Pesquisa e Pós-Graduação em Turismo - Anptur. **Revista Turismo Visão e Ação**, Balneário Camboriú, v. 14, n. 1, p. 19-34, 2012. http://dx.doi.org/10.14210/rtva.v14n1.p019-034

LORÍA, E. G.; SÁNCHEZ, F.; SALAS, E. Efectos de la llegada de viajeros internacionales en el desempleo y el crecimiento económico en México, 2002.2 - 2015.2. **El périplo sustentable**, Toluca, v. 32, p. 1-40, 2017.

LUNA, M. M. A.; ROSA, L. A. N.; MELO, V. P. Planejamento de uma trilha interpretativa como ferramenta do ecoturismo na APA da Barra do Rio Mamanguape - Paraíba, Brasil. **Applied Tourism**, Balneário Camboriú, v. 1, n. 1, p. 7-23, 2016. http://dx.doi.org/10.14210/at.v1n1.p7-23

MAGRO, T. C.; FREIXÊDAS, V. M. **Trilhas:** como facilitar a seleção de pontos interpretativos. Circular Técnica IPEF, Departamento de Ciências Florestais, ESALQ/USP, nº 186, set. 1998, p. 4-10.

MARCONI, M. A.; LAKATOS, E. M. **Fundamentos da metodologia científica**. São Paulo: Atlas, 2003.

MATHEUS, F. S.; RAIMUNDO, S. Os resultados das políticas públicas de ecoturismo em Unidades de Conservação no Brasil e no Canadá. **Revista Brasileira de Pesquisa em Turismo**, São Paulo, v. 11, n. 3, p. 454-479, 2017. http://dx.doi.org/10.7784/rbtur.v11i3.1336

MATO GROSSO DO SUL. **Plano de Manejo do Parque Estadual do Prosa**. Campo Grande: Secretaria de Estado de Meio Ambiente, do Planejamento, da Ciência e Tecnologia - Semac, 2011.

MELLO, J. L. P. **Matemática, volume único:** construção e significado. São Paulo: Moderna, 2005.

MINAYO, M. C. S.; MINAYO-GÓMEZ, C. Difíceis e possíveis relações entre métodos quantitativos e qualitativos nos estudos de problemas de saúde. *In*.: GOLDENBERG, P.; MARSIGLIA, R. M. G.; GOMES, M. H. A. (Orgs.). **O clássico e o novo:** tendências, objetos e abordagens em ciências sociais e saúde. Rio de Janeiro: Fiocruz, 2003, p. 114-142.

MOURA-FÉ, M. M. Geoturismo: uma proposta de turismo sustentável e conservacionista para a região Nordeste do Brasil. **Sociedade & Natureza**, Uberlândia, v. 27, n. 1, p. 53-66, 2015. http://dx.doi.org/10.1590/1982-451320150104

MUÑOZ, A. M. M; FREITAS, S. R. Importância dos serviços ecossistêmicos nas cidades: revisão das publicações de 2003 a 2015. **Revista de Gestão Ambiental e Sustentabilidade**, São Paulo, v. 6, n. 2, p. 89-104, 2017. https://doi.org/10.5585/geas.v6i2.853

NASCIMENTO, H. H. O.; MOREIRA, A. S.; SILVA, J. R. M.; ALMEIDA, N. G. Educação ambiental em ação: o papel do ecoturismo em prol da sustentabilidade das unidades de conservação. **REDE - Revista Eletrônica do PRODEMA**, Fortaleza, v. 12, n. 3, p. 62-68, 2018. https://doi.org/10.22411/rede2018.1203.06

PRALONG, J. P. A method for assessing tourist potential and use of geomorphological sites. **Géomorphologie: relief, processus, environnement**, Paris, v. 3, p. 189-196, 2005. https://doi.org/10.4000/geomorphologie.350

REIS, D. L. R. Avaliação do potencial geoturístico do Parque Estadual Serra do Rola Moça, MG. **Revista Brasileira de Pesquisa em Turismo**, São Paulo, v. 13, n. 1, p. 92-107, 2019. http://dx.doi.org/10.7784/rbtur.v13i1.1482

RODOLFO, A. M.; TEMPONI, L. G.; CÂNDIDO JR., J. F. Levantamento de plantas exóticas na trilha do Poço Preto, Parque Nacional do Iguaçu, Paraná, Brasil. **Revista Brasileira de Biociências**, Porto Alegre, v. 6, p. 22-24, 2008.

SALINAS-CHÁVEZ, E.; SERRATE E. Caracterización turística de los miradores. **Estudios y Perspectivas en Turismo**, Buenos Aires, v. 2, n. 1, p. 48-52, 1993.

SAMPAIO, S. Estudar o turismo hoje: para uma revisão crítica dos estudos de turismo. **Etnográfica**, Lisboa, v. 17, n. 1, p. 167-182, 2013. https://doi.org/10.4000/etnografica.2615

SANTOS, G. N. C.; BERNARDES, M. B. J. Turismo Sustentável e Educação Ambiental: dois importantes aliados na promoção do Desenvolvimento Sustentável. **Caderno de Geografia**, Belo Horizonte, v. 29, n. 58, p. 673-686, 2019. https://doi.org/10.5752/P.2318-2962.2019v29n58p673-686

SILVA, L. O.; FIGUEIREDO, L. A. V. Racionalidades e sensibilidades em trilhas interpretativo-perceptivas: promovendo ações formativas de Educação Ambiental na Vila de Paranapiacaba-Santo André (SP). **Revista Brasileira de Ecoturismo**, São Paulo, v. 4, n. 1, p. 25-58, 2011. https://doi.org/10.34024/rbecotur.2011.v4.5882

TÁXEUS. **Listas de espécies**, 2018. Disponível em: https://www.taxeus.com.br/. Acesso em 06 jun. 2018.

TILDEN, F. **Interpreting our Heritage**. Chapell Hill: University of North Carolina Press, 2007.