

Assessing carrying capacity in protected areas trails: The Formosinho Trail – Arrábida Natural Park (Portugal)

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Introduction

The Arrábida Natural Park (ANP) is a Portuguese protected area (PA) location within the Metropolitan Area of Lisbon, which has 2,5 million inhabitants. Because of the high quality of landscape, the park receives high recreational demand both during weekends and seasonally. The vulnerability of this area requires management to take proactive actions in order to anticipate the negative effects of recreational activities by estimating the carrying capacity (CC) of sites. Nowadays, the CC concept is a formal part of PAs management and since 1999 Portuguese law requires Nature Sport Charts (NSC) for all PAs to include a definition of CC for each *nature-based sport*. However, until now only two PAs have an approved NSC leading to a casuistry management of those areas under increasing pressure.

The model approach presented in this paper aims to contribute to the definition of CC in PAs trails and thus help develop NSC by setting the CC in the Formosinho trail using biophysical and social data. The Formosinho trail is one of the most popular trails within ANP since it crosses the Serra da Arrábida at its highest point (501 meters), and leads through some of the best examples of semi-evergreen woods that give the Arrábida Biogenetic Reserve its international status.

Methods

The methodological approach was divided into four main stages as presented in Figure 1.

Data collection

In the first stage, the study focused on data collection including 12 fieldwork visits to gather ecological information and assess cartographic elements at different times of day and at different times during the year.

Survey analyses and landscape analyses

In order to characterize the visitors of the Formosinho trail and understand their perceptions, 75 questionnaires were completed during the period of May and July 2010. The results allowed researchers to evaluate the quality of visitors experience and main motivations as well as develop a general visitor profile. The survey also generated information regarding potential indicators of impact for recreation experience and related resource conditions. Furthermore, an analysis of the natural parameters of the trail (e.g., geology-lithology, physiography, flora, and indicators of impact) was also conducted.

Synthesis

This stage involved a combination of biological and physical information in order to obtain a biophysical sensitivity,

which was displayed visually on a map. The biophysical sensitivity of a trail is the degree of vulnerability of physical and biological components of a landscape in relation to natural impacts and anthropogenic pressures (Ribeiro, et al., 2002). The sensitivity was determined by the assignment of different values (high, medium and low) for the classes defined for each parameter and subsequent overlay. A “high” value relates to the condition of high sensitivity of a particular resource and a “low” value relates to a lower sensitivity (i.e., greater potential capacity to support trail use without diminishing the resource quality and visitors experience).

The biological sensitivity was derived from trail width and vegetation sampling. This analysis enabled predictions of where damage to vegetation caused by hiking would likely appear along with the location of vegetation with high value ecological values.

The physical sensitivity was obtained from lithology, slope and trail surface measurements. Through this analysis it was possible to determine trail erosion and potential risk areas for erosion.

The interaction between physical and biological sensitivity determined the values of the biophysical sensitivity, indicating that the trail has high biophysical sensitivity (81.49%). The trail, based on its biophysical sensitivity and peculiarities, must be subject to certain proposals of management that gives priority to the safeguarding of resources and environmental restoration in cases of degradable situations.

Proposal for carrying capacity of Formosinho Trail

The CC proposal was developed through the combination of different aspects: *safety*, *visitor's experiences*, and *biophysical sensitivity*.

It is important to ensure the safety of people when they hike on the trail. This is an important factor since the high degree of difficulty (3801.7 meters length and 22.8% average slope) combined with the trail erosion leads to an increased risk of injuries. Regarding the visitor's experience, 14% of visitors considered a group of 25 individuals excessive. This number should work as a guide for visitor experience quality since large groups can lead to ecological impacts on the trail and diminish the visit experience. Biophysical sensitivity was also considered in this analysis because the fragility of the trail is apparent (81.49% of the trail has high sensitivity).

The process described above resulted in a proposed carrying capacity for hiking groups of 4 to 20 visitors. When one considering that the trail trip takes in average of 4 hours, and that it is preferable that groups do not encounter each other, the resulting carrying capacity is three groups per day (12 hours) corresponding to a daily capacity of 12/60 people.

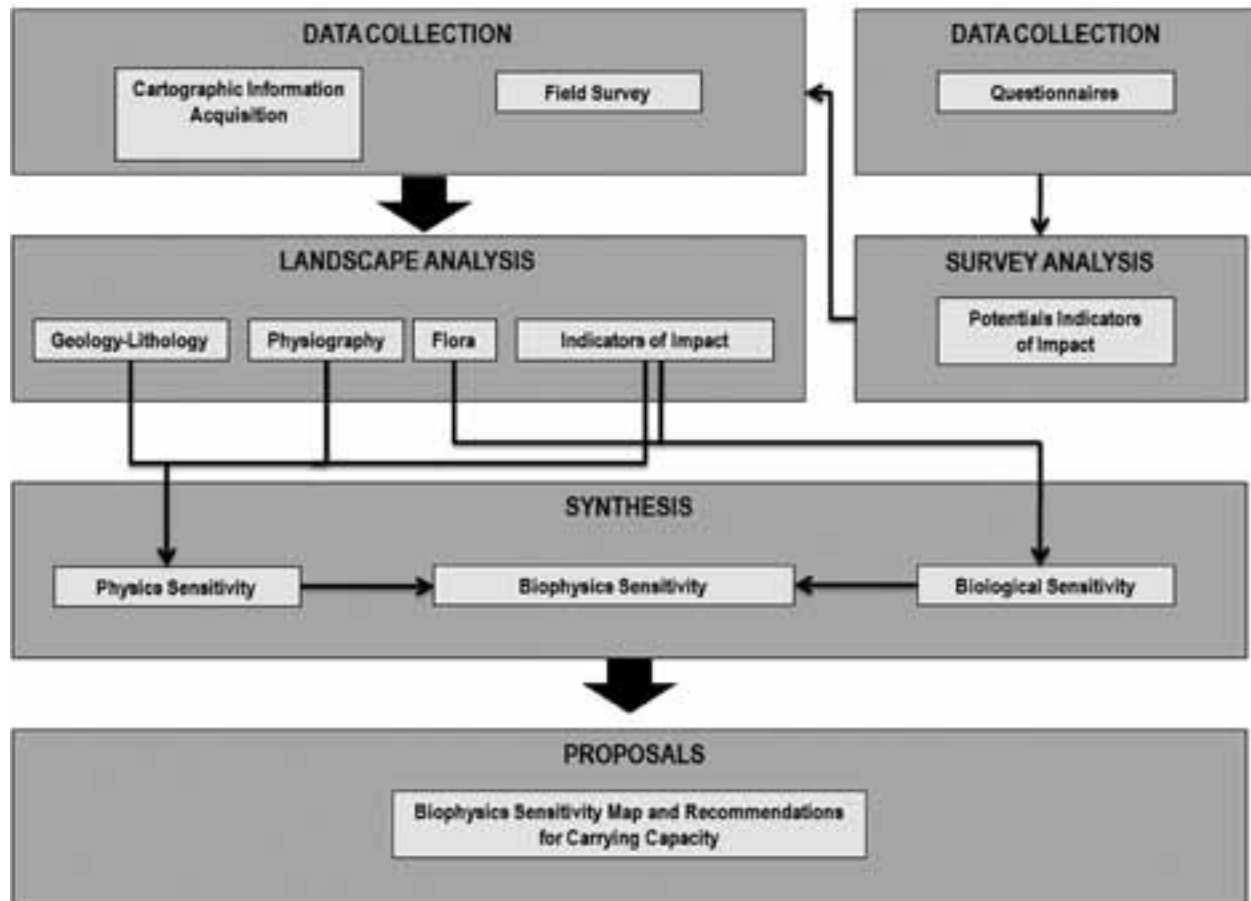


Figure 1. Schematic representation of the methodology

Conclusion

The established ecological assessment and the social survey provide evidence of the current resource and social conditions at the Formosinho trail. This approach can be appropriate to other PAs in Portugal and assists in management decisions concerning the impacts of recreational demand. The CC model established for Formosinho trail does not aspire to be a universal formula but rather a contribution to improving current methodological approaches. This provides a basis for contributing significantly to management and conservation efforts with an objective methodology that is accurate and easy to apply. The approach must be carried out by multidisciplinary teams of specialized techni-

cians, taking into account how much and what kind of environmental damages were caused and what conditions visitors considered acceptable. Periodic reviews allowing changes within a social and ecological context should be carried out in order to update management actions. Thus it is possible to provide both protection of natural values and desirable recreational experiences for users.