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Ecological Carrying Capacity in the Conservation of Mount Kinabalu: A Theoretical and Conceptual Framework

Normah Abdul Latip, Azizan Marzuki, A. Ghafar Ahmad, Mohd Umzarulazijo Umar, Nadiatul Sarah Rais

School of Housing Building and Planning, Universiti Sains Malaysia, 11800, Penang, Malaysia
Department of Urban and Regional Planning, Universiti Sains Malaysia

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ABSTRACT

This paper will focus on review of related literature about ecological carrying capacity theory and conservation process. The methodology applied used the Analytic Hierarchy Process (AHP) methods to prioritize the protection of the environment on the study area. The significance of this study is can providing data that explain the effectiveness of carrying capacity theory as a tool to improve conservation and tourism strategies in protected area. The present study aims to provide an objective tool for sustainable carrying ecosystem using Carrying Capacity Theory for setting conservation and protection priorities with emphasize on Analytic Hierarchy Process (AHP) methods and to further develop a Carrying Capacity Theory that can assist in translating the concern about sustainability crisis. The future finding from this study could be applied to the conservation and tourism and also enables researchers to put more expert knowledge together, allowing more precise decisions and moderating personal judgments regarding conservation and tourism.

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INTRODUCTION

The concept of carrying capacity originates from the field of ecology. It is conventionally defined as the maximum population size of a given species that an area can support without reducing its ability for the same species in the future. This research is inspired with issues about the interaction between social and biophysical environment in the Carrying Capacity Theory and emphasized on two aspects namely conflict and crowding. Several decades of research have demonstrated the importance of understanding both the social and biophysical environment. Changing conditions within each of these settings can have a detrimental effect on natural resources, the visitor experience and/or the natural character. In Sabah, increasing numbers of both domestic and international visitors to conservation areas has led to growing concerns among a variety of stakeholders including the popular press, academic and management interests that at some sites, current human activities may not be sustainable

Review of Related Literature:

"The Limits to Growth", a book published in 1972 and 2004, predicted that the world would exceed its human carrying capacity and had already achieved a state of unsafe overloading, resulting in a sudden and uncontrollable decline in population and industrial capacity, unless the current trajectory of population and industrial growth was decreased (Meadows, D.H., 2004). The concept of carrying capacity originates from the field of ecology (Park, R.F. and E.W. Burgess, 1921). It is conventionally defined as the maximum population size of a given species that an area can support without reducing its ability for the same species in the future. In the human context, it is sometimes defined as the maximum "load" (as product of population and per capita impact) that can safely and persistently be imposed on the environment by people (FAO, 1985). Carrying capacity is an essential component of sustainable development theory, which relates eco-environmental integrity to socio-economic development in situations with limited resource and increased environmental pollutions. Several decades of research have demonstrated the importance of understanding both the social and biophysical environment. Changing conditions within each of these settings can have a detrimental effect on natural resources, the visitor experience and/or the natural character.

Corresponding Author: Normah Abdul Latip, School of Housing Building and Planning, Universiti Sains Malaysia, 11800, Penang, Malaysia.
E-mail: norma_abdlatip@usm.my

In Sabah, increasing numbers of both domestic and international visitors to conservation areas has led to growing concerns among a variety of stakeholders including the popular press, academic and management interests that at some sites, current human activities may not be sustainable (Hughey, K., 2004; Kearsley, G., 2000). In particular, there have been concerns about how changing recreation patterns and activities are affecting the quality of natural resources and experiences, including questions raised about the impacts of activities such as mountain biking, wildlife viewing and many events that been held on the surrounding area (Espiner, S.R. and D.G. Simmons, 1998). The literature reporting the effects of human activity in protected natural areas typically differentiates between 'impacts' that are social and those that are biophysical. In this context, the term impact refers to the specific adverse effects of human activities that represent threats to values identified as significant within the area. Research has shown that both the natural and social environments associated with protected natural areas have the potential to be negatively affected by certain conditions, including the presence and activities of other people. Monitoring indicators of conditions known to detract from the visitor experience or natural character of a place ultimately allows managers to create appropriate limits to human activities and ensure that key values are protected.

Tourism was officially recognized as an industry in Sabah, Malaysia by 1986, albeit on a very small scale. Sabah's reputation as one of the major nature tourism sites in Malaysia is based on its abundant range of forest habitats and wildlife species. Most of these sites are within protected areas where local communities' use of forest and land resources is non-existent or minimal. Mount Kinabalu and surrounding (including Kinabalu Park) is one of main tourist attractions in Sabah. Mount Kinabalu (Gunung Kinabalu) is a prominent mountain on the island of Borneo in Southeast Asia. It is located in the East Malaysian state of Sabah and is protected as Kinabalu Park, a World Heritage Site. Kinabalu is the highest peak in Borneos Crocker Range and is the highest mountain in the Malay Archipelago. Mount Kinabalu is also the 20th most prominent mountain in the world by topographic prominence (Beaman, J.H. and C. Anderson, 2004). In 1997, a re-survey using satellite technology established its summit (known as Lows Peak) height at 4,095 metres (13,435 ft) above sea level, which is some 6 metres (20 ft) less than the previously thought and hitherto published figure of 4,101 metres (13,455 ft) (Hiung, C.S., 2004). Mt Kinabalu and its surrounding Park has a very wide range of habitats, from rich tropical lowland and hill rainforest to tropical mountain forest, sub-alpine forest and heath on the higher elevations. The mountain and its surroundings are among the most important biological sites in the world, with between 5000 and 6000 species of plants, 326 species of birds, and more than 100 mammalian species identified.

In 2000, Mt Kinabalu was included in UNESCO's World Heritage List to preserve and protect its natural heritage. It has also been designated as a Centre of Plant Diversity for Southeast Asia (Phillipps, A. and F. Liew, 2000) Tourism has become a fashion in various countries. But the development of traditional tourism not only brings the opportunity of employment and economic revenue to the residents, but also brings traffic chaos, garbageaccumulation, severe pollution, shortage of resources, ecological environment destruction and other social and environmental issues. In pursuit of the sustainable development of tourist sites, the formations, for example, nature tourism, sustainable tourism, eco-tourism and other theories have been put forward. At the same time, many experts and scholars have also issued the concept of environment capacity and environmental carrying capacity, which gradually entered the period of relatively mature. Carrying capacity was an idea in the engineering and geological area. Afterwards, in order to address problems such as environmental pollution, population explosion and land degeneration, ecologists applied this idea to human ecology.

This research is inspired with two issues in the carrying capacity theory namely conflict and crowding. Conflict is a common and difficult issue in many natural areas around the world (Hammitt, W.E. and I.E. Schneider, 2000), typically characterised by incompatibilities between different uses of the same resource (Ewert, A.W., 1999). Conflict occurs when the goals of discrete user groups are disrupted by the actions or presence of another user group. In this sense, conflict has been reported between users in the same activity, and between varieties of interest groups competing for the use of an area (or whose goals depend on the maintenance of specific conditions in a natural area, such as natural quiet, solitude, freedom to roam). Conflicts in natural resource settings have been found between new and traditional groups, motorised and non-motorised activities, as well as between farmers, recreationists, fishers, tourism operators, hydro-electricity interests and indigenous peoples. Natural resource recreation areas, once the preserve of pioneer explorers and adventurers, are now shared by a variety of interests, creating interactions between individuals and groups who may hold sharply contrasting values for such settings (Ewert, A.W., 1999).

Research Methodology:

This study will used the methods and techniques of an Analytic Hierarchy Process (AHP) for making decisions for the prioritization of Mount Kinabalu environmental protection. The criteria of carrying capacity resources, ecosystem resilience force, engineering safety, mount ecology, and terrestrial

landscape are the main factors for the mountain environment obtained through the AHP method and can be ranked according to experts' opinions of importance. The Analytic Hierarchy Process (AHP) is a structured technique for organizing and analyzing complex decisions, based on mathematics and psychology. It was developed by Thomas L. Saaty in the 1970s and has been extensively studied and refined since then (Saaty, T.L., 2008). The AHP method uses a typical pairwise comparison method to extract relative weights of criteria based on a hierarchical structure. In a hierarchical problem, each element at a given level is associated with some or all elements at the level immediately below. Elements at a single level are compared in terms of relative importance with respect to an element in the immediately higher level. Such pairwise comparisons are then analyzed using an eigenvector method. The AHP method described earlier is a structured, systematic, and effective approach for determining the relative importance of weights. The procedure of AHP can be expressed in a series of steps:

(A) Construct a paired comparison matrix:

A pairwise comparison matrix of criteria is constructed using a scale of relative importance. The judgments are entered using the fundamental scale of the AHP, which is shown in Table 1. In total, n (n-1)/2 pairwise comparisons are evaluated for n criteria. Let a represent an n X n pairwise comparison matrix:

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ a_{21} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & 1 \end{bmatrix} \quad (1)$$

The diagonal elements in matrix A are self-compared; thus, $a_{ij} = 1$. The values on the left and right sides of the matrix diagonal represent the strength of the relative importance degree of the ith element compared to the jth element. Let $a_{ij} = 1/\ a_{ij}$, where $a_{ij} > 0$, $i \neq j$.

Table 1: The relational scale proposed by Saaty (1980) for pairwise comparisons.

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objectiv
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Very strong or demonstrated importance	One activity is favored very strongly over another; its dominanceis demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between adjacent scale value	Used when compromise is needed
Reciprocals	Ratios arising from the scale	If activity *i* has one of the preceding numbers assigned to it when compared with activity *j*, then *j* has the reciprocal value when compared with *i*
Rational		Used if consistency were forced by obtaining n numerical values to span the matrix

(B) Calculate the importance degrees:

The average of normalized columns in a reciprocal matrix provides a good estimate of the principal right eigenvector in the deterministic case (Vargas, L.G., 1982). Let W_i denote the importance degree for the ith criteria. Then,

$$W_i = \frac{1}{n}\sum_{j=1}^{n}(a_{ij}/\sum_{i=1}^{n}a_{ij}), \quad i,j = 1, 2, \ldots, n \quad (2)$$

(C) Test the consistency of the importance degrees:

Due to the limitation of Saaty's discrete nine-value scale and the inconsistency of human judgments when assessing weights during the pairwise comparison process, the aggregation weight vector might be invalid. Examination of consistency of the importance degrees should be made to avoid inconsistencies occurring when using different measurement scales in the evaluation process (Karapetrovic, S. and E.S. Rosenbloom, 1999; Kwiesielewicz, M. and E. van Uden, 2004) suggested the maximal eigenvalue λmax be used to evaluate the effectiveness of measurements. To check the consistency between pairwise comparison judgments, the consistency index (CI) and consistency ratio (CR) are calculated using the equations

$$\mathrm{CI} = (\lambda_{\max} - n)/(n-1) \text{ and } \mathrm{CR} = \mathrm{CI}/\mathrm{RI} \quad (3)$$

Where RI is a random index with a value obtained from different orders of pairwise comparison matrices. If the value of the CR is below 0.1, the evaluation of the importance degrees is considered to be reasonable. In general, the AHP is developed to select the best of a number of alternatives with respect to several criteria.

Expected Results and Discussion:

The process and implementation of Ecological Carrying Capacity Theory in conservation and tourism through Analytic

Hierarchy Process (AHP) model can more developed and clearly highlight and strategized towards sustainability. Results also will enhance the understanding of the interrelations between conservation goals and tourism development in protected area. Besides, result s and AHP methodology can help decision makers prioritize terrestrial engineering and environmental efforts. Result also enables researchers to put more expert knowledge together, allowing more precise decisions and moderating personal judgments. The Mount Kinabalu and a policy of protection priority that takes into consideration the annual limitations of the government's budget and the emergency of protecting environment

The introduction of protection priority using the Carrying Capacity Theory and Analytic Hierarchy Process (AHP) model can be apply in Sabah because the problem of environmental conservation cannot be completely solved at this time due to insufficient knowledge, human skills, strategies and government budgets. Therefore, prioritization of terrestrial protection should be made yearly to match engineering and environmental requirements and annual official budgets. Through this study, the priority of environmental protection will be shown based on the division of some predetermined criteria (using Carrying Capacity Theory and AHP Model). Thus, environmental planning and tourism can be implemented more organized, efficient and sustainable in line with Malaysia's strategic agenda to address global environmental issues. Besides, the implication of this study also can be used for creating public awareness, planning sustainable communities, national and international development.

The result s will suggest an integrated plan for improving environmental conservation and tourism of the Mount Kinabalu and a policy of protection priority that takes into consideration the annual limitations of the government's budget and the emergency of protecting environment for achieving sustainable development.

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