



WWF GREATER MEKONG - CAMBODIA COUNTRY PROGRAMME

BURNING ISSUES:

PHNONG USE OF FIRE AS A NATURAL RESOURCE MANAGEMENT TOOL

Srepok Wilderness Area Project
Technical Paper Series - No. 4



WWF GREATER MEKONG - CAMBODIA COUNTRY PROGRAMME

BURNING ISSUES:

PHNONG USE OF FIRE AS A NATURAL RESOURCE MANAGEMENT TOOL



LIST OF ACRONYMS

CBFiM	Community Based Fire Management
CBNRM	Community Based Natural Resource Management
DDF	Deciduous Dipterocarp Forest
FA	Forestry Administration (Department within MAFF)
HH	Household
IIED	International Institute of Environment and Development
IFFM	Integrated Forest Fire Management
IUCN	International Conservation Union
KML	Kaoh Moeal Leu Village
KR	Khmer Rouge
LMDFE	Lower Mekong Dry Forest Ecoregion
MAFF	Ministry of Agriculture, Forestry and Fisheries
MDF	Mixed Deciduous Forest
MPF	Mondulkiri Protected Forest
NTFP	Non-Timber Forest Products
PT	Pu Tang Village
SEF	Semi-Evergreen Forest
SWAP	Srepok Wilderness Area Project

ACKNOWLEDGMENTS

This study would have not been possible without the support received from IIED and WWF-Cambodia, in terms of financial and logistical assistance, and also ideas and discussion. I am particularly grateful to James MacGregor, Seng Teak, Nick Cox and Andy Maxwell for overall guidance. For Huy Keavuth for the great maps and Khou Eang Hourt for his technical advice. I am grateful also to Martin von Kaschke, Amy Maling, and the WWF-Cambodia/FA staff working in Mondulhiri province for welcoming me into their team, providing logistical support, friendship and advice.

I am grateful to the research team, Mr. Tit Chan, Mr. Em Tray and Ms. Hy Somaly for their dedication, laughter and energy in even the most difficult circumstances. I hope they learnt as much from me, as I did from them.

I would like to express my appreciation to the government and non-government agencies and staff members who are too numerous to mention, but have provided essential input into this study since I first began discussing it in 2002. Lastly, and most importantly, I would like to thank the members of Pu Tang and Koh Myeul Leu villages for housing and feeding us, for answering our numerous questions and welcoming us into their lives.

WWF takes no responsibility for any misrepresentation of material that may result from the translation of this document into any other languages.

Reproduction of any part of this publication (excluding photography) for educational, conservation, and any other non-profit purposes is authorized without prior permission from the publisher, provided that the source is fully acknowledged. No photographs from this publication may be reproduced without authorization from the publisher.

Reproduction for resale or other commercial purposes is prohibited without prior written permission from the publisher.

Photo credits: Megan MacInnes

Copies of this publication are available from
WWF Greater Mekong - Cambodia Country Programme
54, Street 352, Sangkat Boeung Keng Kang 1, Khan Chamkarmorn, Phnom Penh
Telephone: (855) 23 218 034, Fax: (855) 23 211 909
Email: wwfcambodia@wwfgreatermekong.org

Published in 2008 by WWF Greater Mekong - Cambodia Country Programme
© text 2008 WWF. All rights reserved.

TABLE OF CONTENTS

Executive Summary	1
1. Introduction	2
2. Results and Discussion	4
2.1 Introduction	4
2.2 Religious and cultural importance of fire and how it has changed throughout history	5
2.3 How people understand the relationship between fire and the environment	6
2.4 Customary rules and management strategies	9
2.5 Fire-related legislation and policy-making	10
3. Potential areas for policy development	11
3.1 Policy development opportunities within Cambodia's fire-related legislation	11
3.2 Recommendations for how to engage local communities in fire management strategies	12
3.3 Case studies of community-based fire management from other Asian countries	13
4. Conclusion	15
References	16

LIST OF TABLES AND FIGURES

Map : Mondulkiri Province showing study site locations and the Haut-Chhlong Plateau	2
Table 1 : Demographic and socio-economic profiles of study sites	4
Table 2 : How the main annual fire types are used	8
Table 3 : Characteristics of management strategies used	9

Executive SUMMARY

The Royal Government of Cambodia is under pressure to conserve its rich natural resources. Although fire is not considered to be the primary threat to Cambodia's forests, it has adopted a strong anti-fire position within its environmental policies and legislation in order to reduce forest loss. Such an agenda is problematic for Cambodia's dry forest ecosystems, such as the Monduliri Protected Forest, which are dependant on regular fires, for instance those used traditionally by the local indigenous peoples.

This research analyzed the role fire plays within the livelihoods of one such indigenous group, methods employed to ensure its safe and effective use, the socio-cultural importance of fire, the perceived relationship between fire and the environment, and community understanding of Cambodia's fire-related legislation. A "case study" approach was used to compare fire use in two Phnong villages in Monduliri province; the first Pu Tang is located on the Haut-Chhlong Plateau and the other, Koh Myeol Leu is located in the dryforest, on the banks of the Srepok River. The research team consisted of a Scottish researcher and three members of the WWF SWAP staff; two government counterpart staff from MAFF and one Phnong non-government employee. Qualitative methodologies used included focused group discussions and key informant interviews with community members, local authorities, provincial and national level government representatives and NGO employees.

As one of the essential foundations of life, fire has traditionally been one of the most important tools for the Phnong, used for: domestic activities; treatment for sicknesses; managing natural resources; and income generation. Numerous types of fires are known to the Phnong and they are precisely used and controlled according to the local environment, the anticipated outcome, the perceived risk to personal and public property and customary resource tenure systems. Of these strategies, the most pertinent is that for fires in the dry forest and savanna-grassland, protection of

property from fires is the responsibility of the owner (for example through fire-breaks), and therefore people setting fires are not required to consider where the fire will eventually spread to. These fire management techniques are primarily driven by an understanding of the fire-environment relationship in which the environmental context determines whether a resource area will burn or not. Namely, dry-forest, bamboo forests, savanna grassland and sbov areas will burn, but semi-evergreen and evergreen are 'un-burnable' because: a) they have no ground-level fuel and b) they have not been 'cut and dried' so that their leaves are 'cold' and therefore non-flammable. Until recently, animist religious ceremonies and taboos were an indispensable component of using fire in the natural environment, but these beliefs are less followed by younger generations as a result of recent socio-cultural and economic change.

Although all participants had experienced the potential dangers of using fire, the Phnong believe its benefits greatly outweigh its costs. Within the four main fire types researched, fire was used to clear vegetation and reduce weed re-growth, 'clean' the environment of hazardous fuel loads and dangerous animals, maintain soil fertility, ensure good harvests, stimulate greenshoot for domestic animals and thatching, hunting and improve visibility. Conversely, if the Government enforced its ban on fires then harvests would fail, there would not be sufficient fodder for animals, hunting and traveling through the forest would be difficult and dangerous, and fuel loads would increase risking "uncontrollably destructive" fires.

Interviews with local, provincial and national authorities about indigenous use of fire detected a complex situation. Some recognize the importance of fire for local indigenous livelihoods whilst others strongly support the anti-fire position of the Forestry Law and view Phnong use of fire as wasteful and ignorant. Almost all acknowledge that the State simply doesn't have the resources or capacity to enforce or implement fire management strategies in remote areas. The result is an informal agreement by authorities to focus more on awareness raising of the law and less on enforcement. Phnong local communities, both those who are and are not aware of this legal framework, clearly believe that all authorities want to arrest those setting fires and as a result are extremely reluctant to discuss fire use with 'outsiders'.

A number of possibilities for policy development and decentralization of fire management were identified during the final stage of the research study, based on the experiences of community-based fire management within the South East Asian region. These include increasing Phnong representation, participation and decision-making within proposed provincial fire management committees, and during the completion of local legislation. Therefore, although decentralized fire management in other countries has proved able to successfully combine local knowledge with State technical expertise, its potential for the Monduliri context depends on further research and clear, open and non-judgmental dialogue between all stakeholders.

1 INTRODUCTION

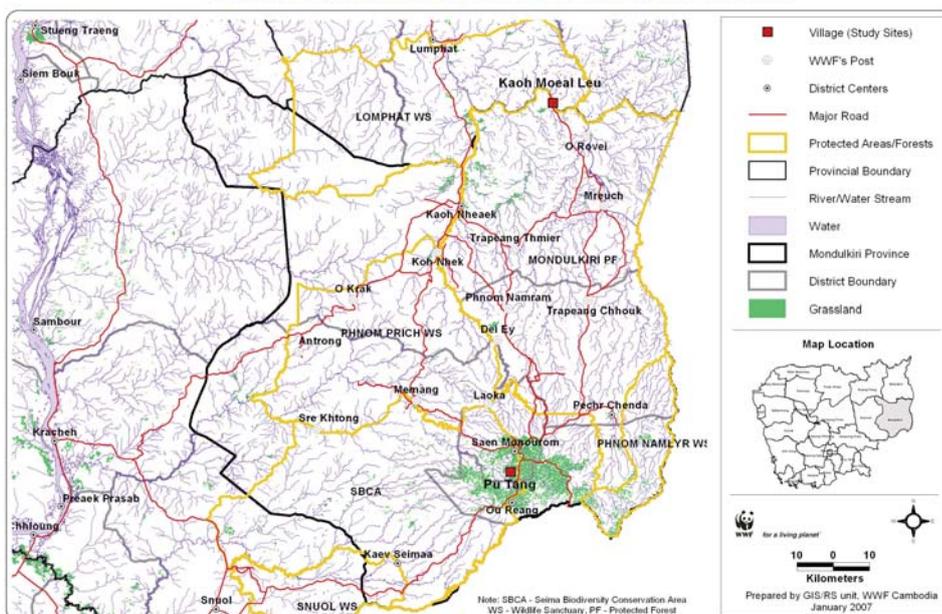
This report presents the findings of a research project which was undertaken in Mondulakiri province in partnership with WWF-Cambodia, the International Institute for Environment and Development (IIED) and the Forestry Administration (FA) department at Cambodia's Ministry of Agriculture, Forestry and Fisheries (MAFF) between October 2006 and January 2007. The research analysed the role fire plays within the livelihoods of the Phnong indigenous group¹, methods employed to ensure its safe and effective use, the socio-cultural importance of fire, how the Phnong perceive the relationship between fire and the environment, and their understanding of fire-related legislation in Cambodia.

Mondulakiri province borders with Stung Treng, Kratie and Ratanakiri provinces and Vietnam, see map below. Until the early 19th Century the province was entirely populated by indigenous ethnic minority groups (Hickey 1982), however war and in-migration increased the numbers of Khmer (Cambodia's ethnic majority), Vietnamese and Cham peoples. From 1998 to 2005 Mondulakiri's population increased by 53%; currently ethnic

minorities are estimated to comprise only 60% of the population (estimated in 2005 to be 49,612) although the Phnong still constitute the ethnic majority (DoP 2006). Traditionally the Phnong are animist, matri-local, matri-lineal and live in fortified villages of fewer than 10 households which moved every 5 - 7 years. Like many indigenous groups, livelihoods are based on diversification; relying on non-timber forest products such as resin, honey, medicines, meat and fish (Nikles 2006, AAH 2003). Traditional agriculture is based on non-irrigated shifting cultivation ('miir' in Phnong language)² where they grow upland rice and other crops, whereas today, those living in lowland (northern and western) areas of the province mainly cultivate irrigated paddy-rice.

Map : Mondulakiri Province showing study site locations and grassland on the Haut Chhlong Plateau

Protected Areas/Forest in Mondulakiri Province



¹ There are approximately 12 different indigenous groups living in Mondulakiri, the largest is the Phnong, also known in literature as Phnong and Mnong.

² Traditional upland shifting cultivation ('slash and burn' agriculture) in which periods of cropping are alternated with periods of fallow. Phnong miir cycles are understood to follow Conklin's 'integral' criteria in which old sites are returned to following a 10-15 year fallow (Conklin, 1954). Rain-fed upland rice is the primary crop, with supplementary fruit, vegetables and medicinal crops.

Mondulkiri province is the core area of Cambodia's 'Eastern Plains', a priority conservation zone within the Lower Mekong Dry-Forest Ecoregion (LMDFE)³ (Tordoff *et al.* 2005). The majority of the province consists of a mosaic of Deciduous Dipterocarp Forest (DDF), Mixed Deciduous Forest (MDF) and Semi-evergreen Forests (SEF) whilst the southeast of the province is known as the 'Haut-Chhlong Plateau'; an area of savanna grassland (see the green colour on page 2) at a higher elevation than the rest of the province (Maxwell and Pinsonneault 2001). Currently 73% of Mondulkiri (approximately 10,500km²) is under some degree of biodiversity protection; the Mondulkiri Protected Forest (named "Mondulkiri PF" in the map) covers 430,000ha and was established in July 2002. It is co-managed through the Srepok Wilderness Area Project (SWA) by WWF-Cambodia and the FA.

The Royal Government of Cambodia (RGC) is under pressure to conserve its rich natural resources and although fire is not considered to be the main threat to Cambodia's forests (in comparison to illegal

logging), there remains a strong policy of stopping all fires within legislation. From a scientific perspective, fire is recognised as having an essential role in the ecology throughout the LMDFE. But these are new theories and internationally there are still many areas of disagreement about how fires and the environment interact in "dry forest" ecosystems such as Mondulkiri (Goldammer 1990, Tordoff *et al.* 2005), these include:

- How important the role of fire is in the environment in comparison to other factors such as soil type?
- What the outcome would be on the environment if fires were stopped completely?
- How and if fires can be managed effectively and safely, and whose responsibility this is?

This report presents a summary of a "case-study" conducted in two primarily Phnong villages in Mondulkiri; the first Pu Tang (PT) is located on the Haut-Chhlong plateau and the other, Koh Myeul Leu (KML), is located in the dry-forest, on the banks of the Srepok River (both villages are marked by red squares on map 1). The research team consisted of a Scottish researcher and three members of the WWF SWAP staff; two government counterpart staff from MAFF and one non-government employee. Qualitative methodologies were used including focused group discussions and key informant interviews with community members, local authorities, provincial and national level government representatives and NGO employees. The study ended by making suggestions about policy opportunities for fire management within a longer-term goal of strengthening local natural resource management and livelihood security⁴.



The research team (left to right: Mr. Tit Chan, Mr. Yim Priya and Ms. Hy Somaly) near Mreuch Ranger Station

³ The LMDFE is defined as 'The landscapes characterized by habitat mosaics (at the large scale) dominated by Deciduous Dipterocarp Forest in Cambodia, Lao PDR, Thailand and Vietnam' in (Tordoff *et al.* 2005:3).

⁴ The full research thesis is: MacInnes, M (2007) 'Phnong use of anthropogenic fire as a natural resource management tool in Mondulkiri province, Northeast Cambodia', unpublished MSc Thesis, University of East Anglia, UK.

2 RESULTS AND DISCUSSION

2.1 Introduction

As can be seen from the demographic details given in Table 1, PT and KML villages are quite different even though they are both mainly Phnong. The population in PT is almost completely Phnong, whereas in KML there are many other ethnic groups living together. Livelihoods in PT are more diversified than in KML, where people are mainly dependant on paddy-rice cultivation.

Table 1: Demographic and socio-economic profiles of study sites

	Pu Tang Village			Kaoh Moeal Leu Village		
Location	Romonea Commune, Sen Monorom District			Nang Ki Leuk Commune, Koh Nhek District		
Distance from provincial capital	8km, 25 minutes by motorbike or car during dry season and 1 hour in wet season.			145km, 7 -9 hours in dry season by motorbike or 4-wheel drive vehicle, 2 days in wet season, access by motorbike only. More easily accessible by river from Ratanakiri.		
Demographic Data		2004*	2005*		2004*	2006**
	Total	647	643	Total	345	373
	Women	327	318	Women	170	183
	Men	320	325	Men	175	189
	Families	128	124	Families	60	72
Ethnicity	1 Stieng family, 122 Phnong and 5 Khmer-Phnong families			Majority Phnong, also Lao, Tampuan, Kreung, Kraol, Jarai, Ede and Khmer		
Geographical characteristics	On north-western edge of the savanna plateau; miir cultivation in forested fertile valleys and savanna area used for forage and hunting.			On the Srepok river; srae cultivation within 5km of village, home-gardens on riverbanks and miir in dry-forest.		
Livelihood practices	Miir rice production	All HH***		Miir rice production	5 HH	
	Srae rice production	0 HH		Srae rice production	72 (All HH)	
	Resin collection	10 HH		Resin collection	1 HH	
	Average hunger gap****	70% HH = > 3 months		Average hunger gap****	60% HH = no gap	

(* DoP 2006, ** Village Chief, Koh Myeul Leu, ***HH means 'household', **** AAH 2003:75)



Seng Maly beside a recently burnt resin tree, on Srepok River

Phnong people describe 'teuk neung pleung' (water and fire) as the essential foundations of life, and this research shows just how important fire is for a whole range of domestic activities; cooking and boiling water; maintaining soil fertility; decorating handicrafts; and as treatment for sicknesses. As a tool for natural resource management, the use of fire is based on the understanding that it can 'clean' the environment: miir fields are cleaned in preparation for planting, forest paths are cleaned for easier walking and savanna grasslands are cleaned to control vegetation and therefore prevent uncontrollable fires. Additionally fire is an essential tool for income generation, as can be seen from the recently burnt resin tree shown in the photo above.

According to theories of anthropology and political-ecology (Blaikie and Brookfield 1987, Biot *et al.* 1989, Kull 2004 and Toledo 2002) we cannot fully understand how people do something (for example use fire) unless we also understand why people do it (for example the socio-cultural, religious and environmental importance of this practice).

2.2 Religious and cultural importance of fire and how it has changed throughout history

Because Phnong people are mainly animist, they believe that the health and well-being of themselves, their family and the wider community depends on maintaining relationships with ancestral spirits and natural spirits in the environment. The importance of this religious belief for how people use fire is that traditionally many religious ceremonies were required before and after using fire to clear a new miir (Condominas 1977). If these were not followed then problems would follow such as bad harvests and disease. Results showed that the most important religious practices today for fire are not burning spirit-forests and (only in PT) the taboo which results from killing particular species of wild or domestic animals when burning new miir sites. Depending on the species killed, resolving this either entails an animal-sacrifice ceremony to 'cool down' the soil, or abandoning the plot altogether and moving to a new location. However, in general, the research showed that today in both villages fire has a decreasing religious, social and cultural importance because:

- a) young people are less interested in learning from the elders and want to do things 'in a Khmer way',
- b) because they can't afford the financial costs of continuing expensive animal sacrifices which they no longer believe in.

Historically, both villages believe their use of fire to be the same as during their ancestors' time with an overall increase recently due to population increase.



Traditional style of Phnong house in Pu Tang village in front of a modern "khmer" style house



Traditional style of house (background) and rice store (foreground) in Koh Myeul Leu village

The exception to this was during the period of regional and national conflict. After returning to their villages in the mid-1980s, Phnong use of fire returned to traditional patterns, except in KML where most households started cultivating srae rice and therefore use of miir-fires has almost ended.

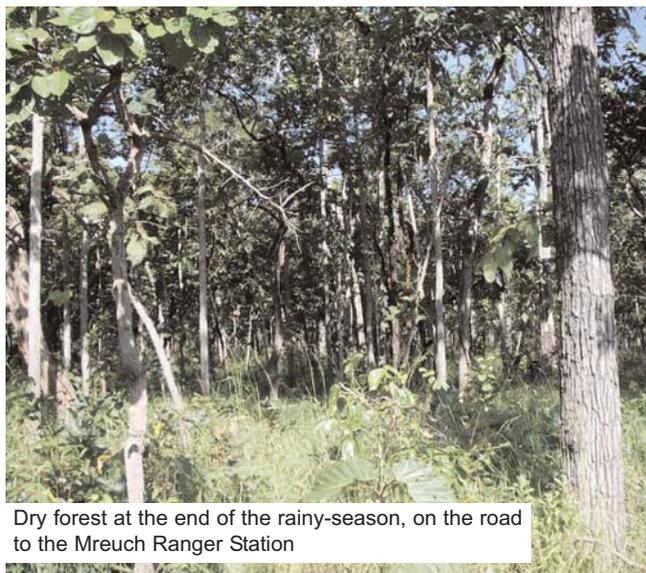
2.3 How people understand the relationship between fire and the environment

It is important to describe how people understand the relationship between fire and the environment because this is the foundation of the logic on which their fire management strategies are based. The Phnong believe that currently almost all fires in Mondulkiri are caused by people and very few had ever heard about fires starting "naturally". The most important relationship between fire and the environment is that fire is not believed to be the most important factor in how an environment is formed. Namely, dry-forest, bamboo forests, savanna grassland and sbov areas will burn, but semi-evergreen and evergreen are 'un-burnable' because: a) they have no ground-level fuel and b) they have not been 'cut and dried' so that their leaves are 'cold' and therefore non-flammable. Therefore, it

is not fire which creates different types of environment or vegetation, but the environment itself which creates the conditions for fires to burn. Fire temperature is understood to depend on the strength of the wind, amount of vegetation (fuel), air temperature and speed of the fire itself; as a result miir fires are hotter than other types of fire. High intensity fires are understood to kill a larger range of species, but are not believed to negatively impact soil quality.



Holding a group discussion with Village Elders, Koh Myeul Leu Village, November 2006



Dry forest at the end of the rainy-season, on the road to the Mreuch Ranger Station



Dry forest recently burnt on the road to Koh Myeul Leu

This study focused on four fire types: burning miir fields; burning sbov grass (*Imperata cylindrica*); burning savanna grassland; and burning the dry forest.

Table 2 (on page 8) is a summary of the main information collected about how these four fire types are used, namely: where and when people use fire, the objectives of using this type of fire, negative impacts from fire use and its suppression, and management strategies employed.



Miir field near Pu Tang village showing recently harvested rice stalks combined with other crops and the line of semi-evergreen vegetation left surrounding the plot to protect it from encroaching grassland fires

Table 2: How the main annual fire types are used

Question	Miir Used in both villages	Sbov	Grassland Savanna	Dry-forest Only used in KML village
	Only used in PT village			
When, where and who?	<ul style="list-style-type: none"> - March-April, burn midday. - New and old sites, for 2 - 10 years (while cultivating rice) 	<ul style="list-style-type: none"> - March, burn any time. - Grows near streams, often near fallow miir 	<ul style="list-style-type: none"> - January-March, burn evening. - Where grazing, NTFP collection, collective ownership. 	<ul style="list-style-type: none"> - March, burn daytime. - Dry-forest areas where fish, collecting NTFPs, graze livestock.
Comment	Burning depends on when vegetation is driest, seasonal calendars indicated that fires are used earlier in KML			
Main and supplementary objectives?	<ul style="list-style-type: none"> - Ensure good harvest: <ul style="list-style-type: none"> • clearing area • maintaining soil fertility • minimising weed re-growth 	<ul style="list-style-type: none"> - Primary - thatching - Secondary - hunting, new growth for animals, clearing 	<ul style="list-style-type: none"> - Primary - new growth for livestock and wild animals - Secondary - clearing paths, improved visibility, hunting, traditional custom, fun 	<ul style="list-style-type: none"> - Multiple: <ul style="list-style-type: none"> • clearing area and soil fertility • new growth for animals • improve forest quality (ease walking, increased visibility) • hunting wildlife
What happens if they don't use fire?	<ul style="list-style-type: none"> - Crop failure: <ul style="list-style-type: none"> • soil loses fertility • planting difficult • weed re-growth too fast - Increased labour clearing vegetation. 	<ul style="list-style-type: none"> - Poor quality regrowth limits available thatching. - Difficult walking. 	<ul style="list-style-type: none"> - New growth poor quality and insufficient quantity. - Vegetation build-up- difficult to walk, hides dangerous animals and , hazardous fuel load. 	<ul style="list-style-type: none"> - Vegetation build-up: <ul style="list-style-type: none"> • walking difficult, dangerous • low visibility • dangerous fuel load - Soil loses fertility, new growth poor quality/quantity
Negative impacts of fire use?	<ul style="list-style-type: none"> - Occasional accidental spread 	<ul style="list-style-type: none"> - Occasional accidental spread 	<ul style="list-style-type: none"> - Frequent accidental spread, small animals sometimes trapped and die. 	<ul style="list-style-type: none"> - Occasional accidental spread, small animals sometimes die. - Tree seedlings can die, larger usually only lose leaves, only 'unhealthy' large trees die
Management strategies?	<ul style="list-style-type: none"> - Set 'headfire'⁵ in average strength wind, burn 'uphill' as 'fire rises'. - Prevention - 2-3m firebreaks, informing neighbouring property owners to assist. 	<ul style="list-style-type: none"> - No consideration context. - Prevention - clearing area, informing neighbours, burning con-joining areas together. 	<ul style="list-style-type: none"> - No consideration context - Prevention - owner's responsibility to protect property near grassland, but taking extra care if burning in risky area. 	<ul style="list-style-type: none"> - No consideration context - Opportunistic (don't monitor impacts), no prevention measures.

⁵ A fire-line which burns in the same direction as the prevailing wind.

2.4 Customary rules and management strategies

This basic division of vegetation being either burnable, or non-burnable and the belief that the majority of vegetation types are stimulated (rather than damaged) by 'normal' fires, is related to broader Phnong understandings of the relationship between humans, fire and the environment. For example, despite over 10 years of very limited fires on the savanna grassland during the KR era⁶, people said the distribution of trees in comparison to grass remained the same as today (one interviewee said there were

fewer trees at the end of the 10 year period); evidence, they believe, that savanna grassland is not primarily caused by the annual fires. This is in direct opposition to some NGO and Government representatives interviewed who strongly believed that the savanna area only exists because of the fires and therefore if the annual burning was stopped, the area would return to forest cover.

The customary rules and strategies for managing fire used by the Phnong appear to range from very strict rules regarding miir burning, to more relaxed, opportunistic management of dryforest fires. This system appears to be based on the potential risk to property (individual or collective), as is summarised in Table 3 below. Men are the key decision-makers for fires which are planned (miir and sbov) whereas the un-planned fires (dryforest and savanna grassland) appear to have no formal decision-making process.

Table 3: Characteristics of management strategies used

Dryforest and Savanna Grassland fires	Miir and Sbov fires
1. Un-planned (done when conducting other livelihood practices), no cooperation with neighbours.	1. Miir pre-planned according to climatic conditions. Both dependant on cooperation with neighbours.
2. Equal decision making between genders (if formal decision is required)	2. Men are key decision makers.
3. Broad target areas found across landscapes, collective ownership of resource. Frequent low intensity fires used to control fuel load, thereby minimising the risk of infrequent, uncontrollable fires.	3. Small, specific target areas are burnt within a larger area which is not burnt, individual ownership of resource area.
4. Benefits and costs of effective fire management felt by all community	4. Benefits of effective fire management felt only by individual households, cost felt by all community
5. No 'management rules' because no property in need of protection, protection of privately owned resources responsibility of the owner, not the fire setter	5. 'Management rules' and prevention measures strongly followed to protect property of fire setter and others.

The results of the research shows that the use of these four types of fires (dry forest, savanna, miir and sbov) also fall into the two broad characteristic types outlined in Tables 3 and 1. Firstly, in terms of ownership, dryforest and savanna fires are a 'collective' activity (any community member can burn any areas which 'belong' to the community) whereas miir and sbov fires are an 'individual' activity (used only by a household in relation to a specific area/resource belonging to them).

Secondly, as both villages had experienced dangerous, uncontrollable fires, customary rules for fire management mainly focus on who is responsible for protecting property. For un-planned dry-forest and savanna fires which are 'uncontrolled' (they have no pre-determined boundary), the owner of property (house, miir field, sbov area etc.) in an area which is potentially burnt is responsible for creating fire breaks as protection. Whereas for miir and sbov fires which are controlled and have a clear pre-determined boundary, strict rules are followed:

- i. Using fire breaks to prevent spread beyond the intended area; usually 2-3m strips of cleared (but not burnt) land surrounding the miir site. Thin strips of evergreen trees are

⁶When the civilian population of Mondulkiri was resettled in Kaoh Niak District for "security" reasons and only soldiers remained on the savanna plateau.

- also left to protect the field from encroaching grassland fires.
- ii. Cooperating with the owners of neighbouring fields prior to setting the fire; burning adjacent areas at the same time or coordinating manual labour to assist and control the fire. If neighbours are not free to assist, the burn is either delayed, or completed but with extra care and wider fire breaks.

Thirdly, management strategies appear to be related to the fire-environment relationship explained above; fire breaks in miir sites adjacent to semi-evergreen trees are viewed to be unnecessary because a) these remote sites pose only minimal risk to other's property, and b) they are located within 'cold trees' (evergreen species) which are therefore non-flammable, as they have not been cut and dried. In dry-forest and savanna regimes, fire is both a controller vegetation and stimulator of new growth, therefore it is viewed as the only effective way to manage fuel loads which therefore reduce the risk of high intensity fires.

2.5 Fire-related legislation and policy-making

None of the community level participants' could cite specific fire legislation, but were aware that 'outsiders'⁷ believe fire is environmentally damaging. They all remembered receiving advice from their Village Chiefs about the potential dangers of fire; that they should either reduce their dependence on it, or burn only in remote areas.

The research team received mixed opinions from local, provincial and national authorities about indigenous⁸ use of fire, which fall into three categories. Firstly, they recognise that it is an important part of local livelihoods, a traditional customary practice which indigenous groups have legislative entitlement to⁹. Secondly, there is a strong belief that fire is always bad in Cambodian law and policies; forest fires are illegal. For example one Commune Chief stated "Burning [the dryforest] is mainly a self-interested custom which has no benefit for the wider community". Thirdly, and most importantly, management of forest fires is simply not a priority for the FA and other Government Agencies. Their

offices are under-resourced and frequently struggle to deal with greater environmental threats such as illegal logging, wildlife trade and conversion of forest to agricultural land. Neither of the provisions in the Forestry Law Articles relating to fire (issuing a Declaration to clarify fire use and establishing Provincial Level Forest Fire Fighters Committees) have yet been implemented. It was interesting that Village Chiefs generally placed themselves in the middle of this division, able to understand both the position of the local community, and also the position of Government thought that their Village Chief was an 'authority' who would report anyone he thought was going to start a fire. The result of these different views is that there appeared to be an 'informal' agreement by authorities at both the national and local levels to focus more on improving community awareness of legislation and the dangers of uncontrollable fires, and less on legal enforcement.

All government representatives interviewed also acknowledged that the contradictions in current fire legislation are made worse due to their insufficient understanding of the relationship between humans, fire and the environment. Some government representatives disputed the scientific understanding that dryforests are dependant on regular fires, whereas others understood the scientific argument, but said that despite the contradictions, the legislation is Cambodian Law and therefore had to be implemented.

⁷ Defined in this report as 'people not originating from the community in question', which include Government Authorities, NGOs and Khmer immigrants to the province.

⁸ During interviews it was not specified if questions were asked only about the Phnong peoples or other indigenous groups living in Monduliri province.

⁹ According to the Forestry and Land Laws, the Community Forestry Sub-decree and the Convention on Biological Diversity to which Cambodia is a signatory.

3 POTENTIAL AREAS FOR POLICY DEVELOPMENT

Because this study was commissioned to help the SWA Project plan for future fire management in Mondulkiri, it ends with an analysis of potential areas for policy development. Recommendations for future research are being developed in a separate document.

3.1 Policy development opportunities within Cambodia's fire-related legislation

Although there is growing recognition by scientists of the value of regular, low intensity fire regimes within the LMDFE, Cambodian fire-related legislation still aims to stop all fires. See for example, Articles 36, 37 and 97 of the Forestry Law (2002), Articles 6, 45, 55 and 57 of the Draft Protected Area Law, Articles 20 and 21 of the Environment Law (2001 revision) and the Provincial Regulations for Mondulkiri Protected Forest (2006), all of which make fire-setting a criminal act. However, interviews with state authorities at local and national levels during the study revealed that the situation on the ground is less clear because some authorities believe that local people managing fire is important due to the lack of the government's own capacity and resources.

This range of different views about how fires should be managed and about what legislation is most appropriate can also be found in similar dryforest environments across the world (Goldammer *et al.* 2002, Price and Bowman 1994, Preece 2001, Yibarbuk *et al.* 2001, Laris 2002, Russell-Smith *et al.* 1997, Moore *et al.* 2002):

- Some types of environments are dependant on the traditional fire management practices used by indigenous peoples.
- Government policies to stop all fires have sometimes had a negative impact on the environment because: a) they ignore local knowledge and experience of managing fires safely, and b) they are not fully implemented due to lack of capacity and resources, especially in remote areas.

- However, local indigenous peoples cannot effectively manage fire on their own, they need support from the state in terms of capacity building, strengthened tenure security and revisions of the policies and legislation.

International approaches for decentralising fire management are often called Community - Based Fire Management (CBFiM)¹⁰ and Integrated Forest Fire Management (IFFM). Because of the resource and capacity restrictions of the Cambodian government to managing fires in remote areas such as the Eastern Plains, three areas were identified by the research team which provide opportunities for decentralising fire management.

1. There are many similarities between the understanding of Phnong Peoples and the understanding of conservation scientists about the relationship between fire and the environment in dry-forest areas. These areas of agreement should be further explored, but this initiative must come from the State and Conservation Organisations.
2. Although Cambodian legislation focuses on stopping all fires, there are some areas which have the potential to increase the involvement of local people in planning strategies for managing fire:
 - The Forestry Law allows fires for 'forest maintenance' which is similar to the goal of Phnong Peoples of 'using fire to manage fire'; for controlling vegetation.

¹⁰ Also known as Community Based Forest Fire Management (CBFFM), but not used in this paper as its forest specificity is not appropriate for the grassland-savanna areas of Mondulkiri.

Local communities could provide considerable support to this process due to their existing knowledge about fire management and also because they live in the remote areas which the FA currently lacks the resources to reach;

- The 'Declaration' (Prakas) related to fire which is intended to support the implementation of the Forestry Law has not yet been drafted. There is therefore the opportunity for discussions about options for decentralised fire management in this document;
 - Provincial 'Forest Fire Fighters Committees' have not yet been established, which again provides potential opportunities for increased local participation in their planning, organization and operation.
3. A CBFiM approach would complement WWF-Cambodia's broader CBNRM methodology of their SWA Project, and would reflect the generally sympathetic view of SWAP's Community Rangers to local fire use. For example, because some Phnong fire management practices are 'sustainable' (within the scope of the study), they would be included in activities which are permitted within the "conservation" and/or "sustainable use" zones (according to MPF's Provincial Regulations¹¹). Increasing local involvement in fire management would improve their tenure security of the natural resources, which has been proved internationally to strengthen overall governance of resources (Dolsak and Ostrom 2003, Rakyutidharm 2002). As has been shown in Thailand "managing the forest with the full involvement of community members is more effective for managing fire if it is an entrenched social responsibility in the first place" (Makarabhirom *et al.* 2002:12).

3.2 Recommendations for how to engage local communities in fire management strategies

In terms of actually sharing fire management strategies and experiences with local Phnong communities in Mondulkiri, this research study can also outline some lessons learnt. The most important of these is that Conservation Agencies and State institutions change their perspective from viewing local use of fire as a 'problem' requiring a 'solution', to viewing local communities as equal stakeholders with essential knowledge, experience and capacity for developing long-term, sustainable and appropriate fire management strategies. This will involve a number of institutional changes to how the MPF staff engage with local communities including: recognizing and valuing local knowledge; and using participatory and inclusionary methodologies to strengthen community-project relations. Secondly, it was noted by the research team that community members were initially reluctant to discuss their own personal use of fire within the presence of FA or Government officials. It was only when a smaller research team returned (without government representatives) that community participants began to speak openly about their personal experiences. Although no-one officially stated their fear, it was clear that people were afraid of discussing what they know to be a criminal activity in front of people who could enforce the law and arrest them. Therefore an essential step for any further discussions on how local fire management strategies can be used within SWAP, is for key project staff members to gain the trust of local communities.

In addition to this, the FA and WWF project leaders need to investigate which approach to decentralised Community Based Fire Management or Integrated Forest Fire Management is the most appropriate for their needs. Both these models can be implemented in a way that planning and decision-making is completely done by the project staff and local community representatives participate primarily as locally available human resources to help manage controlled fires. Alternative models are implemented such that local communities are themselves controlling the management of local fires including planning, implementation and decision-making, whilst project staff provide institutional support to them. There are costs and benefits of both of these models. Identifying the most appropriate approach for MPF will take significant time and resources, and was outside the scope of this study. However, the following pages outline three case studies taken from the Asian region which give some indication of issues which need to be considered.

¹¹ Mondulkiri Protected Forest Provincial Regulations, 2nd February 2006.

3.3 Case studies of community-based fire management from other Asian countries

1) IUCN Non-Timber Forest Product (NTFP) Project, Salavan Province, Lao PDR (1995 to 2001)¹²

1.1 Background and context

Lao PDR's dry dipterocarp forests are actively maintained by fire. Fires are used to clear vegetation, improve movement ease, hunting, provide cattle forage, cultivate mushrooms, stimulate grass for thatching and fodder, and for shifting cultivation. The project is located on the edge of the Xe Bang Nouan National Biodiversity Conservation Area. The Forest Law (1996), Prime Minister's Decrees (No. 164 and 169, 1993) and Order 54 / Ministry of Agriculture and Forestry (1996) give local people rights to use the forest according to their customary beliefs but forbid burning in protected areas. Order 2094/MAF "Fighting Forest Fires During the Dry Season" (1999) gives authority to Provincial and District authorities to implement forest fire management activities and supports the involvement of local communities in forest fire management.

1.2 Scope of project

Provincial authorities established fire control committees in each village following devastating fires in January 1999, which negatively affected local communities. NTFP project staff worked with District Authorities to strengthen village committee members' understanding of the threats of fires and helped them to develop multi-village agreements on fire preparedness strategies and management rules and regulations. Monthly meetings occur between villages to consolidate information on resource use.

1.3 Lessons learnt

Project's success was based on:

- Having strong local level impetus based on shared experiences of uncontrolled fires
- Being grounded within broader CBNRM activities which valued local knowledge and encouraged local people to make their own decisions
- Being supported institutionally by local government structures, decentralization policies and a complementary legal framework

Areas of improvement which were identified by project staff:

- Promote the capacity of district authorities to support local

management systems through training of local facilitators

- Strengthen local monitoring of procedures and resource use to reflect on lessons learnt, identify gaps and influence policy design and implementation
- Develop networks to share information and experiences between local stakeholders and other similar areas

2) Building upon traditional community-based fire management, Shifting Cultivation, Northeast India¹³

2.1 Background and context

Control and management of forest and shifting cultivation fires are traditionally understood to be the joint responsibility of individuals and the village; other fire types used include burning to stimulate new growth for grazing animals, eradicate unwanted vegetation and improve visibility for hunting.

2.2 Scope of traditional fire management

Regulatory measures describe when different fire types can be used and preventative measures for ensuring fire types do not become uncontrollable. There are specific roles and responsibilities for family members during field and forest fires, village level fire prevention committees and the village councils are responsible for imposing fines on either individuals or the whole community.

2.3 Government interventions in fire management and their impacts

Government local fire prevention systems operate in parallel to traditional systems and depend heavily on district and state levels for advisory, supportive and coordinating functions. Fire Control is also based within the State Environment

¹²Adapted from London (2003), full version available from Megan MacInnes.

¹³Ibid.

and Forest Department. Fire intensity and frequency appear to be increasing at the same time that traditional community-based fire management institutions are weakening, which appear to be due to changing livelihood practices. As a result of this, adults are no longer available as fire fighters; people are increasingly dependent on government-initiated fire management programmes; and in addition, increasing population numbers are intensifying land use practices which further increase fire risks.

3) Local communities managing fire in Chiang Mai, Northern Thailand¹⁴

3.1 Background and context

Fire management is traditionally divided between fire management in the "forest type" areas (dipterocarp and mixed deciduous forests) and fire prevention in "conservation forest" areas (dense, evergreen forests) under a community forestry model, in communally owned land. Fires are lit for hunting; accelerating germination of seeds and non-timber forest products (including mushrooms and bamboo shoots); stimulating new growth for grazing animals; early 'prescribed' burns to reduce vegetation and therefore reduce severity of dry season fires; to eradicate pests; and finally within shifting cultivation cycles. However, State definitions of 'communal' and 'state' property conflict with local community definitions, which therefore lead to problems about which fires are 'out of control' in forest areas (State definition is fire on state land with no control) and which are not (State view that fires on communal land are systematic and therefore not forest fires). In addition,

the State rejects local experience of managing fires in forested areas and believes all fires to be damaging to the environment.

3.2 Scope of the fire management

In 1993, severe drought and forest fires occurred, which the State failed to control because responsible agencies lacked capacity or resources to manage natural resources, but the legislation prevents local people from managing natural resources. As a result, local groups developed forest conservation plans, based on traditional knowledge and experiences, both in communal and state owned land; annual early dry season fire breaks are built to protect villages and conservation forests, and volunteer fire patrols are organized. However, these measures are not always effective because the lack of local tenure or rights to access natural resources in protected areas mean that there are no incentives for local people to manage fire safely. State officials believe fires in protected areas are caused by bad local practices, whereas locals believe the Government staff set these fires themselves in order to increase their annual budgets.

3.3 Lessons learnt

- Secure rights to natural resources are important conditions for establishing sustainable fire management systems
- Local people have significant experience and knowledge about fire management which should be integrated within state management strategies, especially if the state lacks the resources or capacity.
- Mis-trust between stakeholders relating to fire management can increase the danger of uncontrolled fires.

These three case studies therefore are examples from similar environments in the Asian region of how government and local communities have worked together to manage fire. The first example from Lao, shows how important it is that local management systems are recognised as a real priority by the local community themselves and that these systems must be supported by local government and complementary legislation. The second example, from India, is an example of how important traditional management institutions are for long-term, responsible, local management. This means therefore that local fire management needs to be implemented in coordination with external projects which also support broader livelihood security. Finally, the third example from Thailand shows the problems which Government agencies can have if they do not respect local natural resource management systems and how important it is for local fire managers to have secure tenure over the resources they are managing.

¹⁴ Adapted from Moore et al. (2002), full version available from Megan Maclnnes.

4 CONCLUSION

The overall finding from this research is that although the Phnong in Mondulkiri recognize fire to be potentially dangerous to humans and the environment, there is a dominant understanding that some types of environments burn (dry forests) and others do not (semi-evergreen forests). As a result, fire is not viewed as the cause of environmental change, instead the environment itself is believed to determine if a fire will burn or not; in other words, whether fire is "good" or "bad" depends on its context, management and season. Local communities who traditionally use fire view it as an essential tool for natural resource management that their livelihoods directly depend upon. They believe that if fire was stopped in either the dry forest, or on the savanna plateau, then this would have negative impacts on both household economies and the wider environment. Miir fires are central to maintaining shifting cultivation nutrient-cycles, whereas in the grassland-savanna and dryforest, fire is viewed as a landscape 'cleaner' to reduce vegetation (potential fuel), increase visibility, safety and ease walking. The management strategies for the four main types of fire discussed appear to fall into two categories which are governed by different customary rules which depend on: a) the expected outcome, b) the resource tenure system and c) the perceived risk to property. Although fire use was traditionally closely tied to traditional religious belief, because of the war and recent socio-economic changes, most people feel that today this relationship is less important than in previous times.

The way that Phnong people use fire is very similar to how indigenous groups manage fire in similar environments in Australia, Africa and Latin America. Phnong understandings of the relationship between humans, fire and the environment is also close to the scientific view of the importance of regular fires for maintaining the dry forest environment throughout the LMDFE. However, current Cambodian legislation make all fires illegal, even though many of the government officials interviewed during this study admitted that they do not have the capacity or resources to enforce these rules and thereby manage fires effectively in remote areas like Mondulkiri. As fire legislation and management structures in Cambodia are not yet complete, there is an opportunity for the Forest Administration office, WWF and other responsible agencies to learn from local indigenous groups, such as the Phnong, about how they manage fire; to decentralize management of fire by including local peoples; and to support this community based fire management through legal frameworks and local government structures.

REFERENCES

- AAH (2003) 'Food Security Assessment Mondulakiri Province', Action Against Hunger, Phnom Penh, Cambodia.
- Biot, Y., Blaikie, P.M., Jackson, C. and Palmer-Jones, R. (1989) 'Rethinking Research on Land Degradation in Developing Countries', Washington DC: World Bank Discussion Paper 289.
- Blaikie, P. and Brookfield, H. (eds) (1987) *Land Degradation and Society*. London: Methuen.
- Brechin, S.R., Wilshusen, P.R., Fortwangler, C.L. and West, P.C. (2002) 'Beyond the square wheel: toward a more comprehensive understanding of biodiversity conservation as a social and political process', *Society and Natural Resources*, 15 41-64.
- Colm, S. (1997) 'Land Rights: the challenge for Ratanakiri's indigenous communities' *Watershed: People's Forum on Ecology*, 3:1.
- Conklin, H.C. (1954) 'An ethnoecological approach to shifting agriculture', *Trans. NY Academy of Sciences*, 17 133-142.
- Condominas, G. (1977) *We have eaten the forest: the story of a montagnard village in the central highlands of Vietnam* (English translation). New York: Farrar, Straus and Giroux Inc.
- Dolsak, N and Ostrom, E (2003) (eds) *The Commons in the New Millennium: Challenges and Adaptations*, Cambridge, Massachusetts: The MIT Press
- DoP (2006) 'Mondulakiri Provincial Statistics', Department of Planning, Mondulakiri Province, Cambodia.
- FAO (2003) 'Community-based fire management: case studies from China, The Gambia, Honduras, India, the Lao Peoples Democratic Republic and Turkey', Bangkok, Thailand: Food and Agriculture Organisation.
- Forsyth, T., (1996) 'Science, myth and knowledge: testing Himalayan environmental degradation in Thailand' *Geoforum* 27(3):375-392
- Guerin, M., Hardy, A., Van Chinh, N. and Tan Boon Hwee, S. (2003) *Des montagnards aux minorités ethniques: quelle intergration nationale pour les habitants des hautes terres du Viet Nam et du Cambodge?*. Paris, France: L'Harmattan.
- Goldammer, J.G. (ed) (1990) *Fire in the Tropical Biota: Ecosystem Processes and Global Challenges*. Berlin Heidelberg: Springer-Verlag.
- Goldammer J.G. (2005) 'Forest Fires: A Global Overview' in Sayer, J. (ed) *The Earthscan Reader in Forestry and Development* pp215-253. London: Earthscan.
- Goldammer, J.G., Frost, P., Jurvelius, M., Kamminga, E.M., Kruger, T., Moody, S.I. and Pogeyed, M. (2002) 'Community participation in integrated forest fire management: experiences from Africa, Asia and Europe' in Moore, P.F., Ganz, D., Cheng Tan, L., Enters, T. and Durst, P.B. 'Communities in Flames: proceedings of an international conference on community involvement in fire management', pp 33-52, Bangkok, Thailand: Food and Agriculture Organisation.
- Hickey, G. C. (1982) *Sons of the Mountains: Ethnohistory of the Vietnamese Central Highlands to 1954*. New Haven and London: Yale University Press.
- Kull, C.A. (2004) *Isle of Fire: The Political Ecology of Landscape Burning in Madagascar*. Chicago and London: University of Chicago Press.
- Laris, P. 2002 'Burning the seasonal mosaic: preventative burning strategies in the wooded savanna of Southern Mali', *Human Ecology*, 30:2, 155-186.
- London, S. (2003) 'Community-Based Fire Management in the Lao People's Democratic Republic: past, present and future' in FAO 'Community-based fire management: case studies from China, The Gambia, Honduras, India, the Lao Peoples Democratic Republic and Turkey', pp 97-120, Bangkok, Thailand: Food and Agriculture Organisation.
- MAFF (2002) 'Forestry Law' Phnom Penh, Cambodia: Ministry of Agriculture, Forestry and Fisheries.
- Makarabhirom, P., Ganz, D. and Onprom, S. (2002) 'Community involvement in fire management: cases and recommendations for community-based fire management in Thailand' in Moore, P.F.,

- Ganz, D., Cheng Tan, L., Enters, T. and Durst, P.B. 'Communities in Flames: proceedings of an international conference on community involvement in fire management', pp 10-15, Bangkok, Thailand: Food and Agriculture Organisation.
- Maxwell, A.M. (1999) 'Holocene Environmental Change in Mainland Southeast Asia: pollen and charcoal records from Cambodia', Unpublished PhD Dissertation, Louisiana State University, USA.
- Maxwell, A.M. (2004) 'Fire regimes in north-eastern Cambodian monsoonal forests, with a 9,300 year sediment charcoal record', *Journal of Biogeography*, 31, 225-239.
- Maxwell, A. and Pinsonneault, Y. (2001) 'Proceedings of the Conservation Strategy Workshop: Dry Forest Landscapes of Northern and Northeastern Cambodia, 27-29th July 2001', Phnom Penh, Cambodia: WWF EcoRegion Based Conservation Programme and WWF-Cambodia.
- Melville, R. (2000) 'A Northeast Forest: field notes on the hill-tribes and fauna of Cambodia', personal monograph, printed by Richard Melville, Hallowell, Maine, USA.
- Moore, P.F., Ganz, D., Cheng Tan, L., Enters, T. and Durst, P.B. (2002) 'Communities in Flames: proceedings of an international conference on community involvement in fire management', Bangkok, Thailand: Food and Agriculture Organisation.
- MoE (1998) 'National Environmental Action Plan', Phnom Penh, Cambodia: Ministry of Environment.
- MoI (2006) 'Guidelines for the interpretation of the Mondulkiri Protected Forest Regulations (unofficial English translation)', Ministry of Interior, Mondulkiri Province, No. 010 Sor Nor No.
- NGO Forum (2005) 'Rethinking poverty reduction to protect and promote the rights of indigenous minorities in Cambodia: a human rights approach to land and natural resources management.' Phnom Penh, Cambodia: The NGO Forum on Cambodia.
- Nikles, B. (2006) 'Use and management of forest resources in Phnong villages, Mondulkiri'. Unpublished Masters Thesis, University of Zurich, Switzerland.
- PFfSEA (2003) 'Community-based fire management: case studies from China, The Gambia, Honduras, India, the Lao People's Democratic Republic and Turkey', Food and Agriculture Organisation of the UN, RAP Publications, Forest Resources Development Service, Working Paper IFFM/2.
- Price, O. and Bowman, D.M.J.S. (1994) 'Fire-Stick Forestry: a matrix model in support of skilful fire management of *Callitris intratropica* R.T. Baker by North Australian Aborigines', *Journal of Biogeography*, 21:6, 573-580.
- Preece, N. (2001) 'Aboriginal Fires in Monsoonal Australia from Historical Accounts', *Journal of Biogeography*, 29, 321-336.
- Rakyutidharm, A. (2002) 'Forest fire in the context of territorial rights in northern Thailand' in Moore, P.F., Ganz, D., Cheng Tan, L., Enters, T. and Durst, P.B. 'Communities in Flames: proceedings of an international conference on community involvement in fire management', pp 112-116, Bangkok, Thailand: Food and Agriculture Organisation.
- Russell-Smith, J., Lucas, D., Gapindi, M., Gunbunuka, B., Kapirigi, N., Namingum, G., Lucas, K., Guiliani, P. and Chaloupka, G. (1997) 'Aboriginal resource utilization and fire management practice in Western Arnhem Land, Monsoonal Northern Australia: notes for pre-history, lessons for the future' *Human Ecology*, 25:2, 159-195.
- Toledo, V.M. (2002) 'Ethnoecology: a conceptual framework for the study of indigenous knowledge of nature' in Stepp, J.R., Wyndham, F.S. and Zarger, R.K (eds) *Ethnobiology and Biocultural Diversity: proceedings of the 7th International Congress of Ethnobiology* pp 511-522. Athens, Georgia: University of Georgia Press and the International Society of Ethnobiology.
- Tordoff, A.W., Timmins, R.J., Maxwell, A., Huy, K., Lic, V., and Khou, E.H. (eds) (2005) *Biological Assessment of the Lower Mekong Dry Forests Ecoregion*, Phnom Penh, Cambodia: WWF-Cambodia.
- White, J. (1996) 'The Indigenous Highlanders off the North-east: an uncertain future' in Centre for Advanced Study, *Interdisciplinary Research on Ethnic Groups in Cambodia: final draft reports*, pp. 333-374. National Symposium on Ethnic Groups in Cambodia, Phnom Penh, 18-19 July 1996.
- WWF-Cambodia (no date) 'The Lower Mekong Dry Forest Ecoregion' Phnom Penh, Cambodia: WWF-Cambodia.
- Yibarbuk *et al.* (2001) 'Fire Ecology and Aboriginal Land Management in Central Arnhem Land, Northern Australia: a tradition of ecosystem management', *Journal of Biogeography*, 28:3, 325-343.