



Impacts of Recreation Activities on Growth and Physiological Characteristics of Upper Mountain Vegetation

A.Z. Azita (Corresponding author)

Department of Forest Production, Faculty of Forestry
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
Tel: 60-3-8946-7585 E-mail: azitazawawi@yahoo.com

A.H. Hazandy

Institute of Tropical Forestry and Forest Products
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
Tel: 60-3-8946-7585 E-mail: hazandy@putra.upm.edu.my

H. Mohd-Zaki

Department of Forest Production, Faculty of Forestry
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
Tel: 60-3-8946-7170 E-mail: zakihamzah@yahoo.com

S. Mohd-Nazre

Department of Forest Production, Faculty of Forestry
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
Tel: 60-3-8946-7196 E-mail: nazre@putra.upm.edu.my

H.Z. Pakhriazad

Department of Forest Management, Faculty of Forestry
Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
Tel: 60-3-8946-7225 E-mail: asato40@yahoo.com

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Abstract

This study examines the impacts of recreation activities on Mount Tahan (2187 m a.s.l); the highest mountain in Peninsular Malaysia by assessing tree diameter, height, leaf area, sapwood area, and chlorophyll fluorescence (CF) of selected species. Vegetation cover was also determined by counting the number of species. Two most dominant tree species in the study plots, i.e., *Tristaniaopsis fruticosa* and *Baeckea frutescens* were selected as representative to assess the impacts on the vegetation growth. Both tree species dominated over 50% of total vegetation in both areas. Meanwhile, CF was determined on *T. fruticosa* since this species was the only broadleaf species found in both areas. Four plots sized 20 m X 20 m representing each disturbed and undisturbed were established in camping and trampling areas. The total number of plant species recorded was 29 in both camping and trampling areas but was found less in disturbed plots. Impacts of trampling and camping on all the parameters at higher altitude in disturbed plots were significantly different from those in the undisturbed plots. For trampling, all growth parameters taken in disturbed plots were found lower than in undisturbed plots. For camping, however, the mean values of vegetation cover were found

lower in disturbed plots compared to undisturbed plots but the mean values of tree diameter, height, leaf area and sapwood area were found greater in disturbed than in undisturbed plots. In contrast, all CF parameters were found higher in disturbed plots for both trampling and camping areas.

Keywords: Recreation activities, Physiological characteristic, Chlorophyll fluorescence, Upper mountain

1. Introduction

Recreation ecology is in a sense a redefining of an age-old activity. Doubtless, human moving through the wilderness or bush have always observed the impacts of others who may have gone before them (Liddle, 1997). The impacts of outdoor recreation, including ecotourism, are extensive and increasing; focusing more and more on the world's remaining natural areas. As attitudes to nature in its untamed state changed from fear to admiration, so many people ventured further and more frequently to explore natural areas, climb mountains and generally to create recreation impacts.

Recreational use of wilderness inevitably results in some change to resource conditions. A variety of impacts to soils and vegetation occur at wilderness campsites and other destinations (Cole & Marion, 1988). Large and sometimes ecologically sensitive areas have been developed with facilities to accommodate visitor use and recreationists unintentionally trample vegetation, erode soil, and disturb wildlife. By virtue of their massive numbers, protected area recreationists pose a real and significant threat to the very resource they so cherish. This is particularly true at backcountry attraction sites, campsites, and along trails, where visitation and its effects are concentrated. Specific consequences of visitation to these areas include the trampling and subsequent loss of ground vegetation, shrubs, tree seedlings, and felling of saplings; erosion of surface litter and humus; exposure, erosion, and compaction of mineral soil; and exposure of tree roots and damage to tree trunks.

In this study, we evaluated the impact of camping and trampling activities on vegetation both in the disturbed and undisturbed areas at Mount Tahan. Mount Tahan has important environmental, cultural and economic values which is important not only in its biological richness but more for its other ecological functions. The objective of this study is to quantify the impacts of camping and trampling on growth and physiological attributes of vegetation in upper mountain area both in disturbed and undisturbed areas. The type, magnitude, and, in some instances, the causes of resource deterioration and improvement can be detected and evaluated. Deteriorating conditions can be detected before severe or irreversible impacts occur, allowing time for implementing corrective actions.

2. Materials and Methods

2.1 Study area

The study was carried out in Mount Tahan (2,187 m a.s.l.), which is the highest point in Peninsular Malaysia located within the Taman Negara (national park), in the state of Pahang with the coordinate of 4°38'N, 102°14'E and with an area of 1,677 square miles (4,343 square km). Mount Tahan is considered as the toughest trek in Southeast Asia. The elevation of the study areas ranged from 1800 m above and topography is hilly with slopes of 50 to 70 degrees. The soils have a high percentage of sandy, loam and rock. There are three ways of climbing this mountain, of which the two most popular ones are from Kuala Tahan and Merapoh. The number of visitors that reached the summit was estimated about 1892 to 2838 from 1996 to 2005.

2.2 Experimental design

This study followed a standard experimental procedures for studying recreational trampling of vegetation proposed by Cole and Bayfield (1993). Most studies has derived conclusions by comparing the vegetation of trampled sites with the vegetation of un-trampled sites. The types of vegetation impact that can be described are changes in vegetation cover, chlorophyll fluorescence measurements and growth attributes. i.e vegetation height and leaf area. In this study, four plots sized 20 X 20 representing disturbed and undisturbed were established in each camping (Botak area) and trampling (trekking trail) areas. For undisturbed, plots were located about 20 m away from disturbed plots whether on the left or the right side depending on the topography of the selected areas. All species were counted and identified whereas two species, i.e., *T. fruticosa* and *B. frutescens* were selected for growth and chlorophyll fluorescence measurements as well as for anatomical studies. For each species, 20 individual trees were randomly selected and labeled.

2.2.1 Diameter, height, leaf area, sapwood area and vessel size measurements

Tree growth is an important facet of stand dynamics. Information about growth can be used to determine if there are any unusual spatial or temporal patterns in growth rates; or if the balance between growth and mortality is adequate to sustain a forest ecosystem. Tree growth data contribute to the investigation of several key forest ecosystem attributes such as sustainability, productivity, and aesthetics. Measurements of stem diameter were taken at about 10 cm above the ground using a digital veneer caliper, whereas height was measured with a meter ruler and a height stick depending on the height of the selected trees. Five trees in each plot were chosen for destructing sampling. All the leaves were excised and bagged. Total leaf area was measured by using LiCor 3100 leaf area meter (LiCor, USA). Meanwhile, sapwood

area was determined from cut stem at 10 cm above the ground. About 10 cm disc from each destructed tree was brought back to the laboratory for anatomical studies.

2.2.2 Chlorophyll fluorescence measurement

Chlorophyll fluorescence is also very useful to study the effects of environmental stresses on plants since photosynthesis is often reduced in plants experiencing adverse conditions, such as water deficit, temperature, nutrient deficiency, polluting agents, and attack by pathogens. Fv/Fm has been used and widely accepted for many years as an indication of the maximum efficiency of Photo system II. It is highly effective and sensitive parameter which may be used as an indicator of sample stress. For each plot, five trees of *T. fruticosa* sp. were chosen for chlorophyll fluorescence measurements. Leaf clips were placed on three leaves per tree with shutter in closed position for dark adaptation. The dark adaptation took about 5 to 10 minutes. A record of one second at full intensity was set using the fluorimeter (Hansatech Handy PEA, UK).

2.3 Data Analysis

All data were analyzed and compared using T-test. The statistical analyses were performed using Social Package for Social Sciences version 12.0 and the significance level was set at 0.05. Species composition and the number of unique species were determine by using Jackknife estimate for quadrat counts ecological software

3. Results

3.1 Species composition

Total species found was 29 in both camping and trampling areas. About 23 species were recorded in undisturbed plots whereas only 14 species were found in disturbed plots (Table 1). However, the number of unique species was 25 based on Jackknife estimate for quadrat counts. It has been recorded that *T. fruticosa* dominate most of the area both in disturbed and undisturbed sites. From the table, we can see that trampling and camping resulted in significant declines in species composition in the study area.

3.2. Growth attributes

In camping areas, the mean values of growth attributes were found higher in disturbed plots than in undisturbed plots (Table 2). For trampling areas (trekking trails) the results are as expected which indicated that the mean values for all the parameters taken in undisturbed plots are higher than those in disturbed plots

3.3. Chlorophyll measurements

The mean values of Chlorophyll fluorescence (CF) parameters were found higher in disturbed plots than in undisturbed plots for both camping and trampling (Table 3). The reading shows that the highest CF values were found in Botak campsite area followed by trekking trail (Figure 1). The lowest mean values of CF were found in undisturbed Botak area.

4. Discussions

In our preliminary studies, significant impacts of camping and trampling activities were found on all the parameters taken. It has been recorded that *T. fruticosa* dominated most of the area both in the disturbed and undisturbed plots. Table 1 shows that trampling and camping activities resulted in significant declines of species composition in the area. In general, species diversity was found lower in affected areas than in those in which conditions are optimal. Higher diversity is always found in ecosystems that are not stressed, that is, they are well watered, have deep rich soils and optimum temperatures for photosynthesis which consisting water availability that exceeds evapotranspiration. Above the optimal temperature, respiration exceeds photosynthesis and growth decreases while below the optimal temperature, metabolic rates are low. Thus, both high and low temperature can be considered as stressful. Diversity generally decreases along a gradient of increasing stress, that is where climate becomes too hot or too cold.

The contrasting results of growth attributes in disturbed and undisturbed plots were found between camping and trampling areas (Table 2). Higher soil minerals and moisture caused by human waste disposals in camping areas might contribute to the results obtained. For camping and trampling, it has been observed that shaking and bending may have caused the stomata to open as leaf water potential fell, thus causing a higher transpiration rate which, in turn, caused lower water potential and consequently reduced extension growth. Besides, compacted soil slows tree growth and resulting in subsequent loss of ground vegetation. Trampling also reduces leaf area where all carbohydrates produced may be utilized in restoring leaf structure.

Unexpectedly, the mean values of CF parameters were found higher in disturbed plots than undisturbed plots for both camping and trampling (Table 3). Normally, CF values is reduced in plants experiencing adverse conditions, such as water deficit, temperature, and nutrient deficiency. These contrasting results could be related to the site quality factors such as higher light intensities in disturbed areas due to more exposure created by human, and breakdown and transport of particles of soil and rock contained minerals. Botak undisturbed area received direct exposure of sunlight and wind

and this coupled with the increased intensity of radiation received at high altitudes on clear summer days which makes the area have higher light intensities and temperature which can place the plants under severe water stress.

The results obtained have shown that the impact of recreation activities on Mount Tahan vegetation is still not alarming. Inconsistent results observed in this study might due to the difference of site conditions and environmental factors. Apart from the generalized effect of recreation activities in terms of exposure and stress, specific site condition and characteristics form particular and specialized habitats for plant growth. Impacts of camping and trampling can be minimized by encouraging the repetitive use of a small number of sites, and concentration use where amount of impact is influenced by the amount of use, vegetation fragility, vegetation density and also type and distribution of recreation activities.

5. Conclusion

All mountain ecosystems have one major characteristic in common which are rapid changes in altitude, climate, soil and vegetation over very-very short distances. Mountain ecosystems sport a high range of biodiversity which is a home to million of different species of plants and animals. This study illustrates that some high elevation vegetation community are relatively benefited from camping and trampling (trekking) activities but it may depend on the degree of disturbance. These preliminary results showed some contrasting outcomes resulted from two main recreation activities at upper areas of Mount Tahan. The differences of tree diameter, height, leaf area, sapwood area and chlorophyll fluorescence (CF) occurred due to the differences in site quality factors. This is all mainly due to elevation changes which produces zones of differing climates, soils and vegetations and also impacted by some disturbances cause by interruption of human activities. However, the damage on vegetation caused by the climbers from low level of recreation activities in Mount Tahan is still not alarming. Where group sizes remain small, recovery can easily be established.

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Table 1. List of species in undisturbed and disturbed plots for both camping and trampling areas

Species	Undisturbed	Disturbed
<i>Baeckea frutescens</i>	86	59
<i>Tristaniosis fruticosa</i>	104	83
<i>Baeckea</i> sp.	78	-
<i>Dacrydium faculifurus</i>	10	-
<i>Beackea</i> sp.	-	14
<i>Auxlonkia backea</i>	11	-
<i>Gleichinea microphylla</i>	4	-
<i>Gaultheria</i> sp.	3	-
<i>Hedyotic</i> sp.	111	58
<i>Citrus</i> sp.	13	-
<i>Melastoma</i> sp.	2	-
<i>Scleria</i>	19	73
<i>Smilax</i> 1	6	-
<i>Smilax</i> 2	3	-
<i>Eria ornate</i>	-	27
<i>Spathoglottis</i> sp.	3	-
<i>Epigeneium</i> sp.	29	
Orchid sp. (1)	27	21
Orchid sp. (2)	11	-
<i>Styphelia malayana</i>	10	23
<i>Scirpus</i> sp.	-	91
Rutaceae	-	36
<i>Nepenthes</i> sp. (1)	51	51
<i>Nepenthes</i> sp. (2)	-	6
<i>Nepenthes</i> sp. (3)	7	29
<i>Dendrochilum</i> sp.	-	14
<i>Dianella</i> sp.	2	-
<i>Coelogyne</i> sp.	38	-
<i>Dipteris conjugata</i>	10	-
Total species	23	14

Table 2. Characteristics of *Baeckea frutescens* used in this study. The values presented in the table are mean and standard error with significant level at $p < 0.05$.

Parameters	Camping area			Trekking trail		
	Disturbed	Undisturbed	F value	Disturbed	Undisturbed	F value
D (cm)	2.25 ± 0.72	1.83 ± 0.26	0.17*	1.61 ± 0.99	1.75 ± 0.27	0.22*
HT (cm)	88.50 ± 7.2	82.65 ± 4.15	2.29*	90.40 ± 8.98	96.90 ± 4.62	1.83*
A _L (m ²)	0.36 ± 0.02	0.27 ± 0.01	0.33*	0.24 ± 0.01	0.29 ± 0.02	0.41*
S _A (cm ²)	0.72 ± 0.07	0.61 ± 0.05	0.62*	1.01 ± 0.16	1.22 ± 0.24	0.12*

Table 3. The values presented in the table are mean and standard error of chlorophyll fluorescence parameters of *Tristanopsis fruticosa* with significant level at $p < 0.05$.

Parameters	Camping area			Trekking trail		
	Disturbed	Undisturbed	F value	Disturbed	Undisturbed	F value
F _o	248.45 ± 4.56	216.79 ± 4.12	8.13*	227.66 ± 6.31	236.48 ± 5.65	6.89*
F _m	993.86 ± 22.80	795.13 ± 19.09	12.41*	919.40 ± 27.51	835.95 ± 24.10	15.23*
F _v	745.43 ± 20.10	578.34 ± 16.56	7.25*	691.75 ± 25.83	599.46 ± 21.29	10.07*
F _v /F _m	0.74 ± 0.005	0.71 ± 0.007	0.02*	0.74 ± 0.009	0.71 ± 0.006	0.04*

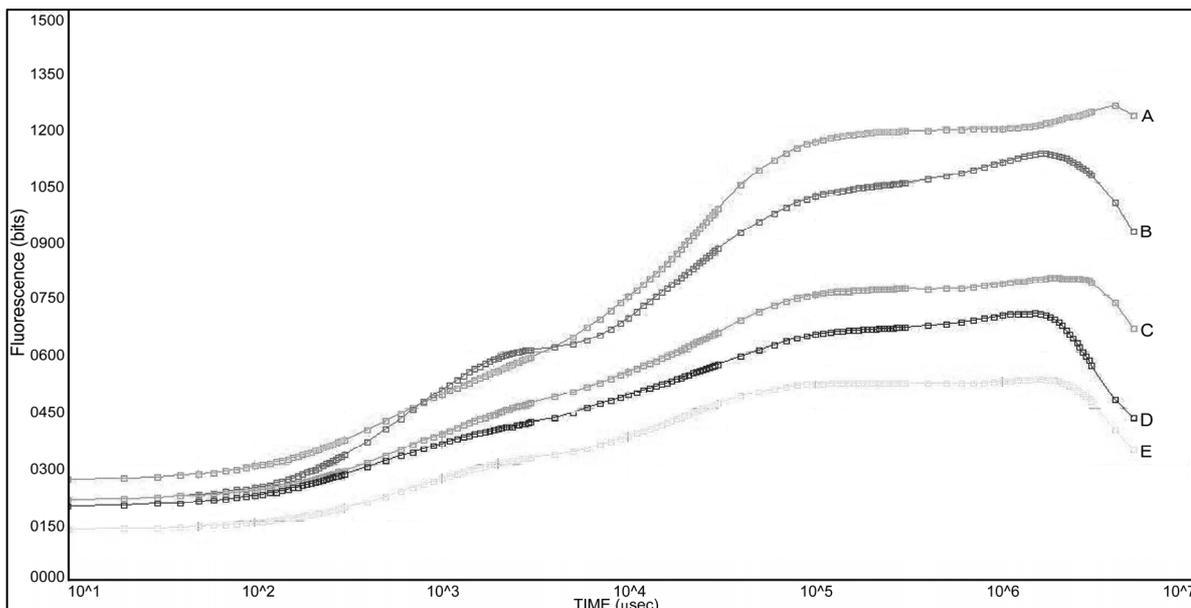


Figure 1. illustrates the means of fluorescence in one second measurement of *Tristanopsis fruticosa* for (A) Botak campsite (B) Trekking trail (C) Undisturbed trekking trail (D) Summit area and (E) Undisturbed Botak