VIEWSHED ASSESSMENT OF TRAILS IN MOUNTAIN PARKS, SABAH

Wilson Wong [1]* & Mui-How Phua[2]

[1] *School of International Tropical Forestry, Universiti Malaysia Sabah, Locked Bag 2073, 88999 Kota Kinabalu, Sabah, Malaysia; Tel: +6-088-320000 (ext. 8774); email : w.wilson@ums.edu.my*

[2] *School of International Tropical Forestry, Universiti Malaysia Sabah, Locked Bag 2073, 88999 Kota Kinabalu, Sabah, Malaysia; Tel: +6-088-320000 (ext. 8773); email : pmh@ums.edu.my*

KEYWORDS: Scenic beauty, Viewshed, Trail, Mountain Parks

ABSTRACT: Scenic beauty is one of important factors in attracting visitors to visit a park and managing this scenic beauty property in parks has gained priority concern in park management. The availability of viewshed analyses function in Geographic Information System (GIS) has provided a tool for park managers in assessing the view. This study is to assess and compare the visible area or viewshed of trails in two mountain parks Sabah, namely the Kinabalu Park (KP) and Crocker Range Park (CRP). The view is assessed by using viewshed analysis, a tool in GIS and using Digital Elevation Model (DEM) from Shuttle Radar Topography Mission (SRTM). The result could provide a baseline and useful information for trail planning especially the scenic beauty along trail in parks which will lead to the increase of visitorsô experience and satisfaction for hiking activity.

1. INTRODUCTION

Scenic beauty is the main visitorsô motivation to visit mountain parks. Shelby *et al.* (2003) pointed out that view can be an important and perhaps the dominant consideration. Numerous studies also supported and confirmed that view is an important element which needs to be given high consideration in parks planning and management (e.g. Barnes *et al. 1997,* Farías Torbidoni *et al.* 2005; Abdullah *et al*. 2005; Vaske *et al.* 1995). Every landscape on earth has its own special appeal and its own distinct geological feature and climatic conditions which produce an individual array of flora and fauna (Leier, 2005). Scenic views of the outdoorôs physical environment vary substantially in the extent to which visitors prefer. Purcell & Lamb (1998) indicated that scale or extent of view along with naturalness, topographic variation and the presence of water as a particularly powerful factor in preference.

A system for managing scenic beauty must be a key component of any forest planning and management system (Meitner & Daniel, 1997). Peron *et al.* (1998) stated that the largest effect on preference was related to scene type, an effect that is difficult to explain using either of the models of preference. View quality rating is an important component of land management that is still undergoing parameter definition and technical development (Germino *et al*., 2001). Both approaches are applied to tasks such as identifying areas of scenic beauty, estimating the visual impact of landscape changes, or comparing the quality of different views. These applications require consideration for viewer perception and incorporating higher-order variables of preference, such as information and psychological variables (Kaplan & Kaplan, 1982). Technical challenges include the incorporation of readily obtainable land cover and elevation data to produce accurate viewshed simulations with practical computer methods (Bishop and Hulse, 1994; Crawford, 1994).

Viewshed analysis is now a common feature of environmental impact statements and should be widely used in visual assessment of parks. The ability to quantitatively model scenic beauty would greatly enhance the incorporation of visual analysis into land management (Germino *et al*, 2001). Bishop & Hulse (1994) suggested that more objective and cost-effective visual assessment and prediction procedures be developed by using GIS together with prediction equations based on assessment of video panoramas of locations affected by landscape change. As this process continues to develop and evolve, a better significant and robust model will appear to fulfill the need for view protection of scenic view. View mitigation measures are able to improve view in parks. Various methods have been proposed and evaluated such as vegetative screening, screening with landforms, native shrub and tree planting (Ramos & Panagopoulos, 2004). View shed analysis can follow several approaches, each suitable for different applications (Arthur *et al*., 1977). While the planimetric approach appeared superior for quantifying the dimensions (areal extent, relief, depth) of viewsheds, the panoramic computer simulations of viewsheds were superior for representing the composition (landcover, diversity, edge) of views observed at ground level (Germino *et al*., 2001). A three-dimensional GIS model, which includes the effects of slope, aspect, and distance, as well as the height of landscape features, is used to calculate the proportion of land-cover areas that make up the view also known as Visual Magnitudes (Grêt-Regamey *et al.*, 2007).

2. LOCATION OF STUDY

This study was carried out in Kinabalu Park (KP) and Crocker Range Park (CRP). KP and CRP are two mountain parks in Sabah under the jurisdiction of Sabah Parks (Figure 1). These parks are blessed with a bountiful of nature attractions of scenic landscape, wildlife and plant. These sites are selected due to its potential in providing nature-based recreational activities in Sabah which is able to benefit socially and economically at the local, state and national levels.

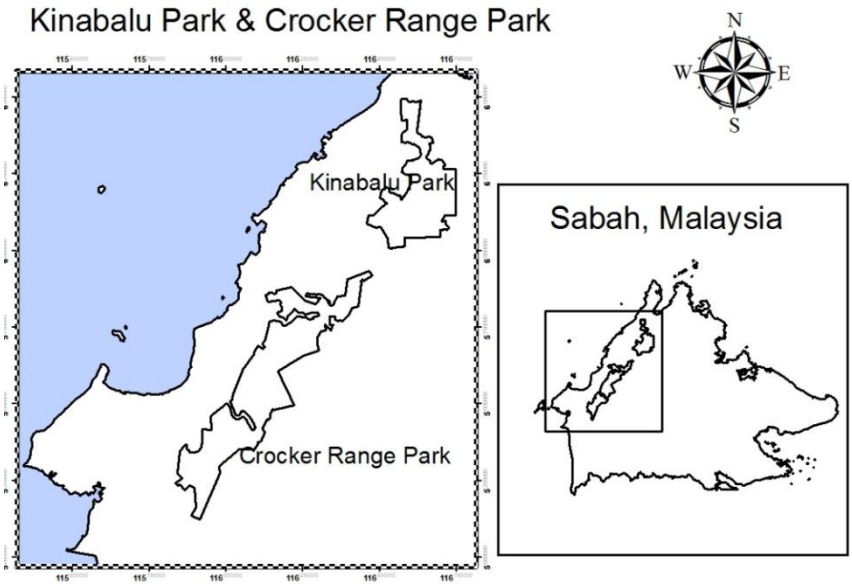

Figure 1 : Location of Kinabalu Park and Crocker Range Park

3. MATERIALS & METHODS

A Viewshed spatial analysis was employed to assess the visibility of three selected trails (Summit trail, Mesilau Trail and Crocker Nature Trail) in Kinabalu Park and Crocker Range Park (see Figure 2). Digital Elevation Model (DEM) or Digital Terrain Model was generated by using Shuttle Radar Topographic Mission (SRTM) data which was obtained from Consultative Group on International Agricultural Research (CGIAR) Consortium for Spatial Information (CGIAR-CSI). CGIAR-CSI was able to provide DEM of 90m resolution of the entire globe. The original SRTM digital elevation data was originally produced by National Aeronautics and Space Administration (NASA). Version 4 of SRTM data from CGIAR-CSI was used for the generation of DEM for the viewshed analysis in this study. This latest version represents a significant improvement from previous versions, using new interpolation algorithms and better auxiliary DEMs.

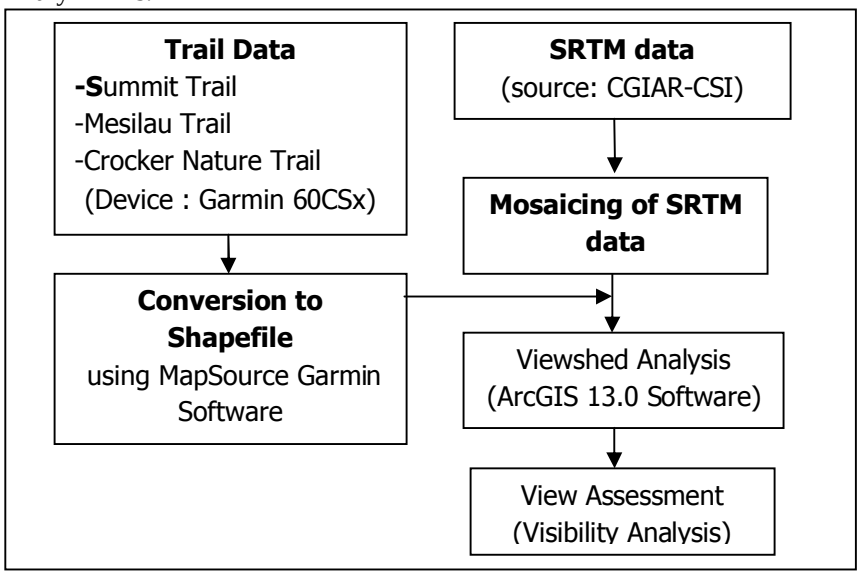

Figure 2. Flowchart of visibility assessment on trails in Kinabalu Park and Crocker Range Park

Trail data for all three selected trails for visibility assessment were obtained by using the Global Positioning System (GPS) device. The GPS device used in this study was Garmin 60CSx model. The trail data were then systematically divided into points of 200 meter intervals which were used for visibility points in the viewshed analysis. The number of visibility points for Summit Trail, Mesilau Trail and Crocker Nature Trail were 16, 27 and 7 respectively. The visibility points and DEM data were then overlaid to generate viewshed by using ArcGIS version 13.0 software. Total visible area and average visible area were then computed and compared amongst Summit Trail, Mesilau Trail and Crocker Nature Trail.

4. RESULTS & DISCUSSIONS

The view assessment investigated the visible area by using viewshed analysis. Viewshed analysis is a widely available function in GIS software. Digital Elevation Model (DEM) is needed for the viewshed analysis. DEM for this study was derived from the Shuttle Radard Topographic Mission (SRTM) data with a resolution of 90m. Objective analyses based on common variables and methods are needed for comparison between viewing points of which this assessment is examining the average visible area of each point.

Table 1. Visibility analysis on trails in Kinabalu Park and Crocker Range Park

	Summit Trail	Mesilau Trail	Crocker Nature Trail
Total Visible Area (Ha)	1,816,911	2,678,493	475,656
Average Visible Area Per point (Ha)	113,557	99,203	67,951

Viewshed analysis result shows that the total visible area (Table 1) for Mesilau Trail (2,678,493 Ha) is the highest compared to the Summit Trail (1,816,911 Ha) and Crocker Nature Trail (475,656 Ha) by 32.16% and 82.21% respectively. However, the average visible area for each point (Figure 3) was highest for the Summit Trail (113,557 Ha), followed by Mesilau Trail (99,203 Ha) and Crocker Nature Trail (67,951 Ha). It is suggested that a visible area is influenced by topographic, elevation and distance of a trail. However, more complex parameters need to be addressed and given consideration in assessing visual quality in parks. View quality rating is an important component that is still undergoing parameter definition and technical development (Germino et al., 2001).

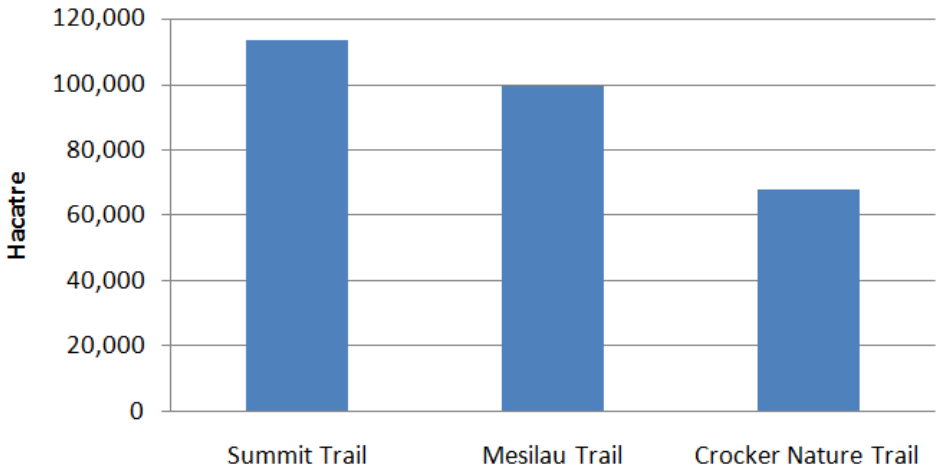

Figure 3. Average visible area per point (Ha)

Although view is important factor in attracting visitors, other factors also influence visitorsô preference on trail use and choice a) conditioned by the degree of accessibility and difficulty; b) other factors such as the popularity of the place, the beauty of the scenery, and recommendation by park staff (Farías Torbidoni *et al.*, 2005). Accessibility and satisfaction factors were found to be critical factors in visitorsô trail choices as also reported by McCool and Reilly 1993; Watson *et al.*, 1996). Farías Torbidoni *et al.* (2005) reported that conservationists and casual visitors mostly

choose short trails while adventurous visitors mostly choose long trails or trails ending on a peak. Peron et al. (1998) presented that the largest effect on preference was related to scene type, an effect that is difficult to explain using either of the models of preference. Scenes of the outdoor physical environment vary substantially in the extent to which they are preferred. Purcell & Lamb (1998) showed that extent of view is important in preference along with vegetation cover which associated with naturalness, where type of vegetation interacted significantly with structural integrity, and foliar density. The result from their study confirmed in general the belief that vegetation plays a significant role in creating preference for natural scenes. Kaplan and Kalpan (1982) suggested that future view quality modeling research should examine the transferability of scenic beauty concepts and measures among regions and over the wide range of scales that views may encompass. The importance to preserve scenic views has gained both public and scientistsô concern. Visual impact assessment should be made available for public review and demonstrate that any proposed development will achieve visual quality objectives (Lucas, 1991). Bishop and Wulse (1994) demonstrated that the use of GIS together with prediction equations based on assessment of video panaromas of locations affected by landscape change, improved objective and cost-effective visual assessment and prediction procedures may be developed.

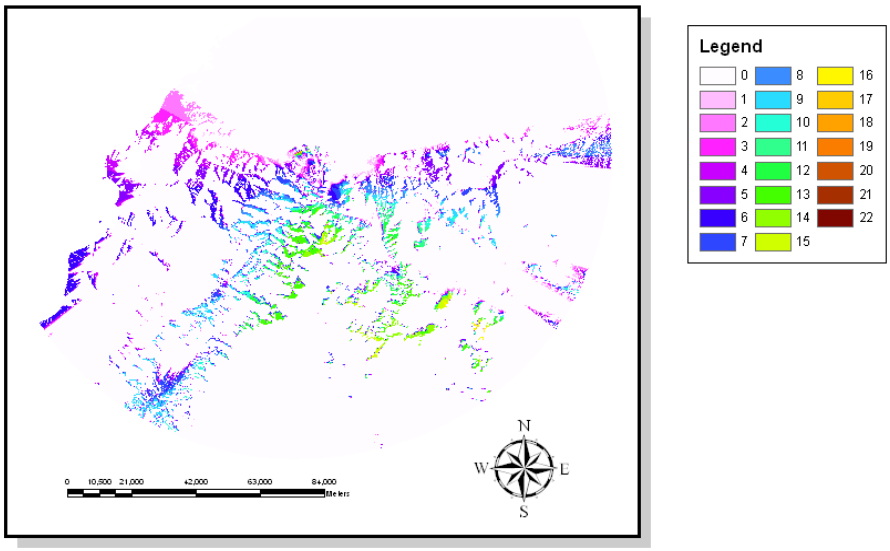

Figure 4 : Viewshed Analysis Result one of the trails being assessed, (Mesilau Trail, Kinabalu Park-5.5 km)

5. CONCLUSION

Views seem to play important factor for visitorsô preference. The view assessment result demonstrated that the visible area of trail in Kinabalu Park is greater than trail in Crocker Range Park. This could explain the reason that Kinabalu Park received higher number of visitors than Crocker Range Park. Preservation of scenery must be prioritized as visitors are found to prefer scenic views (also by Farías Torbidoni *et al,* 2005; Barnes *et al.,* 1997). Scenery-viewing facilities such as viewing-tower, pavilion and trails should be developed, maintained and promoted. While trails in Kinabalu Park has been well developed (e.g. Summit Trail and Mesilau Trail), more scenic trails need to be developed to enable visitors to participate in nature recreation (e.g. scenery-viewing, hiking). A GIS-based tool, namely the viewshed analysis is able to assist in visibility assessment in planning for new trail.

Reference

Abdullah Mohd , Amat Ramsa Yaman , Tan Choon Keat and Yip Hin Wai , 2005. Campersô Characteristic, Recreation Activities and Related Forest Camping Attributes in Shah Alam Agriculture Park, Selangor. Journal of Applied Sciences, 5: 1546-1552.

Arthur, L.M., Daniel, T.C. and Boster, R.S., 1977. Scenic assessment: an overview. Landscape Plann. 4, pp. 109ï 129

Barnes, J.I., Schier, C. and van Rooy, G., 1997. Tourists' willingness to pay for wildlife viewing and wildlife conservation in Namibia. Research Discussion Paper No. 15, Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek, Namibia. 24pp.

Bishop, I.D. and Hulse, D.W., 1994. Prediction of scenic beauty using mapped data and geographic information systems. Landscape Urban Plann. 30, pp. 59ï 70

Crawford, D., 1994. Using remotely sensed data in landscape visual quality assessment. Landsc. Urban Plan., 30: 71-81.

Farías Torbidoni, E. I., Grau, H. R. and Camps, A., 2005. Trail Preferences and Visitor Characteristics in Aigüestortes i Estany de Sant Maurici National Park, Spain. Mountain Research and Development 25 (1), 51ï 59.

Germino, M.J., Reiners, W. A., Blasko, B.J., McLeod, D., Bastian, C. T., 2001. Estimating visual properties of Rocky Mountain landscapes using GIS. Landscape Urban Plannning., 53: 71-83.

Grêt-Regamey A, Bishop, ID, Bebi, P., 2007. Predicting the scenic beauty value of mapped landscape changes in a mountainous region through the use of GIS. Environment and Planning B: Planning and Design 34(1):50ï 67.

Kaplan, S. & Kaplan, R., 1982. Cognition and the environment: functioning in an uncertain world, New York, Praeger.

Leier, M, 2005. 100 Most Beautiful National Parks of the World: a Journey Across Five Continents, Chartwell Books.

Lucas, O.W., 1991. Design of forest landscapes. British forestry comition. Oxford University Press, New York

McCool, SF, Reilly, M., 1993. Benefit segmentation analysis of state park visitor preferences and behavior. Journal of Park and Recreation Administration 11(4):1ï 14

Meitner, M., & Daniel, T., 1997. Vista Scenic Beauty Estimation Modeling: A GIS Approach. In Proceedings, ESRI Users Conference, July 1997, San Diego, California., ESRI Press

Peron, E., Purcell, A. T., Staats, H. J., Falchero, S., & Lamb, R. J., 1998. Models of preference for outdoor scenes: Some empirical evidence. Environment and Behavior, 30, 282-305.
Purcell, A.T., Lamb, R.J., 1998. Preference and naturalness: an ecological approach. Landscape Urban. Planning 42, 57-66

Ramos, B. and Panagopoulos, T., 2004. The use of GIS in visual landscape management and visual impact assessment of a quarry in Portugal. Proceedings of the 8th International conference on Environment and Mineral processing. June 24-26, 2004, Ostrava, Tzech Republic, Vol 1: 73-78.

Shelby, B., Thompson, J. R., Brunson, M., and Johnson, R., 2003. Changes in scenic quality after harvest: A decade of ratings for six silviculture treatments. Journal of Forestry. March/April (p.30-36)

Vaske, J. J., Wittmann, K., Laidlaw, S., & Donnelly, M.P. ,1995. Human-Wildlife Interactions on Mt. Evans. Project Rep. for the Colo. Div. of Wildlife, Human Dimensions in Nat. Res. Unit Rep. No. 18, Colorado State Univ., Fort Collins. 56 pp.

Watson, A., Hendee, J., Zaglauer, H., 1996. Human values and codes of behavior: Changes in Oregonôs eagle cap wilderness visitors and their attitudes. Natural Areas Journal 16(2):89ï 93.