TREE GROWTH, ABOVEGROUND BIOMASS AND CARBON LOSSES FROM THE 2012 MELALEUCA PEAT FOREST WILDFIRE, NAKORN SRI THAMMARAT, THAILAND

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Abstract

During the 2012 exceptional drought period in Nakorn Sri Thammarat province, (from March to September), fires had destroyed ca. 2100 ha. of the Kuan Kreng secondary peat forest, of which consisted pure stand of the *Melaleuca cajuputi*. This study, therefore, aimed to investigate the effects of fire on tree growth, mortality, biomass as well as aboveground carbon loss to the atmosphere. The result revealed that tree mortality increased, the growth rate of survived trees decreased, the aboveground biomass decreased and, hence the loss of carbon as a result of burning was greater compared to burning in other ecosystems in Thailand. Therefore, the restoration project, either by tree planting or improving forest structure and composition should be implemented to improve the forest ecosystem.

Keywords: Kuan Kreng peat forest, Melaleuca, wildfire, tree growth, aboveground biomass, aboveground carbon

Introduction

Fire in the fire-sensitive ecosystems influences forest growth and development, and hence results in forest carbon storage. Recently, the variation of weather condition, in particular the drought pattern, leads to the more frequent and intense anthropogenic burning in Southern part of Thailand. During the 2012 exceptional drought period in Nakorn Sri Thammarat province, (from March to September), fires had destroyed ca. 2100 ha. of the Kuan Kreng secondary peat forest, of which consisted pure stand of the *Melaleuca cajuputi*. Unfortunately, fire effects and the estimation of carbon storage and losses from burning for this forest type have never been investigated. This paper, therefore, addressed the gap of knowledge which is necessary for future forest rehabilitation.

Methodology

In October, 2012, the 5 10x100 m burned plots and adjacent 5 10x50 m unburned plots were setup at Kuan Kreng peat forest, Nakorn Sri Thammarat province (Figure 1). Trees were tagged, and dbh, ht, bark thickness and mortality of the Melaleuca were investigated. These measurements were repeated in May 2013 to obtain tree mortality and growth rate of survival trees. Aboveground forest fuel was collected using harvesting method, while the aboveground tree biomass was estimated using Soonthornwit (2012) and Tanke *et al*. (2001) equations. Pre-, and post-burn of the aboveground carbon pool, and carbon losses from burning was analyzed.

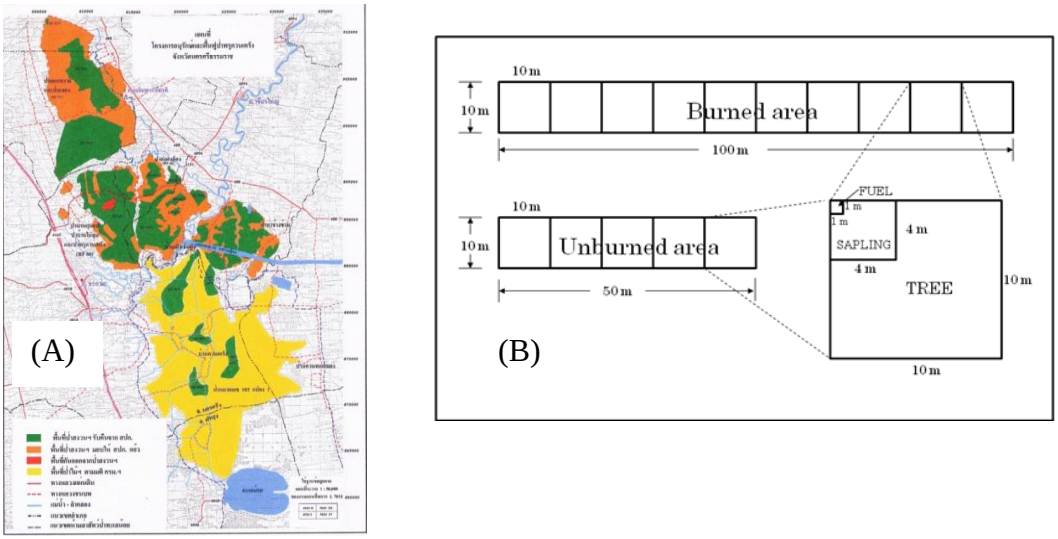

Figure 1 The boundary of Kuan Kreng peat forest (A) and plot layout for the study.

Results and Discussion

Tree growth and mortality

The result showed that tree mortality was 18%, of which dbh, ht and bark thickness of most of dead trees were lower than those of survived trees (Table 1, Figure 2). The correlation between mortality and fire behaviors descriptors were highly significant. The growth rate of trees that survived from burning was significantly lower (0.44 cm.yr^{-1}) compared to the tree in the unburned site (0.68 cm.yr^{-1}), reflecting the influence of burning on future forest structure and composition and hence the need for restoration.

Table 1 Tree mortality at 1- and 8-month after fire.

Plot	No. of Survived trees	Mortality after the fire (%)	
		1-m.	8-m.
FS1	159	3.1	12.6
FS2	90	0.0	25.6
FS3	122	18.9	32.0
FS4	231	0.0	8.7
FS5	87	0.0	11.5
Average	137.8 (59.7)	4.4 (8.2)	18.1 (10.1)

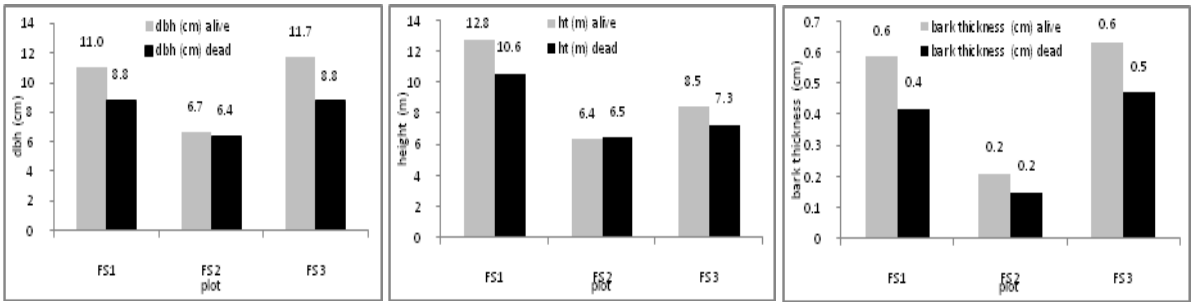

Figure 2 Dbh, Ht and bark thickness of survived trees compared to dead trees.

Aboveground biomass and aboveground carbon pool and losses

The total pre-burn fuel load and tree biomass was 95.5 t.ha^{-1}. Pre-burn available fuel loads (sapling, undergrowth and litter) was ca. 54.9 t.ha^{-1}, while pre-burn tree biomass was 40.2 t.ha^{-1} (Table 2). However, the 2012 fire at Kuan Kreng peat forest had consumed 47.7 t.ha^{-1} (ca. 50% of this pre-burn value). Consequently, the aboveground carbon loss was 22.4 t.C.ha^{-1}, which was greater than losses from other ecosystems in Thailand (Table 3). Therefore, the current devastating fire, which ca. 2100 ha. of the Kuan Kreng secondary peat forest destroyed, had released ca. 43,688.5 t.C. to the atmosphere (equivalent to ca. 160,336.8 t.CO_2) (Table 4).

Table 2. Pre- and post-burn aboveground biomass of available fuel and tree.

	Aboveground biomass (t.ha^{-1})		Biomass losses	
	Pre-burn	Post-burn	t.ha^{-1}	%
Tree	43.81	36.41	7.40	19.64
Sapling	2.50	0.53	1.97	78.80
Undergrowth	8.99	0.08	8.91	99.11
Litter	40.25	10.82	29.43	73.11
Total	95.55	47.84	47.71	49.93

Table 3. Aboveground carbon pools and losses from wildfire.

	carbon pool (t.ha^{-1})		Carbon loss	
	Pre-burn	Post-burn	t.ha^{-1}	%
Tree[1]	20.59	17.11	3.48	16.89
Sapling[1]	1.18	0.25	0.92	78.80
Undergrowth[1]	4.23	0.04	4.19	99.11
Litter[1]	18.92	5.09	13.83	73.11
Charcoal[2]	-	3.65	-	-
Total	44.91	26.14	22.42	49.93

Table 4. Carbon losses as caused from burning in different parts of ecosystems.

Site	Carbon loss (t.ha^{-1})	CO_2 equivalent (tCO_2.ha^{-1})	Source
Cental Kalimantan in 1997	-	350	Page et al. (2002)
Sumatra in 1997	-	42	Murdiyaso et al. (2002)
Cental Kalimantan in 2002	-	42.38	Usup (2006)
Dry diptercarp forest, Huai Kha Khaeng wildlife sanctuary[1]	2.14-4.13	7.85-15.16	Wanthongchai *et al*. (2008)
Mae Moh teak plantation[1]	2.13-3.28	7.82-12.07	Wanthongchai (2011)
Pine forest, Nam Nao national park[1]	2.13-4.76	7.82-17.47	Wanthongchai (2011)
Pine-diptercarp forest, Watchan[1]	1.79-1.81	6.57-6.64	Opachart (2012)
Swidden farm, northern Thailand	12.1-17.3	44.4-63.5	Wanthongchai and Wonsawat (2012)
Peat forest[1]	22.42	82.28	Current study

Remark: [1] Calculated from aboveground parts only.

Implication

Tree mortality, the reduced growth rate of survived trees, the biomass decreased and the loss of carbon as a result of the 2012 burning in the 2nd Kuan Kreng peat forest is reflecting the influence of climate variability on burning regime (fire

size, fire intensity fire severity, fire frequency, and fire season). Therefore, the restoration project, either by tree planting or improving forest structure and composition should be implemented. However, the research is an important key of success for the restoration.

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