International Forest Fire News (IFFN) No. 34 (January – June 2006, 64-71) ISSN 1029-0864

THAILAND

Effects of Forest Fire Protection on Plant Diversity in a Tropical Deciduous Dipterocarp - Oak Forest, Thailand

Abstract

A two-hectare plot of a deciduous dipterocarp-oak forest of Doi Suthep-Pui National park of northern Thailand protected against fire for 28 years was compared with a similar, but frequently burnt forest nearby with respect to changes in plant diversity. The objective of the study was to find out the effects of forest fire protection on plant diversity. To survey the tree communities, six meter wide transects with a total length of 650m in each site were laid out across the slope of the mountain following a bearing of 60^0. To survey the ground flora, quadrates of 2×2 m^2 area were placed in each site covering 2.3% of the total transect area. The importance value percentage (IP) of trees > 10 cm DBH, species composition and diversity for both tree and ground flora communities were calculated. The species richness of both the ground flora and tree species was higher in the protected areas. The occurrence of evergreen or tropophyllous trees was greater in the protected area than in the burnt area.

1. Introduction

Thailand has suffered a rapid decline in forest cover over the past three decades, loosing more than one half of its forested area. With a total forest cover of 60% in 1953, Thailand has only about 25% now (Poffenberger and McGean 1993, Kafle 2005). Recent satellite images indicate much less than this (SPOT, Landsat and ERS). This rampant destruction of forest cover in the past was due to logging concessions, encroachment and development of infrastructure such as roads, hydropower plants and mining. Nevertheless, the practices of shifting cultivation and intentional forest fires are still common in northern Thailand where forest are estimated to cover more than 40% of the land area.

Forest fire has increasingly become a frequent and problematic phenomenon in Thailand. Fires have a major impact on National Parks in particular where protection of the flora and fauna and their habitats is the primary aim. Since plant variety and abundance, flowering, fruiting, and leafing phenologies of trees and soil nutrients status are essential features for ecological niches of wild animals, studies on impacts of forest fire on these factors are essential to properly manage the bio-diversity in such areas.

2. Hypothesis and Objective

This study examined the following hypotheses:

- Prolonged protection of a forest from fire changes the species composition of the ground flora to be more characteristic of a mixed deciduous forest.
- There will be less disturbance effects after protection from fire, therefore, there will be higher plant diversity in protected areas.

Figure 1 shows the hypothesized mechanisms of the effects of fire protection in a deciduous dipterocarp-oak forest.

The overall objective of the research was to determine the effects of forest fire protection on plant diversity.

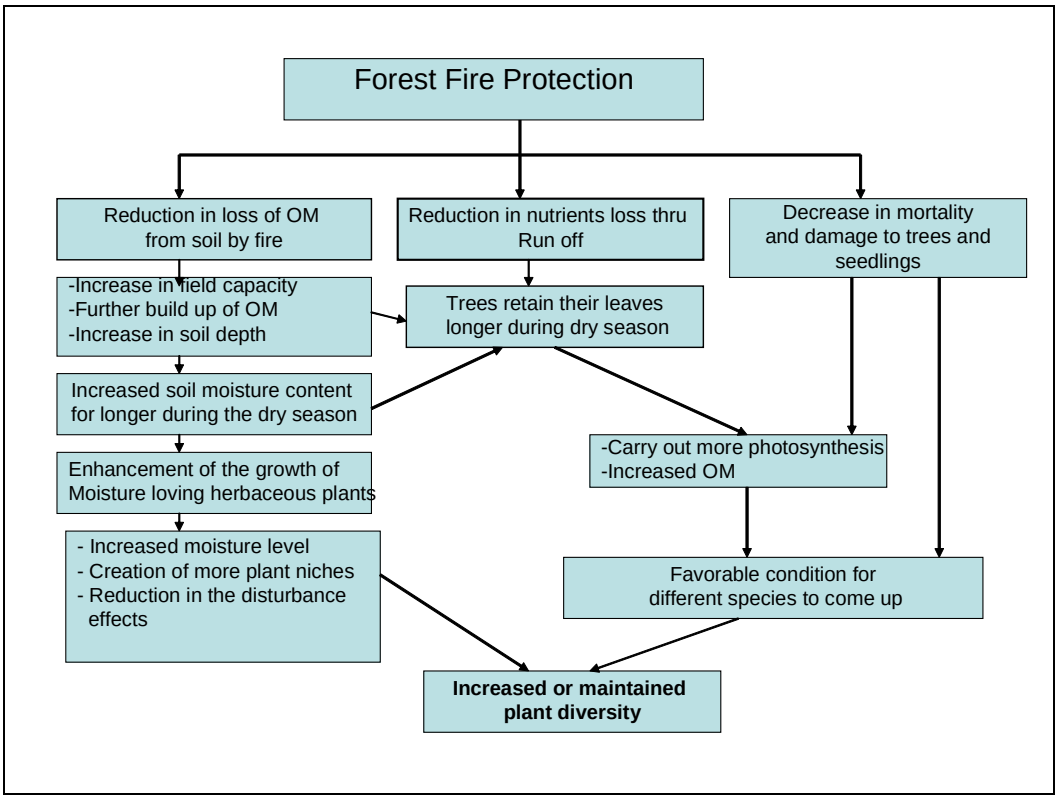

Figure 1. A hypothesized mechanism of the effects of fire protection in a deciduous dipterocarp-oak forest.

3. Methodology

Study area

This study was carried out in deciduous dipterocarp-oak forest (DOF) in Doi Suthep-Pui National park in northern Thailand. The area lies a few kilometres west of Chiang Mai City at approximately 18^0 50' N latitude and 98°50' E longitude. The forest was designated as a National Park in 1981 and covers an area of 261km^2. The DOF is situated from the eastern base at 350 m to 950m elevation whereas the highest point of the park Doi Pui, is at an elevation of 1685 m.

Two sites were selected, one protected against fire for 28 years and the other left unprotected. When selecting the burnt are, besides similar vegetation composition and soil type, much attention was given to other site factors such as aspect, distance from water sources, rocks and elevation. Prior to the final selection, possible sites nearby were reconnoitred and site factors closely examined. GPS was used to locate the exact position of the site. In the protected area three-meter-wide firebreaks had been maintained to prevent fire spreading into the area. The elevations of both sites range from 500 to 650m. The bedrock is granite (Maxwell 1988). In most of the places, soils are shallow, highly weathered, and exposed to soil erosion.

Sampling

Six meter wide transects were laid out across the slope of the mountain, following a bearing of 60^o. There were 4 transects in the protected area (PA) and 5 in the burnt area (BA) laid out with varying length. However, the total length of transects in each area was 650m covering 5% of the total area.

Data collection and Analysis

All trees greater than 10cm diameter at breast height (DBH) were labelled and identified. Similarly, ground flora community was monitored using percent cover of each species with the help of the Domin Scale (Table 1). The area over shadowed by tree seedlings and saplings was also recorded. The

ground flora community was surveyed at the beginning of rainy season (June), during the rainy season (September) and at the end of rainy season (November).

Table 1. Domin scale

Category	Score
+	Single individual
1	1-2 individual
2	<1 % cover
3	1-4% cover
4	5-10% cover
5	11-25% cover
6	26-33% cover
7	34-50% cover
8	51-75 cover
9	>75%< 100% cover
10	100% complete cover

Most of the vegetation data were analyzed statistically using ECOSTAT and SPSS computer programs.

4. Results

Species Composition and Diversity

A total of 130 plant species, with 29 trees and 101 ground flora species, was recorded from the sampled area (Table 2). The protected area supported a richer ground flora community than the burnt area although the species richness of tree community was very similar in both areas. The PA also contained slightly more unique species, found only there, than the burnt area. *Dipterocarpus obtusifolius* var. *obtusifolius* was the most abundant species followed by *Shorea siamensis* var. s*iamensis* in both sites. Two deciduous trees namely *Dipterocarpus tuberculatus* var. *tuberculatus* and *Tristaniopsis burmanica* var. *rufescens* had a greater occurrence in the BA compared to PA, even though their percentage contribution was comparatively low. In the PA, *Lithocarpus elegans, Lithocarpus sootepensis, Buchanania lanzan and Quercus kerrii* var. *Kerrii* were more abundant.

Table 2. Species composition in the sampled area.[1]

Composition	Number of species [2]				
	Total	**PA**	**BA**	**% (PA)**	**% (BA)**
Tree spp. (>10cm dbh)	29	22 (8)	21 (7)	76	72
woody climbers	3	3 (2)	1 (0)	100	33.3
Shrubs	14	10 (3)	11 (4)	71	79
Vines	10	9 (2)	8 (1)	90	80
Herbs	74	52 (27)	47 (22)	70	64
Total	131	96 (42)	88 (34)	74	68

1.The number of tree species is based on transect survey whereas ground flora is based on the quadrate made along transects.
2.Figures in parentheses indicate the number of species only found in that site.

Dipterocarpaceae was the dominant family of trees (Table 3). The percentage composition of individuals of this family was higher in the burnt area (63.58 %) than in protected area (56.8 %).

Table 3. Composition of major tree species >10 cm dbh in the burnt and protected areas.

Species	Number of individuals[1]	
	Protected site	**Burnt site**
Diptercocarpus obtusifolius var. *obtusifolius*	100 (37.45%)	58(35.80%)
Shorea Siamensis	30 (11.24%)	22 (13.58%)
Buchanania lanzan	27 (10.11%)	9 (5.56%)
Shorea obtusa	22 (8.24%)	15 (9.26%)
Quercus kerrii var. *kerrii*	26 (9.74%)	15 (9.26%)
Lithocarpus sootepensis	15 (5.62%)	4 (2.47%)
Lithocarpus elegans	10 (3.75%)	3 (1.85%)
Craibiodendron stellatum	9 (3.37%)	5 (3.09%)
Tristaniopsis burmanica var. *rufescens*	2 (0.75%)	8 (4.94%)
Dipterocarpus tuberculatus var. *tuberculatus*	0 (0.00%)	8 (4.94%)
Miscellaneous	26 (9.74%)	15 (9.26%)
Total	267 (100.0%)	162 (100.0%)

[1]Percentage figures in parentheses indicate relative dominance of the species.

Basal Area, Tree Density and Community Dominance

Basal area and tree density (p>10 cm DBH) were both higher in the PA than in the BA (Table 4). However, average basal area of trees in aggregate was similar in both sites. McNaughton's community dominance index (CD) was practically the same in both sites. This indicates the higher relative dominance values of two most dominant species.

Table 4. Percentage and total basal area, tree density and community dominance of protected and burnt sites.

Community statistics	Unit	Sites	
		PA	BA
Basal Area ha^{-1}	m^2	22.67	13.95
Tree Density (>10 cm dbh)	no/ha	685	415
Community Dominance	%	48.7	49.4

Importance Value of Major Tree Species

More than 50 % of the importance percentage, calculated from relative basal area (RBA), relative frequency (RF) and relative density (RD), was contributed by Dipterocarpaceae in both sites (Table 5).

Table 5. Importance value (iv) of major tree species in the PA and BA

Species	Protected Area					Burnt Area				
	RBA	RF	RD	IV	IP	RBA	RF	RD	IV	IP
Dipterocarpus obtusifolius	0.48	0.07	0.37	0.92	30.7	0.47	.09	.36	.92	30.7
Shorea siamensis	0.19	0.07	0.11	0.37	12.3	0.16	.09	.14	.39	13
Buchanania lanzan	0.06	0.07	0.10	0.23	7.7	0.03	.07	.06	.16	5.3
Quercus kerrii	0.08	0.07	0.10	0.25	8.3	0.08	.07	.09	.24	8.0
Shorea obtusa	0.08	0.07	0.08	0.23	7.7	0.07	.07	.09	.23	7.7
Lithocarpus sootepensis	0.03	0.07	0.05	0.16	5.3	0.01	.07	.03	.11	3.7
Lithocarpus elegans	0.02	0.07	0.04	0.13	4.3	0.04	.06	.02	.12	4.0
Craibiodendron stellatum	0.02	0.07	0.03	0.12	4.0	0.01	.07	.03	.11	3.7
Tristaniopsis burmanica	0.034	0.04	0.01	0.05	1.7	0.02	.06	.05	.13	4.3
Dipterocarpus tuberculatus	0	0	0	0	0	0.04	.06	.05	.15	5.0

(RBA = relative basal area; RF = relative frequency; RD = relative density; IV =importance value; IP = importance percentage).

Species Richness Diversity, and Evenness

Computed values of different community statistics are given in Table 6. The results failed to show a clear distinction between the protected and burnt sites. In PA irrespective of high species abundance and richness, the diversity indices (H') was slightly lower than in BA. However, the values were not statistically different. Also, individuals were more evenly distributed in the burnt area.

Table 6. Species richness, species diversity and evenness indices of trees in the burnt and protected areas.

Community statistics		Protected Area	Burnt Area
Species richness	No	22	21
Diversity	λ H' N1 N2	0.18 2.18a 8.81 5.46	0.17 2.24a 9.43 5.90
Evenness	E5	0.57	0.58

[a] Values of diversity indices of two sites are not statistically different (T-test).

Size class distribution

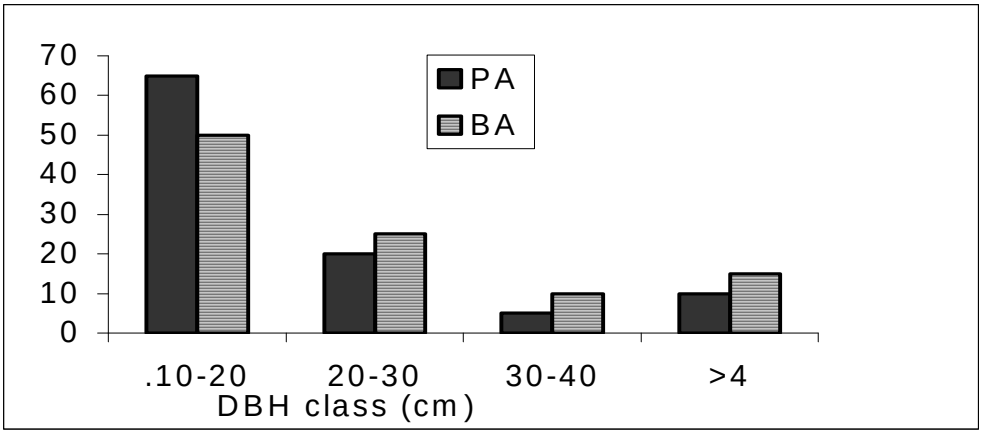

Figure 2. Size class distribution of trees >10 cm category

Figure 2 shows a larger amount of regeneration in the PA than in the BA. Around 73% of the tree individuals found in the PA were 10-20 cm DBH. It further reveals that very young trees were quite abundant in this site. In the BA, however, only 64% of individuals were in this category. There was no marked difference in the distribution of tree individuals in other categories.

Ground flora diversity

Regardless of the significantly lower percentage cover, based on the total Domin score (t-test, p>0.05), the protected area supported a greater number of ground flora species (Table 7). However, the burnt area contained higher species diversity and evenness indices than the protected area. Nevertheless, the species diversity index was not significantly different (t-test, p>0.05)

Table 7. Ground flora diversity, richness and evenness in the protected and burnt areas:

Community statistics		Protected area	Burnt area
Species richness	No	74	67
	R1	12.49	10.298
	R2	3.98	2.91
Diversity		0.812	0.553
	H'	3.401a	3.477a
	N1	30.207	32.37
	N2	12.316	18.080
Evenness	E5	0.387	0.544
Total Domin Score	TDS	349.5	505.0

T-test (p>0.05)

Frequency and Abundance Score

In both sites, very few species were dominant in terms of their frequency and abundance scores. *Themeda triandra* Forssk. (Gramineae) was the most frequent and highly abundant in both sites followed by *Globba schomburgkii* Hk.f. (Zingiberaceae) in the BA and *Scleria lithosperma var. lithosperma* (Cyperaceae) in the PA. The most frequent and highly abundant species in both sites are given in Table 8.

Table 8. Ground flora species with high abundance and frequency scores in the study areas.

Species	Av. Domin score[1]		% Frequency	
	PA	BA	PA	BA
Themeda triandra	83	72	81	86
Uraria lacei	-	15	-	20
Scleria lithosperm var. *lithosperma*	14	18	33	48
Scleria levis	-	19	-	43
Abrus precatorius	10	10	52	43
Globba schombergkii	-	32	-	52
Globba reflexa	8	12	24	33
Dunbaria longeracemosa	-	22	-	57
Aristolochia kerrii	7	-	33	-
Curcuma zedoaria	-	18	-	52
Lygodium flexuosum	9	-	29	-
Scutellaria glanduolosa	10	-	48	-
Murdania loureirii	8	-	24	-
Desmodium laxiflorum ssp. *Laxiflorum*	8	-	29	-

[1] Average of Total Domin Score of July, September and November. The blank (-) does not mean that the species is absent in the site. It indicates the species does not fall within the nine maximum abundant species.

5. Discussion

The greater tree population density in the protected area was a direct consequence of fire protection. The protected area contained 25% more individual trees than the burnt area. Also, it has more young trees of DBH 10-20 cm category than in the burnt area. This suggests that forest fire protection decreased the killing or damaging of trees, which ultimately leads to increased productivity and organic matter in soil, thus more favourable conditions for growing. This result also supports the findings made by Naidu and Sribasuki (1994) that young plants are more badly affected by fires than mature ones.

Another striking feature noticed during the study was that no individuals of *Dipterocarpus tuberculatus* var. *tuberculatus* greater than 10 cm DBH were found in the PA. However, a few emerging coppicing shoots were seen. This observation agrees with a statement made by Barrington (1931) in a study of forest in Burma that "… protection encourages an evergreen undergrowth which prevents the reproductions of *Dipterocarpus tuberculatus* var. *tuberculatus* and would obviously change the vegetation type to a moister type".

Fire protection seemed to have more impact on the herbaceous community than trees. Almost half of the ground flora species recorded were specific to each site. The majority of herbaceous species in the PA were typical of moist condition and some species found in the burnt area are fire resistant . *Phoenix humilis* Roy. var. *humilis (Palmae)* and *Pennisetum pedicellatum* Trin. (Gramineae) are typical examples. Although the total Domin score in the BA is much higher than in the PA, there was no significant difference in the species diversity index. This was probably due to the dominance of a few species rather than the even distribution of species. *Themeda triandra* Forssk. (Gramineae), and *Globba schomburgkii* HK. F. (Zingiberaceae) and *Scleria lithosperma* var. Lithosperma (Cyperaceae) were among the dominant ground flora species in both sites.

6. Conclusions and Recommendations

The greater influence of evergreen or tropophyllous trees and the presence of some shade-loving herbaceous flora in the protected area suggest that the forest environment in the protected area was favoured by plant associated with a mixed evergreen and deciduous forest. However, no distinct differentiation was observed. Hence, the hypothesis that prolonged protection of forest from fire

changes the species composition of the plant community to be more characteristic of a mixed evergreen and deciduous forest was only partially proved. In order to know whether the presence of certain shade demanders was due to changes in the local environment or chance detailed studies in different physiographic conditions are needed.

The higher tree density and more young trees of 10-20 cm DBH category in the protected area adds supports to the idea that the fire protection decreased mortality and damage to trees which ultimately leads to more favourable conditions for different species to grow.

References

Barrington, A.H.M. 1931. Forest soil and vegetation in the Hlaing forest circle Burma. Burma Forest Bulletin 25, Ecology series No.1. Rangoon.

Kafle, Shesh Kanta 2005. Forest Fire and Plant Diversity: A Case from Northern Thailand. Asian Disaster Management News, Vol. 11 (2), 5.

Maxwell, J.F. 1998. The vegetation of Doi Suthep-Pui National Park, Chiang Mai Province, Thailand Tiger paper 15 (4), 6-14.

Naidu, C.V., and K.P. Srivasuki. 1994. Effect of Forest fire on Tree Spices on different areas of Aeshachalam Hills. J. Tropical Forestry. July-September 10 (III), 31-37.

Proffenberger, M., and B. McGean. 1993. Community Allies: Forest co-management in Thailand, South East Asia Sustainable Forest Management Network, Centre for Asia Studies, University of California.

IFFN Contribution by

Shesh Kanta Kafle
Program Manager
Disaster Risk Reduction
Canadian Red Cross
Tsunami Recovery Operations
J. Ajun Jeumpat No.18 B
Banda Aceh
Indonesia

e-mail: shesh.kafle@redcross.ca