Protection Priority in Mountain Environment Using Analytic Hierarchy Process (AHP) on Kinabalu Park, Sabah.

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Abstract

Environmental degradation is one of the largest threats that are happening especially in protected areas. This is due to protected areas provide not only environmental benefits but also social and economic benefits to people and communities worldwide. Kinabalu Park, Sabah is declared by UNESCO as Malaysia's first World Heritage Site in 2000 and the park is classified into category II (National Park). A national park is very closely related to nature-based tourism, being a symbol of a high-quality natural environment with a well-designed tourist infrastructure. Among the main reasons for people coming to Kinabalu Park is to enjoy the beauty of nature as its flora and fauna diversity and also the magnificent mountainous landscape. This paper focuses on prioritizing the environment aspect that being affected by the tourism activities and some of the acts of irresponsible visitors. If the environmental degradation continues, this might harm the environment on the long term basis. The method that will be using is Analytic Hierarchy Process (AHP) to prioritize the protection of the environment on the study area. It can help decision makers to prioritize on which matter that they need to focus more on and also enables to put more expert knowledge together allowing more precise decisions and moderating personal judgments.

Keywords: Environmental degradation, conservation, Kinabalu Park.

1. Introduction

Society nowadays gives more interest in nature based tourism and most of the tourism occurs in fragile areas or areas of high biodiversity. It will cause conflict and crowding based on issues about the interaction between the social and biophysical environment in the carrying capacity theory (Latip et al., 2015). Conflict is a common and difficult issue in many natural areas around the world, due to incompatibilities between different uses of the same resource (Hammitt and Schneider, 2000). Conflict occurs when the group aims are disrupted by the actions of another user group. Crowding is one of researched aspects of tourism and recreation in natural areas. Crowding occurs because of the number of people within a defined area reaches a point which it is perceived to interfere with the values, activities or intentions of the visitors. Growth in a number of visitors and diversity used has cause conflict to appear on management issue in many natural areas.

Kinabalu Park with the area of 75,370 hectares was established on 1964 with the basic purpose for the benefit, education, and enjoyment of the people (Ali and Basintal, 1997). The park is under the management of Sabah Parks Board of Trustees or Sabah Parks. Due to its high biodiversity and the high percentage of local endemics, especially flora, Kinabalu Park has been identified as one of Malaysia's centers of plant diversity and designated as a Centre of Plant Diversity for Southeast Asia (UNESCO WHC, 2007). It is one of the richest plant regions in the world with over 5,000 species of plants included over 800 species of orchids, over 600 fern species and 13 species of pitcher plants. Kinabalu Park is renowned for its ecology, ecology, flora, and fauna had been declaring as Malaysia's first World Heritage Site

in 2000 by United Nations Educational, Scientific and Cultural Organization (UNESCO). Kinabalu Park is one of the most famous attraction spot in Malaysia and specifically in Sabah. With the height of 4,095 meters, Mount Kinabalu becomes one of the main reasons people flocked to come and enjoy the majestic mountainous landscape scenery (Latip and Rais, 2016). For the year 2014 based on the visitor's statistics done by the Sabah Parks, the number of visitors to Kinabalu Park is about 714, 164 and about 58, 428 of them are climbers. The number of visitors has increased from year to year. As the number of visitors increases, the quality of the environment may decrease if the tourism activities are not controlled.

Mountain areas are highly fragile and consist of high biodiversity. This is due to its great latitudinal and climate range of the mountain consist from tropical lowland and hill rainforest to tropical forest, sub-alpine forest and scrub on the higher elevations (Kurzweil, 2013). In addition, the diverse geology gives rise to various types of soils. Evolution of the species influences by the precipitous topography and severe El Nino and other catastrophic events. However, the tourism activities at mountain areas give negative impacts towards its sensitive environment. The quality of the environment may be degraded. Moreover, due to the soil type at Kinabalu Park mostly is ultramafic soil, soil erosion prone to happen easily.

With the rapid development of tourism industry in Kinabalu Park since the park opened in 1964, the park has experienced an increasing use of its natural and cultural environment for tourism, resulting in tourism resources being adversely impacted. Moreover, Kinabalu Park has a highly fragile environment that easily harmed by the tourism activity. The most activity done at Kinabalu Park is mountain climbing related activities other than sightseeing (Talib, Chan and Mereng, 2014). It is essential to maintain or enhance the quality of tourism development for the park (Zhong et al. 2011). Every tourism activities, there are negative impacts towards the environment in the park such as environmental degradation, garbage accumulation, overuse of natural resources, wildlife disturbance and overcrowding of visitors. The high number of visitors to the park, inappropriate visitor behavior, lack of visitor awareness can make the negative impacts much worse. Due to tourism activities that being done within the area, conservation work must be done more properly because of tourism creates pressures on the natural and cultural environment, and also for the resources can be used or enjoy a long period.

With the result from AHP, it will help the park management with their monitoring activity also. Monitor negative environmental impacts such as trail erosion, improper waste dumping, littering, water pollution, illegal collecting of plant or animals and feeding of wildlife. The data are important for virtually all management activities, for public reporting and for communication with the government (Eagles, 2014).

Thus, this paper focuses on prioritizing the environment aspect that being affected by the tourism activities and some of the visitor's irresponsible acts. If the environmental degradation continues, this might harm the environment on the long-term basis if the tourism activities continue at Kinabalu Park. Degradation of the environment because of the tourism occurs at mountain areas is a concern for the park management. In order to reduce the impact towards the environment, AHP is used to help the park management with prioritizing on which factors that they need to give more attention or encounter first. Thus, the tourism at Kinabalu Park can be sustained.

2. Methodology

Analytic Hierarchy Process (AHP) techniques are used as a tool in decision making process for an environment protection at Mount Kinabalu. The main factors are environmental degradation, tourism activities and prohibited acts are the main factors for the AHP and the factors were ranked by the opinion of the respondents. 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, 2008). The procedure of AHP can be expressed in a series of steps:
(1) Construct a paired comparison matrix.

A pair wise 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 pair wise comparisons are evaluated for n criteria. Let a represent an n X n pair wise comparison matrix:

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

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 $a_{ij}> 0$, $i \neq j$.

(2) 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, 1982). Let W_i denote the importance degree for the ith criteria. Then,

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

(3) 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 and Rosenbloom, 1999; Kwiesielewicz and Van Udem, 2004) suggested the maximal eigenvalue λmax be used to evaluate the effectiveness of measurements. To check the consistency between pair wise comparison judgments, the consistency index (CI) and consistency ratio (CR) are calculated using the equations:

$$CI = \left(\lambda_{\max} - n \right)/(n-1) \text{ and } CR = CI / RI \qquad (3)$$

Where RI is a random index with a value obtained from different orders of pair wise 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.

Table 1: The relational scale proposed by Saaty (1980) for pair wise comparisons

Scale	Judgement of preference	Description
1	Equally important	Two factors contribute equally to the objective
3	Moderately important	Experience and judgment slight favour one over the other
5	Strongly important	Experience and judgment stronger favour one over the other
7	Very strong important	Experience and judgment very strongly slight favour one over the other, as demonstrated in practice
9	Extremely important	The evidence favouring one over the other is of the highest possible validity
2,4,6,8	Intermediate preferences between adjacent scales	When compromise is needed

Source: Saaty (1980)

3. Result and Discussion

Tables below show the AHP analysis for environmental degradation, tourism activities and prohibited acts.

3.1 Environmental degradation

Table 2 is the value for AHP analysis for impacts from tourism activities towards the environment. The highest average score and ranked as first soil impacts such as bare ground and soil erosion at a few places in the park with 0.2783. It can be seen that some soil erosion around the park area and due to the type of soil at Kinabalu Park, soil erosion happen naturally sometimes. The Bare ground is spotted mostly at the trails in the park and vegetation area where people always stomp on. The next impact that ranked as second is the impact on vegetation such as the presence of non-native plant, damaged tree and plants and exposed roots of trees with 0.2207. This is because of the soil erosion when the soil is removed then the tree roots are exposed and mostly at the trails where many of the visitors walk through. Damaged tree and plants are because of some of the irresponsible visitors disturb the plant's presence in the park. Furthermore, the presence of non-native species such as the dandelions that is a concern for the park management because it might threaten the native species. Garbage accumulation with 0.1524 is ranked at third. This is due to the increase of a number of visitors to the park and also because of the littering by the visitors. Garbage can be seen scattered at few places in the park where most visitors are occupied. This situation often can be seen during peak season such as during school holidays.

Table 2: AHP analysis for impacts towards the environment

Impacts	Average	Rank
Soil	0.2783	1
Water	0.0511	7
Vegetation	0.2207	2
Garbage	0.1524	3
Smell	0.1228	4
Air	0.1001	5
Noise	0.0745	6

Next, bad smell from the garbage and toilet is ranked at fourth with 0.1228. The bad smell occurs usually when the garbage accumulates. Ranked on fifth is air pollution with 0.1001 due to some people are smoking and from the vehicles at the park. Transportation is one of the cause of air pollution in the park because they still use the non-green buses that still emit heavy black smoke. The climbers take this bus from the park HQ to Timpohon Gate to start their climb. Noise pollution comes at sixth with 0.0745, due to the crowded of visitors mostly during peak seasons and also from the visitor's vehicles. The buses that they using for transport the climbers also produce the loud sound. Ranked as last is impacts on water such as water turbidity, cleanliness of the water and some of can be seen waste in the drainage with the average score of 0.0511. The consistency ratio (CR) should be less than 0.1 for considered to be reasonable and the CR is 0.0487.

3.2 Tourism activities

Table 3: AHP analysis for activities that give impact to the environment

Activities	Average	Rank
Mount Climbing	0.3889	1
Activities at summit	0.1953	2
Bird watching	0.0685	6
Sightseeing	0.1362	3
Nature education	0.1181	4
Photography	0.0930	5

Table 3 is the value for AHP analysis for the activities that give most impact towards the environment. Mount climbing has the highest average score and ranked as first with 0.3889 which means that this activity gives the most impact and need to give priority to the management of the trails and the surrounding. Around 200 people include the climbers, guide and park staffs walk on the summit trails every single day since the park opened for mountain climbing. Follow the activities at the summit such as via Ferrata with 0.1953 ranked as second. In 2007, private companies, Mountain Torq manage the tourist activity at the summit of Mount Kinabalu. Mountain Torq as the first mountaineering training center in South East Asia also offers activities such as via Ferrata, sports and rock climbing, rappelling and mountaineering skills course at the height of 3,200 meters to 3,776 meters on the Mount Kinabalu. It is the world's highest Via Ferrata in a UNESCO World Heritage Site. Rank at third, sightseeing with 0.1362. After Kinabalu Park was declared as one of the World Heritage Site, local and international visitors become more interested with the park and the number of visitors increase. There is no limit numbers of the visitors and might harm the environment. Fourth is nature education with 0.1181, there are designated zone in the park such as botanical garden and natural museum for educational purposes and do not disturb much the environment. Fifth is photography with 0.0930 and the least impact towards the environment is bird watching activity with 0.0685. The CR is 0.0782.

3.3 Prohibited acts

Table 4 is the value for AHP analysis for the prohibited acts done by the visitors that are seen happen in the park surrounding. Littering has the highest average score with 0.5734 which means that this activity is the most frequently seen happen in the park. Littering still occur even though there is rubbish bin being prepared around the park. The walking and summit trails, drainage, river banks and places that are always crowded with the visitor, litters can be seen. Littering prohibited signs are seen in the park area but still, there is some irresponsible visitor that litters around the HQ areas and also along the summit trails. The mountain guides

give the briefing on do's and don'ts that include cannot litter before start the climb. Ranked second is plucking plants with 0.1897 and disturbing animals is ranked fourth or the last activity was seen happen in the park. Kinabalu Park is a protected area filled with the diversity of flora and fauna, some of it is endangered or vulnerable. So supposedly the plants and animals cannot be plucked or disturbed but some visitors plucked the flowers and disturb the plants in the park area and along the trails during climbing. Smoking is ranked third with 0.1779. Some of the visitors do smoke in the park area and the cigarettes might cause the fire at the park. Smoking also contributes to air pollution.

Table 4: AHP analysis for most of the prohibited acts seen in the park

Activity	Average	Rank
Littering	0.5734	1
Disturb animals	0.0590	4
Plucking plants	0.1897	2
Smoking	0.1779	3

4. Conclusion

This paper presents a method using the techniques of an AHP for making decisions for the prioritization of environment protection for Kinabalu Park. The main factors are environmental degradation, tourism activities and prohibited acts for this research. The introduction of protection priority using Analytic Hierarchy Process (AHP) model can be applied 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. The results 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 the environment for achieving sustainable development. Besides, the implication of this study also can be used for creating public awareness, planning sustainable communities, national and international development. As tourism at protected areas continues to grow as do pressures associated with it, effective planning and management of tourism become absolutely critical in order to ensure the ecological sustainability of these areas. Park management can know which tourism activity that gives the most impact towards the environment, then they can give extra attention to the problem and come out with better solutions. Thus, Mount Kinabalu can be managed more organized, efficient and sustainable. As a result, this technique will improve the conservation effort and also sustainable tourism of Mount Kinabalu.

5. Acknowledgement

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