ISSN 0563-8682

Southeast Asian Studies

東南アジア研究

Vol.47 No.3

ISSN 0563-8682

東 南 ア ジ ア 研 究

47巻3号　　2009年12月

目　　次

Land Use Changes in the Uplands of Southeast Asia:
Proximate and Distant Causes

SOUTHEAST ASIAN STUDIES

Vol. 47, No. 3 December 2009

CONTENTS

Land Use Changes in the Uplands of Southeast Asia:
Proximate and Distant Causes

Southeast Asian Studies, Vol. 47, No. 3, December 2009

Land Use Changes in the Uplands of Southeast Asia: Proximate and Distant Causes

Introduction

Stephen J. Leisz,* Kono Yasuyuki,** Jefferson Fox,***
Yanagisawa Masayuki† and Terry A. Rambo††

Humans have been influencing changes in land cover through their changing patterns of land use since the invention of agriculture. The initial small footprints left by agricultural settlements have grown larger overtime and today it is estimated that roughly 50% of the earth's land surface has been affected and transformed by human activities [Vitousek *et al.* 1997; Haberl *et al.* 2007]. This impact is not static, but rather is constantly changing as resource use patterns, farming systems, and settlement patterns change. Since the 1970s, with the application of information from satellite sources to the study of worldwide land use and land cover changes, interest in questions of how and why land use is changing and the impacts of these changes on the natural and built environment has grown. Studies focusing on land use and land cover change have been grouped under the title of "land change science," an inter-disciplinary field that investigates and attempts to understand the dynamics of land use and land cover changes within coupled human-natural systems [Turner *et al.* 2007]. The papers that make up this special issue fit within the scope of this field and attempt to address one of the central questions that land change scientists are addressing today: causes of land use change.

Turner *et al.* [2007] note that most of the proposed causal variables of land use change are proximate factors, such as immigration, subsistence farmers' impacts, deforestation, or local common property resource management strategies [Lambin and Geist 2006] and that more distant factors, such as national policies, tend to be difficult to connect empirically to land use change outcomes. This special issue attempts to address this issue within land change science by focusing on one region of the earth, the montane uplands of Vietnam, Laos, Cambodia, and Hainan Island (China), in Southeast Asia that has

* Department of Anthropology, Colorado State University, Fort Collins, Colorado, U.S.A.
** 河野泰之, Center for Southeast Asian Studies, Kyoto University
e-mail: kono@cseas.kyoto-u.ac.jp
*** East-West Center, U.S.A.
† 柳澤雅之, Center for Integrated Area Studies, Kyoto University
†† Faculty of Agriculture, Khon Kaen University, Thailand

witnessed an increasing frequency of change over the past few decades. Each paper focuses on how land use, and consequently land cover has changed for the specific study area and the triggers, both proximate and distant, that have influenced the changes.

Background

After World War II, from the late 1940s to the late 1980s, the countries and localities of Southeast Asia represented in these articles experienced upheavals due to a state of almost constant warfare within the region. These upheavals were reflected in the local populations' land use changes across the region, including changes in the use of land in remote upland areas. The changes in land use were not uniform. In some parts of the region's uplands individual land holding was dissolved and cooperative farms and state managed forest enterprises were started. Examples of these types of changes in Vietnam are detailed in Truong *et al.* [2009] and Leisz [2009]; while in other parts, such as in Ratanakiri, Cambodia [Fox and Vogler 2009] and parts of Laos [Thongmanivong *et al.* 2009; Saphangthong and Kono 2009], the uplands were depopulated or people were displaced from their village area. Meanwhile, in other places in the region, such as some remote parts of Hainan Island, it appears that land use was little changed until present [Umezaki and Jiang 2009]. Other aspects of the region were also undergoing change. In most cases population grew and in some cases populations moved, but transportation routes and urban areas did not necessarily improve or grow. In some cases populations left urban areas, either because it was believed that the countryside was safer or because of forced migration, and many railways and roads were damaged by conflict.

Many of these conditions started to change in the late 1980s, as the region became more peaceful, and further change accelerated in the 1990s and into the 21st century. During this period multiple internal policies within each country changed, foreign direct investment to the countries increased, and the region, as a whole became more connected with the wider world. No matter if land use systems in the uplands were impacted by wider regional events during the previous decades or not, from the late 1980s to the first decade of the 21st century, events outside of the region's uplands started to make their impact felt and land use systems in the uplands have been changing. These changes in the land use systems have consequently been reflected in the land cover across the uplands.

The six articles in this special issue bring together 15 land use change case studies from the mountainous areas of Vietnam, Laos, Cambodia, and the province of Hai Nan in China. In each of these countries the mountainous areas are experiencing rapid bio-physical and socio-economic changes. Land use change within these countries, and even within the regions of the countries, is often viewed in

isolation from other regions and from other countries. As noted above by Turner *et al.* [2007], local people, drawing on proximate causes, can usually explain why land use is changing within their village, and explanations are often valid for the locality in question, but these changes are not consciously connected to external influences. The reality is that there are forces external to the village locality that are influencing, or driving the change, and these forces are put into motion by triggers, either of a local, national, or regional nature.

All of the case studies in this special issue investigate the following key questions: (1) what are the overall trends in land use change at the case study site? (2) what are the driving forces behind the case's land use change? and (3) what are the triggers that influenced the driving force(s) at each study site? By addressing these questions this issue seeks to compare and contrast the land use change trends, driving forces and triggers across the sites and draw out the relevant lessons regarding the realities of local land use change across the region and the relationship between these local changes and larger national and regional issues and influences.

Overview of Articles

The articles included here all focus on cases of land use change in the uplands of Southeast Asia. All of the articles make use of remote sensing data combined with ground truthing fieldwork and interviews with local people regarding how their land use has changed over each case study's time-period. The remote sensing methodology used by each of the case studies is similar, making use of air photos and visual interpretation and/or Landsat TM/ETM+ imagery and supervised classification techniques. Two of the articles look at the changing land use and land cover conditions of their case study sites from the late-1960s/early-1970s to the late-1990s/mid-2000, while the other four articles focus on changes in land use and cover from the late 1980s through the middle of the first decade of the 21st century.

The article by Saphangthong and Kono and the one by Dao *et al.* look at the period from the late-1960s/early-1970s. Saphangthong and Kono highlight changes in the land use and cover of three composite swidden farming villages in northern Laos over the period from 1973 to 1999. They divide their analysis into two parts for each of the villages, 1973–82 and 1982–99 and conclude that each of these phases have different mechanisms driving the land use changes. During the first phase drastic deforestation occurs, with reduction in forest cover by 40% to 60% depending upon the village. During the second phase forest cover per village remains constant, but there is an intensification of land use, specifically of agricultural land use. The triggers for each of these changes are different. During the first phase the trigger was the dissolution of community based authority and the transition to a central

government sanctioned local administration based authority. The transition left a period of no recognized authority in the study area, which triggered the deforestation of lands that had supported agriculture. The second phase of land use change, the intensification of the use of agricultural land, was also triggered by an external event, the government intervention into each village's land use system by enforcing a ban on shifting cultivation and introducing a land-forest allocation program.

Dao *et al.* examines land use changes in one village in north-central Vietnam. Similar to the previous cases, this article identifies two distinct phases of land use and cover changes. From the late 1960s to the late-1980s/early-1990s there is a decrease in the forest cover of the village. Two triggers are identified. The first is the proximate cause of population increase in the village, while the second is the increase of logging brought to the area by the state forest enterprise (set up in the 1950s) acting in response to the country's policy emphasizing reconstruction and infrastructure building needs. The second land use and cover change phase from the late 1980s to the mid-2000s saw an increase in forest cover. There are three triggers for this increase. The first is a change in government state forest enterprise policy, away from timber extraction and towards reforestation activities. The second is the government intervention at village level that saw the introduction of a wide range of forest conservation and rural development programs including a forest land allocation program at the village level. The third is the implementation of a foreign funded conservation program in the area that provided resources for reforestation activities and forest protection activities at the village level.

The four articles by Thongmanivong *et al.* focusing on northern Laos, by Leisz focusing on north-central Vietnam, by Fox and Vogler *et al.* focusing on northwestern Cambodia, and by Umezaki and Jiang focusing on upland Hainan Island, all discuss changes in land use and cover from the late 1980s through the mid-2000s. Thongmanivong *et al.* study two districts in northern Laos. They conclude that their study area populations are switching from subsistence rice farming to the cultivation of commercial crops, like rubber, and that an expansion of permanent agricultural land at the expense of swidden agricultural and forest fallow lands is taking place. The trigger initiating this change is market influence, facilitated by personal contacts, specifically the communication of information about the benefits of commercial crop cultivation, in this case rubber tree cultivation, versus subsistence rice farming that were transmitted to the study area's population via their transboundary social networks from China.

The article by Leisz focuses on four hamlet case studies of land use and cover change over three districts in north-central Vietnam. The case studies examine the changes in land use and cover from the 1989/93 period to the 1999/2003 period. Within the overall three districts study area land that is covered by mature trees, tree cover increased and land dedicated to agricultural land use decreased. Within the four hamlet case study areas a similar pattern was seen in each case: forest land use increased

and land reserved for agricultural land use decreased. Investigation into the reasons for the increase in tree cover concludes that there are two overriding factors influencing the expansion. The first trigger identified is the government forest and agricultural land allocation programs that were initiated in three of the four case study hamlets during the decade. The second trigger is the influence of the lowland demand for beef and pork that has reached the upland case study hamlets via the market. In each of the hamlet case studies cattle and pig raising for market has increased. The cattle and pigs are sold in the market, providing cash income to the case study population and decreasing the agricultural land needed per hamlet.

Fox and Vogler *et al.* examine three case study villages in Ratanakiri, Cambodia. The case studies illustrate that from 1989 to 2006 one of the village's protected forest area remained virtually intact and its total forest area decreased at a rate of 0.86% per year, while the total forest area of the second case study village decreased at an annual rate of 1.63%, and the forest area of the third case study village decreased at an annual rate of 4.88%. There are two triggers initiating the land use changes in all three of the case study areas: (1) national government policies to liberalize trade and (2) market access to/from the villages. These two in combination have influenced the village populations to initiate a land use schema that include the planting of rubber and cashew trees, whose products are sold in market, and the intercropping of upland rice within the fields where these trees are grown. The differing rates of forest cover change in the three study villages are a result of differing management strategies by the three villages. The one village with the slowest forest loss has been most successful at managing its resources, while the other two villages increasingly view land as a marketable commodity and have responded to market forces by developing more of their forest lands for income or for sale.

The article by Umezaki and Jiang focuses on two villages in the uplands of Hainan Island, China, and the land use and cover changes that have taken place from 1980 to the early 2000s. This period coincides with the dramatic changes in the Chinese economy as the country went from the planned economy period through the transition to a market economy. During this period of time the land-cover of the two study villages transitioned from predominantly grass/shrub to mature or secondary forest cover. While land-covers transitioned in unison, land use did not. Within one of the villages, the forest area expanded in an area that became a nature conservation park, while in the other village, the forest cover expanded in areas where tree plantations were cultivated. The triggers for these changes are identified by the authors as respectively being government intervention, e.g. the enforcement of conservation laws at the village level, and the market demand for cash crops that influenced the planting and expansion of tree plantations.

Conclusions

The articles in this special issue attempt to identify triggers of land use change in the uplands of Southeast Asia. While the case studies that make up this special issue are drawn from geographically disparate locations across the uplands of Southeast Asia, similar triggers of land use change are identified in each. Triggers of land use changes during the 1990s and the early 21st century rose outside the study area and outside the control of the people in each of the study areas. These distant triggers can be grouped into two major categories: central government policy change and market changes.

Central government policy changes are further subdivided into three main categories: land tenure policies, market policies, and policies related to state owned companies. The land tenure policies are the most widespread. In all but one of the case studies government policies related to the ownership or management of forest land is identified as a trigger leading to the increase in forest or tree cover. Government market policies are seen in one case study, Fox and Vogler *et al.*, where policies related to trade liberalization are identified as a trigger that influenced the land use in the study area. In this case, government policy is credited with decreasing the area under forest cover. Dao *et al.* document how government policies related to a state owned enterprise act as a trigger that leads to an increase of forest cover within the study area.

Market changes are shown to have an influence on land use changes in all of the case studies except for one. In northern Laos, Ratanakiri, Cambodia, and Hainan Island, there is strong market demand for tree plantation derived products, such as rubber and cashews. This demand is a trigger that influenced the local population to convert areas previously used for upland rice to tree plantations. This demand originates from locations far afield and illustrates how the world market can trigger local and remote land use, and ultimately land-cover, changes. In the four case studies related by Leisz, the market also has an influence. Market demand for meat from the lowlands of Vietnam influences upland populations to divert labor from upland cultivation tasks to cattle and pig raising tasks. This diversion of labor means that less upland is cleared for crops and tree cover is expanding as trees mature in previously grass and bush land areas.

The articles of this special issue corroborate other case study information that land use is changing across Southeast Asia [Mertz *et al.* 2009; Schmidt-Vogt *et al.* 2009] and that a forest transition is taking place within some of the countries of the region [Meyfroidt and Lambin 2008]. Further, the case studies present a clear message as to the triggers that are driving land use changes. The disparate case studies all point to two general categories of distant triggers. One category is initiated at the central government level and the other is initiated even farther afoot at the world-market level. The conclusion that

can be drawn from the case studies presented in this issue is that land use changes taking place today in the uplands of Southeast Asia are strongly connected with and being triggered by policies and demands initiating from locations that were in many cases not even in contact with the region as recently as 20 years ago.

References

Dao, M. T.; Kono, Y.; Yanagisawa, M.; Leisz, S. J.; and Kobayashi, S. 2009. Linkage of Forest Policies and Programs with Land Cover and Land Use Changes in the Northern Mountain Region of Vietnam: A Village-level Case Study. *Southeast Asian Studies* 47(3): 244–262.

Fox, J.; and Vogler, J. B. *et al.* 2009. Understanding Changes in Land and Forest Resource Management Systems: Ratanakiri, Cambodia. *Southeast Asian Studies* 47(3): 309–329.

Haberl, H.; Erb, K. H.; Krausmann, F.; Gaube, V.; Bondeau, A.; Plutzar, C.; Gingrich, S.; Lucht, W.; and Fishcerh-Kowalski, M. 2007. Quantifying and Mapping the Human Appropriation of Net Primary Production in Earth's Terrestrial Ecosystems. *Proceedings of the National Academy of Sciences* 104(31): 12942–12947.

Lambin, E. F.; and Geist, H. J. 2006. *Land-use and Land-Cover Change: Local Processes and Global Impacts*. Berlin: Spinger, 222 p.

Leisz, S. J. 2009. Dynamics of Land Cover and Land Use Changes in the Upper Ca River Basin of Nghe An, Vietnam. *Southeast Asian Studies* 47(3): 287–308.

Mertz, O.; Padoch, C.; Fox, J.; Cramb, R. A.; Leisz, S. J.; Lam, N. T.; and Vien, T. D. 2009. Swidden Change in Southeast Asia: Understanding Causes and Consequences. *Human Ecology* 37: 259–264.

Meyfroidt, P.; and Lambin, E. F. 2008. Forest Transition in Vietnam and Its Environmental Impacts. *Global Change Biology* 14: 1–18.

Saphangthong, T.; and Kono, Y. 2009. Continuity and Discontinuity in Land Use Changes: A Case Study in Northern Lao Villages. *Southeast Asian Studies* 47(3): 263–286.

Schmidt-Vogt, D.; Leisz, S. J.; Mertz, O.; Heinimann, A.; Thiha, Messerli, P.; Epprecht, M.; Cu, P. V.; Chi, V. K.; Hardiono, M.; and Dao, T. M. 2009. An Assessment of Trends in the Extent of Swidden in Southeast Asia. *Human Ecology* 37: 269–280.

Thongmanivong, S.; Fujita, Y.; Phanvilay, K.; and Vongvisouk, T. 2009. Agrarian Land Use Transformation in Northern Laos: from Swidden to Rubber. *Southeast Asian Studies* 47(3): 330–347.

Turner, B. L.; Lambin, E. F.; and Reenberg, A. 2007. The Emergence of Land Change Science for Global Environmental Change and Sustainability. *Proceedings of the National Academy of Sciences* 104(52): 20666–20671.

Umezaki, M.; and Jiang, H. 2009. Changing Adaptive Strategies of Two Li Ethnic Minority Villages in a Mountainous Region of Hainan Island, China. *Southeast Asian Studies* 47(3): 348–362.

Vitousek, P. M.; Mooney, H. A.; Lubchenco, J.; and Melillo, J. M. 1997. Human Domination of Earth's Ecosystems. *Science* 277: 494–499.

Southeast Asian Studies, Vol. 47, No. 3, December 2009

Linkage of Forest Policies and Programs with Land Cover and Land Use Changes in the Northern Mountain Region of Vietnam: A Village-level Case Study

DAO Minh Truong,* KONO Yasuyuki,** YANAGISAWA Masayuki,***
Stephen J. LEISZ† and KOBAYASHI Shigeo††

Abstract

This paper examines the land cover and land use changes in one village in the Vietnam's northern mountain region. It overviews the changing forest policies in Vietnam from the country's independence in 1954 to 2005 and relates these changes to the management of forest land at the village level. Findings show that until the late-1980s/early-1990s Vietnam's policies encouraged the harvesting of timber for nation building activities and the expansion of cultivated land, leading to the decreased forest area within the village. After this, as government policies changed to encourage forest protection and the planting of trees by local people, tree covered forest land area increased. The trigger for the change in land cover and land use at the village level in both periods is a consistent political intention represented in a series of laws and decrees and consequent extension activities. These established a strong linkage between national and the village level forest governance and led to the almost simultaneous occurrence of national policy change and forest recovery. It is concluded that it is important to recognize the multiple channels that link the government agencies with people and the intensive learning process needed for local people to understand the political intentions behind laws and regulations promulgated at the central government level.

Keywords: land cover change, land use change, forest policy, Vietnam, Pu Mat

I Introduction

Throughout the world, some 350 million people live within or adjacent to dense forests [FAO 2005]. Forests provide a wide range of products, ranging from food to non-food items for people's daily livelihood needs. However, this resource has been depleted seriously over the last century if not to say the

* Center for Natural Resources and Environmental Studies, Vietnam National University, Vietnam
** 河野泰之, Center for Southeast Asian Studies, Kyoto University
e-mail: kono@cseas.kyoto-u.ac.jp
*** 柳澤雅之, Center for Integrated Area Studies, Kyoto University
† Department of Anthropology, Colorado State University, Fort Collins, Colorado, U.S.A.
†† 小林繁男, Graduate School of Asian and African Area Studies, Kyoto University

last few decades. FAO's 2005 statistical data shows the rate of net forest loss slowing down from 8.9 million ha per year during the 1990–2000 period to 7.3 million ha per year during the 2000–05 period. It is believed that this is the result of many countries' policies and programs that emphasize the planting of new tree plantations and the natural expansion of existing forests.

Vietnam's hills and mountains occupy three-quarters of the country's area. The area is home to one-third of the nation's population, a group that has undergone rapid changes to their livelihood systems following a wide range of national-level socio-economic development programs [Be Viet Dang 1993]. As such, land and forest, the main resources used in the local production systems, have suffered from severe human impacts over the last decades.

Vietnam's forest cover has been reduced from 43.2% in 1943 to 28.1% in 1995 [Nguyen Manh Cuong 1999]. This reduction has been attributed to many socio-economic and historical factors including wars and poor management [MARD 2006a; FAO 2005]. Over this period, forest area was not only reduced in quantity but also in quality. Under the impact of human activities, forests have been modified in structure, vegetation type, and species diversity. Consequently the habitats encompassed in forests have changed and various flora and fauna reliant on those habitats are now threatened [UNDP and FPD 2000]. In response to the negative impacts of deforestation and to protect the remaining natural forest as well as to restore the forest cover, the Vietnamese government has issued and enforced new laws and policies.

Government laws that are the basis for forest conservation include:

(1) The 1988 Land Law and the 1993 Revised Land Law, both implemented under *Doi Moi*/Renovation. These laws stipulated that a household is the managing body of land resources and has to be responsible for its property, including forest resources.
(2) The Law of forest protection and development passed by the National Assembly on 8th December 1991.

These general laws are implemented through several decrees and programs including:

(3) The 327 Program established in accordance with Decision 327/CT passed by the Council of Ministers on 15th September 1992 regarding policies on the use of bare land, denuded hills, forests, alluvial flats and water bodies.
(4) The Government Decree 02/CP issued on 15th January 1994 on the allocation of forest land to organizations, households and individuals for long-term use for forestry purposes.
(5) The Government Decree No. 77-CP of 29th November 1996 on sanctions against administrative

violations in the protection and management of forests and the management of forestry products.

(6) The National Five Million Hectares Reforestation Program (5MHRP), a follow-on to the 327 Program, approved in 1997 by the National Assembly. Decision 661 on the implementation and funding of the 5MHRP was approved in 1998 by the office of the Prime Minister. In short the 5MHRP was called the 661 program.

Nghe An is one of most heavily populated provinces in Vietnam. Forest in Nghe An plays an important role in the socio-economy and environmental life of the province's people. This was true in the past and is still true today. Nghe An's forest area is unevenly distributed and is found mostly in the northwestern mountain districts of Ky Son, Tuong Duong, Con Cuong, Que Phong, Quy Chau and Quy Hop. Pu Mat National Park (formerly Pu Mat Nature Reserve) in Anh Son, Con Cuong and Tuong Duong districts has the largest continuous area of natural forest cover in Vietnam. The park has about 91,000 ha of core zone area and about 100,000 ha of buffer zone area. Pu Mat is one of the most important biodiversity nature reserves for Vietnam as well as for the region and the World [Vietnam Pictorial 2003].

The population that lives in the Pu Mat buffer zone has an extremely hard time earning their livelihood because of the steep sloping topography, poor transportation network and severe climate conditions. Their production system is based on traditional upland shifting cultivation, also referred to as swidden, a system that frequently needs to open new fields in forest areas. This has many impacts on forest resources and creates difficulty with regards to the protection and development of this resource [Nghe An DoF 1993]. Together with both large-scale legal and illegal logging along streams in the past, the population's use of the forest resources has changed the flora and fauna makeup of the area. As a result, in 1995 the Social Forestry and Nature Conservation project in Nghe An was proposed, approved and implemented for the purpose of conserving forest resources and biodiversity of the then Pu Mat Nature Reserve and its buffer zone.

The study reported in this paper aims to investigate the process of changes in land cover/land use (LCLU) over the past 50 years and to identify the underlying causes of these changes in the Pu Mat area, with emphasis on the linkage of forest policies and related programs, such as the setup of the Pu Mat Nature Reserve, with LCLU. This study is based on an analysis of the time series data of LCLU generated from remote sensing imagery and field research in Chau Khe village,[1)] located in Con Cuong district, Nghe An province.

1) In Vietnam, although there is sub-unit called hamlet (*thôn/bản*) under village (*xã*), village is the smallest administrative unit that has data or information "officially" documented.

II Study Site and Research Methods

II.1 *Study Site*

Physical Characteristic

The study site of Chau Khe village is located in the southern part of Vietnam's Northern Mountain Region (Fig. 1).

Chau Khe village is one of 12 villages located in Con Cuong District, Nghe An province. Geographically, the village is located between 18°51' and 19°08' North and between 104°31' and 104°48' East. It is about 15 km from the district town, 135 km north-west of Vinh city, Nghe An's provincial capital, and 400 km south of Ha Noi, the capital of Vietnam.

Sharing similar topography to mountainous villages in the west of Nghe An, Chau Khe has very complex and rugged terrain, and includes several mountains with an elevation of over 1,300 m above sea level. High mountains on the northwest-southeast running border of Vietnam and Laos include Pu Mat (1,841 m asl.), Pu Van and Pu Den Dinh. The northeastern slopes of these mountains fall steeply towards the Ca River (locally known as the Lam River). As a result of such topography, Chau Khe has very little flat land (Fig. 2). According to the 2005 village report, the total area of Chau Khe village is 43,888 ha, of which 27,000 ha and 6,500 ha are the core and buffer zones of the Pu Mat Nature Reserve, respectively, which was first established in 1996 and upgraded to Pu Mat National Park in 2003. The core zone is under the management of the provincial government and designated for forest ecosystem and biodiversity conservation. The buffer zone is under State Forestry Enterprise (SFE) management. The remaining area, close to settlements and located in the north-eastern part of the village, is under village management.

The national highway No. 7, running through the north-eastern part of the village in parallel with the Ca River, is the sole route to connect villages and four district towns on the south bank of the Ca River with the provincial capital to the southeast and with Xieng Khoang province, Laos, to the northwest (Fig. 1).

According to records kept at the Con Cuong meteorology station, the area has on average an annual temperature of 23.5°C and annual rainfall of 1,791.1 mm [MARD 2006a]. The village has a tropical monsoon climate that is influenced by the hot and dry southwest wind ("foehn" wind) during the summer and northeast wind. The uneven distribution of rainfall creates two seasons a year, the rainy season from April to November with an average monthly temperature of 25.7°C and an average monthly rainfall of 205.5 mm, and the dry season from December to March with an average monthly temperature of 18.5°C and an average monthly rainfall of 36.8 mm.

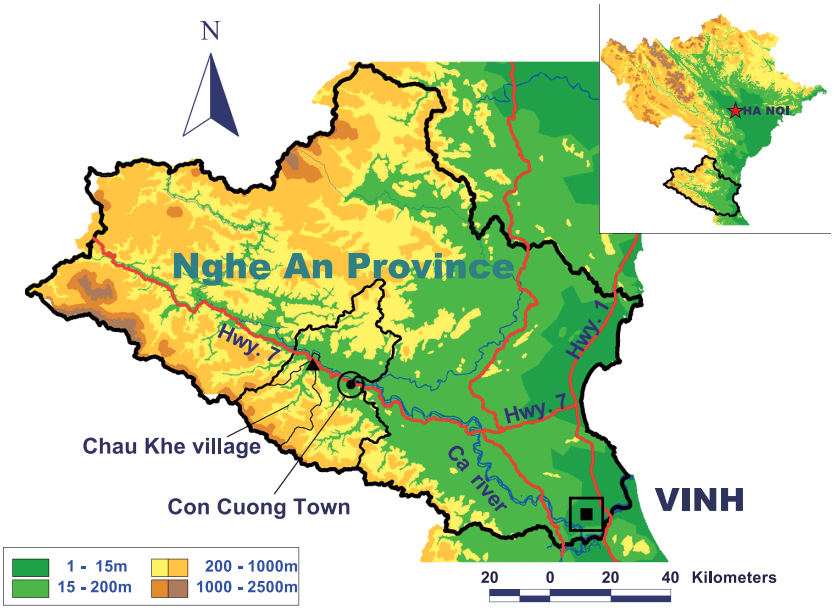


Fig. 1　Location of Chau Khe Village in Vietnam's Northern Mountain Region

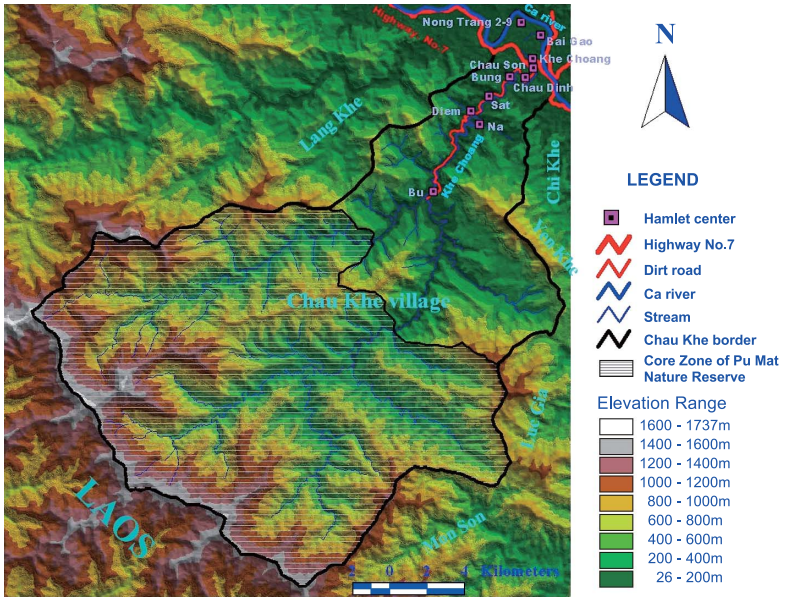


Fig. 2　Topography, Road Network and Hamlet Distribution of Chau Khe Village

Socio-economic Characteristics

The population and the number of households of Chau Khe village was 5,319 and 1,131 respectively in 2005, consisting of three ethnic groups: *Thai* (2,466 persons), *Kinh* (1,586 persons) and *Dan lai* (1,267 persons). There are 10 hamlets, of which three hamlets including Khe Choang (*Kinh*, *Thai*), Bai Gao (*Thai*) and Nong Trang 2-9 (*Kinh*) are located to the north of Highway No. 7, and the remaining 7 hamlets including Chau Son (*Dan Lai*, *Kinh*), Chau Dinh (*Thai*, *Dan Lai*), Bung (*Thai*), Sat (*Thai*), Diem (*Thai*), Na (*Thai*, *Dan Lai*) and Bu (*Dan Lai*, *Thai*) which are located to the south of Highway No. 7. A single dirt road, 16 km long, running along Khe Choang stream connects these hamlets with the village centre located along national highway No. 7. Bu hamlet is the furthest, at the end of the road and close to the core zone of the Pu Mat Natural Reserve (Fig. 2).

Household livelihoods are based on agriculture and forest related activities. Agriculture practices include paddy and upland rice. Upland rice accounts for about two-thirds of rice production. Statistical data sources since 1998 use the term "cash-crop land" to indicate areas of upland agriculture. In fact this land use type includes areas where upland rice and cash-crops like maize, cassava, sweet-potato, beans and peanut are planted. Other sources of household income include animal husbandry activities, the exploitation of non-timber forest products (NTFPs) like bamboo-shoots, rattan, and small bamboo (*nứa*) that naturally grows back every year, and large planted bamboo (*mét*).

II.2 *Image Analysis and Field Survey*

This research adopted an approach that combines the interpretation of remotely sensed imagery with an analysis of statistical data and information collected from field studies.

Remote sensing is a reliable and effective source of detailed data that can be frequently collected and used to support management planning, monitoring and mapping of natural resources. Studies of LCLU changes using remote sensing data can take advantage of having consistent and comparable data [IPCC 2003].

The study uses several types of remote sensing data including Corona satellite photos acquired in 1967, Landsat Thematic Mapper (TM) satellite images in 1989 and 1998 and Enhanced Thematic Mapper (ETM) images in 2005 for mapping and analyzing LCLU changes in Chau Khe.

A forest is an area with a high density of trees. There are many definitions of forest, based on various criteria. Forests can be classified in different ways and to different degrees of specificity. In Vietnamese forest inventory and production planning, forest and forest land is classified by forest type such as evergreen broadleaf, deciduous broadleaf, semi-deciduous broadleaf, needle leaf, mangrove, and so on. Then each type of forest is further sub-classified based on the vegetation structure/status

Table 1　Adopted Land Cover Classification

Class	Description
Closed forest	Multi-storey tree cover, dominated by tall and large trees with or without medium tree (<15 cm diameter, 5–7 m height)
Open forest	Sparse tree cover, selectively logged areas or re-growth, and bamboo
Bush	Small woody trees (<5 cm diameter, <3 m height) mixed with shrubs
Grass	Natural short and long grass with small shrubs (associated with 1 or 2 year fallow areas)
Paddy field	Both flat land or terrace land associate with water content
Upland field	"bare land" (under preparation for planting, newly harvested areas, early seasons) and even cropping area (based on topography, field investigation and distinct signature in digital image processing)
Water body	Water: rivers, streams, lakes, and other water bodies.

according to the 1984 Normative Act QPN6-84 of the Ministry of Forestry. For example depending upon its quality the evergreen broadleaf and semi-deciduous broadleaf forest can be classified as: (I) non-forest, (II) regenerated forest, (III) secondary forest and (IV) virgin/primary forest. Each of these classes is divided into further sub-classes [MARD 2006b].

Using this classification system in this study, however, would create difficulties in carrying out the time-series analysis. It is rather difficult to identify forest type precisely when the source image resolution is low. Moreover, as the changes in forest cover are the central question of this study, classification of forest according to forest canopy cover should be more appropriate. Therefore, tree-related land cover is simply divided into the three classes; closed forest, open forest, and bush where tree canopy is >70%, 40% to 70%, and <40%, respectively. Adding grass, paddy field, upland field and water bodies, and the overall land cover classification is fixed as shown in Table 1.

The 1967 Corona satellite photos were manually interpreted and classified. The results of the classification were transferred to a 1:25,000 base map using recognizable topographic features (streams, roads, mountain ridges, etc.). The land cover maps were digitized and entered into a Geographic Information System (GIS). The accuracy of the final land cover classifications was checked through field surveys. Judging from the authors' experience and knowledge of vegetation types and land cover patterns gained during field investigation of the site, they appear accurate.

Earth Resources Data Analysis System's (ERDAS) Imagine software for image processing was used for the TM and ETM images analyses. All satellite images (1989, 1998 and 2005) were rectified to the same base map used in the aerial photo interpretation step, so that the ground survey data can be located on the images, and the maps have a common area for data extraction and comparison. The satellite imagery was interpreted using supervised classification methods. The training sets/classification keys were selected based on knowledge gained during field investigation combined with information

derived from normalized difference vegetation index (NDVI) analysis of the images, and with information regarding how the images' pixels are clustered that was gained by running an unsupervised classification on each image. Field investigations and observation regarding structural appearance of the different types of vegetation helps to define suitable criteria for each land cover class. NDVI and the results of the unsupervised classification were used as references for fast identification and selection of training sets. Final results were overlaid on top of its false, true color and NDVI image then flickering/swiping (utilities in ERDAS imaging) were used for visual assessment of the accuracy of the results.

Field survey included land cover and use observations, interviews with local officers and the collection of statistical data. These activities were done in June 1999, March 2004, July 2006, May 2007 and December 2008.

Interviews with local people and officers at the village and district levels focused on agricultural practices, forest uses and living conditions, and helped to understand and identify the major factors of LCLU changes. The interviewees include past and present hamlet leaders, production unit leaders, cooperative leaders, village leaders and SFE leaders. The interviews also revealed valuable information about the past socio-economic situation of the site. Information regarding changes in infrastructure (roads and markets) helped the researchers to understand incentives for forest exploitations. Local perceptions on the influences of government policies and programs on LCLU were also revealed from the interviews, making a significant contribution to the understanding of the dynamics of LCLU.

Statistical data was collected from different sources including statistical year books at village, district, province and national levels; official and non-official reports. Data collection included information regarding population, land use areas, and agricultural data about the area planted and productivity of different crops. This data was cross checked and compared with the interview data to see if there were logical connections between the statistical data and the qualitative recollections of the interviewees. Differences and similarities between the recollection data and statistical data were noted. Basic quantitative and qualitative information regarding crop area and yield and production shows the evolution of food sufficiency, and at the same time, reveals pressures on the forest cover.

III Land Cover Land Use Changes

III.1 *Period Before 1967*

Field investigations indicate that, before joining the cooperative in 1960, Chau Khe people's livelihood system was of a self-sufficient nature and based on upland food production. Their activities included swidden agriculture and gathering forest products for food, and hunting for foodstuffs. There was almost

Table 2　Reconstructed Population and Population Density of Chau Khe Village

Item	1967	1989	1998	2005
Population	1,361	3,737	5,136	5,319
Population density (person/km^2)	31	8	11	12

Source: Statistics and reconstructed.

no paddy grown in the village. The village forest was abundant and rich in valuable timber trees. Large trees of more than 30 cm in diameter could be found easily within close proximity by residents for house building. The reconstructed population data based on the district and provincial statistics and field interviews suggests that the population density of the village was less than 10 persons per square km until the end of the 1980s (Table 2). Although the population distribution was uneven in the village area due to the topography and the road network, human impacts on the forest were thought to be limited.

In this period upland fields were opened in old forest areas as villagers believed soils in this area were more fertile. For the same reason, they also opened fields in the long fallow areas where tree diameter reached to 30 cm or more. Upland fields were used for several years and then abandoned because of soil fertility depletion.

After 1960, households of Chau Khe's hamlets formed into hamlet-based cooperatives in the three Red-flags Movement. Depending on the number of laborers in each cooperative, they were divided into several production brigades. People worked together and received products based on their labor points. According to Mr. Mun, born in 1922 and the former village party secretary and village chairman, collective work brought significant changes to the landscape of the village.

While the village continued with traditional upland agricultural practices, each brigade in the cooperative opened larger fields close to each other instead of individuals opening small and separate upland plots. Many big trees were burned down in the newly opened fields. The brigades did not make use of those trees because the forest was still abundant.

The 1967 LCLU map shows large plots of upland field as well as bush and grass fallow land as a consequence of upland cultivation around hamlets (Figs. 3a and 3b). The area of each plot ranges from half a hectare to several tens of hectares. The large areas of upland fields could be indications of the impact of collective work.

Logging activities of Con Cuong State Forest Enterprise (SFE) also affected LCLU. The SFE was established in 1955 to manage forest resources, to exploit timber in particular, in all villages of Con Cuong district including Chau Khe village. Their activities were in line with a common plan from the central government and included exploiting, transporting and processing timber. The SFE first selectively logged high quality timber for making wooden railway ties and logging was carried out by army

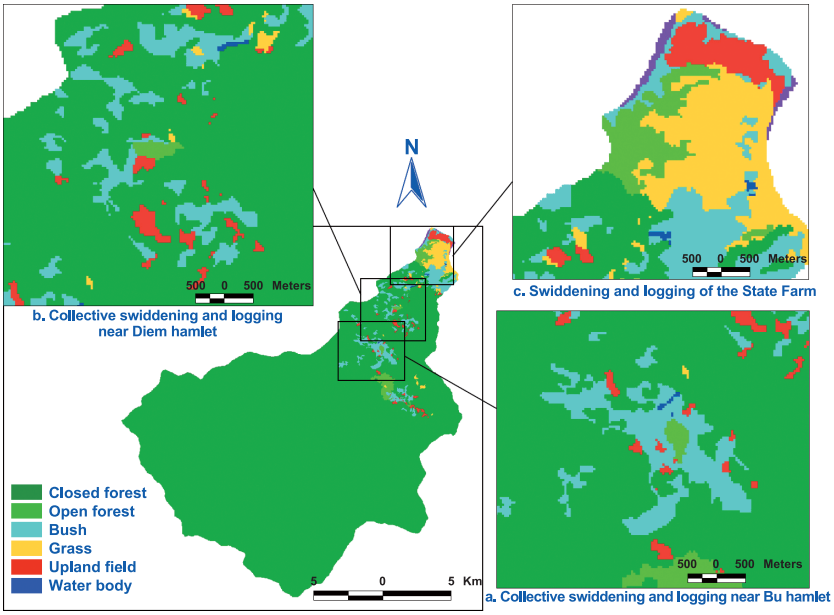


Fig. 3 Chau Khe Land Cover Land Use in 1967

Source: Remote sensing image interpretation

personnel. Later on, the quality of forest was reduced, demand for timber for the country's economy expanded, and the SFE had to use local people for the logging activity.

During the cooperative period, each hamlet had a wood-cutter group (*tổ sơn tràng*) of 8 to 10 people who went to the forest to exploit timber based on the demand of the SFE. People in the hamlet took turns to work in the group, and the SFE provided food for their activities. Logging activities were intensive within 10 km of Highway No. 7 and along the Lam River and Khe Choang stream because of easy transportation. All the work was done by hand axes, hand-saw and animal power was used to transport the logs to the transportation route. Many smaller trees are thought to have been damaged around each logging site and during the transportation of timber to the transport routes. As a consequence this converted forest land to bush, after which the area was in most cases used for swiddening. This implies that government-initiated logging led to the expansion of swidden fields.

In 1961 during the Land Opening/Reclamation Movement, Nghe An authorities resettled people from Nam Dan district to a newly setup resident area called *Nong Trang* 2–9 (State Farm 2–9) in the northernmost part of Chau Khe village. One of the major purposes of the resettlement program was to expand paddy field area, to stabilize food production, and to meet the food requirement at the national level. Although this area has better topographical conditions for paddy development, the new settlers

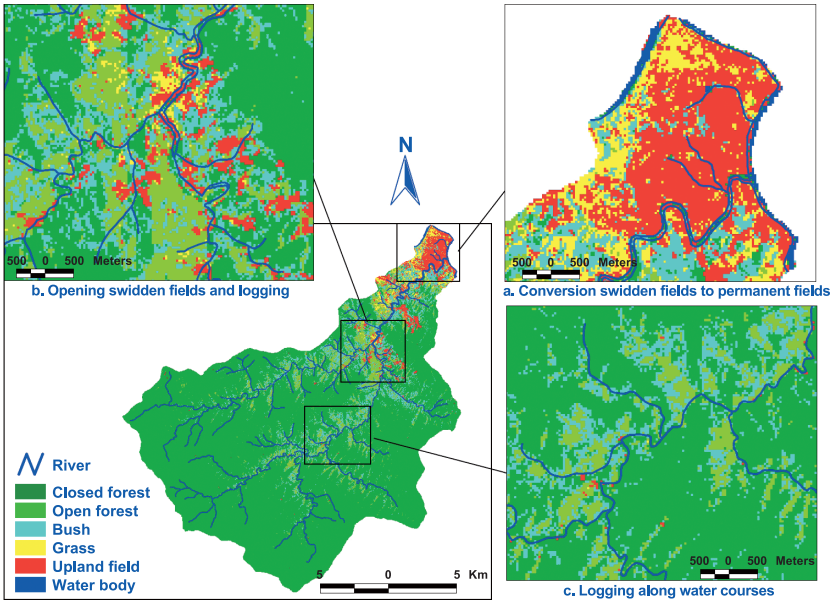


Fig. 4　Chau Khe Land Cover Land Use in 1989
Source: Remote sensing image interpretation

also practiced swiddening, similar to people already living in the area, due to the lack of available water resources as well as a lack of capital for investing in the building of paddy fields. This resulted in an extensive decrease in forest (Fig. 3c). A similar situation of a newly established state farms was reported in a *Nghe An Newspaper* on 23rd May 1962 stated that "In 1961, out of 13,000 ha of reclaimed land, there is very little flat land for paddy. Even in a State Farm that has more than 100 ha of flat land, they did not making use of it, instead they practiced slash and burn cultivation" [Minh Nguyen 1962].

III.2　*Period between 1967 and 1989*

The process of collective agricultural practices continued until 1986. After that people worked individually. Households reclaimed fields to produce more food primarily for their survival. The then deteriorating national economy and food crisis at the national level increased demand for food and is thought to have influenced the expansion of agricultural land in the village. Opening swidden fields was popular in the areas far from Highway No. 7 where forest land was still abundant (Fig. 4b), while the conversion of swidden fields to permanent fields dominated in the areas close to Highway No. 7, including *Nong Trang* 2-9, where land resources are limited (Fig. 4a). As a result, the area of upland fields that included both swidden and permanent fields increased 4.6 times between 1967 and 1989, from

288 ha to 1,328 ha, though in the same period, the population grew 2.7 times (Table 2).

SFE and village households continued timber exploitation after the dissolution of the wood-cutter group in the mid-1980s, in connection with the collapse of collective farming. However, this work was succeeded by individual households. Although the annual volume of exploited timber reached as high as 30,000 m^3 in the 1970s and then fell to 5,000–7,000 m^3 in 1989, logging by villagers accelerated, even doubled, after the introduction of individual logging. The extent of timber exploitation gradually penetrated deep into forest areas, particularly along water courses. The 1989 LCLU map clearly shows the distribution of open forest and bush along the upstream of Khe Choang stream which in 1967 was totally covered by closed forest (Fig. 4c).

As a result of farming and logging activities, the area of closed forest decreased from 40,490 ha in 1967 to 34,891 ha in 1989, while areas of open forest and bush increased from 427 ha and 1,101 ha in 1967 to 2,472 ha and 3,510 ha in 1989, respectively. The spatial distribution of human-induced LCLU including open forest, bush, grass and upland field areas spread from the north-eastern part to the whole village area.

III.3 *The Period after 1989*

Timber exploitation by villagers further accelerated in the early 1990s. The National Assembly started to deliberate the "Law of forest protection and development," under which any logging or exploiting of the forest and destroying of the forest resources or ecosystem would be prohibited. Before this, the villagers had a feeling that the forest was their property and they could exploit it at anytime as they needed. News of the new law upset them, and they realised that their access to the forest would be limited. This became the impetus for villagers to rush to exploit large numbers of trees for the renovation of their stilt houses. Consequently, many houses were upgraded and became larger and better during the period.

As represented by the above law, which was finally approved in December 1991, the end of the 1980s and the beginning of the 1990s was the turning point for forest policies and programs in Vietnam, from utilization-oriented to protection and restoration-oriented policies and programs. SFE, as one of state organizations in the forestry sector, changed its major task from timber exploitation to tree planting and forest restoration in 1989. Its management area was reduced from 61,000 ha in the 1980s to 20,000 in the early-1990s, and further to 8,500 ha in 1996, of which an area of 5,500 ha is located in Chau Khe village. The annual exploitation of timber significantly reduced from 2,000 m^3 to 3,000 m^3 in the mid-1990s and to 1,000 m^3 in the 2000s. On the other hand, the SFE started forest rehabilitation and restoration programs and tree plantation programs and annually implemented these programs on areas

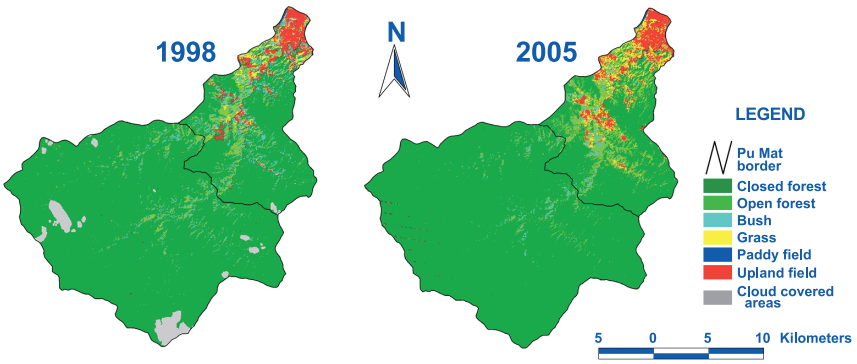


Fig. 5　Chau Khe Land Cover Land Use in 1998 and 2005
Source: Remote sensing image interpretation

of about 300 ha to 400 ha respectively.

The freedom to clear areas for swidden substantially ended at the end of the 1990s. This came about because of the pressure to protect the forest following the establishment of Pu Mat Nature Reserve in 1996. It was a core part of a multi-million US dollar project called "Social Forestry and Nature Conservation in Nghe An Province" [SFNC 2000], an European Commission funded project. The investment plan of the project was approved in December 1995, and implementation began in January 1998 [UNDP and FPD 2000]. The setup of the reserve took a large area of Chau Khe village land for inclusion in the reserve (Fig. 2). About 70% of the village land was designated as a core zone of the reserve, with strict controls over the access local people have by the Forest Protection Station established at Bu hamlet which lies on the only outward route from the reserve by road as well as by stream.

The creation of Pu Mat Nature Reserve had an indirect effect on the forest land use by the villagers, as discussed later, and accelerated the enforcement of laws related to forest protection and development and the implementation of related programs. Consequently, the free cultivation of swidden drastically decreased even in areas outside of the core zone. Although, in order to cope with the limited land suitable for permanent cropping, the Con Cuong district government allowed Chau Khe villagers to have rotational upland fields in certain planned areas in 2003, swidden farming is now disappearing in Chau Khe village.

The 1998 and 2005 LCLU maps clearly show the trend of recovering forest vegetation (Fig. 5). The area of closed forest increased from 34,891 ha in 1989 to 37,165 ha in 1998 and then remained basically stable, at 37,031 ha in 2005, while the area of bush rapidly decreased from 3,510 ha in 1989 to 2,329 ha in 1998 and 846 ha in 2005. The area of open forest fluctuated, from 2,472 ha in 1989, to

1,538 ha in 1998 and 2,785 ha in 2005, reflecting both the impacts of forest conservation and the planting of tree plantations. In the core zone of Pu Mat Nature Reserve, bush and open forest along streams reverted to closed forest, reflecting the restoration process of forest vegetation.

In the area outside the core zone, farming was intensified in terms of productivity and concentrated in terms of the spatial distribution. The area of upland field did not increase much. Rather it is better to say it stagnated after 1989. In 1989 there was 1,328 ha, in 1998, 1,222 ha, and in 2005, 1,449 ha, even though the population of the village increased from 3,737 in 1989 to 5,136 in 1998 and 5,319 in 2005, about a 40% increase during the decade of the 1990s. Villagers have made efforts to expand their paddy field area, but its area was still as small as 30 ha in 1998 and 40 ha in 2005, and the contribution of paddy production to food supply is limited. In-kind income from logging work done for the SFE and the collection of non-timber forest products, such as wild yams, bamboo shoots, rattan, honey, and wild animals to eat or to exchange for food, was reduced during the period. The villager's livelihood in recent years depends more on upland farming on the limited land resources available, a shift which was achieved by means of the conversion from swiddening to permanent cropping and crop diversification from the monoculture of upland rice to a combination of rice, cassava and corn. These shifts resulted in the concentrated distribution of upland fields close to the hamlets.

IV Implications of Forest Policies and Programs

IV.1 *Changes in the Changing Trend of Land Cover Land Use*

The LCLU of Chau Khe was dynamic over the study period (Fig. 6). The proportion of closed forest was 94% in 1967, decreasing to 81% in 1989, and then recovering to 86% in 1998 and 2005. Bush areas show an opposite tendency. There was 2.6% of the bush area in 1976, 8.2% in 1989, 5.4% in 1998 and 2.0% in 2005. The increase in upland field area is drastic during the period between 1967 and 1989, from 0.7% to 3.1%, then stagnated afterward until 2005. These changes suggest that the trend of LCLU in Chau Khe village changed at the end of the 1980s or the beginning of the 1990s from forest-to-agriculture conversion to stabilization. This is exactly when the Vietnam government changed forest policies from exploitation-oriented to protection and restoration-oriented ones.

The results of this study suggest that changes in forest policies at the national level and the changing trend of LCLU at the village level happen almost simultaneously or with a minimum time lag if any. Is there any effective mechanism to link them? Focusing on the tree plantation and extension programs and the establishment of Pu Mat Nature Reserve, we discuss this point.

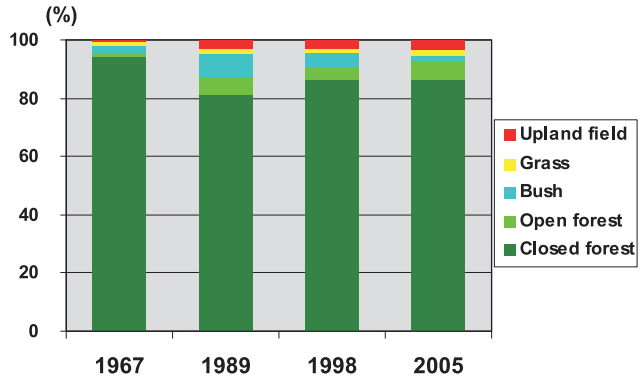


Fig. 6　Changes in Land Cover Land Use of Chau Khe Village
Source: Figs. 3, 4 and 5

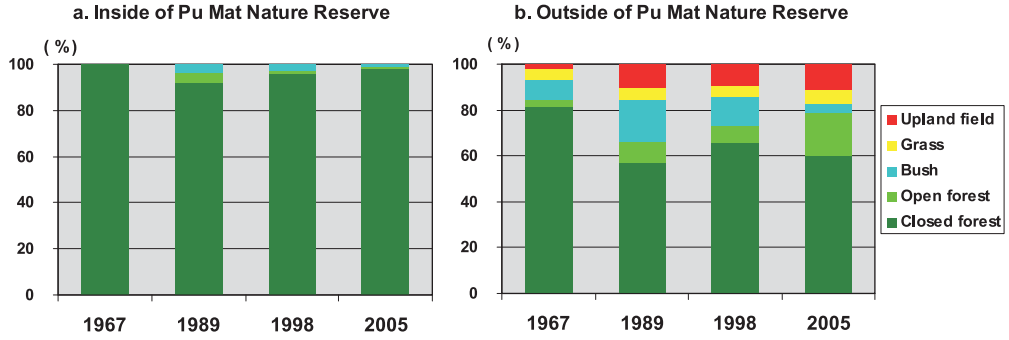


Fig. 7　Land Cover Land Use of the Inside and Outside of Pu Mat Nature Reserve
Source: Figs. 3, 4 and 5

IV.2　*Tree Plantation and Extension Programs*

The SFE, a line agency under the then Ministry of Forestry,[2)] initiated the tree planting and rehabilitation activities in 1989. SFE staff reported that it set up 1,100 ha of forest, consisting of 2 plots for afforestation and a plot for rehabilitation forest, in the first decade. The increase of closed forest area and an almost equal area of decrease in open forest and bush outside the Pu Mat Nature Reserve between 1989 and 1998 reflect these SFE efforts (Fig. 7). Mr. Lai, a former director of Con Cuong SFE, reported that he received two State Labor Heroic Medals, one for timber exploitation or forest destruction in 1985 and the other for forest protection and plantation in 2000.

2) The Ministry of Forestry was subsumed into the Ministry of Agriculture and Rural Development in the late 1990s.

At the same time, the government set up new laws, decrees and programs as listed in the introductory chapter to extend its governance to customary forest management areas and over the utilization of forest by local communities. The laws and decrees provide, in general, all the legalities necessary to cover the setting up of forest management, such as providing the initial support for forest protection and development, and to ensure long-term use of the forest land and to set the fines and penalties charged for illegal forest destruction activities. These, of course, never take effect immediately or in a straight-forward fashion, and it takes time for the policies and programs to go from paper to practice.

In Chau Khe village, activities under the 327 Program started in 1997, five years after Decision 327/CT was passed by the Council of Ministers. The activities included the allocation of forest land to organizations, households and individuals for long-term use for forestry purposes. This land was often degraded forest land and was allocated to local people, with long-term land use rights attached to it, under the provision that trees be planted on it. Because of the timing of the implementation of these activities, the 1998 LCLU map does not reflect the impacts of these programs. This being the case raises the question: if the 327 Program was not responsible, what was the mechanism to restore forest and to stop expansion of upland cultivation before the implementation of these program's activities?

The villagers recognized a sign of changes in forest development policy even before the laws and decrees were issued. Mass media outlets such as TV, radio, and newspaper repeatedly reported on-going deliberations at the National Assembly and debates in the ministries. Villagers also received news from timber traders who have "eyes and ears" to serve their business. These sources provided opportunities for villagers to learn of the new decisions of policy-makers and sometimes lead to villagers' speculative behaviour, such as rushing to exploit timber as mentioned above.

In addition to the core programs such as the 327 Program, the government provided a wide range of extension programs to support local people in improving their living conditions as well as their forest protection activities. These included providing rice subsidies against food shortages, introducing new food crop varieties, providing credit for buying and raising pigs and cattle, providing tree seedlings for planting, and introducing new bamboo species for bamboo tree and bamboo shoot cultivation. Some of these were initiated before the implementation of the core programs. The village authority worked with local people to draft rules on forest exploitation and protection, fire prevention in the dry season, the burning of swidden fields, and created a list of fines and punishments for those who broke the local rules. These extension programs provided the villagers with opportunities to attend meetings, to work with program/project cadres, and to exchange ideas and experiences with their neighbors about land and forest issues.

These are the ways that the villagers learned about new forest policies and also adjusted their own

policies as they gradually changed their attitude toward forest protection. They recognized their responsibilities in terms of not only participating in the programs but also contributing to comprehensive conservation of forest resources.

Small mechanisms including tree planting and forest restoration by a line agency and a wide range of extension activities, including information dissemination from national political debates and experiences of program implementation were aggregated and formed a significant mechanism to change the trend of LCLU changes within the village.

IV.3 *The Establishment of Pu Mat Nature Reserve*

The setup of a forest protection station at Bu hamlet in 1998 was the substantial start of the conservation work of Pu Mat Nature Reserve. Before this, the district forestry sector and the village administration office were in charge, but they did not have a large enough budget and enough manpower to carry out conservation and protection operations.

The station has seven staff members and is obliged to manage 27,000 ha of the core zone. It is very difficult for them to both patrol such a large area and guard at the check point. The whole area is divided into 18 zones for patrolling based on the topography. The zones that are close to the station are a fixed assignment for one or two staff. The zones that are far from the station are taken care of by a group of two or three staff members. Each staff has to be armed and patrol in the forest for 7 to 10 days every month. Besides this, they also have the responsibility for carrying out other activities such as organising meetings to disseminate government policies and regulations and cooperating with village organizations and the SFE for the forest protection and management tasks in the buffer zone.

Although the volume of works assigned to the station staff is large and the frequency of patrolling is limited, the amount of illegal forest exploitation is rapidly decreasing. A station staff member reported that there was one case of illegal logging and 20 cases of illegal collection of non-timber forest products in 2007, which was just 5% of what happened when the station was established. This reflects the changes of the understandings of the villagers regarding forest use and also changes in their actions. The villagers have started to fear carrying out illegal activities. They have learned from the process of receiving warnings, self-criticism, signing commitments not to repeat their offences, having their materials confiscated, such as chainsaws and axes when caught, being forced to pay fines, and being prosecuted when caught. These experiences have been related to other members of the village and as a result, cases of forest violations have been reduced significantly.

Even in the core zone of Pu Mat Nature Reserve, the forest area started to recover before the establishment of Bu station (Fig. 7). The activities of the station are, therefore, not the direct cause of

changes to LCLU trends. Rather the reality of the station and the staff members activities have acted to strengthen villagers' understanding of the new forest policy. This has resulted in an accelerated recovery of the forest not only in terms of area but also in terms of vegetation quality.

V Conclusions

Chau Khe was a forest rich village in the Northern Mountain Region of Vietnam. The villagers' livelihood was subsistence-oriented and based on swidden agriculture and the collection of NTFPs until the 1960s. The government started to intervene in land use activities of the village immediately after the country's independence in 1954. It set up the SFE for logging in the 1950s, implemented collective farming and the procurement system and promoted the migration program from lowland areas in the 1960s. All of these interventions substantially decreased and deteriorated the village's forest resources. The turning point came at the end of 1980s or the beginning of 1990s. Since then, the area of closed forest has increased and those of open forest and bush have decreased. The timing of this change coincides with the time when the central government changed its forest policy from utilization-oriented one to a protection and restoration-oriented one.

The village study reveals that the change in LCLU change trends cannot be directly linked to any specific laws, regulations, or programs. Instead, a wide range of small and repeated extension activities that originate out of the national laws and regulations have linked the policy changes of the national level with the daily activities at the village level. This provided the process and environment for the villagers to learn about the new policy and to adjust their land use to the new governance actions. The consistency in the repeated political messages provided the opportunities for the villagers to confirm their understandings through changes in their local actions and local land and resource use decisions.

This process was well recognized during the mid-term review of Pu Mat Nature Reserve [SFNC 2000].

> The main successes include improved forest protection, an encouraging change in people's attitudes, the spreading of the conservation idea, a biodiversity——friendly forestry, and an increased living standard for many stakeholders. Technologies related to agricultural, livestock and forestry development have been disseminated. In addition, SFNC (Social Forestry and Nature Conservation) has accelerated the land allocation process, which will have a positive impact on the stabilisation of farming systems and on sustainable soil and forest management. Logging activities, both legal and illegal, have decreased, although still threatening the resource.

This case study suggests the importance of the multiple channels that link the government agencies with people and the intensive learning process needed for local people to understand the political

intentions behind laws and regulations promulgated at the central government level. We cannot expect successful forest policy implementation without the cooperation of local people and we can't expect local people to act in accordance with laws and regulations unless they clearly understand what those are and why they are important.

Acknowledgements

We would like to express our sincere thanks to all of the villagers, local officials, and others who welcomed us into their lives during our multiple field visits and allowed us to interview them. Without them this study would not have been possible. We would also like to thank the Ronpaku Program of Japan Society for the Promotion of Science, the 21st Century COE Program "Aiming for COE of Integrated Area Studies," the Global COE Program "Sustainable Humanosphere for Asia and Africa," and Grand-in-aid for Scientific Research "Mechanism of Land Use Changes in Mainland Southeast Asia" for their financial support in carrying out the research.

References

Be Viet Dang, ed. 1993. *Nhung bien doi ve kinh te-van hoa o cac tinh mien nui phia Bac* [Economic and Cultural Changes in the Northern Mountain Provinces]. Nha xuat ban Khoa hoc Xa hoi, Hanoi.

FAO (Food and Agriculture Organization). 2005. *Global Forest Resources Assessment 2005: Progress towards Sustainable Forest Management*. Food and Agriculture Organization of the United Nations, Rome.

IPCC (Intergovernmental Panel of Climate Change). 2003. Basis for Consistent Representation of Land Areas. In *Good Practice Guidance for Land Use, Land-Use Change and Forestry*, edited by Jim Penmam *et al.* the Institute for Global Environmental Strategies (IGES), Kanagawa, Japan.

MARD (Ministry of Agriculture and Rural Development). 2006a. *Cam nang nganh Lam nghiep. Chuong 1 so lieu moi truong tu nhien va lam nghiep Viet Nam* [Forestry Sector Manual. Chapter 1 Natural Environment Data and Vietnamese Forestry].

————. 2006b. *Cam nang nganh Lam nghiep. Chuong 12: Cong tac dieu tra rung o Viet Nam* [Forestry Sector Manual. Chapter on forest survey in Vietnam]. pp. 39.

Minh Nguyen. 1962. *Mot vai y kien nhan xet va de nghi ve phong trao khai hoang o Nghe An* [Some Comments and Proposes on Land Opening in Nghe An province], Nghe An newspaper 23rd May 1962, TVQG.JP5.1962.2-12.

Nghe An DoF (Department of Forestry). 1993. *So Lam nghiep Nghe An 1993* [An Overview of Nghe An forestry], De an tong quan lam nghiep tinh Nghe An.

Nguyen Manh Cuong. 1999. Information Technologies for Forest Management in Vietnam. *Workshop Proceedings: Application of Resource Information Technologies GIS/GPS/RS) in Forest Land & Resources Management. October 18–20, 1999*. Hanoi, Vietnam

SFNC (Social Forestry and Nature Conservation). 2000. Introduction, Social Forestry and Nature Conservation in Nghe An Province (SFNC): ALA/VIE/94/24. http://www.mekonginfo.org/mrc_en\contact.nsf/0/D62C8A67FE8831E447256C39002752F6/$FILE/main_en.html

UNDP and FPD (United Nations Development Program and Forest Protection Department). 2000. Proceedings of Integrated Conservation and Development Projects: Lessons Learned Workshop, Hanoi-Vietnam, 12–13 June 2000.

Vietnam Pictorial. 2003. An Introduction to Pu Mat National Park. (Bao Anh Viet Nam, 2003. Tai lieu gioi thieu Vuon Quoc gia Pu Mat)

Southeast Asian Studies, Vol. 47, No. 3, December 2009

Continuity and Discontinuity in Land Use Changes: A Case Study in Northern Lao Villages

Thatheva SAPHANGTHONG* and KONO Yasuyuki**

Abstract

This article highlights land use changes of composite swidden farming villages in the northern part of Laos under the drastic transformation of political and economic systems at national and regional levels, including civil war, independence, implementation of a planned economy and the introduction of a market-oriented economy, during the last several decades. Interpretation of remotely sensed images and farming system analysis of the selected study villages revealed the extensive development of agriculture coupled with a rapid deforestation in the 1970s and the early 80s and the intensification of land use and commercialization of farming in the following period. These findings suggest two kinds of mechanisms of land use changes: continuous and gradual changes under a social regime and discontinuous and drastic changes when the social regime collapses. This article concludes that the latter mechanism is much more destructive and exploitative than the former and dominates the long-term tendency of land use changes.

Keywords: land use changes, deforestation, shifting cultivation, social regime, air- and satellite-born images, Oudomxay province

I Introduction

It is widely observed that simplified cause-consequence relationships of land use changes have gained sufficient public currency to influence environment and development policies [Lambin *et al.* 2001]. The simplification is most influential in the tropics where land use has drastically changed, particularly in terms of deforestation, under the influence of rapid population growth and the spread of globalized market economy and where exogenous forces took the initiative for developing countermeasures to control land use. Laos is one such case. The major direct causes of deforestation are supposed to be shifting cultivation, together with forest fire and logging, driven by population growth and an increasing demand for cultivated land [DOF 2003]. This understanding led to a policy to stop shifting cultivation, a major production mode of rice particularly in Northern Laos, and to reestablish forest cover to 17

* Ministry of Agriculture and Forestry, Lao PDR
** 河野泰之, Center for Southeast Asian Studies, Kyoto University
e-mail: kono@cseas.kyoto-u.ac.jp

million ha or 70% of the national land [IUCN 1997]. Attention to forest conservation has been substantially strengthened since the First National Forestry Congress in 1989, and materialized as the land-forest allocation program by the Decree No. 99/PM dated 12th Dec. 1992 and the Decree No. 186/PM dated 12th Oct. 1994 which was later replaced by the Forest Law of 1997 [Saphangthong 2007].

According to macro-statistics, Laos's population increased from 2.7 million to 5.2 million and area used for cultivating major crops increased from 500 thousand ha (2.1% of the national land) to 960 thousand ha (4.1%) during the three decades between 1970 and 2000 [CPI 2005]. The annual rate of increase for both is 2.2%, suggesting that the per-capita area of cultivation is constant and agricultural land expansion is driven by population growth. Shifting cultivation of upland rice occupied more than 30% of the total rice growing area by the mid 1990s [*ibid.*], and forest land decreased from 70% of the national land in 1940 to 49.2% in 1982, 47.1% in 1992 and 41.4% in 2002 according to the statistics of Department of Forestry [Bouahom 2009; DOF 2003]. These national-level statistics may support the simplified idea that population growth and the expansion of agricultural land, particularly of shifting cultivation, is the major cause of deforestation.

Several questions related to this belief, however, arise from a simple glance at the same statistics. The area used for planting upland rice hit a high of almost 300 thousand ha in 1980, then decreased, and is now around 100 thousand ha [CPI 2005]. This suggests that a reduction of shifting cultivation and a decrease in forest land occurred simultaneously. Consistency of the macro-statistics should also be questioned. There is a big gap in forest land area statistics provided by the Department of Forestry and FAO, of which the latter shows almost constant forest cover of around 70% during the last five decades [FAO 2005]. This difference may be partly due to the difference in the definition of forest land. The minimum tree canopy adopted by the Department of Forestry and FAO is 20% and 10%, respectively.

More importantly, the simplified cause-consequence relationships can be questioned when we reflect on Lao history in the latter half of the 20th century. It was not straightforward, but rich in socio-economic upheavals. After the withdrawal of France from Indochina in 1954, civil war and consequent social disorder continued until the beginning of the 1970s. Independence in 1975 settled political struggles, but the implementation of a planned economy in the late 70s and early 80s stagnated the national economy. The introduction in 1986 of *Chin Tanakan Mai*, a market-oriented economic policy, and "converting Indochina from a battlefield into a market place" policy proposed by Chartchai Choonhavan, the then Prime Minister of Thailand, at the end of the 80s were the turning-points of the national and regional economies respectively. Since then, Laos has invited international cooperation and foreign investment to build its infrastructure, modernize administration and develop industries, which, since the 1990s, have gradually spread from the capital city to rural areas [LCI 2003]. These

social and economic movements have had substantial impacts on land use and have caused discontinuity in land use changes, in addition to bringing about continuous changes which reflect evolving population dynamics.

The present study aims to reconsider the mechanisms of land use changes in Laos during the past several decades to supplement and/or substitute the simplified idea of cause-consequence relationships by highlighting land use changes at the village level. Land use at the village level is thought to be the most integrated information on how people recognize, utilize, manage and govern land resources, and the most important basis of their livelihood systems. Land use changes at the village level not only reflect local demography and migration, trading and marketing, customs and regulations of land resources, but they are also affected by population dynamics, economy, state policies and administration at the national, as well as regional levels.

The study site is the basin of the Beng River, a tributary of the Mekong River, located in three districts, Meuong Beng, Meuong Houne and Meuong Pakbeng, of Oudomxay Province, Northern Laos. The river is about 150 km in length. The valley has wider lowlands than other valleys in Northern Laos, which creates a slightly different landscape from other locations. About 25% of the watershed area is flat to gently undulating alluvial plains and terraces adjacent to the river and its tributaries are at an elevation of about 300 to 500 m above sea level, while the remaining 75% are occupied by hilly to mountainous lands (Fig. 1). Annual rainfall is about 1,300 mm, of which 75% to 80% occurs in the peak rainy season from June to August. Virtually no primary forest survives, but the tops of mountains and many watercourses support well-matured secondary forest. These areas are defined for conservation and protected by village and district authorities.

Based on toposequence and land use practices, the basin can be divided into upper, middle and lower sub-basins. The upper sub-basin is characterized by relatively wide lowlands with paddy fields. Some degree of upland cropping is practiced and a high cover of well-matured secondary forest is observed. In the middle sub-basin, both upland and lowland agriculture is practiced. Intensive shifting cultivation is observed on sloping lands due to the narrow valley area and limited lowlands. Forest cover in this area is the smallest. The lower sub-basin has the widest lowland in the basin (about 6–8 km) and people practice only upland agriculture in this part. Soils here are *Cambisols* and *Luvisols* which are rich in carbonate deposition and suitable for upland cropping but not so for paddy cultivation due to high permeability and less capacity to sustain water ponding. Rocky limestone mountains that are not suitable for agriculture seem to be a very good protection for the natural forest. However, some logging still exists. Three villages were selected for intensive study, one from each sub-basin, Napa Tai in the upper, Samkang in the middle, and Oudom in the lower sub-basins (Table 1).

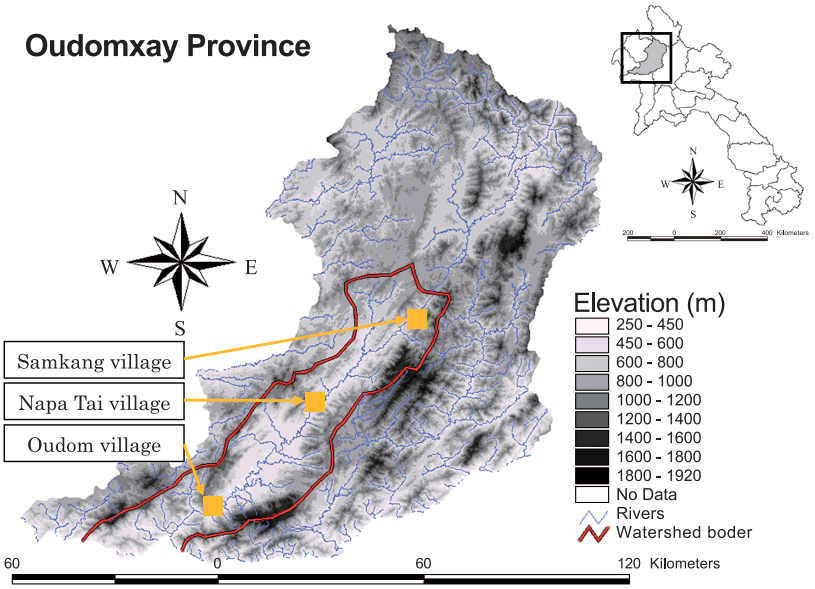


Fig. 1　The Study Area: Nam Beng Basin

Table 1　Outline of the Study Villages

Village Name	Napa Tai	Samkang	Oudom
Ethnicity	Lao Lu	Thai Khao	Khmu Rok
Year established	1964	1906	1976
Number of household	124	148	84
Number of family	169	241	115
Population	774	965	616
Village total area (ha)	4,175	1,777	2,880
Present land use (%)			
Paddy field	4	13	1
Upland field	12	19	16
Garden	—	1	—
Grass land	19	47	25
Conservation forest	40	12	28
Protecting forest	10	—	20
Recovering forest	14	7	9
Settlement area	1	1	0

Sources: Interview to the village headmen, Sep. 2002

The study period is three decades from the early 1970s to early 2000s because older air-born images are not available. Field surveys were conducted several times between 1999 to 2002.

II Methods

Past land cover was interpreted from old air- and satellite-born images. Information on changes in population and farming practices was collected by interviews carried out in the study villages. Changes in land use and farm economy were then estimated. Based on these findings, the mechanism of land use changes is discussed below.

II.1 *Interpretation of Land Cover Changes*

Elevation, slope and land cover maps were produced according to the following procedure [Saphangthong 2007].

1) *Base Maps*

Topography maps with the scale of 1:50,000 published in 1965 by the Survey Department, Government of Laos were selected as the base map for this study.

164 ground control points (GCP) were set up by *in situ* measurement using the global positioning system (GPS) during field surveys in 2000, 2001 and 2002 for image rectification.

Contour lines with 20 m interval of the topographical maps were first digitized using ArcView. Then, a digital elevation model (DEM) with 5 m interval was created by interpolating digitized contour lines using ArcInfo. Finally the slope maps were produced using ArcView.

2) *Air- and Satellite-Born Images*

A wide range of air- and satellite-born images are available for the study area. Aerial photos (1982 and 1999) and satellite images from Corona 2 (1973), Spot (1992 and 2000) and Landsat TM 5 (1997) were tested as data source, and Corona 2 (1973) and aerial photos (1982 and 1999) were found to be most suitable for the present study. The resolutions of the Landsat TM and Spot images are 30 m and 20 m, respectively, and much coarser than those of the aerial photos and Corona 2 images which are around 6 m. This caused a significant difference in the texture of the interpreted land cover maps. High resolution images are more suitable to small area analyses like those carried out at a village level. The scales of the images are 1:60,000 for Corona 2 images, 1:30,000 for 1982 aerial photos and 1:50,000 for 1999 aerial photos.

Aerial photos and Corona 2 images were orthorectified based on the above-mentioned DEM and GCPs. All images were subsequently transformed to the same coordinate system (UTM, WGS84 datum, Zone 47 North) and were re-sampled to a resolution of 5×5 m.

3) *Image Interpretation*

The modified UNESCO classification was selected for the present study [Patrick and Lisa 1992]. This classification is simple and widely used for land cover/land use studies in various areas. Land cover classes under this classification are dense forest, open forest, bush, grass, agricultural land and urban and built up area. Agricultural land is further divided into the sub-classes of paddy field and upland field.

Both aerial photos and Corona are monochrome images and must be visually interpreted. This work needs high proficiency and experience and was done by the first author after several months training. The visual interpretation was supported by the information collected from local people, as well as the DEM. Interviews with the village headman and 20 farmers in each village provided information on land cover/land use and farming practices in the past and present. Finally, three land cover maps for each village were produced.

II.2 *Estimation of Population Changes*

Population statistics are available only at the province level, and no record is available at the village level. Therefore, we had to depend on the memory of villagers. Villagers reported demographic data either as the population number, number of households, or number of families at the time when some event happened in the village. Among the three indices of demography, the number of households was the most popular answer given by the informants. The number of households, or the number of houses with somebody living in them, is visible information, while the number of families is invisible because two or more families may live together in one household. Events are understood in this paper to include movement of settlement, the receiving migrants and so on. This information is with irregular intervals.

Therefore, the changes in the number of households for the whole study period were estimated by interpolating collected information and using the provincial statistics as a reference for converting other indices to the number of households.

II.3 *Estimation of Land Use and Farm Economy*

Based on the results of image interpretation and population estimation, land use and land cover of non-

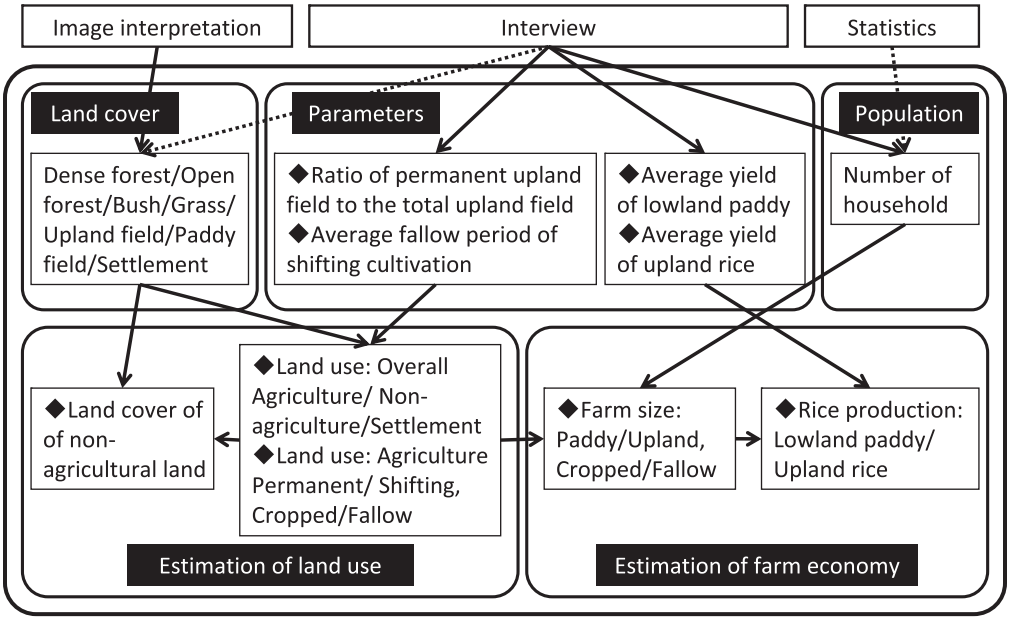


Fig. 2 Procedure to Estimate Land Use and Farm Economy

agricultural land was identified, and changes in farm size and per-household rice production were estimated assuming the four parameters related to agricultural practice of each village and at the time of the acquired images (Fig. 2).

1) *Parameters*

Four parameters are required to be fixed, namely the ratio of permanent upland field to the total upland field (Rp), average fallow period of shifting cultivation (Yf), average yield of lowland paddy (Ydp) and average yield of upland rice (Ydu) of each study village at every year of the acquired images, namely 1973, 1982 and 1999.

In the study area there are three modes of farming. These are lowland paddy cultivation, shifting cultivation of upland field and continuous cultivation of upland field. Rp is the proportion of the third mode of cultivation to the total upland cultivation in terms of area. Villagers use the same land for cultivation every year in cases of lowland paddy cultivation and continuous cultivation of upland field. In the case of shifting cultivation, one-time cropping is followed by several years' fallow, and grass and bush vegetations recover during the fallow period. Yf is the average period of fallow before the land is re-used for cultivation. The staple food of people in the study area is rice which is produced both in lowland irrigated fields and in shifting cultivation fields. Ydp and Ydu are yields of lowland paddy and

upland rice production.

Information related to these parameters including mode of cropping, crops cultivated and their productivity, fallow period, forest vegetation and sources of cash income during the study period was collected through interviews with the village headmen and 20 farmers in each study village. The values of these parameters were then carefully fixed.

2) *Estimation of Land Use*

Abbreviating percentages of areas covered by dense forest, open forest, bush, grass, upland field, paddy field and settlement as Ad, Ao, Ab, Ag, Au, Ap, and As, the areas of agricultural and non-agricultural lands were calculated as follows.

Area of permanent upland field (Aup) (%)

$$Aup = Au * Rp$$

Area of shifting upland field (Aus) (%)

$$Aus = Au * (1 - Rp)$$

Area of fallow land (Af) (%)

$$Af = Aus * Yf$$

Area of agricultural land including fallow land (Aa) (%)

$$Aa = Ap + Aup + Aus + Af$$

Area of non-agricultural land (An) (%)

$$An = 100 - Aa - As$$

Land cover of non-agricultural land was then estimated with the following procedure.

Proportion of dense forest in non-agricultural land (Pd) (%)

$$Pd = Ad / An \text{ if } Ad < An \text{ or } 100$$

Proportion of open forest in non-agricultural land (Po) (%)

$$Po = Ao / An \text{ if } Ad + Ao < An \text{ or } 100\text{-}Pd$$

Proportion of bush in non-agricultural land (Pb) (%)

$$Pb = Ab / An \text{ if } Ad + Ao + Ab < An \text{ or } 100\text{-}Pd\text{-}Po$$

Proportion of grass in non-agricultural land (Pg) (%)

$$Pg = Ag / An \text{ if } Ad + Ao + Ab + Ag < An \text{ or } 100\text{-}Pd\text{-}Po\text{-}Pb$$

3) *Estimation of Farm Economy*

Abbreviating the total village area as At and number of households as H, farm size is calculated as follows:

Average area of lowland field per households (Fp) (ha)

$$Fp = At * Ap / H$$

Average area of upland permanent cultivation field per household (Fup) (ha)

$$Fup = At * Aup / H$$

Average area of upland shifting cultivation field per household (Fus) (ha)

$$Fus = At * Aus / H$$

Average area of fallow land (Ff) (ha)

$$Ff = At * Af / H$$

Average farm size (Ft) (ha)

$$Ft = Fp + Fup + Fus + Ff$$

Rice production per household is calculated as follows:

Lowland paddy production per household (Pp) (ton)

$$Pp = Fp * Ydp$$

Upland rice production per household (Pu) (ton)

$$Pu = Fus * Ydu$$

Total rice production per household (Pt) (ton)

$$Pt = Pp + Pu$$

III Changes in Population and Land Use of the Study Villages

III.1 *Napa Tai Village*

III.1.1 *Population*

Napa Tai village was established in 1964. A villager reported that there were 30 households at that time. It increased to 55 households in 1973 when the ceasefire was achieved in this area and 62 households in 1975 when Lao PDR was established. In the same year, a Hmong village, called Kyu Sang Van, moved into the eastern part of the village territory from a nearby area to look for virgin forest suitable for shifting cultivation and to have better access to the newly constructed road that passes through Napa Tai village. This migration reflects social stabilization owing to the ceasefire and the establishment of a new political regime. The Hmong village had 73 households, so the total number of households jumped to 135 in 1975.

The number of households continuously increased to 189 in 1983 and reached 299 in 1998. Then the government promoted a resettlement program for the Hmong village to a nearby road-side land

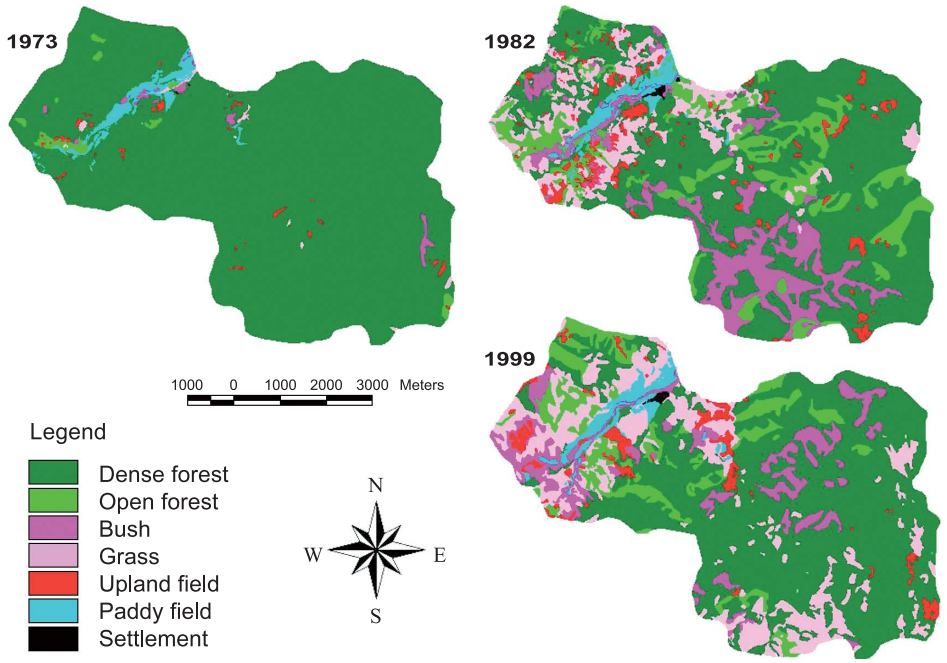


Fig. 3　Changes in Land Cover of Napa Tai Village

outside the territory of Napa Tai village. 177 households of Kyu Sang Van village followed the program. This resulted in a decrease in the number of household to 122. Since then, the number of households again gradually increased to 124 in 1999 and 132 in 2003.

Changes in the number of households during the last four decades from 1964 to the present were estimated by a simple interpolation of the above information. The move-in of Kyu Sang Van village in 1975 and its move-out in 1998 make the curve discontinuous. The numbers of households when the images are acquired are identified as 55, 189 and 194 in 1973, 1982 and 1999, respectively.

III.1.2 *Land Use*

Fig. 3 is land cover maps of Napa Tai village in 1973, 1982 and 1999 produced by the method mentioned above. Table 2 numerically summarized areas of each land cover class.

The village was purely a lowland paddy-based village in the 1970s. Upland fields as well as open forest, bush and grass lands were almost zero at that time and most mountain slopes were covered with dense forest.

Land use suddenly changed between 1973 and 1982. Upland fields jumped from 18 ha in 1973 to 192 ha in 1982. Open forest, bush and grass lands occupied more than 10% each in 1982, resulting in a

Table 2 Changes in Land Use and Farming System of Napa Tai Village

Year	1973	1982	1999
Land cover (%)			
Dense forest	95.0	56.8	57.8
Open forest	1.0	13.1	9.3
Bush	0.7	12.4	8.7
Grass	0.7	10.6	17.6
Upland field	0.4	4.6	3.6
Paddy field	2.2	2.3	2.8
Settlement	0.0	0.2	0.2
Parameters			
Ratio of permanet upland field to total upland field (Rp)	0.7	0.5	0.1
Fallow period (Yf) (year)	10	5	3
Yield of lowland paddy (Ydp) (t/ha)	2.0	2.0	2.5
Yield of upland rice (Ydu) (t/ha)	1.2	1.2	1.0
Land use: Overall (%)			
Agriculture	3.8	18.4	16.1
Non-agriculture	96.2	81.4	83.7
Settlement	0.0	0.2	0.2
Agricultural land use			
Permanent (%)			
Upland	7.4	12.5	2.2
Paddy	57.8	12.5	17.4
Shifting (%)			
Cropped	3.2	12.5	20.1
Fallow	31.6	62.5	60.3
Upland cropping intensity	0.25	0.29	0.27
Land cover of non-agricultural land (%)			
Dense forest	98.8	69.8	69.1
Open forest	1.0	16.1	11.1
Bush	0.2	14.1	10.4
Grass	0.0	0.0	9.4
Farm size (ha/household)			
Cropped			
Paddy	1.7	0.5	0.6
Upland (permanent)	0.2	0.5	0.1
Upland (shifting)	0.1	0.5	0.7
Sub-total	2.0	1.5	1.4
Fallow	0.9	2.6	2.1
Total	2.9	4.1	3.5
Rice production (t/household)			
Lowland paddy	3.3	1.0	1.5
Upland rice	0.1	0.6	0.7
Total	3.4	1.6	2.2

sudden decrease in dense forest land from 95% in 1973 to 57% in 1982. These changes were partly due to the migration of Kyu San Van village in 1975 whose major production mode was shifting cultivation. But expansion of upland fields and forest degradation can be observed even on mountain slopes along the valley where the original settlement is located and in the western part of the village. This indicates that the original villagers themselves started to practice shifting cultivation.

Changes between 1982 and 1999 are much more moderate than those between 1973 and 1982. Dense forest, grass and paddy fields increased, while open forest, bush and upland field decreased. Significant changes during this period are first, an increase in paddy field area from 98 ha in 1982 to 117 ha in 1999. Although the increasing rate is smaller than that of household growth during the same period as discussed later, this indicates villagers' intention to intensify agricultural production by means of the expansion of paddy fields. Second, the decrease of open forest and bush and the increase of grass happened in parallel to the maintenance of the area of shifting cultivation fields. This suggests that vegetation recovery during the fallow period slowed down, keeping grass vegetation on fallow lands for longer periods.

III.1.3 *Farming System*

Villagers reported that opium was the major crop of upland cultivation during the early 1970s. Opium was intensively cared for similar to home gardening, and they repeatedly cultivated the same land. Opium cultivation, however, has gradually decreased since the early 1980s and, instead, upland crop cultivation, particularly of upland rice, with one time cropping followed by three to five years fallow has increased. These trends continue up to the present day. The fallow period of shifting cultivation reduced to two to three years in the late 1990s. Yields of lowland paddy are 2 to 3 t/ha at present and they were slightly lower before. Yields of upland rice are around 1 t/ha at present and they were slightly higher before. Based on these reports of villagers, Rp, Yf, Ydp, and Ydu parameters are assumed as shown in Table 2.

Table 2 shows that permanent upland cropping increased in the 1980s and decreased later on. This indicates that opium cultivation expanded after the ceasefire when the economy was restored and declined because of the eradication program of the government probably in the late 1980s and 1990s. Shifting cultivation has drastically expanded from 5 ha in 1973 to 136 ha in 1999. Fallow land consisted of bush and grass lands in the 1970s when the fallow period was still long enough, around 10 years in length, but it has been dominated by grass since the 1980s due to shorter fallow period of five years or less. The upland cropping intensity, and the ratio of cultivated upland field to total upland agricultural land including fallow land, has been constant during the last three decades between 0.25 and 0.29, though

any customary mechanism to coordinate the ratio could not be found.

Farm size of lowland paddy field sharply decreased from 1.7 ha in 1973 to 0.5 ha in 1982, and then slightly recovered to 0.6 ha in 1999. The farm size of shifting cultivation field area has increased from 0.1 ha in 1973 to 0.7 ha in 1999, apparently as a substitute of upland rice for lowland paddy. Farm size of upland permanent field increased in the 1980s and decreased after that, reflecting a boom of opium cultivation at that time. The average size of agricultural land including fallow land has been stable and between 3 and 4 ha throughout the study period.

Rice production was totally dependent on lowland paddy in 1973, while the proportion of upland rice has gradually increased up to about 30% in 1999 reflecting changes from a paddy-based village to a composite swidden farming village. Rice balance at the village level was surplus in 1973, in deficit in 1982 and sufficient in 1999. Villagers reported that they faced severe food shortages during the period of agricultural collectivization in the late 1970s and early 1980s. The results of the rice production estimation fit this experience of villagers well, suggesting that these estimations are reasonable.

III.2 *Samkang Village*

III.2.1 *Population*

Samkang village was established in 1906. Villagers reported that there were 72 families with the population of 400 in 1969 when the village was attacked by bombing and they had to escape to the nearby forest. The number of households was 67 in 1974 when the ceasefire was achieved and 72 in 1982. This village also received migrants under the local government program. In 1994, six households of a Hmong village, called Phone Si, moved into the territory of this village. Several others came in the following years, and finally 44 households settled down by 2000.

Changes in the number of families and households during the study period were estimated by a simple interpolation. The curves show two jumps. First, a rapid increase in household numbers occurred in the early 1970s from 45 to 70, and then they were maintained at the same level until the mid-80s. The second jump occurred in the late 1990s due to the migration of Phone Si village. The numbers of households where the images are available are identified as 62, 72 and 177 in 1973, 1982 and 1999, respectively.

III.2.2 *Land Use*

Fig. 4 is land cover maps of Samkang village in 1973, 1982 and 1999, and Table 3 numerically summarized areas of each land cover class.

Samkang village was a composite swidden farming village in the 1970s, having 53 ha of lowland

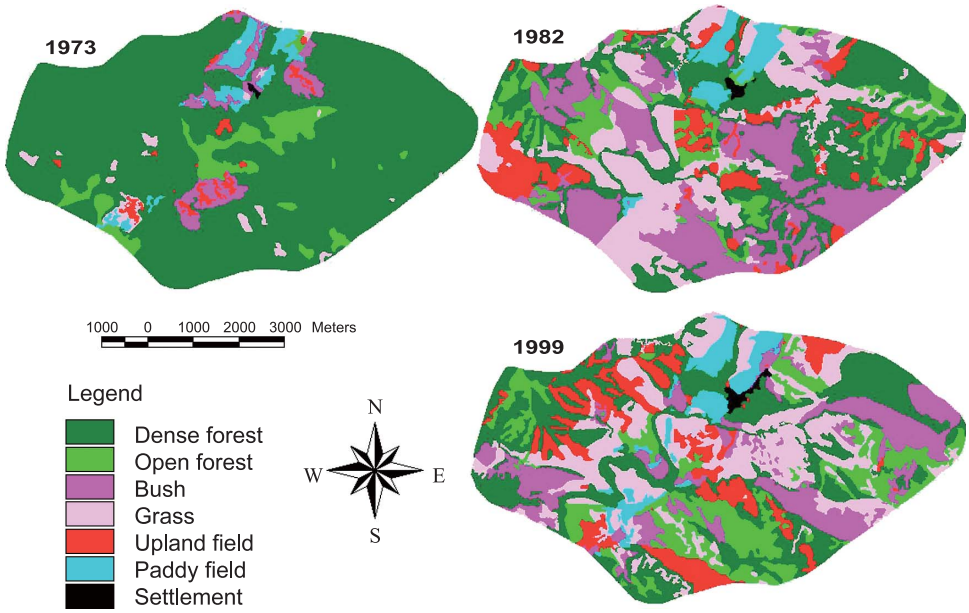


Fig. 4　Changes in Land Cover of Samkang Village

paddy and 31 ha of upland fields. More than 80% of the village territory was covered with dense forest though small patches of open forest, bush and grass lands already existed among the dense forest areas.

Land cover suddenly changed between 1973 and 1982 as observed at Napa Tai village. Dense forest sharply decreased to 30% and the other types of land use increased. This change covered all parts of the village including eastern and western slopes and land along the valley. Villagers did not report the migration of people into the village during this period. Therefore, these changes were thought to be caused by the villagers and/or external people who stayed temporarily at the village.

Changes between 1982 and 1999 were moderate. Open forest has increased, while bush land has decreased. Paddy field increased from 65 ha in 1982 to 88 ha in 1999, but the increase is limited due to lack of suitable land for further expansion.

III.2.3　*Farming System*

Villagers reported that opium was the major upland crop until the 1970s. It was grown in permanent fields in a similar fashion to home gardens. In the late 1970s, shifting cultivation of upland rice with a long-term fallow increased because lowland paddy cultivation was collectivized and resulted in low yields and the shortage of rice. Opium cultivation was gradually reduced from the early 1980s due to govern-

Table 3 Changes in Land Use and Farming System of Samkang Village

Year	1973	1982	1999
Land cover (%)			
Dense forest	82.6	30.7	29.9
Open forest	6.4	10.4	15.4
Bush	4.4	22.3	15.3
Grass	1.7	22.8	22.3
Upland field	1.8	9.9	11.6
Paddy field	3.0	3.6	5.0
Settlement	0.1	0.3	0.5
Parameters			
Ratio of permanet upland field to total upland field (Rp)	0.8	0.6	0.1
Fallow period (Yf) (year)	10	8	2
Yield of lowland paddy (Ydp) (t/ha)	2.0	2.0	2.5
Yield of upland rice (Ydu) (t/ha)	1.2	1.2	1.0
Land use: Overall (%)			
Agriculture	8.4	45.2	37.5
Non-agriculture	91.5	54.5	62.0
Settlement	0.1	0.3	0.5
Agricultural land use			
Permanent (%)			
Upland	17.1	13.1	3.1
Paddy	35.7	8.0	13.3
Shifting (%)			
Cropped	4.3	8.8	27.9
Fallow	42.9	70.1	55.7
Upland cropping intensity	0.33	0.24	0.36
Land cover of non-agricultural land (%)			
Dense forest	90.3	56.3	48.2
Open forest	7.0	19.1	24.8
Bush	2.7	24.6	24.7
Grass	0.0	0.0	2.3
Farm size (ha/household)			
Cropped			
Paddy	0.9	0.9	0.5
Upland (permanent)	0.4	1.5	0.1
Upland (shifting)	0.1	1.0	1.0
Sub-total	1.4	3.4	1.6
Fallow	1.0	7.8	2.1
Total	2.4	11.2	3.7
Rice production (t/household)			
Lowland paddy	1.7	1.7	1.3
Upland rice	0.1	1.2	1.0
Total	1.8	2.9	2.3

ment pressure. In the 1990s, migrants from Phone Si village moved into the village, and they were engaged in shifting cultivation. As a consequence of this, the fallow period of shifting cultivation was reduced to two to three years in the late 1990s. Based on these reports from villagers, Rp, Yf, Ydf and Ydu are assumed as shown in Table 3.

Changes in permanent upland cropping show a similar trend to that of Napa Tai village, it increased in the 1980s and decreased later on. Shifting cultivation drastically increased from 6 ha in 1973 to 185 ha in 1999. Fallow land vegetation was bush and grass until recent years, but it is now totally grass due to a shorter fallow period. The upland cropping intensity dropped from 0.33 in 1973 to 0.24 in 1982, but increased to 0.36 in 1999.

Farm size of lowland paddy field was constant at 0.9 ha during the 1970s and 1980s and dropped to 0.5 ha in 1999, while farm size of shifting cultivation increased from 0.1 ha in 1973 to 1.0 ha in 1982 and was maintained at this size until 1999. Rice balance reflected these trends, sufficient in 1973 and 1999, and a substantial surplus in 1982. This may suggest that rice exchange, most probably among nearby villages, was activated during the early 1980s when lowland areas suffered from collectivized farming, though the government strictly controlled rice trading at that time. The estimated average size of agricultural land including fallow land was 11 ha in 1982. This indicates that extensive farming was practiced at that time.

III.3 *Oudom Village*

III.3.1 *Population*

Oudom village was originally located near the present location, but most of the villagers escaped and settled down in the western highland area in the late 1960s due to heavy bombing in the valley area. In 1970, there were 20 households with 40 families living in a highland village, called Mok Prang, while only four households with six families remained in the valley village, Oudom. Owing to the ceasefire and the newly constructed road No. 2 along the valley area, all the households of Mok Prang came back to Oudom by 1973, and Oudom village had 23 households with 46 families. It increased to 30 households and 50 families in 1980 and 85 households and 125 families in 2003. There was no large-scale migration to this village during the study period, but some villagers who joined the army returned back to the village with their families, and several families of nearby mountainous villages moved in during the study period. Therefore, since the beginning of the 1970s, the number of households has gradually increased. The number of households in 1973, 1982 and 1999 were estimated to be 23, 35, and 75, respectively.

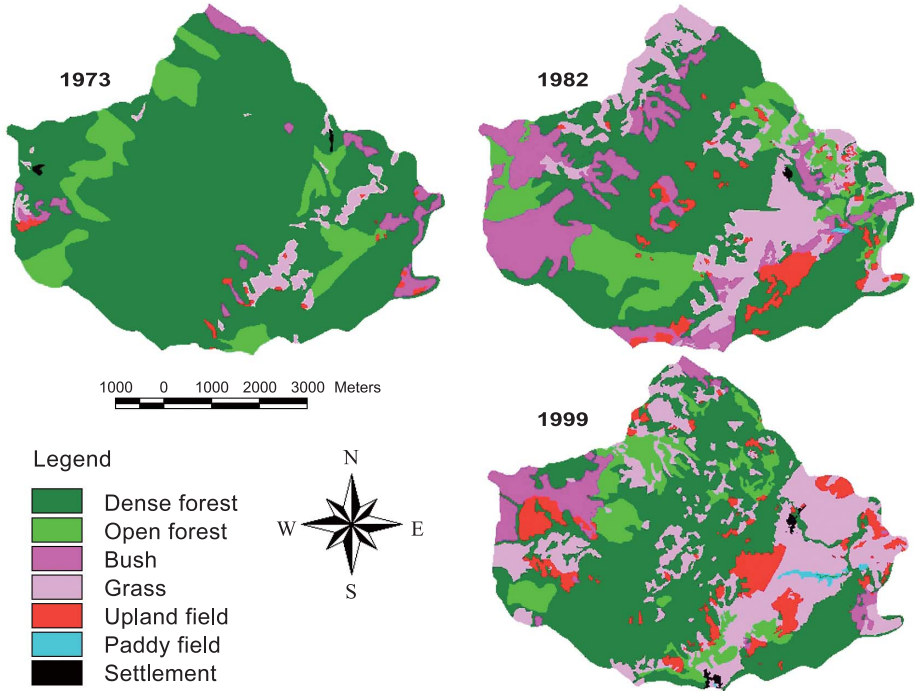


Fig. 5 Changes in Land Cover of Oudom Village

III.3.2 *Land Use*

Fig. 5 is land cover maps of Oudom village in 1973, 1982 and 1999, and Table 4 numerically summarized areas of each land cover class.

Oudom Village has been a purely upland-based village. Agricultural activities were concentrated in the western highland and the valley areas until the 1970s. The area between the western highland and the valley was totally covered with dense forest because this area has a rocky surface and is not suitable for cultivation. More than 90% of the village territory was covered with either dense or open forests in 1973. Open forest did not deteriorate due to human activities, but forest vegetation was naturally poor due to outcrops of limestone.

Land use suddenly changed between 1973 and 1982. As observed in the other villages, dense forest drastically decreased and forest cover was 60% in 1982. Instead, bush, grass and upland field significantly increased. The increasing rates were 5.0, 5.1 and 6.1 times for bush, grass and upland field, respectively. This suggests the rapid expansion of shifting as well as permanent upland cultivation during this period. The expansion of upland fields continued after 1982. It increased two times between 1982 and 1999 and reached 8% of the village area. The total area of bush and grass, however, decreased

Table 4　Changes in Land Use and Farming System of Oudom Village

Year	1973	1982	1999
Land cover (%)			
Dense forest	80.7	46.6	49.2
Open forest	11.3	13.2	9.9
Bush	3.5	17.3	22.2
Grass	3.6	18.4	9.5
Upland field	0.7	4.3	8.4
Paddy field	0	0.1	0.4
Settlement	0.2	0.1	0.4
Parameters			
Ratio of permanet upland field to total upland field (Rp)	0.0	0.3	0.5
Fallow period (Yf) (year)	10	10	2
Yield of lowland paddy (Ydp) (t/ha)	2.0	2.0	2.5
Yield of upland rice (Ydu) (t/ha)	1.5	1.5	1.5
Land use: Overall (%)			
Agriculture	7.7	34.5	17.2
Non-agriculture	92.1	65.4	82.4
Settlement	0.2	0.1	0.4
Agricultural land use			
Permanent (%)			
Upland	0.0	3.7	24.4
Paddy	0.0	0.3	2.3
Shifting (%)			
Cropped	9.1	8.7	24.4
Fallow	90.9	87.3	48.9
Upland cropping intensity	0.09	0.13	0.50
Land cover of non-agricultural land (%)			
Dense forest	87.6	71.2	59.8
Open forest	12.3	20.2	12.0
Bush	0.1	8.6	26.9
Grass	0.0	0.0	1.3
Farm size (ha/household)			
Cropped			
Paddy	0.0	0.1	0.2
Upland (permanent)	0.0	1.1	1.6
Upland (shifting)	0.9	2.4	1.6
Sub-total	0.9	3.6	3.4
Fallow	8.7	24.8	3.2
Total	9.6	28.4	6.6
Rice production (t/household)			
Lowland paddy	0.0	0.2	0.4
Upland rice	1.3	3.7	2.4
Total	1.3	3.9	2.8

during the same period from 36% in 1982 to 32% in 1999. This suggests that the fallow period of shifting cultivation was shortened and shifting cultivation moved to permanent cropping.

Paddy field is still very limited in this village, occupying 12 ha or 0.4% of the village land in 1999. This is because soils in this village are highly permeable and not suitable to lowland paddy cultivation.

III.3.3 *Farming System*

Villagers reported that they produced upland rice through shifting cultivation with a fallow period of more than 10 years until the 1970s. Forest land was abundant and they could easily find suitable land for shifting cultivation. They also produce opium in the late 1970s and 1980s as a source of cash income. Opium was grown in upland fields which were continuously used for more than 10 years. But they stopped opium production in the late 1990s due to strict government control. At the same time, villagers shortened the fallow period of shifting cultivation to two to three years and introduced continuous and commercial cultivation of hybrid maize and soybean. Soils in this village are fertile and upland rice yields were 1.5 to 2 t/ha throughout the study period, higher than in the other study villages. Based on these reports, Rp, Yf, Ydp and Ydu are assumed as shown in Table 4.

In contrast to Napa Tai and Samkang villages, both permanent and shifting fields continuously increased in Oudom village. Grass and bush were dominant vegetation of the fallow land in 1973 and 1982, but there was only grass in 1999 because of the shorter fallow period. Cropping intensity drastically increased from 0.13 in 1982 to 0.50 in 1999. This suggests rapid intensification of upland use, shortening of the fallow period and introduction of continuous cropping, in the 1990s owing to fertile soils.

Average farm size of lowland paddy fields was negligibly small throughout the study period. Average farm size of upland field is much larger than that of the other villages. Between 1982 and 1999, average farm size of permanent field increased from 1.1 ha to 1.6 ha and that of shifting field decreased from 2.5 ha to 1.6 ha, indicating the conversion of shifting fields to permanent fields. Overall farm size including fallow land was tremendously large in 1982 suggesting that quite extensive farming was practiced just after the ceasefire and the achievement of social stability.

Oudom was a rice-deficit village in the 1970s even though they had rich forest at that time. This may indicate that they could easily obtain some kinds of wild food from the forest which steadily substituted rice. They had surplus rice production in 1982. This was probably for exchange with nearby villages due to a shortage of rice production in lowland areas as observed in Samkang village. At present, they have, on average, a sufficient amount of rice for their home consumption.

IV　Mechanism of Land Use Change

The trend of land use changes commonly observed among the three villages is quite different between the first period (1973–82) and the second period (1982–99). In the first period, forest, dominating on slope land in 1973, rapidly deteriorated, and mosaic land use patterns containing forest, fallow land, shifting upland field and permanent upland field emerged by 1982. On the other hand, the land use patterns were more or less maintained in the second period.

IV.1　*The First Period (1973–82)*

During the first period, the number of households increased 3.4, 1.2 and 1.5 times, while the dense forest area decreased 40%, 63% and 42%, upland fields increased 11.3, 5.6 and 6.2 times and fallow land also increased 9.1, 9.1 and 4.3 times in Napa Tai, Samkang and Oudom villages, respectively. The area of paddy field was maintained or slightly increased, and the cropping intensity of upland field increased at Napa Tai and Oudom villages and decreased at Samkang village. The average farm size excluding fallow land increased 2.4 and 4.0 times in Samkang and Oudom villages while 25% decreased in Napa Tai village. Rice balance deteriorated in Napa Tai village, while it improved in Samkang and Oudom villages. These findings suggest that this period is characterized by extensive development of agriculture coupled with a rapid conversion of forest to both permanent and shifting upland fields.

Population increase may be a basic cause of land use conversion from forest to agricultural land. Its effect is significant at Napa Tai village which received a substantial number of migrants during the period. The expansion of agricultural land and consequent increase of rice production could not meet the increasing demands for food for the village and resulted in rice shortages at the village level. In the other two villages, however, population growth during the period was moderate and the drastic land use conversion cannot be explained by the increasing demand for food. What then are the major causes?

The study area suffered from civil war in the 1960s and early 70s. Villagers had to construct shelters in the forest and move there to escape from bombing. This social disorder forced people to survive with minimum farming activities and almost no other economic activities. This situation changed in the early 1970s when bombing stopped and peace was achieved. People were eager to restore their livelihood. First, they tried to produce enough food for their survival. Some people moved to new areas to look for more fertile land for rice production and to have better access to the road network, some of which were constructed for military purposes during the civil war time [Walker 1999]. Second, they initiated commercial cropping of opium and rice for sale or exchange. Harvesting timber may have been another source of income at that time, and immigrants may have temporarily come in the study area to

engage in it. All of these activities would have drastically degraded forest vegetation.

These activities were not coordinated at any levels of community and local administration, but were spontaneous. Indigenous governance of the village community was eroded after the establishment of Lao PDR. The new government intervened in the village society in various ways. It forced villagers to stop traditional rituals and festivals which were important occasions to implicitly confirm their membership in the community [Tomita *et al.* 2008]. It also implemented collective farming, replacing mutual assistance-based labor and harvest allocation adjustment, a major strategy to maintain food security [Matsuura 2005]. On the other hand, the local administration was still immature and the government faced severe economic crisis. This period was exactly the time when the social regime of rural villages was in transition, shifting from a community-based regime to a local administration-based one. In terms of land use, customary land use regimes collapsed, but new regimes did not emerge yet. This transition allowed villagers as well as external invaders to exploit forest resources without any long-term perspective.

IV.2 *The Second Period (1982–99)*

During the second period, the number of households increased more than two times at Samkang and Oudom villages, but did not change at Napa Tai because of outbound migration. The area of dense forest did not significantly change in any of the villages. Paddy field increased in all villages, and upland field decreased in Napa Tai village and increased in Samkang and Oudom villages. The average farm size excluding fallow land decreased slightly in Napa Tai and Oudom villages and drastically in Samkang village. Fallow land per household also decreased slightly in Napa Tai and sharply in Samkang and Oudom villages. Rice balance improved in Napa Tai village where rice production was in deficit at the beginning of this period and shifted from a surplus to sufficiency in Samkang and Oudom villages, suggesting rice is no longer an attractive cash crop. These findings indicate that this period is characterized by farm-level intensification of agriculture by means of the shortening of the fallow period and the conversion of shifting cultivation to permanent cultivation.

Lack of available land is undoubtedly the basic limiting factor of agricultural development during this period. The existing forest land is thought to be mostly unsuitable for cultivation, and the expansion of agricultural land was no longer possible for villagers in the study area. First, this caused the shortening of the fallow period within the shifting cultivation system, and later changes to the permanent cropping of fields.

Intensification was accelerated by government intervention into the land use system at the village level. The government held up a policy target of banning shifting cultivation and, as a transitional

measure, introduced the land-forest allocation program in the study area since 1997 under which the fallow period of shifting cultivation was limited to two years. In parallel, the extension service for permanent cultivation of commercial crops such as hybrid maize was initiated [Kono and Fujita 2008]. The government also promoted a migration program for shifting cultivators settled in mountainous areas and far from the road network to move them to areas of the valley bottom and near the road. This relieves the population pressure in the deep mountain areas and allocates more land for environmental purposes such as bio-diversity conservation areas, but increases population pressure in areas suitable for intensive agriculture where population density is already high.

These findings indicate that the villagers' efforts of intensification and commercialization of agriculture under the limitation of available land and the intervention of the government achieved comparatively stable land use without deteriorating the farmers' economy during the second period.

V Conclusions

Lambin *et al.* [2001] observe that "population growth is never the sole and often not even the major underlying cause of forest-cover change," and "tropical deforestation is driven largely by changing economic opportunities which are linked to yet other social, political and infrastructural changes." This is exactly what we observed in Northern Laos. Regardless of changing trends of household numbers, three study villages show quite similar tendencies of land use changes, drastic deforestation in the first period (1973 to 1982) and moderate land use intensification in the second period (1982 to 1999). Dense forest cover reduced 40% to 60% during the first period, and did not significantly change in terms of area during the second period, suggesting most of the forest lands suitable to agricultural use under the technology level available at that time were converted beyond the needs of people's livelihood within a limited period. Population has continuously increased in the second half of the 20th century in Laos, but land use changes show discontinuity. Changes in the fundamentals of the area are in most cases gradual, while changes in land use are sometimes drastic.

Mechanisms of land use changes have conceptually two phases. One is a jump, which is a drastic change and creates a new and crude framework of land use, and the other is gradual and combines changes which adjust the actual land use with what it ought to be. "What land use ought to be" is formed through the process of repeated negotiations, compromises and consensus making among the stake-holders under the given social, economic and cultural conditions. This process functions when the actions and discourses of the stakeholders are mutually visualized and they are compelled to share the social regime as a member of the village community, local society or the citizen. Fox *et al.* [2009] point

out that swidden is disappearing at a pace never experienced in Southeast Asia, and identified six major causes including classifying swiddeners as ethnic minorities within the nation-state, dividing the landscape into forest and permanent agriculture, expansion of forest departments and the rise of conservation, resettlement, privatization and commoditization of land and land-based production, and expansion of market infrastructure and the promotion of industrial agriculture. These causes are functioning because the people, willingly or unwillingly, recognize and accept these movements and share the social regime regardless of their position in the society.

The first phase of land use change, on the other hand, happens when the social regime collapses and the stakeholders lose the common ground to share the process of negotiation and consensus-making. "First come, first served" is a unique principle, and violence, including physical and political, can be a dominant tool to govern the relationship among the stakeholders. Any legitimate institutions, including community-based customs and laws and regulations implemented by the government, minimize their functions to limit the demands for land use, and the extent of land use change is controlled only by the natural barriers such as temperature, water and soil.

Conceptual consideration of the mechanism of land use changes suggests that social regimes can operate as a fundamental determinant factor of land use change. The transitional period of social regimes is the most crucial and risky time when destructive and exploitative land use can happen. Values accumulated on lands, including nutrient, biomass, biodiversity and wisdom, are neglected. Rules over the land are delegitimized and the land enters into a period when it is considered an "open access" resource disconnected from any actor. This continues to be a case until stakeholders reemerge and a new system of rules and regulations of the land are recognized as legitimate. The structure and transformation of a social regime should be highlighted to achieve sustainable land use, particularly those that keep long perspectives in mind.

Acknowledgement

We are very grateful to Dr. Bounthong Bouahom and Dr. Phouangparisak Pravongviengkham, Ministry of Agriculture and Forestry, Government of Laos, for valuable information and advice, and to the National Agricultural and Forestry Research Institute (NAFRI) and Oudomxay Provincial Agricultural and Forestry Office for assistance and support to field survey and data collection. We also extend our sincere thanks to the 21st Century COE Program "Aiming for COE of Integrated Area Studies," the Global COE Program "Sustainable Humanosphere for Asia and Africa," and Grand-in-aid for Scientific Research "Mechanism of Land Use Changes in Mainland Southeast Asia" for their financial support.

References

Bouahom, B. 2009. Lao Agriculture in Transition: From Subsistence to Commodity Production. In *Proceedings of the International Workshop on Sustainable Natural Resources Management of Mountainous Regions in Laos*. Vientiane: National Agriculture and Forestry Research Institute, forthcoming.

Committee for Planning and Investment (CPI). 2005. *Statistics 1975–2005*. Vientiane: National Statistics Center.

Department of Forestry (DOF). 2003. *Comparison of Different Land Use and Vegetation Types in Laos in 1982–1992–2002*. Vientiane: National Office for Forest Inventory and Planning.

FAO (Food and Agriculture Organization). 2005. *Global Forest Resources Assessment 2005*. Rome: FAO.

Fox, J.; Fujita, Y.; Ngidang, D.; Peluso, N.; Potter, L.; Sakuntaladewi, N.; Sturgeon, J.; and Thomas, D. 2009. Policies, Political-Economy, and Swidden in Southeast Asia. *Human Ecology* 37: 305–322.

International Union for Conservation of Nature (IUCN). 1997. *The World Commission Union, Environmental and Social Management Plan for Nakai-Nam Thuen Catchment and Corridor Areas*. Report to Government of Lao PDR. Vientiane: IUCN-Lao PDR.

Kono, Y.; and Fujita, K. 2008. Introduction of Commercial Cropping and Transformation of Rural Villages. (in Japanese) In *Raosu Nosanson Chiiki Kenkyu*, edited by S. Yokoyama and Y. Ochiai, pp. 395–429. Tokyo: Mekon.

Lambin, E. F. *et al.* 2001. The Causes of Land-use and Land-cover Change: Moving beyond the Myths. *Global Environmental Change* 11: 261–269.

Laos Cultural Institute (LCI). 2003. *Raosu Gaisetsu*. (in Japanese) Tokyo: Mekon.

Matsuura, M. 2005. Changing Livelihood Activities and Peasants' Living Strategies in Northern Laos. A master thesis, Kyoto University.

Patrick, S. B.; and Lisa, D. E. 1992. *Preliminary Compilation of a Series Level Classification of the Vegetation of the Western U.S. Using a Physiognomic Framework*. ICFWRU, Moscow, ID, 83843.

Saphangthong, T. 2007. Dynamics and Sustainability of Land Use Systems in Northern Laos. A doctoral thesis, Kyoto University.

Tomita, S.; Kono, Y.; Kotegawa, T.; and Chowdary, V. M. 2008. Land Use Technology and Regime Formation in the Mainland Southeast Asia. (in Japanese) In *Eco-history of Monsoon Asia*, Vol. 2, edited by C. Daniels, pp. 191–202. Tokyo: Kobundo.

Walker, A. 1999. *The Legend of the Golden Boat*. Richmond: Curzon Press.

Southeast Asian Studies, Vol. 47, No. 3, December 2009

Dynamics of Land Cover and Land Use Changes in the Upper Ca River Basin of Nghe An, Vietnam

Stephen J. Leisz*

Abstract

This paper draws on four hamlet case studies and a broader three district study to identify land cover and land use changes in the upper Ca River Basin of Nghe An Province and the possible trigger events that are influencing land cover and land use changes. The study uses two chronosequences of Landsat TM and ETM+ imagery, from 1989 to 1993 and from 2000 to 2003, to classify the land cover and land use for the larger study area and for the hamlet study areas. This information is combined with socio-economic data that was collected at the district and hamlet level in a series of field studies carried out from 1997 to 2003. Results show that areas of mature tree cover have expanded, the area devoted to long-term swidden/fallow land use has decreased and the area under permanent agriculture and short fallow swidden systems have increased, across both of the scales studied. The analysis indicates that a forest transition is taking place at the broader three district level and also within the four hamlet case study areas. Two trigger events are identified that may have helped initiate the forest transition. One is the agriculture and forest land allocation programs that were initiated in the districts and in three of the four hamlets during the 1990s and early 2000s and the second is market influences that appear to be linked to the increase in cattle and pig raising in the case study hamlets.

Keywords: land cover, land use, forest transition, deforestation, swidden/fallow, Vietnam, land allocation

Introduction

Deforestation in Vietnam

Official statistics and maps of Vietnam suggest that from 1943 to the mid-1990s Vietnam had some of the highest deforestation rates in the world and lost much of its forest cover. Officially, in 1943 43.2% of Vietnam was covered by forest [Nguyen 1999; Vo and Le Thac 1994]. By 1990 government statistics show that forest cover in the country had shrunk to 28.8%. Statistics show that deforestation continued into the mid- and even late 1990s [De Koninck 1999], but by the late 1990s and early 2000s forest

* Department of Anthropology, Colorado State University, Fort Collins, Colorado, U.S.A.
e-mail: steve_leisz@yahoo.com

cover started to recover. During this time statistics show forest cover expanding at annual rates of up to 2% [De Jong *et al.* 2006]. However, while statistics show forest cover recovering overall, not all forest cover types are recovering to the same extent or even expanding. The Global Forest Resources Assessment 2005 [FAO 2005] shows that overall, Vietnam's forests have increased in size from 9,363,000 ha in 1990, to 11,725,000 ha in 2000 and 12,931,000 ha in 2005. In contrast, the area under primary or natural untouched forest has continued its decrease from 384,000 ha in 1990 to 187,000 ha in 2000, to 85,000 ha in 2005. This suggests that all of the forest transition taking place in Vietnam is in the form of planted forest, or human managed forest, and that primary or natural forest is under increased pressure.

The government places almost all of the blame for deforestation in the mountains, where most of the remaining primary forest is, on the swidden/fallow farming system that is found there [Dang 1991; Do 1994; Morrison and Dubois 1998; Tachibana *et al.* 2001; Castella *et al.* 2006]. Others question this and suggest that the blame for deforestation rests with certain state policies that have encouraged the migration of lowland people to the uplands and with other state supported practices in the past, such as logging, and in the present, such as the promotion of tree plantations for pulp, and promoting plantation tree crops such as coffee, tea, pepper plantations, and other fruit trees [Poffenberger *et al.* 1997; De Koninck 1999; Lang 2001; 2002; D'haeze *et al.* 2005]. In contrast, the forest transition that is observed to be taking place is believed to have been triggered by government policies, most notably the agriculture and forest land allocation policies that were promulgated in the uplands during the 1990s and early 2000s [Sikor 2001; Tachibana *et al.* 2001; Castella and Quang 2002; Meyfroidt and Lambin 2008]. This paper investigates land cover and land use changes in three mountainous districts of Nghe An Province during the reported forest transition period (from 1989 to 2003). It investigates patterns of both land cover and land use change at two scales: at the broad district level scale in three districts, and at a fine, hamlet level scale, in four hamlet case studies. The paper also attempts to identify the trigger events that have led to the changes in land cover and land use that are identified.

The mountains in the upper Ca River Basin offer a good proxy for the overall situation found in Vietnam's uplands during the late 1980s through the early 2000s. The dominant land use system in the uplands, including Nghe An's uplands, has historically been based on medium to long rotation swidden/fallow systems. The study area has been the home to a number of state forest enterprises since the 1960s. The area has also been the focus of recent land allocation and reforestation programs. Finally, the area is the home to one of the largest remaining areas of primary forest in Vietnam. Focusing on the upper Ca River Basin, this paper overviews the land cover and land use situation in the three districts, and then focuses on four specific case studies. The changing socio-economic and legal situation

vis-à-vis the dominant farming systems and land use management systems is reviewed. Land use/cover changes are documented through interviews with key district level and hamlet level informants and through the analysis of satellite imagery for eight of the fifteen years studied. Finally, the trends in driving forces behind, and trigger events of land use changes for each case study, are identified as well as for the larger three district area.

Study Area and Case Study Sites

Study Area: Con Cuong, Tuong Duong, Ky Son Districts

The upper Ca River Basin runs through Nghe An Province in north central Vietnam. Nghe An is one of the poorest provinces in the country and the three districts of Con Cuong, Tuong Duong, and Ky Son in the upper reaches of the Ca River, in western Nghe An along the border with Laos, are the poorest districts within the province. These districts also encompass some of the best remaining forest area in northern Vietnam and are home to a variety of ethnic minorities including H'mong, Thai, and Kho Mu. Fig. 1 shows the location of the province, the three districts focused on in this article, and the four case study site locations.

The topography of the districts varies from flat valley plains to steep mountains. In Con Cuong and Tuong Duong the valley plains change progressively to rolling hills and steeper mountains as one travels south and north of the river. The annual mean temperature is between 22 and 24 degrees Celsius with highs of 40 degrees during the months of June, July and August and lows of 5 degrees during the months of December, January, and February. These temperatures vary significantly as one travels away from the river and climbs into the mountains. Average yearly rainfall is 1,500 mm, and average humidity is between 80% and 85%.

The transportation network in the study area is dominated by one all-season, paved, road, National Highway 7, which runs parallel to the Ca River, and by the river and stream system. Besides the national highway there are many all season, paved and gravel covered roads that run north and south away from the river. Many of these have been either upgraded from seasonal roads, or newly built from the mid-1990s to present. The river and stream system is also used extensively for transportation. Some of the hamlets north of the river are only accessible by walking paths or by river travel. In these areas river travel via motorized boats has been increasingly popular since the mid-1990s.

The livelihood systems found in the study area are dominated by agriculture. Farming systems vary in the province from subsistence long rotation swidden/fallow systems (fallow periods greater than 10 years) in the uplands near the Laos border, to medium rotation swidden/fallow systems (fallow periods

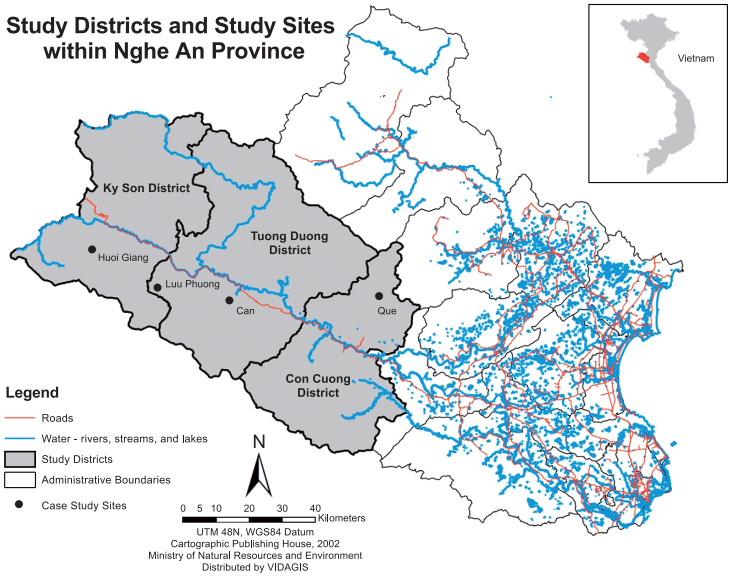


Fig. 1　Case Study Districts and Locations within Nghe An Province

between 5 and 10 years) further east in the study area. Intensive irrigated paddy and agriculture and plantation forestry is also found in the lowland parts of the river basin in the study area, mainly in Con Coung District.

During the late 1980s and early 1990s forestlands and upland management were reformed across the nation and upland/forestland allocation was carried out. In 1993 the government extended the 1988 land law into the uplands [Ahlback 1995; MAFI 1993; Sikor 1995; De Koninck 1999] allocating forestland in the same manner as agricultural land was allocated both in the lowlands and in the uplands. In 1993 the government implemented the Law for the Protection and Development of Forests, formalizing a new process for allocating rights to forestland based on the willingness of households to plant trees [Gomeiro *et al.* 2000]. The 1993 law was modified by Decree No 85/1999/ND-CP in 1999 [Socialist Republic of Vietnam 1999], allowing, according to some interpretations, for the allocation of sloping land for agricultural purposes if the land had been used for agriculture in the past. In the three district study areas and in each of the case study sites, however, similar to other reports [Sikor 1995; 2004; Sowerine 2004; Vien *et al.* 2005], local variability in the application of forestland and upland allocation at the district, commune, and hamlet levels were analyzed and one is thus not able to generalize regarding the amount of land that was allocated for use per household.

Case Study Sites: Que, Can, Luu Phuong, and Huoi Giang Hamlets

Que hamlet is located within the buffer zone of Pu Huong Nature Reserve and is accessible year-round by motorcycle and four-wheel drive vehicles via hard-pack dirt road. There is little flat land in the hamlet and traditionally a rotational swidden system was practiced. In 1998 4 ha of flatland were converted to paddy area with support from district officials. Allocation of both paddy and upland areas was done in 1998. Rather than allocate upland areas to individual households the upland area was allocated to the hamlet and the hamlet authorities then re-allocated it to households based on calculated household cultivation needs. Upland agricultural fields are officially limited to the southeast section of the hamlet's territory where the commune authorities stipulated 16 ha should be cultivated yearly with a rotation cycle of five years. However, the hamlet leader stated that the area cultivated each year is closer to 60 ha, since most households need to plant approximately 1.5 ha of land in order to produce enough rice for consumption [Jakobsen *et al.* 2007]. Today, with the development of paddy fields and the limitation on upland agriculture the farming system has started to move towards a composite swidden system [Rambo 1998]. Animal husbandry is practiced, but is limited in the hamlet.

Can hamlet is located within the Pu Mat National Park buffer zone and accessible from the main road via a 2 km all-season hard-pack dirt road. It is located in an open valley surrounded by hills that turn to mountains as one moves south towards the National Park. The farming system is a composite swidden system that has both irrigated paddy and upland rotational swidden fields. Land allocation of paddy fields was first done in 1987/88. Upland forest and field areas were allocated in 1996/97. Paddy and upland fields were reallocated in 1999 and 2002/03 respectively. Each land allocation exercise has been externally funded by the European Union's "Pu Mat National Park Social Forestry and Nature Conservation Project." The allocation of upland forest and field areas included the delineation of areas in the uplands that can officially be used for upland cultivation purposes. Animal husbandry is practiced and district extension officers support the hamlet's pig raising efforts. Following land allocation, the raising of cattle is limited due to conflicts over cattle damage to crops, a situation that led to a hamlet regulation limiting cattle raising. Buffalo are mainly raised as draft animals although some are raised for the market. Due to proximity to Pu Mat National Park, and inclusion in an European Union funded project, the hamlet has drawn attention from both national and local officials resulting in environmental and land allocation/tenure regulations being implemented at an earlier date than has been the case in surrounding hamlets. The regulations have also been strictly enforced.

Luu Phuong hamlet is located on an all season hard-pack dirt road. The hamlet's center is in a wide valley surrounded by rolling hills. The valley has been transformed into bunded rice paddies. For as

Table 1 Basic Information for Each Hamlet Studied for 2003/04

Hamlet Name	Que	Can	Luu Phuong	Huoi Giang
Commune/District	Binh Chuan, Con Cuong	Tam Thai, Tuong Duong	Luu Kien, Tuong Duong	Tay Son, Ky Son
Population	409 (69 households)	835 (183 households)	751 (147 households)	891 (103 households)
Ethnicity	Thai	Thai	Thai	H'Mong
Year of land allocation	1998	1987–88 (rice paddy, periodically re-allocated by family need); 1996/97 Pu Mat buffer zone established —— limitations on upland fields near core area. 1999 green book for forest land; 2002/03 upland areas (agriculture and forest land) reallocated	2001/02 (upland agriculture land); 1996 (rice paddy area to 110 households)	No land allocation
Area allocated	80 ha uplands; 4 ha rice paddy	80 ha uplands; 27.5 ha rice paddy	50 ha uplands; 47 ha rice paddy	N/A
Distance from district town/main market*	35 km	10 km	15 km	12 km
Transportation route	Improved-unpaved hard-pack road	Improved-unpaved hard-pack road (2 km); asphalt road (8 km)	Improved-unpaved hard-pack road (8 km); asphalt road (7 km)	Improved-unpaved hard-pack road
Type of transportation between hamlet and district town	Motorcycle	Motorcycle; bicycle; walking	Motorcycle; small truck; walking	Motorcycle; walking
Travel time to district town (minutes)	60–120	20–60	30–120	45 minutes (motorcycle); 2 to 3 hours (walking)

Source: fieldnotes

Note: * The main market is in the district town.

long as anyone can remember a composite swidden farming system has been practiced. In 1996 land allocation of the paddy area took place. Reallocation of paddy fields was redone in 2000/01, when upland field areas were also allocated. The upland area that can officially be used for swidden farming is restricted to two small valleys that enter the main valley from the north. It is reported that fallow periods have decreased. In 2000/01 the road was improved and connection to the market improved. Families with paddy land raise two rice crops when water is available. Both pig raising and cattle raising are popular in the hamlet. Pigs are generally raised in pig sties, while cattle are left to wander in the forests. Cattle owners leave salt out at their houses to encourage their cattle to return every few days to their house to lick the salt. In recent years cattle raising for the market has increased.[1)]

Huoi Giang hamlet is divided into upper, middle, and lower hamlet sectors based on their distribution along the road. The district recognizes these as three separate administrative hamlets with separate administrative officials, but locally there are no recognized borders between the hamlets, agriculture land is intermixed, and the three share customary hamlet leaders. The hamlet is located on a hard-pack dirt road in the mountains about 12 km south of, and 1,000 m higher than, Muong Sen, Ky Son's district town. The livelihood system of the hamlet is based on a long-fallow rotational swidden system. Corn and rice are the main crops. Fields are cultivated for three years, the first in rice, the second with rice or corn, and the third with cassava. Fields are fallowed for up to 20 years, but often for only 10 years. The hamlet was a nomadic hamlet until approximately 55 years ago when the French administrators built the road and the households started to move to roadside locations. Livestock raising is popular. Some pigs are raised, but the main livestock activity is cattle rearing for market. Cattle are left to wander in the forests until three to six months before they are to be sold, and then they are penned and fed forage that is especially raised in fields. Some households have taken advantage of the availability of district funds to hire lowland *Kinh* laborers, who are familiar with wet paddy cultivation and terrace construction, to build terraces for them. However, the terraces are not cultivated as water resources are not sufficient for wet paddy cultivation.

Methods

A variety of methods were used in this research to collect socio-economic data. Semi-structured and

1) Informants report that lowland cattle buyers from Vinh City, Hanoi, and Ho Chi Minh City started visiting hamlets in the late 1990s. They contract with farmers to bring cattle to the district capital on a fixed date and give the farmer a down payment for the cattle. The farmers drive the cattle to district capital on the agreed date and the buyer pays the remainder for the cattle.

structured interviews at district, commune and hamlet level with a focus on hamlet-level livelihoods, farming systems, land tenure rules and forest tenure rules were carried out. Land administration and forest protection personnel were interviewed at the district level; commune chairmen, vice chairmen, and land administration personnel were interviewed; and hamlet leaders and farmers were interviewed regarding land allocation procedures, reliance on customary tenure systems, hamlet and household livelihood systems, and farming systems. A structured questionnaire covering these topics was administered to 30 randomly chosen households in each hamlet. Historical socio-economic and demographic data were collected from records kept at the district and commune headquarters and from focused interviews with hamlet informants who were chosen for their knowledge of specific subjects (e.g. hamlet headmen and party leaders regarding hamlet history, boundaries, demography, administration, tenure systems, conflict resolution, farming systems, land cover and land use; agriculture officers regarding farming systems, agricultural crops, soil conditions, land cover and land use; older residents for their knowledge of hamlet histories; traditional healers for their knowledge of forest products and changes in plant communities over time, etc.).

Land cover and land use information, as well as information for ground truthing the satellite image interpretations, was collected in the following ways. Transects were walked to better understand the types and distribution of land cover and the land use in each hamlet. Field and hamlet boundaries were measured using GPS receivers, tape measures, and compasses. Detailed information on agriculture field productivity was gathered through interviews and measurements in the field. Post-fieldwork Landsat TM and ETM+ images were classified into upland agriculture fields, paddy, and fallow regrowth land cover types for the years 1989, 1991, 1992, 1993, 1998, 2000, 2001, 2002, and 2003. This was done by first level slicing normalized differential vegetation indexes and infra-red indexes for each year and then setting thresholds that most accurately delineated the upland fields and wet paddy areas from areas that were covered with other types of vegetation. Fallow and forest land cover types were derived from year-on-year chronosequence analysis of images combined with a supervised classification of the images. All results were checked against a total of over 400 ground truth points collected in 1998, 1999, 2000, 2001, 2003, and 2004. Classification accuracy for the upland fields and paddy areas are greater than 90% for each year. Fallow areas were mapped at greater than 80% accuracy. A full discussion of the methods used is found in Leisz [2007].

Results

Study Area Socio-economic Changes

From the early 1990s to the early 2000s the socio-economic situation in the three district study area changed in many ways. According to the national census records available population grew overall in the study area from the 1989 to the 1999 census by 5.27% (Table 2). This rate of population increase is lower than for the province of Nghe An and for the nation as a whole, which for the same period were 18.62% and 17.60% respectively [Socialist Republic of Vietnam 2001]. However, when the increase is looked at by district, it is clear that the two districts with the best road access, Con Cuong and Tuong Duong, are also those districts that appear to have had the lowest population increase over this time period, 1.53% and 0.42%, while the most remote district, Ky Son, has the highest population increase, 17.04%, and is roughly at the national average for this time period.

There are several possible reasons for the low population growth rate in Con Cuong and Tuong Duong. One may be that during this time there were some dramatic changes in these two districts that influenced people to move away from the districts or that allowed them to more freely leave the districts. One of these was that the forest enterprises closed down, and many of the workers associated with those industries, who were of Kinh ethnicity, appear to have left. Second, the government stopped its policy of sponsoring the resettlement of Kinh lowlanders to the uplands, and indeed there is anecdotal evidence that some of those who had been resettled in Con Cuong and Tuong Duong in the 1970s and 1980s left the uplands and returned to the lowlands, or even migrated to the central highlands. Finally, there is the possibility that the 1989 census numbers are just wrong. During the 1989 census there were not many resources available for carrying out the census and it is plausible that some remote areas where not actually counted in the estimate, but rather were estimated.

An examination of the population data on a commune by commune basis shows that there are a number of communes in Con Cuong and Tuong Duong District that lost large amounts of population. Some of these are easily explainable. Examples are Kim Tien Commune in Tuong Duong, which is

Table 2 Population Change in the Study Area Districts

District	1989 Pop	1999 Pop	Pop Change	% Change
Con Cuong	61,747	62,691	944	1.53
Tuong Duong	68,769	69,061	292	0.42
Ky Son	47,881	56,042	8,161	17.04
Overall	178,397	187,794	9,397	5.27

Source: Socialist Republic of Vietnam, General Statistics Office, 2001

going to be flooded when a dam is constructed there and people were already being resettled from the commune as early as the late 1990s; and Tam Thai Commune, also in Tuong Duong, which is in the buffer zone of Pu Mat National Park and had hamlets resettled out of the buffer zone, and out of the commune. Others, such as Cam Lam Commune in Con Cuong, which is on a good road with a large amount of agriculture land, are not as easily explainable, but may have lost population due to rural to urban migration, which has been seen in other parts of Vietnam [Pham and Hill 2008].

Other changes which have taken place in the study area include changes in land tenure laws, which were described in the previous section describing the study area and case study sites. Land titling of lowland areas was undertaken during the period between 1993 and 2003 and forestland and agricultural allocation in the uplands was started, and in many cases completed, during this time. Transportation routes were improved and new roads were built: National Route 7 was repaved and widened, but only through Tuong Duong District, and small feeder roads north and south of the river were paved and turned into all season roads, again mostly in Con Cuong and Tuong Duong districts. Water transportation also became more reliable as motorized boats started to ply the river in greater numbers. Market forces for certain agricultural products were also felt in the districts as livestock traders from the lowlands started to come into the districts to source and buy cattle, and in some cases pigs, for the growing beef and pork market in the lowland. As a result livestock raising expanded in all of the districts studied.

Study Area Land Cover and Land Use Changes

Fig. 2 visually illustrates how land cover in the study area changed during the period from 1993 to 2003. The quality of the tree cover increased from 1993, when there were 107,488 ha of mature (near primary) trees, to 2003, when 267,531 ha of mature trees where identified, an increase of 160,043 ha. However, overall natural tree cover decreased from 493,544 ha to 450,162 ha (Table 3) between 1993 and 2003, a decrease of 43,382 ha. The reason for the overall decrease in natural tree cover area is that from 1993 to 2003 there was a decrease in transitional tree cover area, a land cover that is usually associated with fallow land use. While some of this area became mature tree cover, a large amount of the area that had been transitional tree cover became covered with bush, grass and small tree land cover in 2003 as this land cover category increased in size by 18,363 ha. Also a large area of the 1993 transitional tree cover was converted to new agriculture field area in 2003. The area covered by the cultivated crop land cover class increased by 24,239 ha between the 1993 and 2003 land cover maps. Residential and built up land cover areas increased in spatial extent by 780 ha between 1993 and 2003.

Change in land cover can also be displayed as a change in land use for the study area. This article

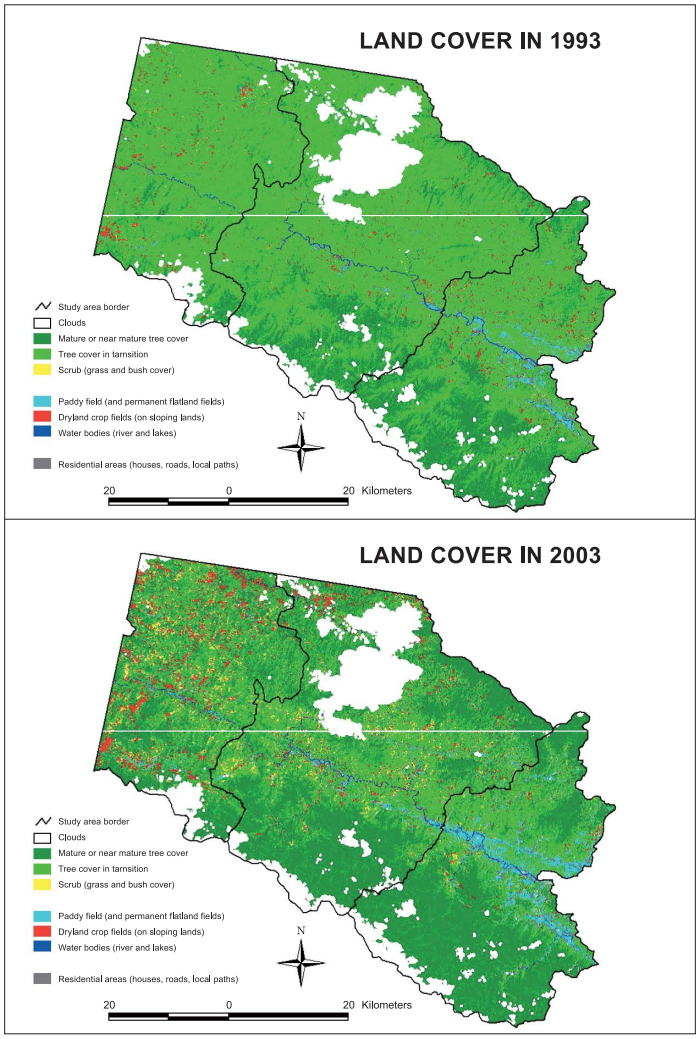


Fig. 2 Land Cover in the Study Area 1993 and 2003

Source of imagery [before analysis]: www.usgs.gov/pubprod/aerial.html

Note: The land cover analysis does not cover all of the three districts due to limitations of the Landsat Imagery that is available.

attempts to graphically differentiate between land use and land cover. Land cover as described in the previous section is the type of vegetation or other natural covering (e.g. water, rocks, bare dirt) or manmade cover (e.g. pavement, built structures) covering the surface of the study area. Land use considers if the land has been used by humans for agriculture regardless of whether agriculture is currently being practiced on it; if the land is not actively managed by humans, e.g. natural water areas or non-managed natural forest areas; or used as residential land by humans. Land use is mapped by

Table 3　Land Cover Changes in the Study area 1993 to 2003 Land Cover Maps

Land Cover Category	Land Cover in 1993 (ha)	Land Cover in 2003 (ha)	Change: 1993 to 2003 (ha/%)
Total Natural Tree Cover	493,544	450,162	–43,382/–9%
Tree cover: Natural, Mature (or near mature; possibly including trees regrowing in long-fallow areas)	107,488	267,531	160,043/149%
Tree cover: Natural, in transition from herbaceous to tree dominated	386,056	182,631	–203,425/–53%
Total Herbaceous Cover	4,143	22,506	18,363/443%
Herbaceous dominated: Scrub (grass, bush, few small trees)	4,143	22,506	18,363/443%
Total Agricultural Crop Cover	21,463	45,702	24,239/113%
Human planted: Paddy fields/cultivated flat land	7,580	20,445	12,865/170%
Human planted: Sloping cultivated fields	13,883	25,257	11,374/82%
Other Land Cover	10,379	11,159	780/7.5%
Water	2,057	2,057	0
Other —— human (residential/built land)	8,322	9,102	780/9%
Total area	529,529	529,529	0

considering the type of land cover and whether that land cover is associated with human activities or not, and if so, what type of activities it is associated with. For the purposes of this analysis the following land cover types indicate human land use: residential land cover indicates residential land use; land cover indicating that an area was cultivated during at least one of the years when the image classifications were done indicates either permanent cultivated agricultural land use (e.g. land is cultivated on a yearly basis) or intermittent cultivated agricultural land use (e.g. swidden/fallow land use); and land cover consisting of vegetation that is known to be associated with fallow land indicates swidden/fallow land use. Water and tree cover, which was not cleared during the respective five year image chronosequence classifications, are considered non-human land use areas (e.g. natural water areas and natural forest areas). Table 4 details the relationship between the land cover categories and the land use types and Fig. 3 illustrates the results of mapping the study area for land use.

As indicated in the previous section on land cover, mature natural forest areas increased in size, indicating that natural forest area land use increased in size (Table 5). From 1993 to 2003 natural forest area land use expanded into parts of the study area that had previously been used as fallow land in the rotational swidden/fallow agriculture system found in the study area. Area devoted to agriculture land use correspondingly decreased. However, indications are that shorter term swidden-fallow land use systems expanded, indicated by the increase in areas where there was at least one-year of an active field identified during the second five year image chronosequence. Also, areas of permanent cultivated

Table 4 Land Use Categories and the Associated Land Cover Types

Associated Land Use	Land Cover Type	Comment
Forest land use	Mature or near mature tree cover	This land cover type is only classified as forest land use if it is mature or near mature tree cover during the whole chronosequence of the satellite images.
Agricultural land use: swidden/fallow system land	Tree cover in transition Scrub Dryland crop fields (on sloping lands)	Tree cover in transition and scrub (grass and bush) are synonymous with vegetation growing back in areas that have been cleared for upland fields; dryland crop fields are indicative of swidden/fallow systems if they are not cleared in all of the chronosequence images for each time period.
Agricultural land use: permanent agriculture land	Dryland crop fields (on sloping lands) Paddy fields	Dryland crop fields are considered permanent if they are classified as cleared land in all of the chronosequence images for each time period; paddy is considered permanent agriculture land.
Other land use: residential land use	Residential areas	Areas with land cover associated with residential land use (buildings, roads, etc.)
Other land use: water	Water	Lake, river, and stream areas.

Table 5 Land Use Change in the Study Area during the Chronosequence Periods: 1989 to 1993 and 2000 to 20003

Land Use Type	Period: 1989 to 1993 (ha)	Period: 2000 to 2003 (ha)	Change (ha/%)
Forest land use: mature tree cover on the area for the chronosequence period*	224,419	266,740	42,175/19%
Agricultural land use	294,653	251,366	43,287/–15%
Swidden/Fallow System Land: fallow field during chronosequence period	261,296	160,508	–100,788/–39%
Swidden/Fallow System Land: active swidden field during at least 1 year of chronosequence period	25,855	70,486	44,631/173%
Permanent Agriculture Land (classified as paddy or other cultivated flat land for all years of chronosequence period)	7,502	20,372	13,202/174%
Other land use			
Residential Land	8,322	8,956	780/9%
Water	2,135	2,467	0
Total area	529,529	529,529	0

Note: * Does not include all areas of 'near mature' trees that are included in mature tree land cover.

fields (e.g. areas cultivated at least one time per year on a yearly basis), in other words, permanent agriculture land use, increased from the 1989–93 period to the 2000–03 period. Residential land use also increased between the two time periods.

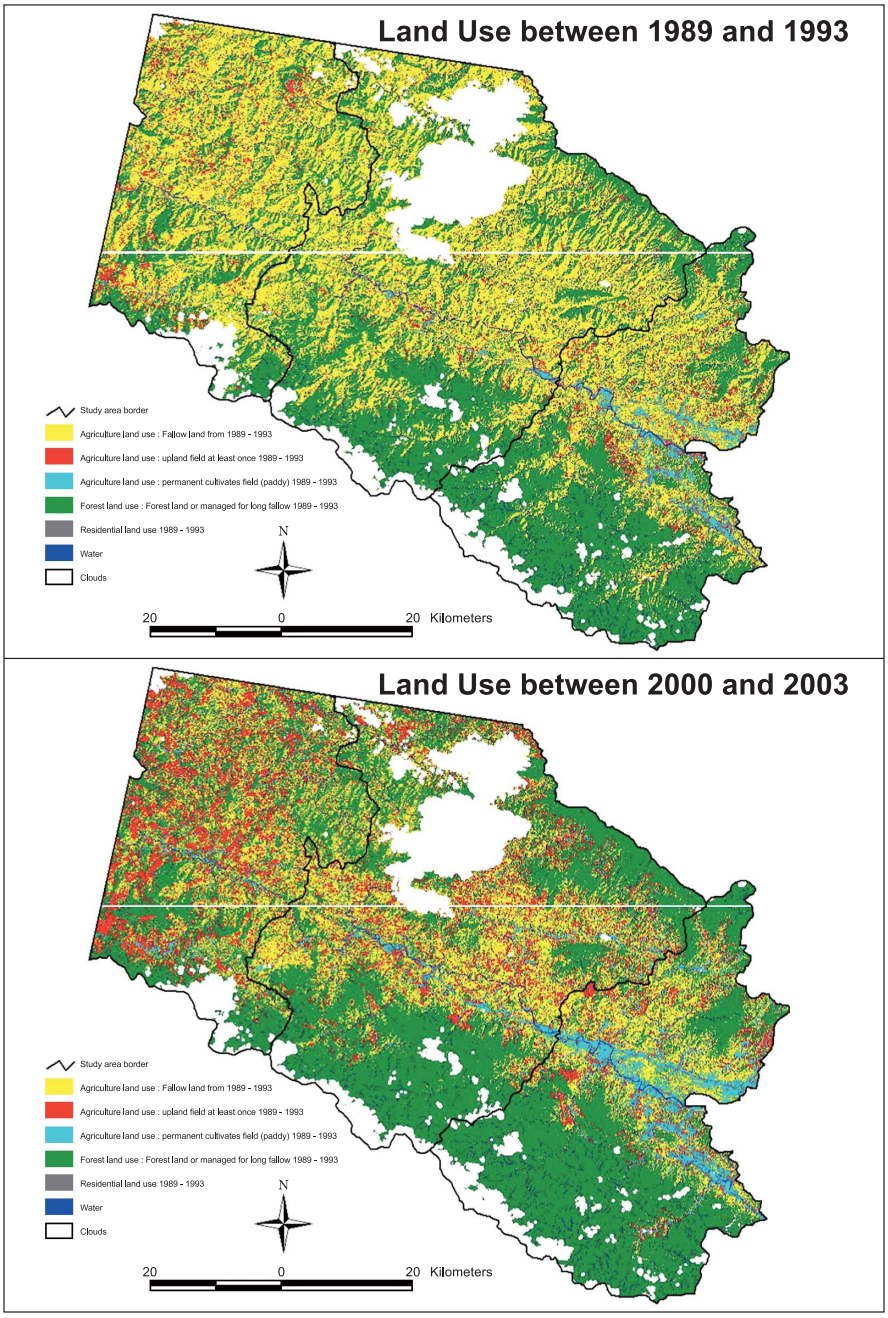


Fig. 3　Land Use in the Study Area 1989 to 1993 and 2000 to 2003

Source of imagery [before analysis]: www.usgs.gov/pubprod/aerial.html

Note: The land use analysis does not cover all of the three districts due to limitations of the Landsat Imagery that is available.

Table 6 Population Changes in Case Study Hamlets

Hamlet	Population 1993 (at or around)	2003 (at or around)	% Change
Que	320	409	27.8
Can	675	835	23.7
Luu Phuong	554	751	35.6
Huoi Giang	832	891	7.1

Source: Fieldnotes/hamlet interviews.

Case Studies: Socio-economic, Land Cover and Land Use Changes

In general, the socio-economic changes in each of the case study hamlets mirror the overall three district study area's changes. Population in each hamlet increased during the 10 year study period, but to different extents (Table 6). Transportation routes between National Route 7 and each of the hamlets were improved, but none of them are connected to the main market by paved road. Changes in land tenure and in the way land allocation was implemented in the hamlets are the most varied. Three of them, Que, Can, and Luu Phuong, all had land allocation of both paddy fields and upland areas (forestland allocation and upland agriculture land allocation) take place by 2003. However, Huoi Giang has had no land allocation done within its territory. Two of the hamlets, Luu Phuong and Huoi Giang, report that they have expanded their cattle rearing efforts and attribute the expansion to market demand. One, Can hamlet, has expanded pig raising, but not cattle raising. Que hamlet originally expanded cattle raising, but in the early 2000s had to scale back on these efforts due to the scarcity of financial resources within the hamlet that are needed to start, or in their case, replenish, a herd.

Land cover and land use changes in each of the hamlets mirror the broader, smaller scale, changes in the three district study area. Fig. 4 shows the changes in land cover for each hamlet and Fig. 5 shows changes in land use for each of the hamlets.

All of the hamlets' exhibit land cover changes and land use changes that reflect the overall changes in the three district study area (Tables 3 and 4). In general land cover in each shows a pattern of decreased area under transition tree cover, while mature, or near mature tree cover has increased and land cover associated with both permanent and swidden agriculture has increased (Table 7).

Land use change patterns in each of the hamlets also mirror the larger study area's patterns. Areas of land cover associated with natural forest area land use have increased. Long-term fallow areas have decreased, while shorter-term fallow, permanently cultivated areas, and residential land use areas have increased in size (Table 8).

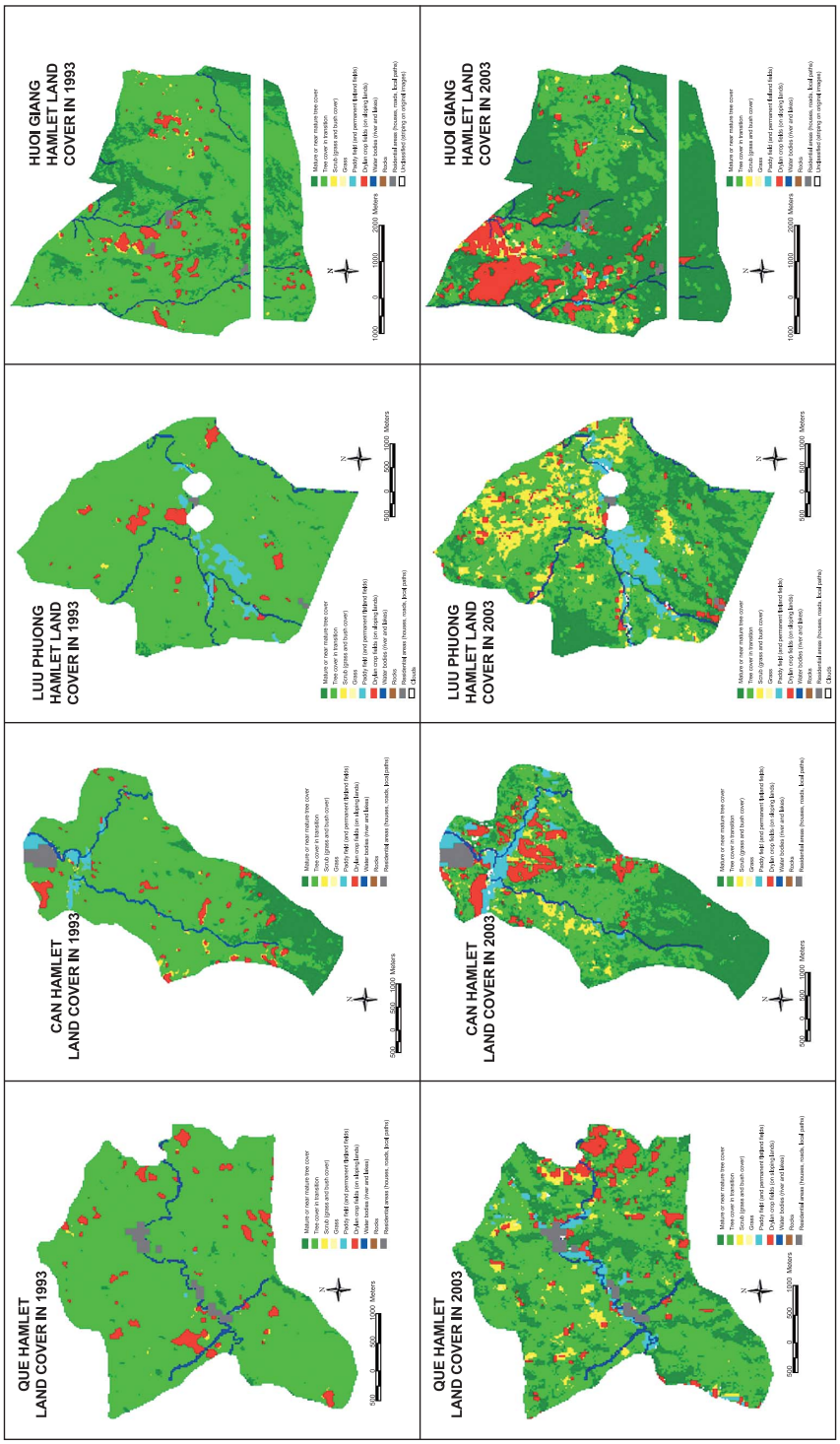


Fig. 4　Land Cover in Four Case Study Areas 1993 and 2003

Source of imagery [before analysis]: www.usgs.gov/pubprod/aerial.html

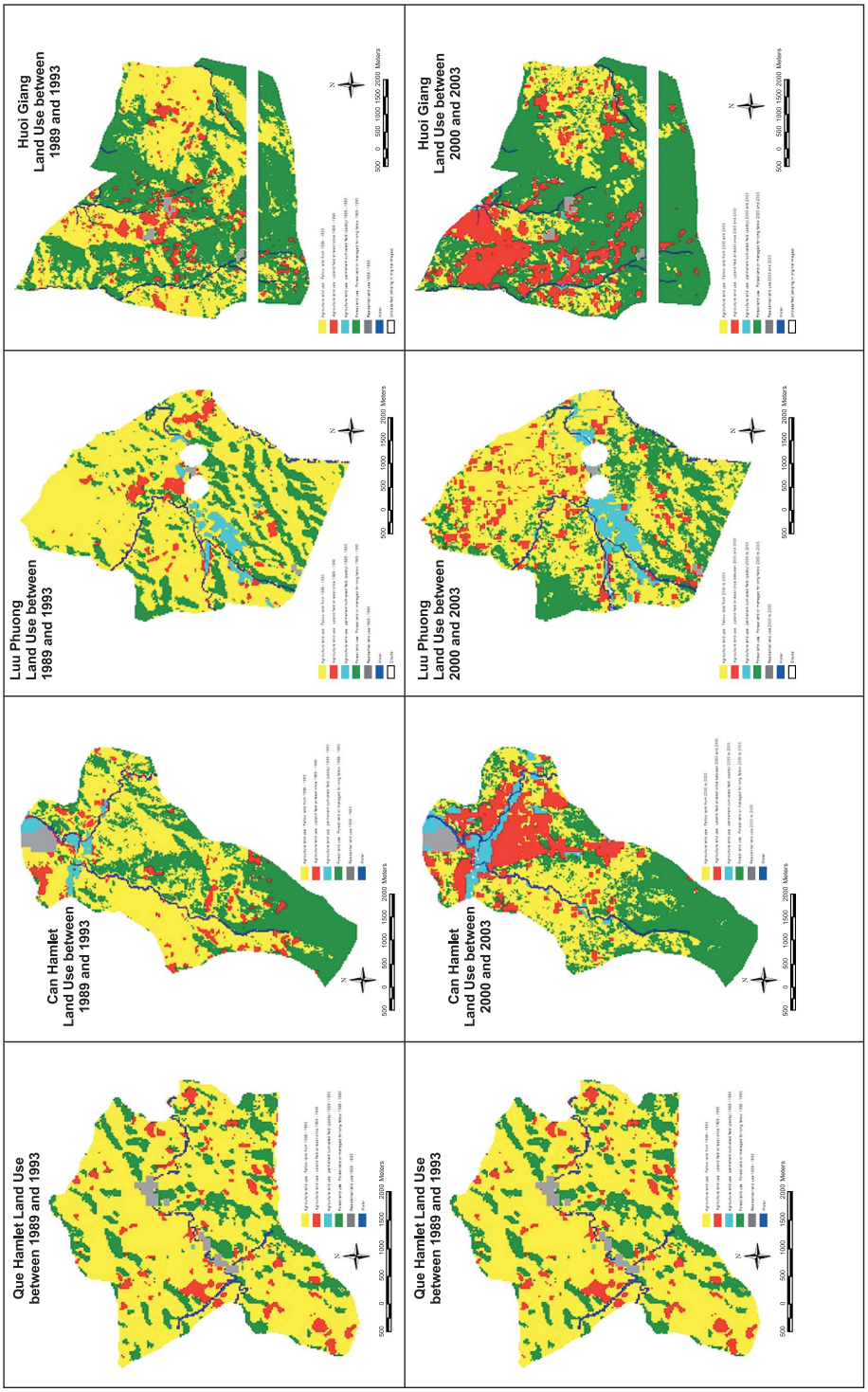


Fig. 5 Land Use in Four Case Study Areas 1993 and 2003

Source of imagery [before analysis]: www.usgs.gov/pubprod/aerial.html

Table 7 Hamlet Case Study Land Cover Change from 1993 to 2003 Land Cover Maps

Land Cover Category	Que Hamlet			Can Hamlet			Luu Phuong Hamlet			Huoi Giang Hamlet		
	1993 (ha)	2003 (ha)	Change (ha)	1993 (ha)	2003 (ha)	Change (ha)	1993 (ha)	2003 (ha)	Change (ha)	1993 (ha)	2003 (ha)	Change (ha)
Tree cover: Natural, Mature (or near mature; possibly including trees regrowing in long-fallow areas)	23	354	331	260	646	386	23	519	496	686	2,286	1,600
Tree cover: Natural, in transition from herbaceous to tree dominated	1,478	1,000	–478	1,289	704	–585	1,859	1,016	–843	2,935	1,013	–1,922
Total Natural Tree Cover	1,501	1,354	–147	1,549	1,350	–199	1,882	1,535	–347	3,621	3,299	–322
Herbaceous dominated: Scrub (grass, bush, few small trees)	3	63	60	19	80	61	6	291	285	29	102	73
Total Herbaceous Cover	3	63	60	19	80	61	6	291	285	29	102	73
Human planted: Paddy fields/cultivated flat land	1	36	35	39	97	58	61	110	49	0	14	14
Human planted: Sloping cultivated fields	69	109	40	68	156	88	56	63	7	169	418	249
Total Agricultural Crop Cover	70	145	75	107	253	146	117	173	56	169	432	263
Other —— human (residential/built land)	28	31	3	32	31	–1	7	8	1	25	27	2
Unclassified (clouds, striping)							43	48		228	212	
Total	1,602	1,593		1,707	1,714		2,055	2,055		4,072	4,072	

Table 8 Hamlet Case Study Land Use Change during the Two Chronosequence Periods

Land Use Type	Que Hamlet			Can Hamlet			Luu Phuong Hamlet			Huoi Giang Hamlet		
	1989 to 1993 (ha)	2000 to 2003 (ha)	Change (ha)	1989 to 1993 (ha)	2000 to 2003 (ha)	Change (ha)	1989 to 1993 (ha)	2000 to 2003 (ha)	Change (ha)	1989 to 1993 (ha)	2000 to 2003 (ha)	Change (ha)
Forest land use: mature tree cover on the area for the chronosequence period	309	353	44	628	631	3	412	520	108	1,849	2,300	451
Agricultural land use	1,265	1,209	–56	1,047	1,052	5	1,593	1,479	–114	1,970	1,533	–437
Swidden/Fallow System Land: fallow field during chronosequence period	1,154	903	–251	896	624	–272	1,440	1,189	–251	1,703	837	–866
Swidden/Fallow System Land: active swidden field during at least 1 year of chrono-sequence period	110	290	180	112	331	219	92	180	88	267	681	414
Permanent Agriculture Land	1	16	15	39	97	58	61	110	49	0	15	15
Other land use												
Residential or built up land	28	31	3	32	31	–1	7	8	1	25	27	2
Unclassified							43	48		228	212	
Total	1,602	1,593		1,707	1,714		2,055	2,055		4,072	4,072	

Discussion and Conclusion: Driving Forces, Trends, and Trigger Events

The socio-economic trends in the three district study area and in the case study sites all point in the same direction. Overall the population is growing and the hamlets are becoming more connected to the market. Correspondingly, the market is having an effect on what the hamlets produce, as all the hamlet case studies indicate that there has been an increase in the production of livestock, either pigs or cattle, for the market at the hamlet level. Land allocation of both agricultural land and forest land has been carried out in three of the case study hamlets, and district officials in all three districts report that this policy will continue to be implemented.

Changes in land cover and land use across the three district study area and within the case study hamlets show similar, though complex, trends. Older, mature, tree cover is increasing in extent of area covered, while transitional tree cover is decreasing, herbaceous land covers are increasing in area extent, and agricultural crop cover is increasing in areal extent. Land use patterns mirror these trends. Area devoted to natural forest land use, shorter-rotation swidden/fallow land use, and permanent agriculture land use have all increased, while areas devoted to longer duration fallow land use have decreased in size. These trends in observed land cover changes versus observed land use changes send a mixed signal. If the land cover changes are only considered, then one is led to believe that a forest transition [Mather 1992] is not taking place in Vietnam. If the land use changes are considered one is led to the opposite conclusion, a conclusion that is in line with other researchers [Meyfroidt and Lambin 2008], since land use changes indicate that more land is being devoted to natural forest land use than in the past, e.g. land use in the study area is transitioning to forest land use. A detailing of the evidence for the forest transition hypothesis in the study area follows:

– An increase in the incidence of shortened fallow periods, or no fallow periods, associated with upland agriculture land use for all of the hamlets. This is seen in the change in the size of upland areas that are cleared for at least one year during the respective chronosequence of images. For the study area overall there is a 173% increase in this land use category from the first to the second period. For the case study sites increases are: Que 180 ha increase; Can 219 ha increase; Luu Phuong 88 ha increase; Huoi Giang 414 ha increase.

– An increase in the area devoted to permanent agriculture land use. For the overall study area this category of land use increased by 174% from the 1989–93 period to the 2000–03 period. For the case study sites changes in this land use category are: Que 15 ha increase; Can 58 ha increase; Luu Phuong 49 ha increase; Huoi Giang 15 ha increase.

– An increase in the area devoted to forest land use. For the study area overall this category of land use increased by 19%. For the case study sites changes in this land use category are: Que 44 ha increase; Can 3 ha increase; Luu Phuong 108 ha increase; Huoi Giang 451 ha increase.

– A decrease in long-term fallow land use. This decrease is indicated by the change in the amount of land found in the land use category "swidden/fallow system land: fallow field during chrono-sequence," which is a category that would include mostly, or wholly, long-term fallow lands. For the overall study area this land use category decreased 39% from the first to the second chrono-sequence of images. For the case study sites changes in this land use category are: Que 251 ha decrease; Can 272 ha decrease; Luu Phuong 251 ha decrease; Huoi Giang 866 ha decrease.

– An increase in the land cover category of "mature tree cover." For the overall study area this land cover category increased by 149% from the first to the second time period. For the case study sites changes in this land cover category are: Que 331 ha increase; Can 386 ha increase; Luu Phuong 496 ha increase; Huoi Giang 1,600 ha increase.

The trigger events associated with a forest transition are considered to be a broad set of factors that can include economic, political, institutional and cultural practices [Mather *et al.* 1999]. In the case of Vietnam it has been suggested that the forest land allocation policies are the triggers that have initiated the forest transition, as these policies have been broadly credited with decreasing, or reversing, the deforestation trends [Sikor 2001; Tachibana *et al.* 2001; Castella and Quang 2002]. The results of this study provide some support for the hypothesis that land allocation is influencing the movement towards increased forest land use. However, only three of the case study hamlets have experienced allocation of forest and agriculture land. Huoi Giang, where neither agricultural land allocation nor forest land allocation have taken place, has experienced the biggest increase in mature tree cover, the biggest increase in forest land use, and the biggest decrease in land used for long-term fallow. In association with these changes Que, Can, and Luu Phuong have all increased the amount of land they devote to permanent agriculture. Huoi Giang, though, has not responded in this way, increasing their permanent agriculture land by only 0.4%.

These results suggest that while land allocation may be one of the trigger events leading to a change in land use practices that ultimately leads to land cover change and increased forest land cover, another trigger event may be the increased connection with the market. All of the hamlets have increased their production of livestock for sale in the market. Increased livestock production, especially the production

of cattle, requires that pasture land be available for cattle raising. In the uplands of Vietnam pasture land can be grass and bushland, but it can also be tree covered, e.g. forest, land. In the past forest cattle have been raised by the hill tribes in Southeast Asia, and the H'mong are well-known for their skill in raising forest cattle. The increase in livestock, especially cattle, production, and the increased revenues that are associated with this production, provide another, complementary, explanation for the change in land use, and associated change in land cover, that lead towards a forest transition. By leaving more land tree covered, and allowing the land use to revert to "forest land use," upland residents are also providing more pasture land for their cattle. As demand for cattle increases, and it becomes even more lucrative to raise cattle as opposed to cultivating upland rice, it can be expected that forest land use will increase at the expense of swidden or upland cultivated fields. This trigger has not been identified in other studies looking at upland land cover changes in Vietnam, but may play an important role in the forest transitions that are taking place.

References

Ahlback, A. J. 1995. *On Forestry in Vietnam, the New Reforestation Strategy and Assistance*. UNDP/FAO Project VIE/92/022. Hanoi.

Castella, J. C.; and Quang, D. D., eds. 2002. *Doi Moi in the Mountains. Land Use Changes and Farmers' Livelihood Strategies in Bac Kan Province, Vietnam.* Ha Noi: The Agricultural Publishing House.

Castella, J. C.; Boissau, S.; Hai Thanh, N.; and Novosad, P. 2006. Impact of Forest Land Allocation on Land Use in a Mountainous Province of Vietnam. *Land Use Policy* 23(2): 147–160.

Dang, N. V. 1991. La culture sur bruˆ lis et le nomadisme. *Etudes Vietnamiennes* 1: 16–28.

De Jong, W.; Sam, D. D.; and Hung, T. V. 2006. *Forest Rehabilitation in Vietnam: Histories, Realities and Future*. Center for International Forestry Research (CIFOR), Bogor, Indonesia.

De Koninck, R. 1999. *Deforestation in Vietnam*. International Development Research Center (IDRC), Ottawa.

D'haeze, D.; Deckers, J.; Raes, D.; Phong, T. A.; and Loi, H. V. 2005. Environmental and Socio-economic Impacts of Institutional Reforms on the Agricultural Sector of Vietnam: Land Suitability Assessment for Robusta Coffee in the Dak Gan Region. *Agriculture, Ecosystems and Environment* 105(1–2): 59–76.

Do, D. S. 1994. *Shifting Cultivation in Vietnam: Its Social, Economic and Environmental Values Relative to Alternative Land Use.* International Institute for Environment and Development, London, UK.

FAO (Food and Agriculture Organization). 2005. *Global Forest Resources Assessment 2005: Progress Towards Sustainable Forest Management*. Food and Agriculture Organization of the United Nations Rome.

General Statistics Office. 2001. *Results of the 1999 Population and Housing Census*. Ha Noi: Statistical Publishing House.

Gomiero, T.; Pettenella, D.; Giang, P. T.; and Maurizio, P. 2000. Vietnamese Uplands: Environmental and Socio-Economic Perspective of Forest Land Allocation and Deforestation Process. *Environment, Development and Sustainability* 2: 119–142.

Jakobsen, J.; Rasmussen, K.; Leisz, S.; Folving, R.; and Quang, N.V. 2007. The Effects of Land Tenure Policy on Rural Livelihoods and Food Sufficiency in the Upland Village of Que, North Central Vietnam. *Agricultural Systems* 94: 309–319.

Lang, C. 2001. Deforestation in Vietnam, Laos and Cambodia. In *Deforestation, Environment, and Sustainable Development: A Comparative Analysis*, edited by D. K. Vajpeyi, pp. 111–137. Praeger, Westport, Connecticut and London,

————. 2002. *The Pulp Invasion: The International Pulp and Paper Industry in the Mekong Region*. Technical report, World Rainforest Movement, Uruguay.

————. 2007. Reinterpreting the Uplands of Vietnam: Towards Understanding and Correcting a Misreading of Its Land Cover, Land Use, and Resource Management System. Ph.D. Dissertation. Geography Department, University of Copenhagen. Copenhagen, Denmark.

Leisz, Stephen J. 2007. Reinterpreting the Uplands of Vietnam: Towards Understanding and Correcting a Misreading of Its Land Cover, Land Use, and Resource Management System. Ph.D. Dissertation. Geography Department, University of Copenhagen, Copenhagen, Denmark.

MAFI (Ministry of Agriculture and Forest Industry). 1993. *Bare Lands in Vietnam: The Existing Situation and the Improving and Using Orientation Up to the Year 2000*. MAFI. Hanoi.

Mather, A. S. 1992. The Forest Transition. *Area* 24(4): 367–379.

Mather, A. S.; Fairbairn, J.; and Needle, C. L. 1999. The Course and Drivers of the Forest Transition: The Case of France. *Journal of Rural Studies* 15(1): 65–90.

Meyfroidt, P.; and Lambin, E. 2008. The Causes of the Reforestation in Vietnam. *Land Use Policy* 25: 182–197.

Morrison, E.; and Dubois, O. 1998. *Sustainable Livelihoods in Upland Vietnam: Land Allocation and Beyond*. Forestry and Land Use Series 14. International Institute for Environment and Development (IIED), London.

Nguyen M. C. 1999. Information Technologies for Forest Management in Vietnam. Workshop Proceedings: Application of Resource Information Technologies GIS/GPS/RS) in *Forest Land & Resources Management*. October 18–20, 1999. Hanoi, Vietnam.

Pham, B. N.; and Hill, P. S. 2008. The Role of Temporary Migration in Rural Household Economic Strategy in a Transitional Period for the Economy of Vietnam. *Asian Population Studies* 4(1): 57–75.

Poffenberger, M.; Walpole, P.; D'Silva, E.; Lawrence, K.; and Khare, A. 1997. *Linking Government and Community Resource Management: What's Working and What's Not.* Report of the 5th Asia Forest Network Meeting, Surajkund, India, 2–6 December 1996. Research Network Report No. 9, Asia Forest Network.

Rambo, A. T. 1998. The Composite Swiddening Agroecosystem of the Tay Ethnic Minority of the Northwestern Mountains of Vietnam. In *Land Degradation and Agricultural Sustainability: Case Studies from Southeast and East Asia*, edited by A. Patanothai, pp. 43–86.

Sikor, T. 1995. Decree 327 and the Restoration of Barren Land in the Vietnamese hHghlands. In *The Challenges of Highland Development in Vietnam*, edited by A. T. Rambo, R. R. Reed, Le Trong Cuc and M. R. DiGregorio. Honoulu. U.S.A.: East-West Centre.

————. 2001. The Allocation of Forestry Land in Vietnam: Did It Cause the Expansion of Forests in the Northwest? *Forest Policy and Economics* 2(1): 1–11.

————. 2004. Conflicting Concepts: Contested Land Relations in North-western Vietnam. *Conservation & Society* 2(1): 75–95.

Socialist Republic of Vietnam. 1999. "Decree No. 85/1999/ND-CP," in D. Tran, 2003. *The Farm Economy in Vietnam*. Hanoi: The Gioi Publishers.

————. 2001. *Nien Giam Thong Ke* [Statistical Yearbook] *2000*. Statistical Publishing House, Hanoi, Vietnam. 599 pp.

Sowerine, J. C. 2004. Territorialisation and the Politics of Highland Landscapes in Vietnam: Negotiating Property Relations in Policy, Meaning and Practice. *Conservation & Society* 2(1): 97–136.

Tachibana, T.; Nguyen, T. M.; and Otsuka, K. 2001. Agricultural Intensification versus Extensification: A Case Study of Deforestation in the Northern-hill Region of Vietnam. *Journal of Environmental Economics and Management* 41(1): 44–69.

Vien, T. D.; Nguyen Vinh Quang; and Mai Van Thanh. 2005. *Decentralization of Forest Management and Impacts on Livelihoods of Ethnic Minority Groups in Vietnam's Uplands*. The Agriculture Publishing House. Hanoi, Vietnam.

Vo Quy; and Le Thac Can. 1994. Conservation of Forest Resources and the Greater Biodiversity of Vietnam. *Asian Journal of Environmental Management* 2(2): 55–59.

Southeast Asian Studies, Vol. 47, No. 3, December 2009

Understanding Changes in Land and Forest Resource Management Systems: Ratanakiri, Cambodia*

Jefferson Fox,** John B. Vogler*** and Mark Poffenberger****

Abstract

This paper draws on case studies from three communities in Ratanakiri to illustrate both the forces driving land-use and tenure change as well as how effective community stewardship can guide agricultural transitions. The study combines a time series of remotely sensed data from 1989 to 2006 to evaluate changes in land use, and relates this data to in-depth ground truth observations and social research from three villages. The methodology was designed to evaluate how indigenous communities who had historically managed forest lands as communal resources, are responding to market forces and pressures from land speculators. Krala Village received support from local non-government organizations (NGOs) to strengthen community, map its land, demarcate boundaries, strengthen resource use regulations, and develop land-use plans. The two other villages, Leu Khun and Tuy, each received successively less support from outside organizations for purposes of resource mapping and virtually no support for institutional strengthening. The remote sensing data indicates that in Krala, over the 16 year study period, protected forest areas remained virtually intact, while total forest cover declined at an annual rate of only 0.86% whereas in Leu Khun and Tuy the annual rates were 1.63 and 4.88% respectively.

Keywords: land use, land cover, forest management, resource management systems, Cambodia

I Introduction

Over the past decade, Ratanakiri Province has experienced unprecedented changes in land use and tenure. This study analyzes remotely sensed images taken in 1989 and December 2006 to assess changes in vegetative cover in three areas near Banlung the provincial capital, and draws on in-depth case studies from three communities in the research area. The researchers were particularly interested in how forest cover changed over the 17 year period, and what replaced it. We sought explanations for changes in land and forest management practices in social, economic, and demographic factors. Since

* An earlier version of this paper was published as Fox, McMahon, Poffenberger, and Vogler [2008].

** East-West Center, 1601 East-West Road Honolulu, Hawaii 96848
e-mail: foxj@eastwestcenter.org
*** Anthropology, University of Hawaii, Manoa
**** Community Forestry International, Lake Tahoe, CA

all study communities and their surrounding land and forests were traditionally under similar forms of indigenous resource management characterized by swidden farming, we wanted to understand how these human ecosystems were adapting, or not adapting, to agricultural commercialization and the influx of migrants and investors in the region, as well as an annual population growth of over 4%.

The research was conducted in 2007 in collaboration between Community Forestry International (CFI) and the East-West Center (EWC). CFI has been supporting community networking in the province since 2003, while EWC researchers have been engaged in studying the area for over a decade [Fox 2002]. The concept of the methodology was to analyze a time series of satellite images to identify changes in land cover, and to conduct in-depth studies with communities, to understand why changes in land use are occurring and to assess the social implications of these changes.

II Introduction to Place

The Cambodian province of Ratanakiri, "the mountain of precious stones," lies about 600 km northeast of Phnom Penh. It is bordered by Vietnam on the east and Laos on north and covers approximately 12,500 km^2 (Map 1). Due to its distance from major regional centers and a high prevalence of malaria, the province remained remote and isolated from Western influences until recently [Bourdier 1995]. With the exception of two ethnographies [Fontanel 1967; Matras-Troubetzkoy 1983], no study of human geography or anthropology had been undertaken in the province until the 1990s.

The Sesan and Srepok Rivers cross the province flowing west from Vietnam to the Sekong River, a tributary of the Mekong. The northern portion of the province, between the Sesan River and the Laotian border, is covered with broadleaf evergreen forest. Approximately 12,600 people, 18% of the province's population, live here. South of the Srepok River, the province is covered with a tropical deciduous forest. Approximately 7,000 people, 10% of the population, live here [Bourdier 1995]. The remaining area, between the two rivers, is composed of red basaltic soils on a high plateau (300 m elevation) and is covered with tropical secondary forests, forests "formed as a consequence of human impact" [Brown and Lugo 1990: 3]. This area includes the provincial capital, Banlung. Approximately 51,000 people, over 70% of the population of the province, live here. Ethnic communities in Ratanakiri include the Brao, Jarai, Kachah, Kraveth, Krung, and Tampuen [Lebar *et al.* 1964].

This study was conducted in the high plateau area in the *Khums* (communes) of Ting Chac and Ke Chong in Bar Kaev District, and Poey in O Chum district (Map 1). Elevation ranges from 100 to 400 m. The region has a monsoonal climate, with a rainy season beginning in May or June and lasting until October or November. Annual rainfall is always above 2,000 mm, and can reach 2,950 mm in Banlung

Map 1 Research Sites in Ratanakiri Province

[Bourdier 1995]. Almost no rain falls between December and April. Vegetation is composed primarily of broadleaf evergreen and deciduous forests [*ibid.*].

Krala Village, Poey Commune

Krala is a Krung village of about 420 people in O Chum District, located about 25 km north of Banlung. The research team selected Krala to represent a community with the least amount of change as well as a community where indigenous community institutions remain in control of communal lands, with support from local non-government organizations (NGOs). Krala was re-established immediately following the fall of the Khmer Rouge, and the current settlement area of the village was established at its present site in 1984. During the Khmer Rouge regime much of the community's population were relocated to Voensai District where they were forced to farm paddy rice. Unlike many of the indigenous communi-

ties adjacent to major roads in the province (although the Voensai road has been a target of less change than the highway to Vietnam), Krala has managed to maintain control over 100% of its traditional land, and stands as a model for other communities who are facing a similar struggle. While the ownership of Krala's traditional land has not changed, the use of their land has seen a significant transition from entirely swidden agriculture in the early 1990s to the current mosaic of swidden fields and cashew plantations. In 1994, only four families in the village had planted cashew trees, but by 2000, nearly 100 of the 135 families in the village had planted cashews on their land. Now, it is estimated that every family in the village has at least 0.5 ha of cashew trees. Krala has been the focus of several prior research studies that have resulted in a considerable amount of NGO attention and support in the village.

Leu Khun Village, Ke Chong Commune

Leu Khun is a Jarai village that the research team selected to represent an established indigenous community where land-use change is accelerating. Leu Khun was re-established in 1979, when community members returned from lowland areas where the Khmer Rouge had forced them to relocate. At that time there were 70 families who resettled the village, with a total population of 250. The population has since grown gradually to 130 families with 639 people. From 1986 to 1992, Vietnamese logging companies felled much of the larger, old growth forests surrounding Leu Khun. Much of the remaining forest was felled by the Cambodian military throughout the 1990s, ending around 2002. Smaller-scale illegal felling continues.

Tuy Village, Ting Chac Commune

Tuy is a predominantly Tampuen village located along the main road (Road 78) between the provincial capital of Banlung and the Vietnamese border, approximately 20 km east of Banlung. The research team selected Tuy to represent "high land use change," based on reports that extensive land sales were taking place in the village and the surrounding communities. While the village has existed in its present location for many generations, the entire community was forced off their land in order to work lowland rice areas during the Khmer Rouge period. In 1982 approximately 85 families (210 people) returned to resettle the village. By 2005, the population had grown to 103 families (458 people), at which time 23 of the families chose to break away in order to form a new village (Trang Village) as a result of internal conflicts between two community leaders. Tuy's forests were logged extensively from 1985 to 1989 by Vietnamese companies, and later by the Cambodian military from 1990 to 1993. Since 2000, Tuy has seen significant changes not only in land use, but also in land tenure with estimations of more than half of the community's productive land having been acquired by outsiders. People in Tuy increasingly see

land and forests as market commodities and indigenous institutions as having diminished ability to guide community policies and behavior.

III Methods

To understand both the nature and extent of land-use changes, a series of focus group and individual interviews were conducted in each of three villages representing varying degrees of land-use and land tenure change. The selection of villages was based on anecdotal evidence and reports from NGO members working throughout the province. Data for this report was collected during two field visits to the selected villages during the first half of 2007. The first visit was conducted in January 2007, and comprised focus group discussions with community members in each of the three villages, followed by individual interviews with two to three selected individuals from each community. The focus group discussions were designed to identify overall community attitudes and practices surrounding land management decision-making, and broad patterns of land use within the community. The discussions also aimed at revealing areas of conflict surrounding land and natural resources and at assessing the status of communal land tenure as reflected in incidence of land sales, land grabbing, and efforts by the community to preserve their lands. Additional effort was made to identify changes over time in social conditions and economic/food security status that might serve as a metric in measuring the social impact of observed changes in land use and tenure.

Individual interviews were conducted to provide concrete examples of individual practices surrounding land use, and to identify the actual prevailing conditions and procedures by which land is either converted to other uses or transferred to new owners.

These interviews were also aimed at gauging the family's economic status and possible impacts of their particular changes in use or availability of resources. A second field visit was conducted in April, 2007, as a means to both clarify data from the first visit, and to collect additional geospatial data surrounding changes in land use. Sketch mapping was conducted to identify patterns of land use, and areas of current and ongoing land conflict.

Sketch mapping is a method for collating and plotting information on the occurrence, distribution, access and use of resources within the economic and cultural domain of a specific community. Sketch mapping should be conducted at the onset of a community based activity, but only after rapport has been established with the community because the community may consider resource distribution, use and access as sensitive issues [IAPAD 2009]. Some additional information used in this report was derived from interviews with government officials from the Department of Land and NGO workers from several

organizations with experience working in the study communities. Among those NGOs consulted in the making of this report were the Non-Timber Forest Project (NTFP),[1] the Highlander Association (HA)[2] and the Indigenous Community Support Organization (ICSO).[3]

In order to assess the spatial patterns of land cover and land use (LCLU) change in the three villages, remotely sensed satellite image data, ground truth information, and derived land cover products were analyzed with emphasis on changes occurring in the 17-year period between early 1989 and late 2006. Baseline land cover for the three villages was derived from a Landsat Thematic Mapper image acquired on 8 January 1989 and obtained from NASA's Global Orthorectified Landsat Data Set. More recent land cover was derived from an Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) satellite image acquired on 25 December 2006 and obtained from the NASA/USGS Land Processes Distributed Active Archive Center (LPDAAC).

A 13-class GeoCover land cover map product was obtained from MDA Federal (www.mdafederal.com) for the 8 January 1989 Landsat image as an independent land cover data source. Additional ground truth data sources included 1:50,000 scale scanned topographic maps, an IKONOS 1-m resolution panchromatic image acquired on 29 December 2001 for Krala village and surrounding area, and 243 GPS ground truth data points obtained during field work in January of 2006 and 2007. Using the orthorectified Landsat TM as a georeferencing source, all imagery and raster datasets were rectified to the UTM coordinate system, WGS84 datum, and units of meters. In addition, official land-use planning maps were obtained for each village from the provincial land office in Banlung. The planning map for Krala was finalized in 2006, and completed in 2005 and 2004 for Leu Khun and Tuy villages, respectively. These maps were coregistered to the georeferenced datasets above, and village boundaries and designated land-use planning boundaries were digitized and added to the GIS database.

Remote sensing image analysis involved a combination of unsupervised and supervised classification approaches. First, given the limited amount of ground reference data from 1989 for the study region, an unsupervised classification using a maximum likelihood algorithm was performed on the 1989 Landsat image using ERDAS Imagine image processing software and resulting in separated spectral

1) The Non-Timber Forest Products Project (NTFP) was founded in August 1996 by a group of donors interested in establishing a long-term project to address issues of land tenure and management of natural resources by indigenous communities in Ratanakiri. Activities undertaken by the NTFP include natural resource management (NRM), land-use planning, informal education, community health, agriculture, gender training, and advocacy.
2) Highlanders Association is an association of indigenous community people in Ratanakiri.
3) Indigenous Community Support Organization is a Cambodian NGO that supports indigenous peoples retaining their rights and resources —— while undertaking a form of development that is designed by indigenous peoples, for indigenous peoples.

clusters. In addition to the six visible and near-infrared bands of the Landsat scene used in the unsupervised classification, a normalized difference vegetation index (NDVI) enhancement was generated as a separate map in order to distinguish relative differences in standing green vegetation biomass throughout the study region. Using knowledge of the study area, available ground references, and the NDVI map, clusters were assigned to one of 10 land cover classes, including deciduous forest, evergreen forest, shrub/scrub, grass, barren, settlement, non-paddy agriculture, paddy, wetland, and water.

Analysis of the 2006 ASTER image involved first generating an NDVI enhancement map from the 15 m resolution red and near-infrared image bands (ASTER image bandwidths for bands 1–4 are comparable spectrally to Landsat bands 2–5). Image-to-image radiometric calibration was performed to allow comparison between sensor data. An image-pair comparison of the 1989 NDVI and 2006 NDVI was performed in order to readily identify and map areas of significant change (and little change) in biomass between the two dates.

By creating two-date NDVI composite images, areas with significant changes in biomass between dates (e.g., due to clearing land, clearing land followed by regrowth of natural vegetation or agriculture, or maturity of younger vegetation in the 1989 image to mature vegetation in 2006) are evident (appear bright red in composite displays). For those areas of relatively little or no change in NDVI, an initial assumption was made that the basic land cover had remained relatively stable.

This was further verified using visual interpretation of the higher resolution ASTER bands, consulting ground truth GPS field data and photos, and village land-use planning maps, and, in the case of Krala, visual inspection of the 1 m IKONOS panchromatic image. For the areas (and associated pixels) of relatively little or no change, the land cover information class from 1989 was carried forward to the 2006 land cover map. Areas exhibiting changes in biomass between the two dates were isolated for further spectral analysis using a supervised classification approach. Using available reference data, including 2006 and 2007 GPS field data, spectral training sets were created for each of the ten land cover classes mentioned above. A supervised classification was then implemented using a maximum likelihood classifier and the resulting clusters were evaluated for separability and further split or aggregated until a final classification map was produced.

Final class maps for both 1989 and 2006 dates were smoothed using a 3×3 majority filter to remove inherent speckle in the underlying satellite data. For comparison of classification maps between dates and across the three villages, the classification scheme was further simplified (and classes aggregated) into seven classes, including forest (deciduous and primarily evergreen), young fallow and immature cashews (includes shrub/scrub and grass), non-paddy agriculture, paddy, settlement, wetland, and water. Finally, land-cover class area and percent cover statistics from 1989 and 2006 class maps were calculated,

summarized and compared by village area and also by the specific land-use planning zones demarcated for each village. This allowed for assessing overall village land cover change and also in analyzing the extent to which each village managed its land according to its respective participatory land-use plan.

IV Results: Changes in Land and Forest Resource Management Systems

Table 1 shows changes in land cover and population in the three villages between 1989 and 2006. In 1989 villagers in Krala had access to approximately 11 ha of forests per person. By 2006 this had dropped to 5 ha per person. This represented a loss of approximately 13% of the forest cover (almost all forest cover in this region is composed of broadleaf evergreen species). Most of this forest cover was converted to various types of agriculture including cashews and other cash crops. Permanent agricultural land cover grew by a rate of approximately 15% per year during this period. In 1989 villagers in Leu

Table 1 Changes in Land Cover and Population in the Three Villages in 1989 and 2006

Land cover as mapped \ Village/Year		Krala 1989	Krala 2006	Leu Khun 1989	Leu Khun 2006	Tuy 1989	Tuy 2006
Forest	Ha	2,479	2,142	1,034	782	1,143	488
	% of land cover	**94**	**81**	**65**	**49**	**79**	**34**
	Ha/loss per year	20		15		39	
	Annual rate of change (%)	–0.86%		–1.63%		–4.88%	
	Years left under current loss rate	**108**		**53**		**12**	
	Ha/person	11	**5**	3	**1**	5	**1**
Young fallow and immature cashews	Ha	129	112	408	216	236	72
	% of land cover	5	4	26	14	16	5
	Annual rate of change (%)	–0.83		–3.67		–6.75	
	Ha/person	0.5	0.25	1	0.34	1	0.16
Agriculture (permanent, cashews, rubber, and paddy)	Ha	38	386	153	574	53	854
	% of land cover	**1**	**15**	**9**	**36**	**4**	**59**
	Annual rate of change (%)	14.61%		8.09%		17.76%	
	Ha/person	0.16	**0.86**	0.5	**0.9**	0.25	**2**
Other (water and settlements)	Ha	0	6	0	24	12	30
	% of land cover	0	<1	0	1	1	2
	Annual rate of change (%)	45.69%		58.07%		5.54%	
	Ha/person	0	0.01	0	0.04	0.06	0.06
Population	Total population	235	450	320	639	210	458
	Annual rate of change (%)	3.9%		4.15%		4.69%	
	People/km^2	**9**	**17**	**20**	**40**	**15**	**32**

Khun had access to less forest land (3 ha per person) than villagers in Krala had in 2006 (5 ha per person). Between 1989 and 2006 villagers in Leu Khun lost approximately 16% of their forest cover resulting in approximately 1 ha per person in 2006. Permanent agricultural cover increased during this period by 421 ha or 8% per year. In Tuy we see a loss of almost 45% of forest cover and an increase in agricultural cover of approximately 54%. In 2006, however, villagers in Tuy had access to twice as much permanent agricultural land per person as villagers in both Krala and Leu Khun (2 ha as opposed to approximately 1 ha per person).

Participatory land-use planning (PLUP) and small scale land-use mapping began in Ratanakiri in 1996–97 and a GIS Unit designed to support community land mapping was established in Banlung in 2000. PLUP is a standardized process supported by the Cambodian government where villagers receive training in how to read topographic maps and aerial photographs. Under the PLUP program, the GIS Unit assists villagers to draw sketch maps of their current land and to develop maps (known as PLUP maps) that represent an effort by development workers, local government officials, and community leaders to clarify territorial boundaries and to develop coherent zones of land-use activities. When we overlay the PLUP maps with the remotely sensed images we can observe how well land-use practices conform to village land-use zoning objectives.

Krala Village, Poey Commune

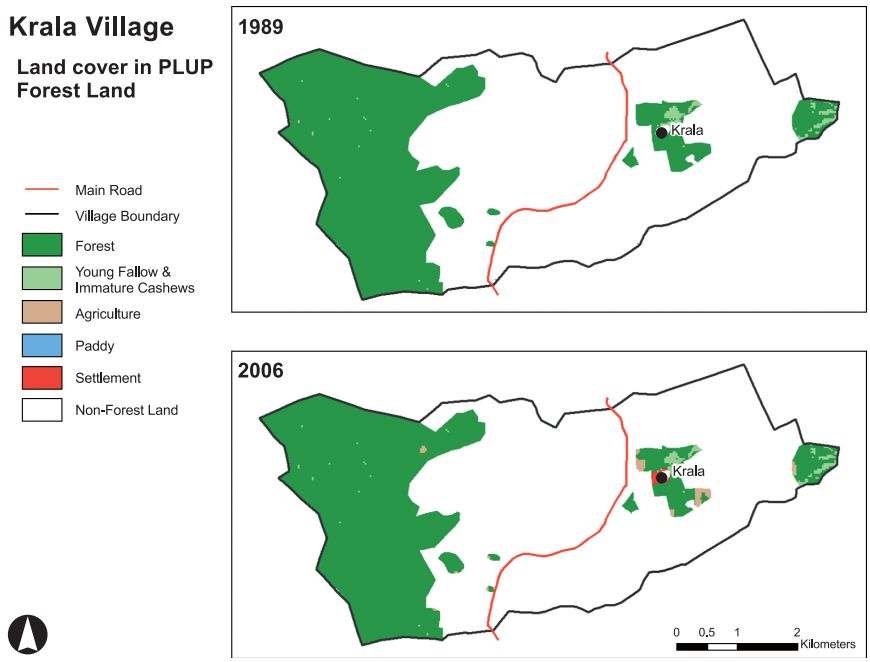
Table 2 summarizes land-use zoning and land cover in Krala in 1989 and 2006. Reading left to right across the table, villagers in Krala sought to protect 35% of their land base as protected forest. In both 1989 and 2006 the remotely sensed images suggest that the villagers successfully achieved this goal (34%) (see Map 2). The areas villagers zoned to use for both swidden (mixed used) and permanent agriculture have seen the most change during this period although a large majority of this area still remains forested (Map 3). The most pronounced change in land use in Krala was the expansion of cashew trees from just a few ha in 1994 (<1% Table 2) to an estimated 500 ha in 2007 (8% Table 2). Villagers consider planting cashew to be an easy task as they can be planted in June along with rice. The trees become fully established within the course of the rainy season and are able to grow without irrigation or fencing. Villagers report that they do not need to be fertilized and that they do not have any problems with pests. Most farmers plant the field with both upland rice and cashew trees and continue to intercrop rice with the cashews for three to four years until the trees become mature and begin yielding nuts.

CIDSE (Coopération Internationale pour le Développement et la Solidarité) now known as DPA (Development Partner in Action) assisted villagers in Krala in developing their cashew cultivation, often

Table 2 Land-use Zoning and Land Cover in Krala 1989 and 2006

Land use as zoned \ Land cover as mapped		% Krala PLUP	% Forest 1989	% Forest 2006	% Young Fallow and Immature Cashews 1989	% Young Fallow and Immature Cashews 2006	% Agriculture (permanent, cashews and paddy) 1989	% Agriculture (permanent, cashews and paddy) 2006	% Other (water, settlement) 1989	% Other (water, settlement) 2006
Participatory Land-Use Planning	Protected Forest (and bamboo, spirit, others)	**35**	**34**	**34**	1	<1	<1	<1	0	<1
	Mixed-use (trees and swidden)	36	33	28	2	2	**1**	**6**	0	<1
	Agriculture (cashews, private, barren, paddy, etc.)	28	26	19	2	1	**<1**	**8**	0	0
	Other (settlements, wetlands)	1	1	1	<1	0	0	<1	0	<1

Note: The first column (% Krala PLUP) shows that villagers zoned 35% of their land as forests, 36% as mixed used, 28% as agriculture, and 1% as other. The second column shows that in 1989 that almost all the land zoned for protected forests was still in protected forests (34%). In addition, however, most the village's land based zoned for mixed use was still forest (33%), land zoned for agriculture was still forests (26%), and all the land zoned for other was still forest (1%). The third column shows that in 2006 that almost all the land zoned for protected forests was still in protected forests (34%). In addition, however, most the village's land based zoned for mixed use was still forest (28%), land zoned for agriculture was still forests (19%), and all the land zoned for other was still forest (1%).

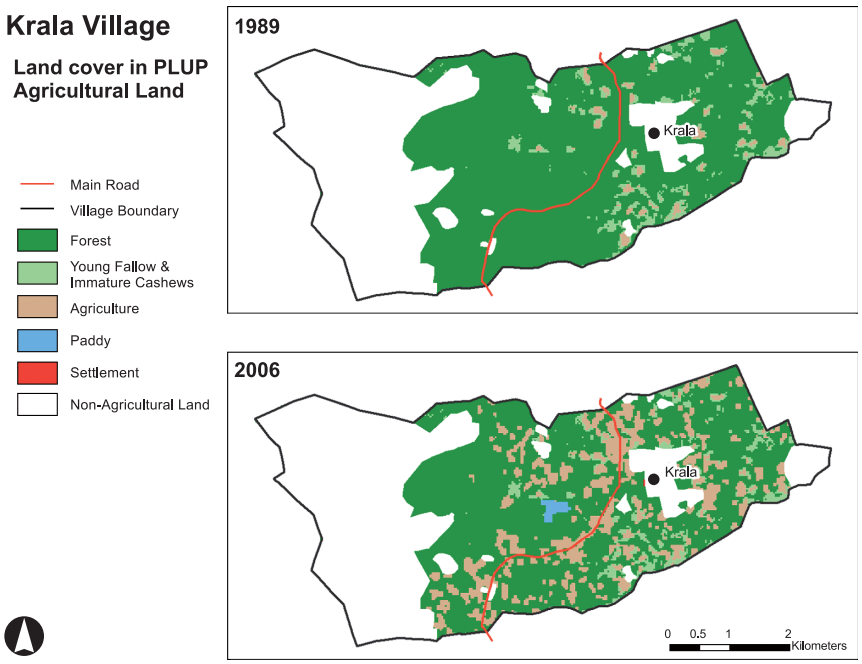


Map 2 Land Cover (1989 and 2006) in Krala in Areas Zoned as Forest in the PLUP Exercise

Note: Zoning indicates intended use, not necessarily current use. Hence, some land zoned as forest in 1989 and already been converted to agriculture.

providing seeds to farmers, as well as some training in the practices of cultivation. CIDSE also assisted a number of village families to establish mango trees. Today, as people continue to plant cashews and other fruit trees, they purchase their seeds either in Banlung or from others in the community. The practice of cashew cultivation within the community has spread largely through social networks or peer learning. Individuals watch or participate in the planting of cashews in the field of a friend or family member and then apply those same techniques within their own fields. They describe a strong sense of cooperation and willingness to assist others in growing cashew and do not perceive any sense of competition or threat from others entering the market.

Villagers, however, do not collaborate in the harvesting, transporting, and bargaining or selling of the nuts. Each family harvests and sells their nuts individually, sometimes swapping labor during the harvesting activities, but without any consolidation of product or collective bargaining. Most community members take their cashews to the Banlung market to sell because they can get a better price than if they sell to the people who come to the village. Last year they received 2,500R for cashews in Banlung, but only 2,300R if they sold to the buyers who come to the village. While most people prefer



Map 3　Land Cover (1989 and 2006) in Krala in Areas Zoned as Mixed-use and Agriculture in the PLUP Exercise

Note: Zoning indicates intended use, not necessarily current use. Hence land zoned as agriculture in 1989 was still in forest in both 1989 and 2006.

to travel to the market in order to yield the higher price, some community members still prefer the ease of conducting the transaction in the village.

Although all families are now producing cashew nuts, and most have begun to see profits from this activity, the people of Krala seem to agree that swidden agriculture is still extremely important for their food security. One community member explained that even if he could entirely purchase paddy rice with cashew money, they would prefer the upland rice that they produce, and intend to continue farming in this way into the future.

Villagers in Krala have not yet started to cultivate rubber. One community member, Mr. Hayoen Tang, indicated that he wanted to begin planting rubber during the 2007 season, and hoped to demonstrate the benefits of planting rubber to others in the community. Individuals generally recognize that rubber can be significantly more profitable than cashews and is something that they are considering for the future. Their chief concern is that it is very expensive to start and requires at least seven years before they can begin reaping any profit. At the moment, few members of the community have the financial and food security to risk the initial investment. However, other individuals indicated that they

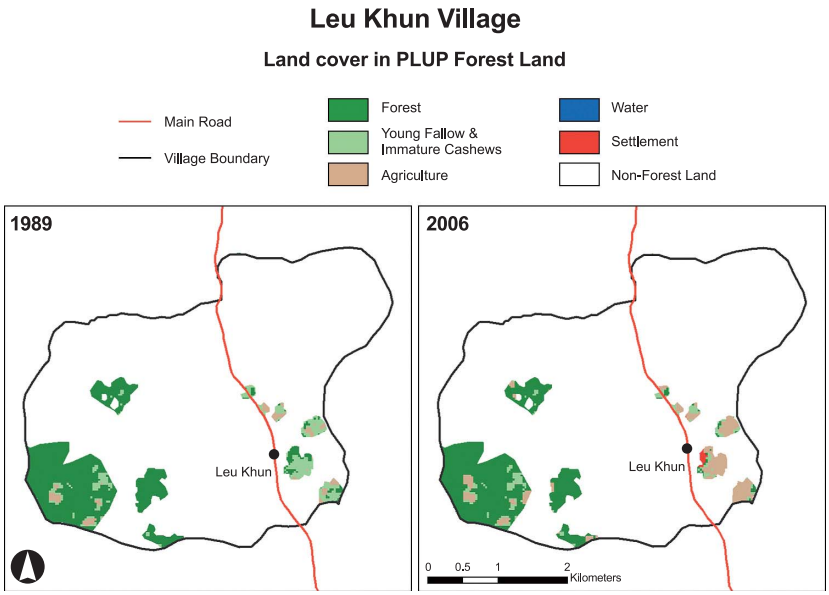
have begun to think about saving some of their profits from cashews for developing rubber trees on their land. This offers a timely alternative to the current model of rubber production where powerful individuals purchase land from communities to develop rubber plantations.

The NTFP, a local NGO, has worked steadily in Krala since 1996 assisting villagers to form an 11 member natural resource management (NRM) committee which meets weekly to map land use and develop land management plans. As part of the agreements established within the NRM committee, each community member is allowed up to 5 ha of land for permanent cultivation, which at the moment means cashews. While not all families are using all of the allotted land for cultivation at the moment, an estimated 30–40% of the families are using the entire 5 ha that is permitted by the community. There are no limits set for how much land a family can use for swidden cultivation. In general, though, most families tend to use between 1 and 2 ha on which they grow upland rice, cassava and some short-lived fruit trees like banana and papaya.

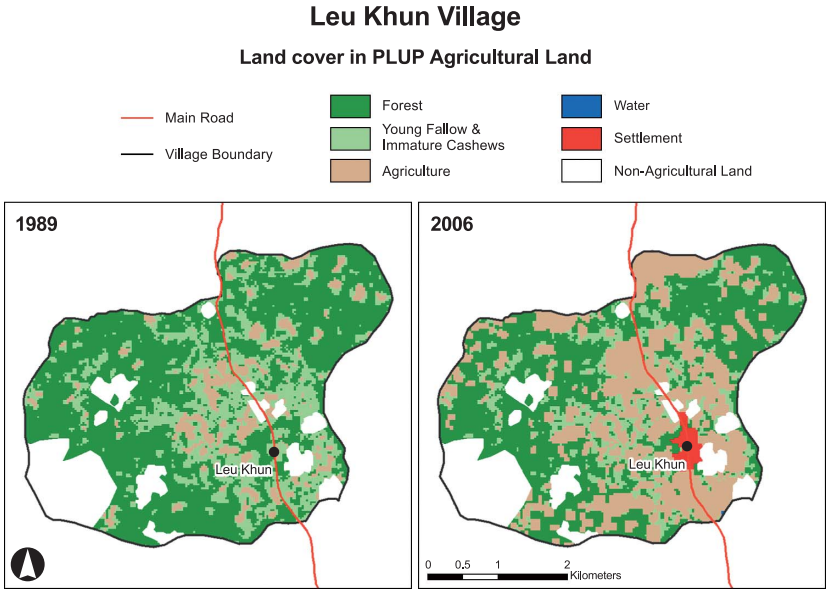
All the families in the community also plant fruit trees, such as orange, mango and jackfruit within their swidden fields. Because they are now planting fruit trees within these fields, they are less likely to use fire for clearing the field at the start of the subsequent farming season. As a result of this, they feel that there may be a greater problem with insects that would normally be killed during the burning and clearing of the field. While they recognize that there may be a problem associated with this change in their field preparation practices, they are unsure of what they should do about their insect problem.

Leu Khun Village, Ke Chong Commune

Table 3 shows changes in land-use zoning and land cover in Leu Khun village. The land zoning data for Leu Khun village was collected as part of a "fast mapping" exercise at the commune-scale, performed by the Provincial Rural Development Committee with minimal input from members of the affected villages [Sarem, Ironside and Van Rooijen 2005]. The PLUP mapping exercise did not define individual village boundaries, and the boundaries reflected here represent the results of a consultation with village members conducted as part of this investigation. Of the land area which Leu Khun residents identified as their domain, the earlier PLUP map designated only 13% as protected forest (Table 3). Within areas designation as protected forest, forest clearing persists and there remains no active effort at protection (Map 4). The PLUP map also designates 86% of Leu Khun's land base for mixed trees (forest fallow) and swidden agriculture (Table 3). The villagers have kept almost half of this land as forest fallow and converted the rest to cashews (Table 3 and Map 5).



Map 4　Land Cover (1989 and 2006) in Leu Khun in Areas Zoned as Forest in the PLUP Exercise



Map 5　Land Cover (1989 and 2006) in Leu Khun in Areas Zoned as Mixed-use and Agriculture in the PLUP Exercise

Tuy Village, Ting Chac Commune

Table 4 shows changes in land-use zoning and land cover in Tuy village. The PLUP mapping exercise conducted there in 2002 was done with considerably more community input than the Leu Khun mapping exercise. In Tuy, villagers sought to zone 27% of their land as protected forest (Table 4). By 2006, half of this protected land was converted to agriculture (primarily rubber planted by outsiders) (Table 4 and Map 6). Villagers zoned about 68% of their land for various types of agriculture (both swidden and permanent) (see Table 4). By 2006 most of this conversion had been completed (again mainly to rubber, which was entirely planted by outsiders who purchased the land illegally (Map 7). Villagers have only about 15% of their land base left for conversion to agriculture if they wish to keep anything under protected forests.

V Driving Forces of Change

Land-use practices are changing rapidly in most indigenous communities in Ratanakiri. Part of this reflects a broader agricultural transition that has been occurring in the uplands of Southeast Asia for decades [Fox and Vogler 2005]. Traditional forms of subsistence agriculture that relied on a cycle of farming followed by lengthy fallow periods are being replaced by sedentary, market oriented farming systems. While a few rubber estates were established in Ratanakiri during the colonial period [see Matras-Troubetzkoy 1983], the advent of cash crop farming by indigenous communities has largely emerged since 1993 when Cambodia opened up for international investments and new road networks began to reach further into rural Ratanakiri.

Theories of agrarian transitions have been around since Malthus [1798] first proposed that population growth drove land degradation; and Ester Boserup [1965] much later suggested that population pressure drives a change from shifting cultivation towards annual cultivation. Harold Brookfield [1972; 1984] recognized that change is not only driven by pressure, but by new opportunities that change the productivity or quality of labor. He suggested that 'pressure of population' should be replaced by the idea that the social and cultural contexts within which people produce and consume must be central to any understanding of agricultural systems and agrarian change. Jonathan Rigg [2006] argues that today, scholars of agrarian transitions struggle to keep up with the pace of change as individuals and households restructure their lives and livelihoods in response to a wide assortment of influences ranging from aspirational changes through to emerging physical resource scarcities and state interventions.

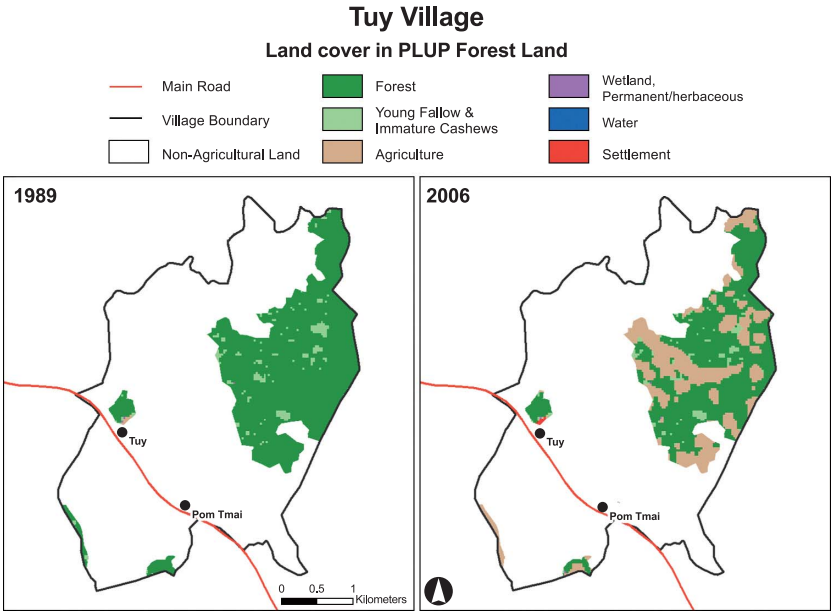
Driving forces that affect all three villages include national policies to liberalize trade and markets, and high market prices for rubber and cashews. Annual population growth in all three villages over the

Table 3 Land-use Zoning and Land Cover in Leu Khun 1989 and 2006

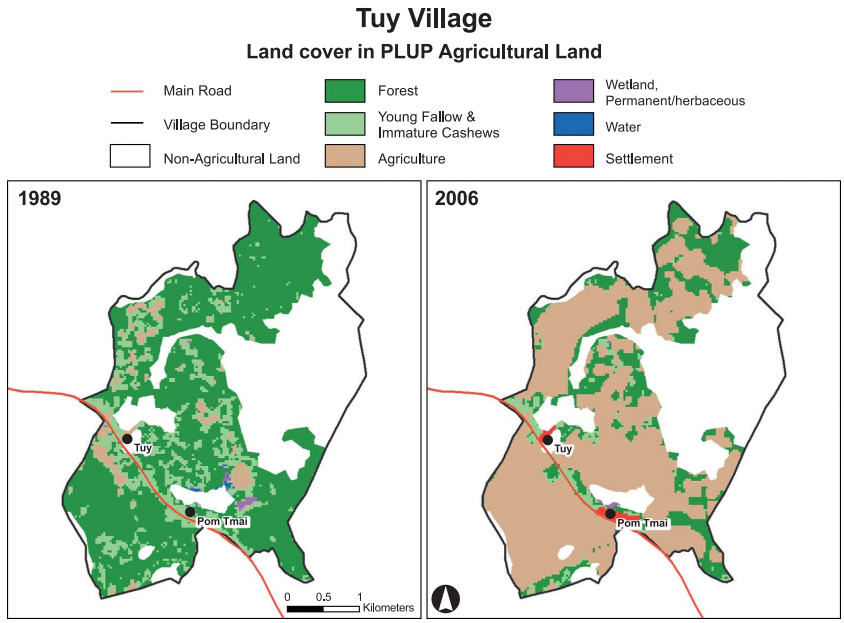
Land use as zoned \ Land cover as mapped		% Leu Khun PLUP	% Forest 1989	% Forest 2006	% Young Fallow and Immature Cashews 1989	% Young Fallow and Immature Cashews 2006	% Agriculture (permanent, cashews and paddy) 1989	% Agriculture (permanent, cashews and paddy) 2006	% Other (water, settlement) 1989	% Other (water, settlement) 2006
Participatory Land-Use Planning	Protected Forest (bamboo, spirit, others)	13	**10**	**9**	2	1	1	2	0	<1
	Mixed-use (trees and swidden)	86	**54**	**40**	**23**	**12**	**9**	**33**	0	1
	Agriculture (paddy, etc.)	<1	<1	<1	0	0	<1	<1	0	0
	Other (settlements, wetlands)	<1	<1	<1	<1	<1	0	<1	0	0

Table 4 Land-use Zoning and Land Cover in Tuy 1989 and 2006

Land use as zoned \ Land cover as mapped		% Tuy PLUP	% Forest 1989	% Forest 2006	% Young Fallow and Immature Cashews 1989	% Young Fallow and Immature Cashews 2006	% Agriculture (permanent, cashews, rubber and paddy) 1989	% Agriculture (permanent, cashews, rubber and paddy) 2006	% Other (water, settlement) 1989	% Other (water, settlement) 2006
Participatory Land-Use Planning	Protected Forest (bamboo, spirit, others)	27	**26**	**16**	1	1	**0**	**10**	0	0
	Mixed-use (trees and swidden)	42	**34**	**12**	7	1	**1**	**29**	0	
	Agriculture (rubber, etc.)	26	**16**	**3**	7	2	**2**	**19**	<1	1
	Other (settlements, wetlands)	5	3	2	1	<1	<1	1	<1	1



Map 6 Land Cover (1989 and 2006) in Tuy in Areas Zoned as Forest in the PLUP Exercise



Map 7 Land Cover (1989 and 2006) in Tuy in Areas Zoned as Mixed-use and Agriculture in the PLUP Exercise

last 15 years was relatively the same ranging from 3.9% in Krala to 4.69% in Tuy (Table 1). Population density (people per square kilometer) in Leu Khun, however, was already greater in 1989 (20 people) than in Krala in 2006 (17 people) (Table 1). Dove [1982] estimated the territorial needs of swidden cultivators in West Kalimantan, Indonesia, to be approximately 16 people per square kilometer. This suggests that population pressure may have been one of the forces driving land-use intensification in Leu Khun and Tuy, and perhaps to a lesser extent in Krala.

Other forces that affected the villages differently include the development of the road infrastructure that made it much easier to get to Tuy than the other villages, illegal logging which occurred primarily in Tuy and Leu Khun, and the active engagement of NTFP and other NGOs in assisting villagers in Krala to develop land-use plans, and to promote education.

Signs of an emerging cash economy are abundant within the three villages. Many families possess motorbikes and several have televisions and VCD players, which they power with batteries that are charged in Banlung. Villagers also collect money for sacrifices and other community needs. In Leu Khun village, one villager explained that when the water pump in the village breaks, leaders collected 10,000R (US $2.50) from each family to get the pump fixed. She said that people generally do not complain or resist making such contributions. Additionally, villagers receive regular visits from a variety of vendors on motorbikes, selling items such as ice cream, used clothing, assorted plastic wares and even family portraits. Portrait vendors offer a variety of templates in which an individual's photo may be inserted, such as standing by a new car in front of a large house. During one visit to a village, a large group of people were seen selecting and ordering their photographs that ranged in cost from 10,000R (US $2.50) for a single picture to as much as 30,000R if purchased with a frame.

Moreover, the need for cash has grown rapidly in indigenous villages in response to new opportunities to educate children. Some parents noted that an education is necessary in order to be able to negotiate better prices for goods in the market, and to be able to talk with government officials. Yet, the level of education available within the study communities was low. Some students have left their villages to study in the district township or in Banlung. While there are no "official" fees associated with attending district schools, teachers regularly expect students to seek them out for individual tutoring sessions (which are considered vital for a obtaining a passing grade), for which the students must pay. There are many stories of outright payment for passes in higher grades. Also many students do not have relatives to stay with while attending schools in towns making the cost that much higher. The NGOs working in Krala have helped the village to develop two schools that are fully functional and attended by most children.

There are currently nine students from Krala who are studying at the high school level in Banlung

while there are none from Leu Khun.

Perhaps the most significant common denominator among the three communities from the perspective of land-use change is the nearly universal reliance on cashew nut or rubber production as the primary source of cash income. While all villagers from all three communities continue to rely on upland rice farming as their primary means of food production, virtually every family relies heavily on profits from cashew or rubber sales to supplement their family's food needs. Overall, people from all three villages indicate that they are in a better economic position than they were in the 1990s, and they point to cashew and rubber production as the primary factor in this relative increase in prosperity.

The common scenario within all three communities involves an integration of upland rice cultivation with the establishment of tree plantations, whereby rice is intercropped with cashew or rubber trees for a period of three years until the trees mature and become productive. As the trees reach maturity and preclude the continued cultivation of rice, the common practice is to then clear an additional field, or extend the current field, and begin the process again.

While this basic scenario of land usage change is equally descriptive of all three study communities, the most striking distinction can be seen in the level of coordination, planning and an overall awareness of the need for setting limits and maintaining portions of the land for swidden agriculture and forest conservation. Krala village, having been the focus of intensive NGO support for more than a decade, has evolved a strong management structure along with a clearly defined approach to land use planning. As such, each member of the community is highly aware of their rights to land usage as well as their responsibility to the community as a whole. With an eye on livelihood and environmental sustainability, they have developed set limits on the amount of land available for each family, thereby limiting the amount of overall community land that will be converted to commercial production.

VI Conclusions

As land is increasingly viewed as a marketable commodity, especially if planted with valuable crops like cashew or rubber, economic incentives are created to develop forest lands for income or for sale. Demographic growth, both through natural increase and immigration, combined with corruption, economic expansion, challenges the viability of more traditional land management models as natural resources become scarce.

It is clear that land use is changing rapidly in all three study villages, reflecting broader patterns operating in Ratanakiri and other parts of the uplands of mainland Southeast Asia. Some of this change reflects a broad-based agricultural transition from forms of swidden farming to commercial cash crop-

ping, especially the adoption of cashew trees. The commercialization of farming systems has created a new source of income for many indigenous families, while at the same time stimulating land markets and accelerating land alienation. The Krala case study demonstrated the vital role NGOs can play in strengthening indigenous institutions and establishing clear policies on land use and tenure. Because of this support, villagers in Krala are successfully building on new market opportunities while sustaining their forest resources and cultural institutions.

By contrast, communities like Tuy which did not have the support of NGOs are being rapidly transformed into areas where villagers sell their land and migrants move into the areas. At the present time, many Ratanakiri villages are like Leu Khun, struggling to maintain community lands and forests in the face of growing pressures. Whether these communities will share the fate of Tuy and experience a chaotic pattern of land-use and tenure change, or stabilize their resources like Krala and systematically move into new modes of production depends on a number of factors. Even Krala may succumb to disintegration if social systems are not respected.

A key variable is the extent to which these communities will receive support from outside agencies including both NGOs and government programs, and receive some protection from illegal land speculators. In all study areas, villagers noted the importance of NGOs in helping them to retain their communal land and learn how to deal with local government and market forces. The study also showed that long term, sustained community building is a key to success in establishing viable community institutions that can guide land-use and tenure policy making.

Finally, local government officials and community leaders require training and guidance in national land policy and an open and transparent framework for dialogue at the commune, district, and provincial level. There is an urgent need to clarify land and forest resource management rights and responsibilities throughout the province, especially in an effort to protect the ancestral domain claims of the region's indigenous communities. The Forestry Administration has the role and responsibility to demarcate the state public forest domain and to determine which areas are suitable for community forestry. The Forestry Administration also has the role of coordinating with the Ministry of Land Management, Urban Planning and Construction in order to delineate land for inclusion in communal titles of indigenous communities. While much of the legal framework is in place to begin establishing recognized community forestry sites and to begin issuing communal titles, the priority must be placed on the mobilization and strengthening of communities.

Acknowledgements

The authors would like to thank the people of Krala, Leu Khun and Tuy Villages for their support in helping us to understand how their world is changing. The staff of the provincial Department of Land was particularly helpful in providing valuable data on previous land-use mapping activities in the study communities. Special mention should also be given to Non-Timber Forest Project (NTFP) for sharing their experiences, as well as to the staff of the Ratanakiri Natural Resources Management Network (RNRMN), the Highlanders Association, and the Indigenous Communities Support Organization (ICSO). The study also appreciates the support of the John D. and Catherine T. MacArthur Foundation who financed the field work, data analysis and write-up under their Conservation and Sustainable Development Program.

References

Boserup, E. 1965. *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure*. Chicago: Aldine.

Bourdier, F. 1995. *Health, Women and Environment in a Marginal Region of Northeastern Cambodia*. Paper presented at Cuban National Committee of the IGU: Environment, Society, and Development, Cuba. July 31–August 5, 1995.

Brookfield, H. 1972. Intensification and Disintensification in Pacific Agriculture: A Theoretical Approach. *Pacific Viewpoint* 13(1): 30–48.

————. 1984. Intensification Revisited. *Pacific Viewpoint* 25(1): 15–44.

Brown, S.; and Lugo, A. 1990. Tropical Secondary Forests. *Journal of Tropical Ecology* 6: 1–32.

Dove, M. 1982. The Myth of the "Communal" Longhouse in Rural Development: The Kantu of Kalimantan. In *Too Rapid Rural Development*, edited by C. MacAndrews and C. L. Sien. Athens: Ohio University Press.

Fontanel, J. 1967. *Ratanakiri Etude du Milieu Naturel d'une Region Frontiere du Cambodge*. Grenoble: Geographie, Institut de Geographie Alpine.

Fox, J. 2002. Understanding a Dynamic Landscape: Land Use, Land Cover, and Resource Tenure in Northeastern Cambodia. In *Linking People, Place, and Policy: A GIScience Approach*, edited by S. Walsh and K. Crews-Meyer. Boston: Kluwer Academic Publishers.

Fox, J.; and Vogler, J. 2005. Land-use and Land-cover Change in Montane Mainland Southeast Asia. *Environmental Management* 36(3): 394–403.

Fox, J., D.; McMahon M. Poffenberger; and J. Vogler. 2008. *Land for my Grandchildren: Land Use and Tenure Change in Ratanakiri: 1989–2007*. Community Forestry International, Phnom Penh, Cambodia.

IAPAD (Integrated Approaches to Participatory Development). 2009. http://www.iapad.org/resource_mapping.htm

Lebar, F.; Hickey, G.; and Musgrave, J. 1964. *Ethnic Groups of Mainland Southeast Asia*. New Haven: Human Relations Area Files Press.

Malthus, T. R. 1982. *An Essay On The Principle of Population* (1798 1st edition). London: Penguin Classics.

Matras-Troubetzkoy, J. 1983. *Un Village en Foret: L'essartage chez les Brou du Cambodge*. Paris: SELAF.

Rigg, J. 2006. Land, Farming, Livelihoods, and Poverty: Rethinking the Links in the Rural South. *World Development* 34(1): 180–202.

Sarem, K.; Ironside, J.; and Van Rooijen, G. 2005. Understanding and Using Community Maps among Indigenous Communities in Ratanakiri Province, Cambodia. In *Mapping Communities: Ethics, Values, Practice*, edited by J. Fox, K. Suryanata, and P. Hershock. Honolulu: East-West Center.

Southeast Asian Studies, Vol. 47, No. 3, December 2009

Agrarian Land Use Transformation in Northern Laos: from Swidden to Rubber

Sithong THONGMANIVONG,* FUJITA Yayoi,** Khamla PHANVILAY*
and Thoumthone VONGVISOUK***

Abstract

Land use and farmers' livelihoods in mountainous regions of northern Laos are rapidly moving away from subsistence to market based agricultural systems, changing farmers' relationship with land and natural resources. The current study examines patterns of land use change in northern Laos, especially focusing on the expansion of agricultural land in upland areas. It also examines factors that influence local farmers' livelihood and their decisions on land use. A series of government policies that were implemented since the 1980s restricted upland farmers' access to upland fields and fallow forests, and led to the relocation of upland communities. The opening of regional borders for trade in the early 1990s, which brought new economic opportunities for local farmers, further accelerated the demand for agricultural land and led to a concentration of population in settlements along the road. A combination of both external and internal factors are influencing households in rural areas to actively seek new economic opportunities and adapt their livelihood basis, as well as altering their relationship with land and resources. This rapid transformation also questions the effectiveness of the government's resource management policy that developed during the 1990s aiming to control expansion of upland shifting cultivation practices through delineation of resource boundaries.

Keywords: northern Laos, upland, land use, livelihood change, rubber

I Introduction

Recent studies on land use change point out a complex relationship between direct and indirect factors that influence deforestation [Geist and Lambin 2002; Lambin *et al.* 2003]. In order to better understand the cause and process of deforestation, it is not only necessary to observe the physical patterns of change but also examine local contexts, and factors that influence different stakeholders' relationship with resources. Case studies on land use change in Southeast Asia indicate mounting political and eco-

* Faculty of Forestry, National University of Laos
** 藤田弥生, University of Chicago
e-mail: yayoi@uchicago.edu
*** Kyushu University

nomic pressure on commercially valuable natural resources and upland agricultural systems as leading causes of forest degradation [Fox and Vogler 2005; Kummer and Turner 2007].

The current study in northern Laos brings focus to local transformation of land use and livelihoods in Luang Namtha province bordering southwest China where a network of new roads are being developed and improved as part of the Greater Mekong Sub-region's Economic Corridor supported by the Asian Development Bank (ADB).[1] Upland swidden and fallow forests in this region are rapidly being converted into commercial agricultural lands as rural farmers become increasingly engaged in cash crop production [Thongmanivong and Fujita 2006]. The study not only assesses changing land use patterns, but also examines different factors that influence stakeholders' decisions on resource use and management.

In order to examine changing patterns of land use, we have applied a spatial analysis in selected districts of Luang Namtha province. Our study also incorporates interviews with key local stakeholders (i.e. district authorities, farmers and investors) on agricultural production and land use. We also analyzed local stakeholders' narratives on land use to understand complex factors that influence their decisions to regulate what each stakeholder perceived to be external resource users or "others,"[2] while justifying ones own cause for claiming land, and expanding commercial agricultural land use. Finally, our study examines the effectiveness of the government's resource management policy that aims to regulate deforestation in the uplands.

II Research Site and Method

II.1 *Research Site*

Luang Namtha province lies northwest of Laos bordering China and Burma. It's landscape is predominantly mountainous with elevation ranging between 560 to 2,094 m above sea level. The average

1) ADB supports development of Economic Corridors across the Greater Mekong Sub-region, which only includes countries of mainland Southeast Asia and Yunnan Province of China. Three main corridors include North-South, East-West and Southern, while there are numbers of road projects within each proposed corridor (See http://www.adb.org/GMS/). See also Thomas Fuller's article on the implications of the road on regional economies in the New York Times (21 March 2008).

The current research is part of a regional multidisciplinary project funded by the National Science Foundation, and carried out by researchers from the Chiang Mai University of Thailand, the Kunming Institute of Botany of China (Yunnan province), the National University of Laos, the World Agroforestry Centre (ICRAF Chiang Mai) and the East West Center (Honolulu, Hawai'i, U.S.A.). The overall goal of the regional research project is to understand dynamic patterns and drivers of land use and livelihood change across the Mountainous Mainland Southeast Asia (MMSEA). A group of researchers from the Faculty of Forestry of the National University of Laos and the Environmental Program of the East West Center jointly conducted the current study.

2) Often villagers used Lao words like *kachao* and *phun* which is referred to as "them" to distinguish "others" from the villagers themselves or *hao* or *peuak hao* which refers to "us."

annual rainfall is 1,340 mm/year reaching a maximum of 1,800 mm during the rainy season (between April and September). We selected Sing and Viengphoukha districts for our study considering the historical significance of the region as a crossroads for trade, and its mountainous landscape traditionally dominated by forest and upland swidden farming (Fig. 1).

Sing district borders present day Xishuangbanna prefecture of Yunnan province and Burma. Sing district was historically known as a principality[3] of *Xieng Kheng* (which later changed its name to *Muang Sing*) that stretched along the Mekong River and was ruled by ethnic Tai Lue people [Grabowsky 1999]. Yunnanese traders caravanned through *Muang Sing* to and from China, Burma and Siam. Izikowitz [2001], a Swedish ethnographer that reached *Muang Sing* in 1937 illustrated colourful and lively local markets in *Muang Sing* filled with people of different ethnic groups. While the region prospered from trade during the colonial period, trade and livelihoods were disrupted during the Indochina wars, as it became a major battlefront [Mirsky and Stonefield 1970]. Viengphoukha also played an important role in pre-colonial trade as the Yunnanese caravan travelled to and from China and Siam [Walker 1999].

The trade through Viengphoukha and Sing districts persisted during the French colonial administration much to its dismay, and continued until the late 1940s when the Communist took over China and restricted cross border trade. In the period that followed, the Indochina war decimated the population of the region and inhibited regional trade with Thailand.[4] After 1975 when Laos became a socialist country, the region was repopulated. However, regional trade was inhibited due to mounting political tension between Laos, China and Thailand. In 1990, Luang Namtha regained political and economic significance as regional political tensions with neighbouring countries relaxed. The mining and tourism sectors grew as the road networks improved and regional borders were reopened in the early 1990s. Chinese investments in agriculture especially sugarcane and rubber also increased, accelerating conversion of upland swidden and fallow into permanent agricultural land. Concurrently, international and bilateral agencies' supported food security and livelihood improvement programmes in the uplands in an effort to promote sustainable resource management.

II.2 *Research Method*

In order to understand the land use and livelihood changes in northern Laos, the current study incorporates different methods. Spatial analysis was used to assess forest and agricultural land use change in the study sites. Time series satellite images of two districts were analyzed by using a supervised

3) Region ruled by Tai Lue (a branch of Tai-Kadai ethnolinguistic group) prince.
4) According to Evrard and Goudineau [2004], more than 50 percent of the population in Luang Namtha was displaced during the period between 1960s and 1970s.

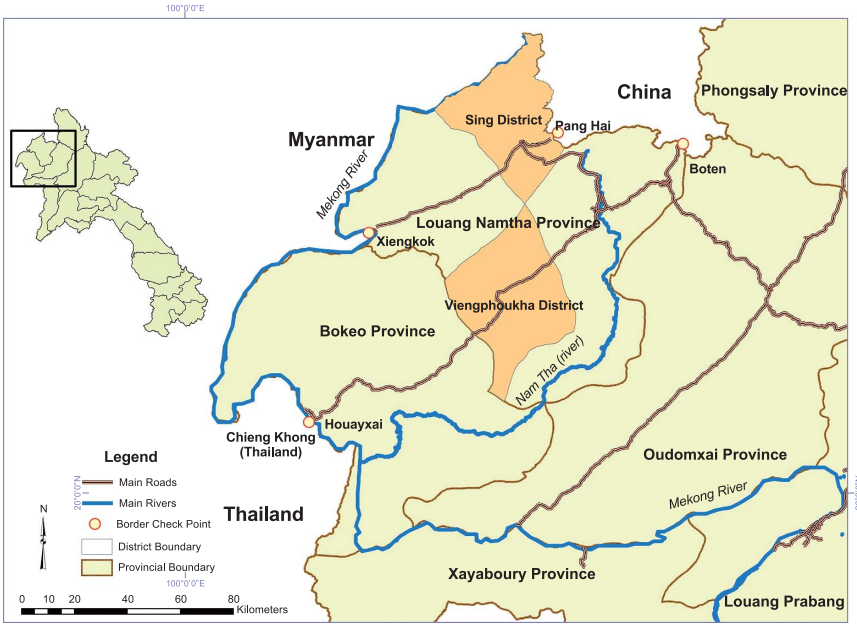


Fig. 1 Map of Northwest Laos and Research Site
(Sing and Viengphoukha Districts)

Source: by Phanvilay

classification method. Based on the interpretation of satellite images and observations in the field, we classified land use into five main categories, which include dense forest, secondary forest, grass and shrub, upland agricultural land, and lowland agricultural land (see Table 1 and Appendix for definition of land use categories).

From the spatial analysis, we can identify land use change patterns such as deforestation, and expansion of agricultural land use in two districts. The results of our spatial analysis were compared with information on agricultural production collected in each district. We also interviewed staff at the District Agriculture and Forestry Office (DAFO)[5] and villagers in the district to understand the causes of land use changes and resource management practices.

Information from 1995 and 2005 Population Census was also spatially analyzed in the current study

5) In August 2005 District Agriculture and Forestry Office (DAFO) was renamed as District Agriculture and Forestry Extension Office (DAFEO) and placed under the supervision of Provincial Agriculture and Forestry Service Centre (PAFESC) to emphasize its role as a provider of extension services. In 2008 PAFESC was reorganized as a division within the Provincial Agricultural and Forestry Office (PAFO). In 2009, DAFEO reverted back to DAFO. In the current paper, we will use DAFO to refer to this line agency of the Ministry of Agriculture and Forestry at district level.

to understand the movement of villages, and distribution of population in two districts over a decade. This allows us to assess areas of population concentration, as well as the mobility of ethnic groups and villages. In order to understand the reasons for population movement in each district, we interviewed local stakeholders including district administrative offices (i.e. District Planning Office, DAFO) and village organizations (i.e. village leaders, village elders).

We also analyzed the narratives of stakeholders in the current study to understand factors that affected their decisions on land use, and actions that they took which influenced the existing land and resource management practice. We interviewed local stakeholders including local government authorities and the development agency (German Technical Cooperation Agency, GTZ), as well as private investors and local farmers to understand their perceptions and reasons for land use change. The narratives of different stakeholders are analyzed in order to examine the effectiveness of government policies that aim to control upland shifting cultivation.

III　Land Use and Demographic Changes

III.1　*Land Use Change*

From the spatial analysis of satellite images, land use change in the study districts are summarized in Table 1. Analysis indicates a greater loss of dense forest area in Sing district from 60 to 40 percent between 1991 and 2004, compared with a less dramatic decline of dense forest in Viengphoukha, which remains at approximately 70 percent of land area. Steady decline of primary forest area in Sing district is replaced by expansion of secondary forest and upland agricultural land. Upland agricultural land in particular has increased from three to seven percent in Sing district between 2000 and 2004. In contrast, both dense and secondary forest declined in Viengphoukha while grass and shrub area increased significantly. During our fieldwork, we found that areas classified as grass and shrub included areas of

Table 1　Landcover and Land Use Changes in Sing and Viengphoukha Districts

Land Use Categories*	Sing			Viengphoukha	
	1991	2000	2004	1997	2007
Dense forest	60%	52%	42%	74%	69%
Secondary forest	23%	36%	35%	21%	12%
Grass and shrub	8%	2%	5%	3%	15%
Upland agriculture	3%	3%	7%	2%	3%
Lowland agriculture	7%	8%	11%	1%	1%

Source: Based on spatial analysis using data from Landsat TM [2007]
Note: * See appendix for definition of each categories.

newly established rubber field suggesting a landscape in transition: from a landscape dominated by forest and long fallow cycle swidden landscape to intensive monoculture.

The results of the spatial analysis questions the effectiveness of government policies during the 1990s that aimed to control deforestation, especially efforts to regulate expansion of shifting cultivation in the upland areas. Provincial and district agriculture and forestry offices led programmes that delineated state conservation forests throughout the 1990s with the support of international donors [See also Fujita and Phengsopha 2008]. Land and Forest Allocation (LFA) policy was among these polices that developed during the early 1990s, and was implemented throughout the 1990s to delineate village boundary and promote forest conservation at the village level.[6] While LFA recognized the customary rights of villagers to access and manage resources, the main goal of the policy was to increase forest conservation by restricting villagers' access to upland swidden fields and fallow forests by converting these lands into different categories of conservation forests.

In both districts, DAFO led the delineation of resource boundaries in villages throughout the 1990s and the early 2000s. It also collaborated with provincial agricultural offices to manage national conservation forest including the Nam Ha National Biodiversity Conservation Area (NBCA), as well as areas designated as provincial conservation forests.[7] However, as Table 1 suggests, that the implementation of policies such as LFA and the introduction of national and provincial forest areas, were far from protecting or increasing dense forest areas.

In contrast to the results from the spatial analysis, agricultural statistics of Luang Namtha province indicate an overall decline of upland rice production area from over 14,000 ha to 6,000 ha between 1990 and 2005 [MAF 2006]. District statistics in Sing district also show a dramatic decline of upland rice production area from over 1,500 ha to 500 ha between 1999 and 2005 [DAFO 2005]. While there is political pressure upon local government agencies to minimize the area of shifting cultivation, we also learnt during the field interviews that an increasing numbers of farmers were converting swidden and fallow forests into permanent agricultural land. In Sing district, farmers converted swidden and fallow forests especially along the road into sugarcane and rubber plantations. In Viengphoukha, farmers are increasingly clearing fallow forests into agarwood and rubber plantations.

The conversion of swidden and fallow forests into permanent agricultural land began early in Sing district, as the formal opening of the regional border with China brought investors from China who

6) LFA is led by local authorities such as DAFO. There is numerous literature which discusses problems of LFA including Vandergeest [2003]; Evrard and Goudineau [2004]; Ducourtieux *et al.* [2005]; Fujita and Phanvilay [2008]; Fujita and Phengsopha [2008].

7) Nam Ha NBCA particularly became a model for eco-tourism, as it provided economic benefits to local communities as well as to the local government in order to maintain forest conservation [Schipani 2007].

provided inputs for local farmers. Land conversion was especially prominent in areas along the road. An increasing number of farmers began to cultivate rubber since 2000, as groups of pioneer farmers that planted rubber during the early 1990s began to sell dried latex to Chinese traders and make profits given the appreciating price of rubber. By 2003, local authorities including the DAFO and District Planning Office (DPO) in Sing District expressed the view that the widespread expansion of rubber, and clearance of forest areas in the upland region, especially along the road, was "out of control."

In Viengphoukha, the conversion of upland swidden and fallow forests into permanent agricultural land is still a new phenomenon. However, since the mid 2000, an increasing numbers of investors from outside of the district are approaching provincial and district authorities to seek land concessions and opportunities to engage local villagers into contract farming. The influx of new agricultural investment in Viengphoukha in the last few years has resulted in the rapid clearance of old fallow forests into permanent agricultural land. Encroachment and clearing of forest is also becoming a critical issue in Nam Ha NBCA [Schipani 2007].

III.2 *Demographic Change*

Based on the 2005 Population Census, the total population in Sing district and Viengphoukha is 30,548 and 18,800 respectively. The average annual growth rate of the population between 1995 and 2005 in two districts was 3.6 and 5.3 percent respectively, higher than the national average of 2.3 percent [NSC 1995; 2005]. Fig. 2 spatially represents census data from two districts to understand demographic changes. We crosschecked village names with local authorities and corrected locations during the fieldwork. In both districts, population became highly concentrated along the road over time.

Table 2 also shows that the number of registered villages declined in the two districts between the two census periods. The decline of villages are due to both government policy encouraging relocation, and due to spontaneous relocation. During the 1990s, the government encouraged the consolidation (*kan taohom*) of small upland communities to areas along the road where district government can provide public services such as schools and health care. The effort was often supported both directly and indirectly by international donors to develop "focal sites" for rural development [Baird and Shoemaker 2007]. Both Table 2 and Fig. 3 indicate that consolidation particularly affected upland minority villages: Akha people in Sing district, and Khmu people in Viengphoukha.

Although we observe "consolidation" of upland villages and the relocation of upland communities to areas along the road, Cohen [2000] claims that in Sing district, the district governor abandoned plans to relocate upland communities in the mid 1990s. This was based on considerations to curtail any emerging ethnic tensions over access to resources in the lowland and its periphery where productive

Table 2 Numbers of Villages by Ethnicity

Sing Ethnic Groups	1995	2005	Viengphoukha Ethnic Groups	1995	2005
Tai Lu, Nua, Dam	28	25	Tai Lu, Yang	3	3
Khmu	1	1	Khmu	44	26
Akha	69	55	Akha, Kui	7	9
Hmong, Mien	9	9	Hmong	2	2
Mix	3	4	Mix	9	6
Total	110	94	Total	65	46

Source: Based on National Census of 1995 and 2005

agricultural land was increasingly becoming scarce. Representatives from DAFO also confirmed during the interview that the "district no longer supported relocation" since 2000 but that the problem persisted: "more (upland) people wanted to come down." This indicated that movement of the upland population was not only directly influenced by the government's consolidation policy but triggered due to the emerging economic opportunities especially in areas with road access.[8)]

In their studies, Evrard and Goudineau [2004] as well as Vandergeest [2003] claim that more recent cases of displacement in Laos are being induced by development projects and government policies. For example, policies that restrict upland farmers' access to agricultural land, such as LFA, have led to shorter periods of fallow and loss of agricultural productivity [Lestrelin and Giordano 2007]. As a result, farmers are forced to seek new economic opportunities for family survival including the option of relocation [Vandergeest 2003]. Cohen [2000] and Lyttleton *et al.* [2004] claim that government policies regulating shifting cultivation and opium production in Sing district led many upland Akha people to become more dependent on agricultural wage labour outside of their own villages. Based on our fieldwork, we also found that government policies pressured households to adapt their land and resource use practices. However, at the same time household responses to political and economic pressures were variable. Households with capital and social assets adopted new agricultural practices (i.e. lowland paddy rice cultivation) and commercial crops (i.e. rubber, sugarcane). Their adaptation to emerging economic opportunities involves early migration to new territory, as well as the transformation of old swidden and fallow fields into permanent agricultural land, excluding "other" users. On the other hand, households with less capital and social assets are becoming dependent on wage labour and economic opportunities outside of their villages while loosing access to communal land and resources [See also Thongmanivong and Vongvisouk 2006].

8) Based on interviews with villagers, as well as personal communications with staffs from GTZ, and DAFO.

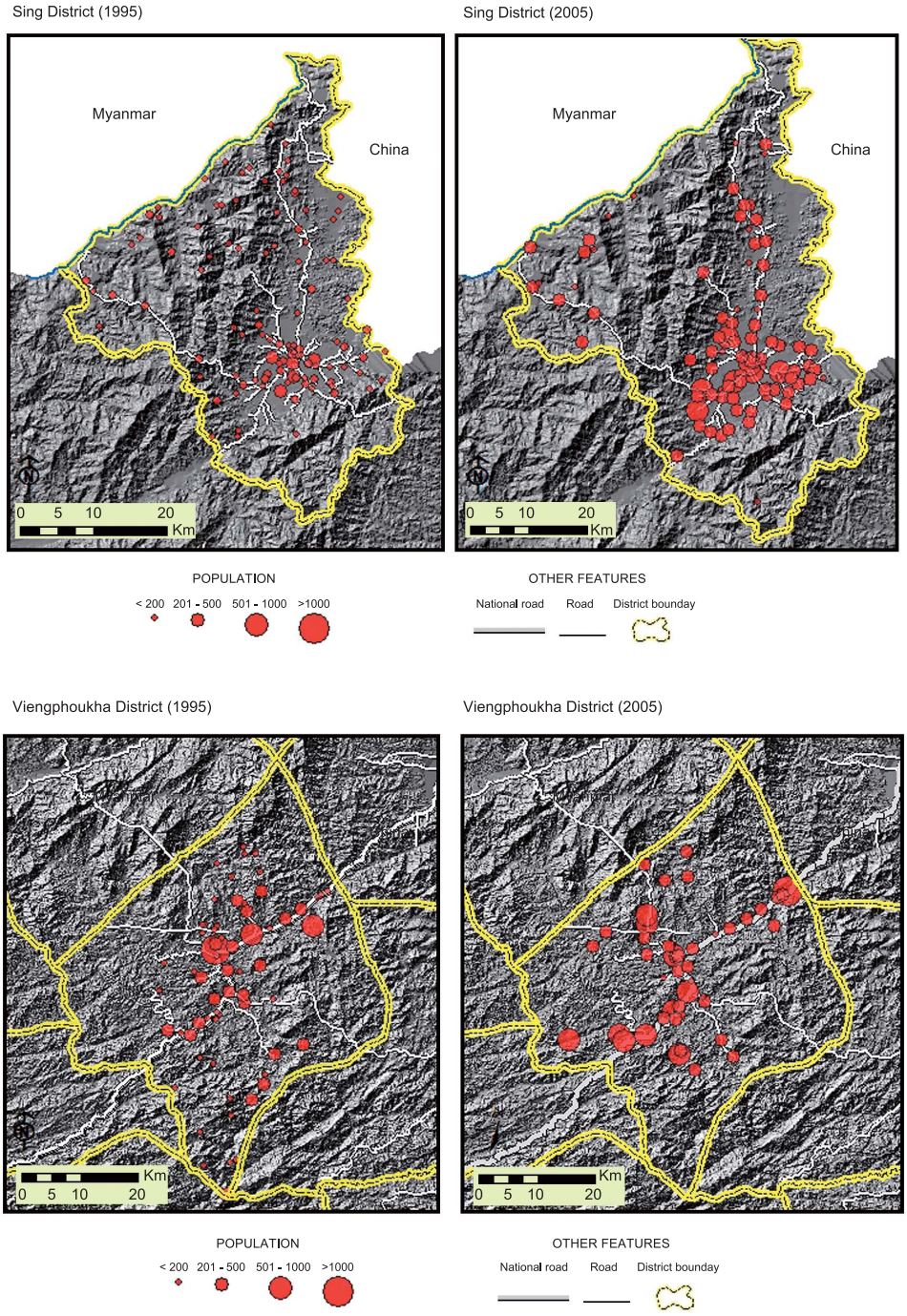


Fig. 2　Population Distribution in Sing and Viengphoukha (1995–2005)

Source: Based on National Census of 1995 and 2005

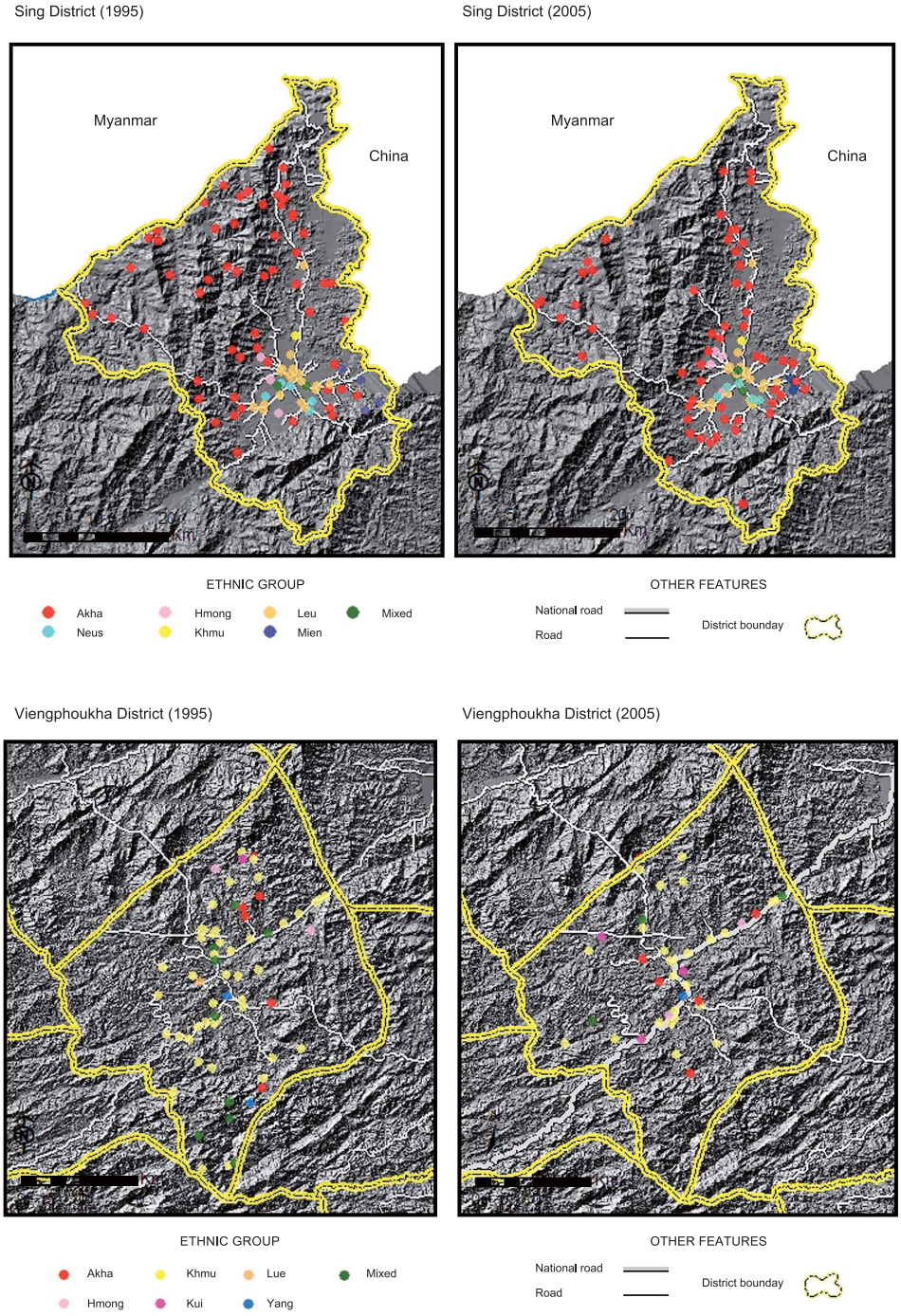


Fig. 3 Ethnic Distribution in Sing and Viengphoukha District (1995–2005)
Source: Based on National Census of 1995 and 2005

IV　Narratives of Stakeholders

In this section, we examine the narratives of local farmers in Sing district to understand the causes of land use and livelihood change. We also examine the narratives of investors that support the expansion of rubber cultivation in Sing district, as well as the narratives of local authorities on development and management of resources in the upland region.

IV.1　*Farmers*

The first Akha farmers that planted rubber in Sing district included a village leader and his family from a village located in Mom sub-district along the national border with China. The family's biggest motivation for planting rubber was its profitability. Since the opening of the border with China, it became easier for villagers to visit their relatives on the other side of the border. "Our relatives in China were poor like us before. Now they are rich because they plant rubber. They live in a nice house, they have motorcycles."[9] Village leader's family already accumulated wealth from livestock and sugarcane. Village leader considered rubber as a long-term investment for his family.[10] He was the first in his village to claim and convert areas of swidden and fallow land into a rubber field. He was also the first to convert areas of sacred forest into smallholder rubber. He claims "people used to be afraid of spirits in the past, but now the spirits are afraid of people," indicating a change in customary rule for managing sacred forest.

In a neighbouring lowland Lu village, villagers also began to cross the border into China when the road was improved in the early 1990s. Starting in the same period, villagers also began to cultivate sugarcane for a Chinese sugar factory. They used old swidden and fallow fields surrounding their village, as this was the customary territory of the village. It was traditionally reserved as an agricultural land during difficult times, especially when the yield from rice paddy was low. It was also a communal resource where villagers collected forest products, and grazed cattle. Access for this land by other villagers were loosely recognized until 2000 when the villagers began to cultivate rubber. By then the population in the areas surrounding the village also became denser as upland Akha people relocated to the area. Although the newly introduced LFA defined village boundaries, demand for agricultural land grew and pressures on forest areas increased as the farmers' production shifted from subsistence-based

9) Akha or Hani farmers on the other side of the border in Xishuangbanna prefecture in China began to plant rubber during the mid 1980s (1982–85) after the Chinese government allocated agricultural lands to households for smallholder production of rubber See also Chapman [1991] and Sturgeon [2004].

10) Sugarcane was considered as less of a long-term investment, as it required capital for replanting every three to five years.

to market-based agricultural production system focused on crops such as rubber. Furthermore, pressure on forest areas was aggravated as the provincial governor of Luang Namtha granted rights to local military unit to clear forests in the village along the Chinese border to plant rubber, encroaching into the village conservation forest. This created resentment and anxiety among the villagers and accelerated their efforts to make claims to existing land prior to "others," including neighbouring villagers and state agencies.

According to a representative of DAFO in Sing district, incidences of encroachment, and overlapping claims to agricultural land became rampant from 2000, as increasing numbers of farmers began to engage in commercial farming. "Most of the villages in our district now plant rubber." DAFO was one of the district authorities where village leaders reported complaints of "others" encroaching into their village territory. This notion of "others" often included neighbouring villagers that encroached into one's village, as well as state agencies such as the local military unit, as well as relatives and traders from China, and local politicians that supported few villagers to plant rubber. Increased competition over resources caused conflicts among villagers and "others." The competition was not only externally induced. In some of the villages, farmers reported incidences where young seedlings were stolen from the fields by village members indicating a persisting conflict within the village.

IV.2 *Investors*

Since 2000, there are a total of 16 Chinese and four Lao companies registered to promote rubber plantations in Luang Namtha [PCIP 2008]. The majority of these investors registered officially after 2005. Chinese investors promoting rubber favour Luang Namtha for its proximity to Xishuangbanna and its similar climatic and environmental setting. Many of the investors from China that officially registered their business in Luang Namtha also justified their cause claiming that land is abundant and "under utilized" in northern Laos, and that rubber would bring "development and progress" to the region and alleviate the backward ethnic minorities from rural poverty. Other Chinese investors emphasized the importance of rubber as "an alternative to opium production" and that their investment will help to "industrialize" the agricultural sector in Laos. Chinese investors also claimed that they were equipped with "experience," and "scientific knowledge" to promote rubber in Laos. These positions and perspectives taken by Chinese investors reflect politicized motivation of their investment activities in Laos. There is also an economic motivation for investment in Laos, as one Chinese investor claims, "it is cheaper to set up a rubber plantation in Laos compared to China." This is due to a lower cost of labour and land in Laos.

On the other hand, numerous other small-scale investments operate locally without official regis-

tration [See also Shi 2008]. For instance, an owner of a small agriculture trading company based in Sing district is an ethnic Han born in China near the Lao border. He moved to Sing district in the late 1980s and started a small furniture business. He then built a guesthouse catering to Chinese business persons and labourers in the early 1990s as the regional border was re-opened for trade. As he made connections with representatives of the State Seed Company in Xishuangbanna, he began to sell agricultural inputs supplied through the State Seed Company to local farmers in Laos. He provided high-yielding rice varieties and vegetable seeds as well as other inputs such as fertilizers and pesticides to Lao farmers on credit. The trader then purchased products after harvest and sold them in China.

In the late 1990s, the trader began to invest in rubber. His company first rented land from local farmers in Sing district and produced rubber seedlings. Then, the company approached local farmers that wanted to plant rubber, and offered to provide inputs and a service to plant rubber for them in exchange for sharing 50 percent of planted trees on farmers' land. He explained his operation as such that "villagers kept their land and trees while I maintained my share of trees." This arrangement allowed the trader to maintain rubber with his own company workers. In other words, the Chinese trader did not have legal access to rubber fields but by negotiating directly with local farmers he gained *de facto* access to land. The arrangement is beneficial for the Chinese trader from three main perspectives. First, he gained access to land without formal land registration. Secondly, his company can manage plantation with skilled labour from China and maintain productivity of rubber trees, ensuring a steady supply of latex. Thirdly, by directly negotiating and agreeing on the terms and conditions of investment with villagers, his company did not register their new investment activities. Instead, local villagers reported rubber planting as their own agricultural investment to DAFO.

Such small-scale investment practice is not only limited to the Chinese. Similarly, relatively well-off local individuals in Laos are acquiring land outside of their own village to plant rubber. In one Lu village, an entrepreneurial farmer provides inputs on credit to Akha farmers in a neighbouring village. In return, Akha farmers agreed with the Lu farmer-investor to share 50 percent of their profits from sales of latex. However, many Akha farmers lost their rubber trees prior to tapping as they continued to borrow money and rice on credit from the Lu villager-investor. The accumulating debt is settled by giving away the right to own the rubber trees. As the Akha farmers gave their rights away, the Lu investor regained access to upland agricultural land, which was once part of his village but was allocated to Akha migrants during the 1990s following the LFA. Although the land still officially belonged to Akha farmers, the rubber trees belonged to the Lu investor giving him *de facto* tenure to land. The Lu investor says that he needs to "train and hire Akha people" when the tapping begins.

The narratives of small-scale investments in Sing district indicate a high success of informal invest-

ment arrangement to set up a rubber plantation involving local traders and farmers. Officially registered investors on the other hand are struggling with local bureaucracy to find land and setting up their activities in Luang Namtha. A representative of a registered Chinese company based in Sing district is frustrated with the reluctance of district authorities to assist his company's investment project through the Provincial Committee Investment and Planning (PCIP) after it was approved by the provincial governor. The company registered investment activity to plant rubber and develop a processing factory in the northern areas of Sing district. According to the representative of the company, delay is largely caused by DAFO, which is authorized to identify 500 ha of land for the company to promote contract farming with local farmers. The representative of the company complained about the frequent "changes" and "lack of consistency" in government policy in Laos.

IV.3 *Local Policy Makers*

As part of the national effort to decentralize the decision-making process, and to expedite screening process, PCIP is authorized to screen investment under a million US dollar and seek approval from the provincial governor. In Luang Namtha, the governor encourages foreign investment, but he declared in 2005 that rubber should not be promoted as a concession but instead involve farmers without taking away their rights to land. Following the governor's decision, PCIP also encouraged smallholder rubber investment in Luang Namtha. Representatives of PCIP consider that smallholder rubber can create economic opportunities for rural households and alleviate poverty. However, under the current process of screening and approving investment proposals, neither the availability nor suitability of land for rubber is fully considered by a joint investment committee led by PCIP prior to the investment approval. There is hardly any consideration on whether local farmers are willing to participate in the proposed investment activity. Instead, PCIP authorizes PAFO and DAFO to define the land area for investors after the governor approves investment proposal.

Luang Namtha's PAFO supports rubber as one of the potential cash crops that farmers can introduce to their upland agricultural system in order to minimize their dependence on shifting cultivation. Both PAFO and DAFO take a position that shifting cultivation (*tang pa het hai*) is a cause of deforestation. However, foresters at PAFO that led forest conservation activities and LFA in the province during the 1990s are concerned about the increasing conflicts over land, particularly as interest in rubber became widespread. "In the past, land was abundant and cheap, people traded and transferred (land) without payment. Now with increased interest in rubber, the land value has increased. Poor households are often disadvantaged in making claims to land. Communal land areas are lost." This suggested a break-down of communal resource management practices due to changing livelihood and agricultural system

in rural communities. Members of PAFO felt that the encroachment into conservation forests was threatening the management framework introduced during the 1990s. Members of PAFO especially emphasized the need for the "scientific assessment considering the suitability for rubber" prior to the investment decision and reconsidering the existing resource management framework including LFA to accommodate the growing demand for agricultural land use. This implied a criticism of current investment approval process that disregarded the existing resource management framework.

At the district level, DAFO is faced with mounting pressures to resolve conflicts over access to land and resources as investors and government agencies demand land and labour for rubber, and also at the same time as local villagers and small-scale investors clear upland forests for rubber. The widespread interest in rubber among multiple stakeholders makes it difficult for members of DAFO to mediate and resolve conflicts effectively using the existing resource management framework. The premise of existing resource management framework, such as LFA assumes a subsistence livelihood basis of upland farmers, and prioritizes forest conservation. It has not adapted quickly to accommodate to the growing demand for agricultural land use. Furthermore, a lack of clear legal tenure for customary land further resulted in open-access resource problems compounded by a rising numbers of people accessing resources and a high demand for agricultural commodities such as rubber.

V Conclusion

Our case study in northwest Laos indicates an increasing expansion of upland agricultural land at the expense of forest loss and degradation. The conversion of swidden and fallow forest into commercial agricultural land is especially rampant in areas along the road where population is concentrated. In both Sing and Viengphoukha, ethnic minority groups such as Akha and Khmu whose livelihood once was dependent on upland agricultural system are significantly affected by this change. The movement of population is not only due to government policy to consolidate rural villages, but also a combination of responses to government policies that regulate upland farmers' access to land and resources (induced migration), and a response to new economic opportunities (spontaneous migration).

As our study showed, tracts of old upland swidden and fallow forests that were classified as conservation forest during the 1990s are especially under pressure of being converted into rubber plantations. The limited capacity of local agencies including PAFO and DAFO, as well as village communities, to regulate overlapping claims to resources means that clearing and planting rubber is a direct means to exclude "others" and justify one's own claim to land. As we have seen in the narratives of farmers and investors, the planting of rubber, a long-term crop is often a direct way of acquiring exclu-

sive rights to land regardless of the ambiguous legal status of land ownership. The expansion of rubber thus, commoditizes the upland swidden and fallow forests, which had been a part of the customary resources of the past. This not only magnifies the weakness of current resource management institutions such as LFA by questioning its basic assumption and premises, but also leads to a break down of communal resource use and management practices.

Farmers' narratives provide an insight into factors that influenced their decision to introduce new commercial crops like rubber in their upland agricultural system. Many farmers were influenced through knowledge about rubber conveyed through their sometimes transboundary social networks more so than through the government extension programs. The success of farmers in China and in Laos that adopted rubber earlier stirred farmers' interest in the new crop. Information about the increasing price of rubber also attracted upland farmers that were already growing sugarcane on swidden and fallow lands. Regardless of the drop in the price of rubber during 2007 and 2008, farmers continue to indicate an interest in rubber as a long-term investment. As we have seen in the narratives of farmers, some are anxious of losing access to land and potential economic opportunities to "others." The breakdown of resource management framework also implies that planting rubber is a means to secure one's claim to land. The narratives of investors also highlight different ways in which investors approach local farmers in order to access land. Our study highlights that small-scale investors based on existing family and business ties are more successful in making claims to land and operating their investment as they directly negotiate with farmers.

Our study also elucidates the presence of pioneer farmers, or farmers that are able to quickly transform their existing asset such as livestock, or profit from other commercial crops (i.e. sugarcane, maize, watermelon, etc.) in order to capture emerging economic opportunities. By planting a long-term crop like rubber on swidden and fallow forests, which had been a communal resource but is now becoming an open-access resource, pioneer farmers legitimatize their claims to land, while excluding other resource users. Competition for agricultural land is increasingly intensifying in our case study site, especially as farmers find different ways to work with investors. Other than formal contract farming, there are other small-scale investors including relatives, and local traders, wealthy local individuals and politician that provide inputs for farmers quickly and more flexibly based on informal arrangements.

Finally, our study suggests the need to consider the effects of the market economy on different groups of households. While there are farmers that can quickly mobilize assets and adapt their production system to the market economy, others are loosing their land-based assets and becoming increasingly dependent on wage-labour. Widespread conversion of swidden and fallow forests into rubber particularly affects the latter group of farmers, as buffer resources from swidden and fallow forests for

food and income are lost. Another pressing issue for the latter group of farmers is the limited livelihood option as they begin to loose access to land and resources, forcing them to relocate as the only option for their survival.

Appendix

Definition of land use classification categories

Dense forest	Land cover dominated by trees and has crown cover density of 20 percent or higher. Trees have DBH (Diameter, Breast, and Height) measurement of more than 10 cm and height is more than 10 m tall. These land cover are usually classified as protection forest, conservation forest and are found on steep terrain that are difficult to access.
Secondary forest	No presence of large trees but mostly dominated by bamboo. Trees have DBH of less than 10 cm and are shorter than 10 m. Most of this area is old swidden fallow forests. This category is found throughout the district, and often is adjacent to active swidden fields.
Grass and shrub	This type of land cover is often a young fallow field where the vegetation is predominantly bushes and grass. However, in some instances this includes recently established rubber plantations.
Upland agriculture	All agricultural lands with slopes greater than 8 percent. This includes active shifting cultivation area, and areas that were newly cleared for agricultural purpose (i.e. rubber, sugarcane production).
Lowland agriculture	All agricultural lands with slope equal to or less than 8 percent. This category is mainly lowland paddy field, pasture for cattle grazing and other clear lands.

References

Baird, I. G.; and Shoemaker, B. 2007. Aid or Abetting? Internal Resettlement and International Aid Agencies in the Lao PDR. *Development and Change* 38(5): 865–888.

Chapman, E. C. 1991. The Expansion of Rubber in Southern Yunnan, China. *Geographical Journal* 157(1): 36–44.

Cohen, P. 2000. Resettlement, Opium, and Labour Dependence: Akha-Thai Relations in Northern Laos. *Development and Change* 31: 179–200.

Committee for Planning and Cooperation, Northern Eight Provinces and Asian Development Bank. 2004. *Lao People's Democratic Republic: Northern Region Development Strategy Executive Report*. Vientiane.

DAFO (District Agriculture and Forestry Office). 2005. *Agricultural Statistics*. Sing District. Luang Namtha Province.

Ducourtieux, O.; Laffort, J.-R.; and Sacklokham, S. 2005. Land Policy and Farming Practices in Laos. *Development and Change* 36(3): 499–526.

Evrard, O.; and Goudineau, Y. 2004. Planned Resettlement, Unexpected Migrations and Cultural Trauma in Laos. *Development and Change* 35(5): 937–962.

Fox, J.; and Vogler, J. 2005. Land-Use and Land-Cover Change in Montane Mainland Southeast Asia. *Environmental Management* 35(5): 1–10.

Fujita, Y.; and Phanvilay, K. 2008. Land and Forest Allocation in the Lao People's Democratic Republic: Comparison of Case Studies from Community-Based Natural Resource Management Research. *Society and Natural Resources* 21: 120–133.

Fujita, Y.; and Phengsopha, K. 2008. The Gap between Policy and Practice in Lao PDR. In *Lessons from Forest Decentralization: Money Justice and the Quest for Good Governance in Asia-Pacific*, edited by C. Colfer; G. R. Dahl; and D. Capsitrano, pp. 117–131. London: Earthscan.

Fuller, T. 2008. In Isolated Hills of Asia, New Roads to Speed Trade. 21 March, 2008 *New York Times*. New York.

Geist, H. J.; and Lambin, E. F. 2002. Proximate Causes and Underlying Driving Forces of Tropical Deforestation. *BioScience* 52(2): 143–150.

Grabowsky, V. 1999. Introduction to the History of Muang Sing (Laos) Prior to French Rule: The Fate of a Lu Principality. *Bulletin del Ecole Francaise d'Extreme-Orient* 86: 233–291.

Izikowiz, K. G. 2001. *Lamet: Hill Peasants in French Indochina*. Bangkok: White Lotus. Originally published in 1951 by Ethnographic Museum, Gothenberg.

Kummer, D. M.; and Turner II, B. L. 2007. The Human Causes of Deforestation in Southeast Asia. *Bioscience* 44(5): 323–328.

Lambin, E. F.; Geist, H. J.; and Lepers, E. 2003. Dynamics of Land-use and Land-Cover Change in Tropical Regions. *Annual Review of Environment and Resources* 28: 205–241.

Lestrelin, G.; and Giordano, M. 2007. Upland Development Policy, Livelihood Change and Land Degradation: Interactions from a Laotian Village. *Land Degradation and Development* 18(1): 55–76.

Lyttleton, C.; Cohen, P.; Rattanavong, H.; Thongkhamhane, B.; and Sisaemgrat, S. 2004. *Watermelon, Bars and Trucks: Dangerous Intersections in Northwest Lao PDR.* Macquarie University.

MAF (Ministry of Agriculture and Forestry). 2006. *Agricultural Statistics*. Vientiane.

Mirsky, J.; and Stonefield, S. E. 1970. The Nam Tha Crisis: Kenney and the New Frontier on the Brink. In *Laos: War and Revolution*, edited by N. S. Adams and A. W. McCoy, pp. 155–178. New York, Harper and Row.

NSC (National Statistic Center). 1995. *1995 Population Census*. Vientiane: Department of Statistics.

————. 2005. *2005 Population Census.* Vientiane: Department of Statistics.

PCIP (Provincial Committee for Investment and Planning). 2008. *Internal and External Rubber Investment in Luang Namtha Province*. Luang Namtha: PCIP.

Schipani, S. 2007. Ecotourism as an Alternative to Upland Rubber Cultivation in the Nam Ha National Protected Area, Luang Namtha. *Juth Pakai* 8: 5–17.

Shi, W. 2008. *Rubber Boom in Luang Namtha: A Transnational Perspective*. Vientiane, Rural Development in Mountainous Areas of Northern Lao PDR, German Technical Cooperation (GTZ).

Sturgeon, J. 2004. Post-socialist Property Rights for Akha in China: What is at Stake. *Conservation and Society* 2(1): 139–161.

Thongmanivong, S.; and Fujita, Y. 2006. Recent Land Use and Livelihood Transitions in Northern Laos. *Mountain Research and Development* 26(3): 237–244.

Thongmanivong, S.; and Vongvisouk, T. 2006. Impacts of Cash Crops on Rural Livelihoods: A Case Study from Muang Sing, Luang Namtha Province, Northern Lao PDR. In *Hanging in the Banlance: Equity in Community-Based Natural Resource Management in Asia*, edited by S. Mahanty, J. Fox, M. Nurse, P. Stephen and L. McLees, pp. 106–121. Bangkok: Regional Community Forestry Training Center and East-West Center.

Vandergeest, P. 2003. Land to Some Tillers: Development Induced Displacement. *International Social Science Journal* 55(175): 47–56.

Walker, A. 1999. Regimes of Regulation: 18001988. In *The Legend of the Golden Boat: Regulation, Trade and Traders in the Borderlands of Laos, Thailand, China and Burma*, edited by A. Walker. Honolulu: University of Hawai'i Press.

Southeast Asian Studies, Vol. 47, No. 3, December 2009

Changing Adaptive Strategies of Two Li Ethnic Minority Villages in a Mountainous Region of Hainan Island, China

UMEZAKI Masahiro* and JIANG Hongwei**

Abstract

The authors reconstructed the changes of adaptive strategies in two Li ethnic minority villages (Shuiman and Paori villages) in Hainan Island of China. Shuiman village lies at the foot of Mount Wuzhishan and has been influenced by government by-laws for environmental conservation and tourism promotion since the 1990s, while Paori village has adopted cash crops that have been introduced by the government since the 1980s. The interview surveys conducted with the villagers, together with the analyses of satellite images indicated that in Shuiman village, the past grasslands became secondary forest dominated by *Haname lidacea* over the past 20 years, while, in Paori village, the shrub/grasslands and secondary forest as well as the place where slash-and-burn gardening was practiced, were converted to cash crop gardens. The area of "mature forest" or "secondary forest" has increased in both village territories. "Triggers" of such changes were enforced by government by-laws in Shuiman and the villagers' adoption of cash crops after "epochal" events in Paori village. External factors such as the price of cash crops on world markets and the conditions of infrastructure also affected changes in the adaptive strategies of the villages.

Keywords: cash crops, tourism, Li, Hainan, China

I Introduction

Hainan Island is located to the south of the Chinese mainland. In 2000, about seven million people inhabited the island with its subtropical monsoon environment. It was until recently one of the least developed regions in China. Large cities developed only in coastal regions and the road network did not fully extend to the mountainous inland until the 1970s. Developmental inequality between the coastal region and the inland region was remarkable. Since the 1980s when the transition from a planned economy to a market economy took place in China, various development projects have been launched,

* 梅崎昌裕, Department of Human Ecology, Graduate School of Medicine, University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo 113-0033, Japan
e-mail: umezaki@humeco.m.u-tokyo.ac.jp
** National Museum of Japanese History, 117 Jyonai, Sakura, Chiba 285-8502, Japan

first in the eastern coastal regions and then extended to the inland [Liang, Umezaki and Ohtsuka 2003]. In 1988, the entire Island became Hainan Province (previously Hainan Island was part of Guangdong Province). The province was designated a Special Economic Zone (SEZ) by the Chinese government for the promotion of tourism and economic development. Since then, a huge amount of money has been invested in development projects by enterprises from mainland China or foreign countries, and since the 1990s it has been one of the most rapidly developing provinces in China.

We have conducted human ecology studies in Wuzhishan region of Hainan Island since 2000 [Shinohara 2004]. Our major concern was to reconstruct the transformation of the adaptive strategies of the ethnic minority communities which are under drastic change. In Wuzhishan region, the enforcement of new government policies was regarded as the fundamental trigger of change. Tourism policy, for example, together with an environmental conservation policy, affected people's daily subsistence behaviour in urban/peri-urban areas or the area around Mount Wuzhishan. In contrast, in the remaining areas, particularly along the major road at relatively lower altitudes, economic development policy initiated change in the indigenous food production system toward the market economy by introducing cash crops. Transformation in resource management and social organization followed in either of the areas, which eventually affected the health status and the welfare of the people, as well as the biomass and biodiversity of the natural environment surrounding the communities. Accordingly, land cover and use have changed drastically.

In the present article, we describe the changes in two inland communities, one from the area around Wuzhishan Mountain and the other from the area along the major road, in Wuzhishan region of Hainan Island. Special attention is paid to clarifying the internal and external "triggers" for each change and the consequent changes in land cover and land use.

II Research Localities

Wuzhishan city is located in the mountainous inland, some 250 km to the south of Haikou (the provincial capital) and 90 km to the north of Sanya (tourism centre). It is the home of the Qi dialect of the Li ethnic minority, and the autonomous government of Li and Miao ethnic minorities existed until the 1980s. The name of the region came from Mount Wuzhishan (1,867 m above sea level) located in the northeast of the current city territory (Fig. 1). Since mature forest and rich flora and fauna have been well preserved, a nature reserve was established on the mountain and its surrounding areas in 1986. This became a resource for tourism development since the early 1990s.

The introduction of market-oriented cash cropping and tourism were two major development

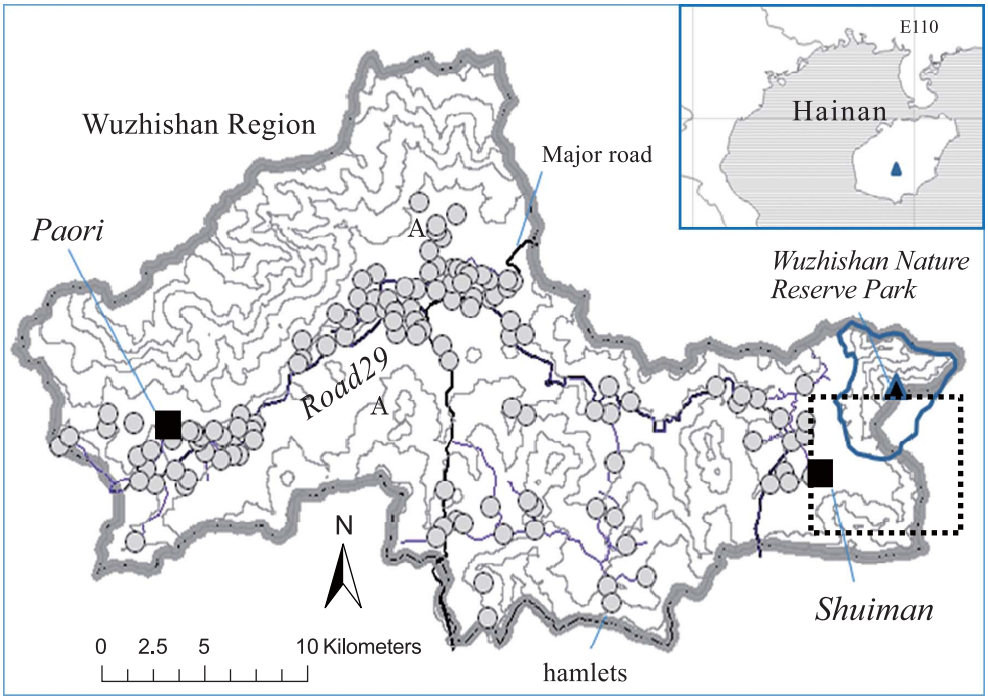


Fig. 1 Locations of Hainan Island, the Study Villages (Shuiman and Paori) and Mount Wuzhishan

Note: Contour line marked "A" shows the altitude of 300 m; interval between contour lines is 100 m. A dotted line square shows the coverage of IKONOS image shown in Fig. 3.

projects which were implemented in different intensities according to the infrastructure and environment in each area. Bananas, rubber, lychee and longan have been mainly introduced to the villages along the major road at relatively lower altitudes, while tourism development has been limited to urban/peri-urban areas and to the villages around Mount Wuzhishan.

Fieldwork was conducted in two Li ethnic minority villages, Shuiman and Paori (Fig. 1). Shuiman village had 190 people (32 households), while Paori village had 179 people (28 households) in 2001. Shuiman village lies at the foot of Mount Wuzhishan and has been influenced by tourism development, while Paori is on provincial road No. 29 (constructed in 1965) and has sought to increase income with cash cropping.

III　Shuiman Village

III-1. *Transformation of Food Production System from 1930 to 1980*

Summarizing the Chinese literature on the Li people in the 18th and 19th century, Nishitani [2004] showed

that all people living near Mount Wuzhishan conducted shifting cultivation, hunting and gathering. Rice cultivation in paddy fields seems to have started about the beginning of the 20th century. A German ethnographer who traveled in Hainan Island in 1931 and 1932 stated that the people who lived near Mount Wuzhishan conducted rice cultivation in paddy fields and shifting cultivation in the mountains. Large areas around the villages were maintained as grassland through regular burning and people depended more on shifting cultivation than on rice cultivation in paddy fields for their livelihood. Rice, maize, foxtail millet, finger millet, sweet potato, bean, pumpkin and tobacco were planted in slash-and-burn gardens [Stübel 1937]. Monkeys and birds that damaged the crops in the gardens and deer in the forest were hunted. Villagers gathered wild edible plants instead of growing leafy vegetables in gardens. There was only one rice crop a year.

In the 1930s there were two villages 4–5 km further up the river from Shuiman. In 1958, their people were moved to Shuiman to create a single collective. During the period of "planned economy" between 1958 and 1980, the collective farm practiced rice cultivation in paddy fields and slash-and-burn cultivation in the areas around the village. Buffaloes were reared collectively in the grassland far from the villages.

III-2. *Transformation of Food Production System from 1980 to Present*

With the nation-wide economic-system transition from a planned economy to a market economy in the early 1980s, the collective was disbanded as an economic unit and the "Household Production Responsibility System" was introduced. Each household started to produce various crops in addition to rice in paddy fields so as to improve their own economic status. Also in 1984 a road passable by cars and trucks reached a small town 3 km from Shuiman, and a small path was constructed to Shuiman village in the late 1980s. Wuzhishan Nature Reserve was established in 1986 with 13,435 ha of land [Li *et al.* 2001]. The reserve covered all territory of the former small villages together with the eastern part of Shuiman village. The Hainan Provincial by-law for Nature Reserves prohibits the construction of buildings in nature reserves, deforestation, cattle grazing, hunting, gathering medicinal herbs, clearing for cultivation, collecting soil and stones, and mining. After this by-law was enforced, the people in Shuiman village abandoned slash-and-burn gardening in the mountain and regular burning for the maintenance of grassland. The frequency of hunting and gathering in the reserve was also reduced.

After these changes, the land use pattern of Shuiman changed drastically. The sites previously used for slash-and-burn gardens and the grasslands around the villages changed to secondary forest. People explained that the secondary growth currently dominated by *Haname lidacea* were the previous grasslands, while secondary growth where we could find pioneer species such as *Alchornea liukiuensis*

hayata and *Mallotus japonicus* were former slash-and-burn gardens. We can use this ethnobotanical knowledge to reconstruct the past distribution of grassland and slash-and-burn gardens as will be described later. The area presently used for cultivation is far smaller than that used in 1980.

The introduction of cash crops paralleled the abandonment of slash-and-burn gardens and grasslands. Crops such as bananas, tea, a species of medicinal herb (*Alpinia oxyphylla*) and a timber tree (*Cunninghamia lanceolata*) were planted in slope gardens behind the paddy fields. In 2001, the average area per household for bananas was only 0.18 ha, 0.01 ha for tea, 0.13 ha for *Alpinia oxyphylla*, and 0.03 ha for *Cunninghamia lanceolata*. Pigs, ducks and fish were also reared. Rubber (*Hevea brasiliensis*), longan (*Dimocarpus longan*) and lychee (*Litchi chinensis*), the major cash crops in lower areas in Hainan, were introduced to Shuiman but did not grow due to the cooler environment. Overall, cash cropping in Shuiman provided only a marginal income.

The intensification of rice cultivation in paddy fields was another notable change in Shuiman village. Hybrid cultivars of rice have been planted since the 1980s, to which fertilizer and pesticide sold by the national agricultural institutions were applied. Improvement to the irrigation system made it possible to stabilize water flow to the paddy fields. Liang *et al.* [2003] reported that the per hectare land productivity of rice increased from 1,130 kg in 1952 to 2,040 kg in 1980, then to 3,000–4,500 kg in 2000–01. The difference between 1952 and 2000 was even greater (6–9 times) if we considered annual land productivity, because the people cultivated rice only once a year in the 1950s, while they grew two crops in 2000. Even during the last two decades, the land productivity of rice increased by 1.5–2 times. As a result, total production of rice in the village far exceeded the dietary requirement. The surplus rice was sold to the government, who purchased it at a fixed rate, or it was traded for meat, fish, or vegetables brought to the village by the motorbike peddlers several times a day.

In 2001, the subsistence strategy in Shuiman heavily depended on intensified cultivation of rice in paddy fields. Per capita area of paddy field was 770 m^2, which produced 450–690 kg of rice annually [Umezaki 2004]. Since one person consumed 0.5 kg of rice in a day, per capita amount of surplus rice was 250–500 kg, equivalent to 400–800 Yuan in 2001 (1 kg rice = 1.6 Yuan) About half of the surplus was used for obtaining cash to purchase fertilizer, pesticide, rice seed, and implements for the next cultivation cycle. The remaining surplus, equivalent to 200–400 Yuan, was used to purchase pork (6 Yuan/500 g), fish (3 Yuan/500 g) and other foods. In case one individual spent all of the 200–400 Yuan just for pork, they could purchase 17 to 33 kg of pork in a year, or 50–100 g daily. During an 18 day period in August 2001, an average of 6 out of 10 Shuiman households purchased pork or fish from motorbike peddlers at least once a day. It was judged that the people's nutritional requirement could be fulfilled mostly by the production of rice in paddy fields, if they could obtain appropriate amounts of vitamins and dietary fibers

from other sources. This is in great contrast to the situation in 1980; a one-time village leader explained that several households were then short of rice during the period before the harvest.

In Shuiman village, side dishes other than purchased ones included wild plants/animals, and vegetables grown in kitchen gardens adjacent to the villages. Sweet potatoes, cassava, and maize were also inter-cropped with the cash crops. It is worth noting that various wild grasses were frequently collected in or around paddy fields. Of 38 species of grasses found in an irrigation channel, 25 were edible. Of the 29 species in a ridge between rice fields, 5 were edible. Of 19 species grown in paddy fields, 8 were edible. Also 13 species were used as medicinal herbs for daily health problems. Shuiman people tended not to spray pesticides on the ridge between paddy fields or in irrigation water channels, because of concern about chemical pollution of the wild vegetables. Miyazaki [2002], in his vegetation survey, reported that five plant communities were found in paddy fields in Shuiman, while only one was found in Paori.

III-3. *Impact of Tourism*

After unsuccessful trials by several enterprises in the 1990s, full-scale tourism development was undertaken by a joint venture, Wuzhishan Tourism Limited (WTL) [Liang *et al.* 2003]. This joint venture opened a resort on 1 May 2002. The concept was to show the "exotic culture of Li ethnic minority" as well as the "beautiful primeval nature around Wuzhishan Mountain." More than 1,000 tourists visited the resort during the first three months after opening. They enjoyed the view of Mount Wuzhishan, and visited replicas of traditional houses and storehouses in the villages. The resort is still under development. In 2004, a 5 km promenade was constructed in the forest adjacent to Shuiman village. A butterfly garden operated by a different company was also opened.

The tourism development has influenced the daily life of the Shuiman people in several ways. People could earn money by being employed by the company or by selling the materials (bamboo and timber) for construction of the resort. They also received compensation payment for the crops and trees in the customary land, the collective use right of which was transferred to the company. Secondly, the indigenous resource management norms showed signs of change. The Li people had long made very strict distinction between what was "planted/grown" and what "grew naturally." While the planted crops were used only by the people who planted them, the plants that grew naturally were used by anybody, irrespective of their place of residence or ethnicity. Medicinal herbs, edible plants, wild animals, honey, and wild tea leaves, for example, have been utilized not only by the Shuiman people but also by the neighbouring Li villagers, Miao ethnic minority people, or Han people. No spatially defined commons under collective resource management existed. The people who have such magnanimous

resource management norms were good guides for the visitors who wished to make money from wild resources. Traders of precious butterflies, giant stag beetles (Genus *Docus*), orchids, or medicinal herbs, arrived at Shuiman village and exploited such animals or plants, despite the fact that collection in the reserve is prohibited by law. The Shuiman people did not complain at first, but some of them later started to claim that such economically valuable resources around Shuiman village should not be exploited freely by the people from outside. The indigenous norms for resource management may change toward "tighter" ones as the people understand the economic value of these resources on the world market.

IV　Paori Village

IV-1. *Introduction of Bananas, Rubber, Longan, and Lychee*

Paori is one of villages in Fanyang township that is located in the northwest of Wuzhishan city. Provincial Road No. 29 runs along Chang Hua River that flows from east to west through the township. Paddy fields and villages are located in the flat areas between the river and the mountainous hinterland. The people in Paori speak the Ha dialect of Li ethnic minority.

The indigenous food production system in Paori in the 1930s consisted of cropping rice in paddy fields, slash-and-burn cultivation, hunting and gathering. In contrast to Shuiman, the people may have depended more on rice cultivation in paddy fields than on slash-and-burn cultivation [Odaka 1944; Stübel 1937]. Per capita annual production of rice has increased from 130 kg in 1952 (double cropping; South-Central College for Nationalities 1992) to 240 kg in the early 1970s, then to 480 kg in 2000 (also double cropping) [see Jiang 2004]. This was due to the introduction of hybrid cultivars of rice and improvement of the irrigation system, together with the application of effective pesticides and fertilizer. The production of rice exceeded the nutritional requirement level and the people produced a surplus.

Bananas were first planted as a cash crop in Paori village after the economic system's transformation to a market economy in the early 1980s. Since banana shoots could be reproduced in the village, most households started to plant bananas in their gardens by 1984. A part of the production was sold to the market, while the remainder was consumed in the village. In 1985, rubber was introduced. One person decided to purchase 600 rubber seedlings for 600 Yuan (equivalent to the price of 4,000 kg of rice in 1985) and planted them in his slash-and-burn gardens where he had planted rice and cassava the previous year. In 1987, among the 24 households in Paori village, 12 planted rubber when the township government provided free seedlings according to the number of holes people prepared in their gardens. However, many of them did not take serious measures such as drainage or fencing to protect seedlings

from damage by buffaloes. Many rubber gardens were neglected.

An event that changed the people's understanding of cash cropping occurred in 1995. The person who had first planted rubber started tapping and could earn a considerable amount of money. He used the profit for protein-rich foods such as pork and fish, and also for the professional training of his son at an agricultural college in an urban area. The people in Paori village had a clear image of success. As a result of this, the area of rubber gardens has rapidly increased and the people have started to intensively manage the rubber.

Another epochal event occurred in 1998. One person in a neighbouring village succeeded in harvesting longan and lychee fruit and earned what looked to the Paori people like an enormous sum of money (400 to 600 Yuan from each tree). He received an official commendation as a model farmer from the Chinese government and traveled to Beijing to participate in an award ceremony. His success shocked the people in the township resulting in many people in Paori starting to devote their effort to grow more lychee and longan. Almost all secondary forest areas were converted to cash crop gardens for lychee and longan. People eventually spent longer hours on cash cropping than before, while surplus rice from paddy fields was used for investment in cash cropping rather than for purchasing protein-rich foods.

IV-2. *Abandonment of Buffalo, Logging, and Rural-urban Migration*

Notable changes in Paori village in the recent past are the abandonment of buffalo rearing, increased frequency of logging in mature forest far from the village, and migration of all unmarried females to urban areas. Buffaloes were indigenously reared in grasslands or secondary forest around the village. After the government's by-law regulated the burning of grasslands and most secondary forest were converted to cash crop gardens, the people came to tie buffaloes to stakes in the village to prevent damage to cash crops, which resulted in their allocation of additional labour resources for rearing buffaloes.

In 2001, a buyer visited Paori village to purchase buffaloes. Since the price of one buffalo was equivalent to a small tractor, most people decided to sell their buffaloes and to buy small tractors. The villagers told how they were released from the burden of rearing buffaloes as well as plowing paddy fields with buffaloes.

Logging of valuable trees such as *Dalbergia odorifera* or *Gmelina hainanensis* is a common activity for men during the agricultural off-season. Of 52 men between 15 and 40 years of age, 36 logged in 2001. A portion of the earnings was used for investment in cash cropping. On the other hand, all 17 unmarried women in Paori (aged 16–30 years) migrated to urban areas in the northern part of the

province. They worked in the service sector to remit money to their families regularly and also to bring electrical goods, such as televisions and videos, or motorbikes back to the village. Sometimes a portion of their remittances was also used for investment in cash cropping.

V　Land Cover and Land Use Changes Over the Past 20 Years

V-1. *A Case in Wuzhishan Region: An Analysis of Landsat Images*

To investigate the land cover change due to social and subsistence changes in Wuzhishan region, a Landsat ETM+ image was taken on 31 December 1999 and a Landsat MSS image taken on 1 January 1980 were analyzed. First, ground control points were recorded using a global positioning system (GPS) (Trimble Pathfinder Pro); post processing differential correction of the ground control points was done using data collected by a GPS base station. The images were then geo-referenced. Second, supervised classification of the Landsat ETM+ image was done based on 25 training sets that represented each of the 6 land use categories: "mature forest," "shrub," "grassland," "paddy fields," "wasteland or urban area," and "watery area." Training data for the classification of the Landsat MSS image were obtained by interviewing people about the land use in 1980 for 31 training sites.

Systematic accuracy assessment on the basis of randomly sampled test sites could not be conducted because the limited road networks in the target region made it difficult to visit all the test sites within the period of our fieldwork. Alternatively, we brought the results of land cover classification in 1980 and 1999 to the study villages and investigated its validity with the villagers. For example, on the site that was secondary forest at the time of our fieldwork but was classified as grassland in 1980, the authors asked the villagers if the site was really grassland in 1980. On the site that was shrub at the time of our fieldwork but was classified as mature forest in 1980, the authors asked the villagers if the site was mature forest in 1980. Through such on-site investigation, we judged the results of land cover classification in 1980 and 1999 was usable for descriptive comparison, though they lack objective accuracy assessment restricting the quantitative analyses of land cover change over time.

Fig. 2 shows the land cover maps of four townships in Wuzhishan city in 1980 and 1999. We can see the vast transition of "shrub/grassland" to "mature forest." This observation is in agreement with the people's narratives. They explained that, during the period of people's commune in the 1960s and 1970s, most of the secondary forest was burned for cultivating gardens and paddy fields, and valuable timber trees in mature forest were cut down. In contrast, in the 1980s, the government banned any burning of the shrub/grassland and restricted the hunting of wild animals and gathering of plants in the mature forest. An observation post was established on the top of the mountain for close watch over the

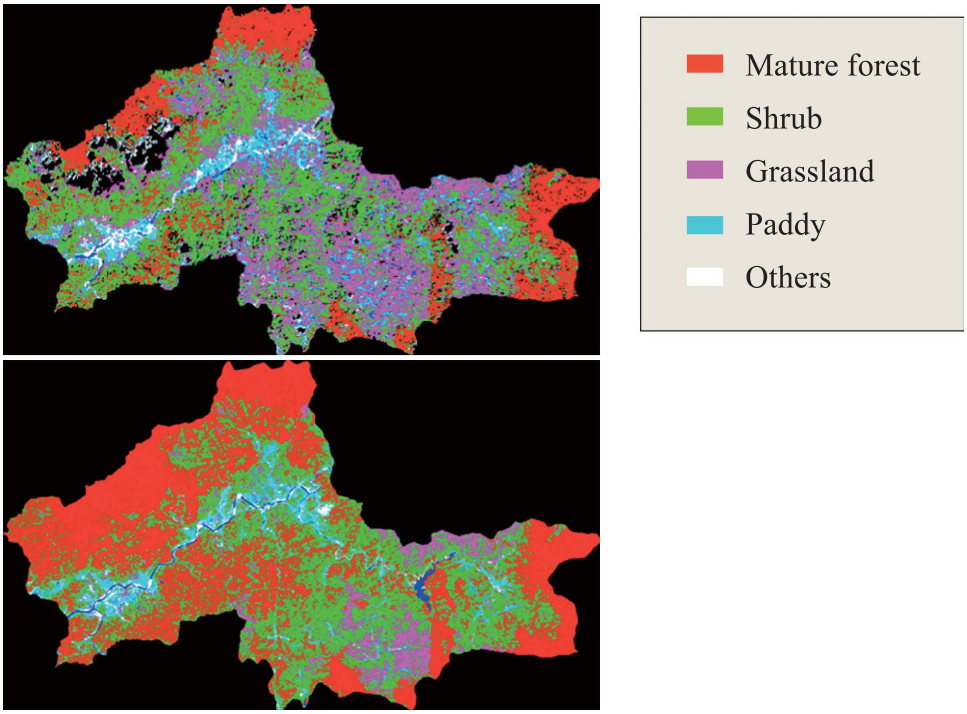


Fig. 2 Land Cover Maps of Wuzhishan Region in 1980 (up) and 1999 (down)

Note: Landsat MSS image taken on 1 January 1980 was used to make the land cover map in 1980; Landsat ETM+ image taken on 31 December 1999 for the land cover map in 1999. Black spots on 1999 map indicate the location of cloud cover and its shade.

resources. At relatively higher altitude areas (which Shuiman people inhabited), the past grasslands became secondary forest dominated by *Haname lidacea*, currently used as a symbol of nature conservation park in Wuzhishan area. In low altitude areas (where Paori people live), the shrub/grasslands and secondary forest, as well as the places where slash-and-burn gardening was practiced, were converted to cash crop gardens. They were also classified as "mature forest" or "secondary forest." Triggers that increased the size of "mature forest" and "secondary forest" from 1980 to 1999 were different by region. This was accompanied by the enforcement of government by-laws in the higher altitude areas (Shuiman), and the planting of cash crops in the lower altitude areas (Paori).

V-2. *A Case in Shuiman Village: Analysis of IKONOS Image*

An IKONOS image taken on 24 March 2001 was used to produce a map of land cover for the Shuiman village territory. Training data (n=91) were collected for each of the 21 land cover categories. On the basis of the results of the supervised classification, land cover maps that distinguished "paddy field,"

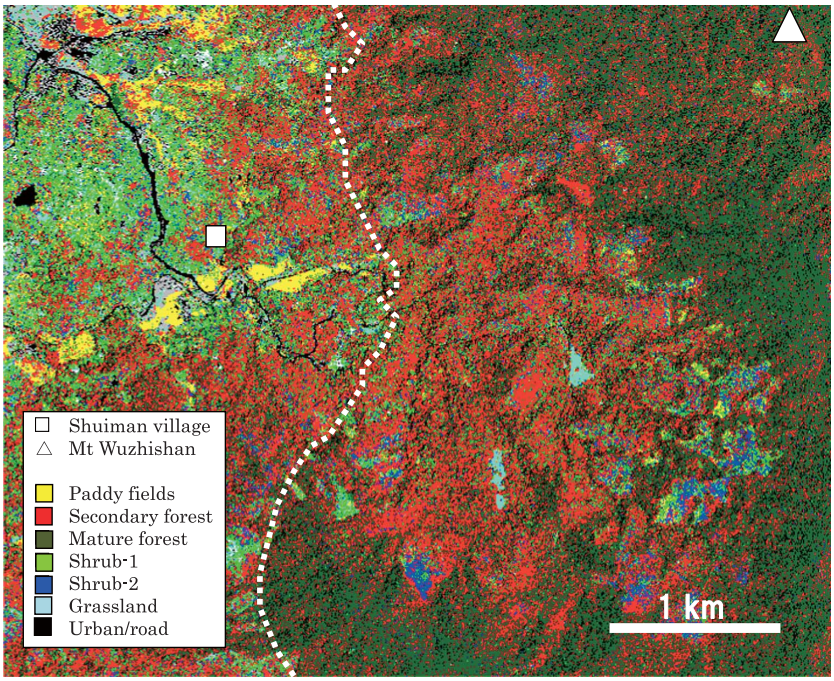


Fig. 3　Land cover of Shuiman Village in 2001 Drawn Based on an IKONOS Image Taken on 24 March 2001
Note: See Fig. 1 for the location of this image in Wuzhishan region.

"secondary growth dominated by *Haname lidacea*," "mature forest" and "others" were made.

As previously mentioned, the villagers explained that the secondary growth currently dominated by *Haname lidacea* was previously grasslands. *Haname lidacea*, a deciduous broad-leaf tree, often grows in stands and its light-green leaves turn yellow or red in December and January. The leaves fall not long after and new leaves bud in February to March. When the IKONOS image was taken on 24 March 2001, *Haname lidacea* trees had vivid light-green leaves, which made it possible to distinguish the trees from others.

Fig. 3 shows the classified IKONOS image. Yellow parts show the location of paddy fields under use. The mature forest expanded around Mount Wuzhishan to the south and then to the west. The secondary growth dominated by *Haname Iidacea* is indicated with red color. The classification results agree with the villagers' explanation that the areas around the village were mostly grassland in 1980, then transformed to secondary forest over the 20 years.

V-3. *A Case in Paori Village: Analysis of QuickBird Image*

We investigated land use patterns of Paori village in 2004, using a geo-referenced QuickBird satellite image (60-cm resolution panchromatic image, acquired on 3 December 2003) which we linked to field data as described below. First, one of the authors (H.W.J.) and a villager visited his plot(s), and mapped the boundary of each "parcel" (a portion of or whole paddy field or cash crop garden) on the printout of the satellite image. A GPS device (GPS Pathfinder Pocket, Trimble, Inc.) was used, if needed, to delineate the exact shape and location of each parcel. Then each parcel was labeled with a serial number. This process was repeated with all the household heads (n=37), and, in total, 747 such parcels were identified. The 747 parcels served as the units of land use, since size and shape of these parcels appeared to remain unchanged for twenty years (from 1985 through 2000). Then, the land use types of each unit for the years 1986, 1995, and 2000 were reconstructed through interviews with the landowners. On the satellite image displayed using geographic information system software (ArcGIS 9.0, ESRI, Inc), the boundaries of cash crop gardens, paddy fields, and other types of agricultural fields, which were visually identifiable, were traced, and vector files of each of these were made. By applying an ArcGIS area calculation algorithm (ArcGIS manual: Using ArcGIS Spatial Analyst, ESRI inc.), we calculated the size of each parcel.

Maps in Fig. 4 are the land use of the Paori villagers in 1986, 1995, and 2004 [Jiang and Umezaki 2009]. In the 1980s, the people in Paori conducted rice cultivation in paddy fields and slash-and-burn cultivation on the slopes. Grasslands were maintained in the back of the hamlet for rearing buffalo. Since the introduction of cash crops, all slash-and-burn gardens and grasslands, and most of the secondary forest have been converted to cash crop gardens. Of 556,100 m^2 cash crop gardens in 2004, 46% (255,800 m^2) were shifting fields, 33% (183,500 m^2) were secondary forest, 9.6% (53,300 m^2) were grassland, and 2.9% (16,100 m^2) were paddy fields in 1985 [Jiang 2006]. After 2004, cash crop gardens were further enlarged; the area was 710,350 m^2 in 2008, which was 128% of that in 2004 [Jiang *et al.* unpublished data].

VI Conclusions: Triggers of Land Cover/use Changes in Wuzhishan Region

In this paper we have shown how, over the past 20 years, in Shuiman village, the past grasslands became secondary forest dominated by *Haname lidacea*, while the shrub/grasslands and secondary forest, the place where slash-and-burn gardening was practiced, were converted to cash crop gardens in Paori village. They were classified as "mature forest" or "secondary forest." Triggers that increased the size of "mature forest" and "secondary forest" from 1980 to 1999 were the enforcement of government by-

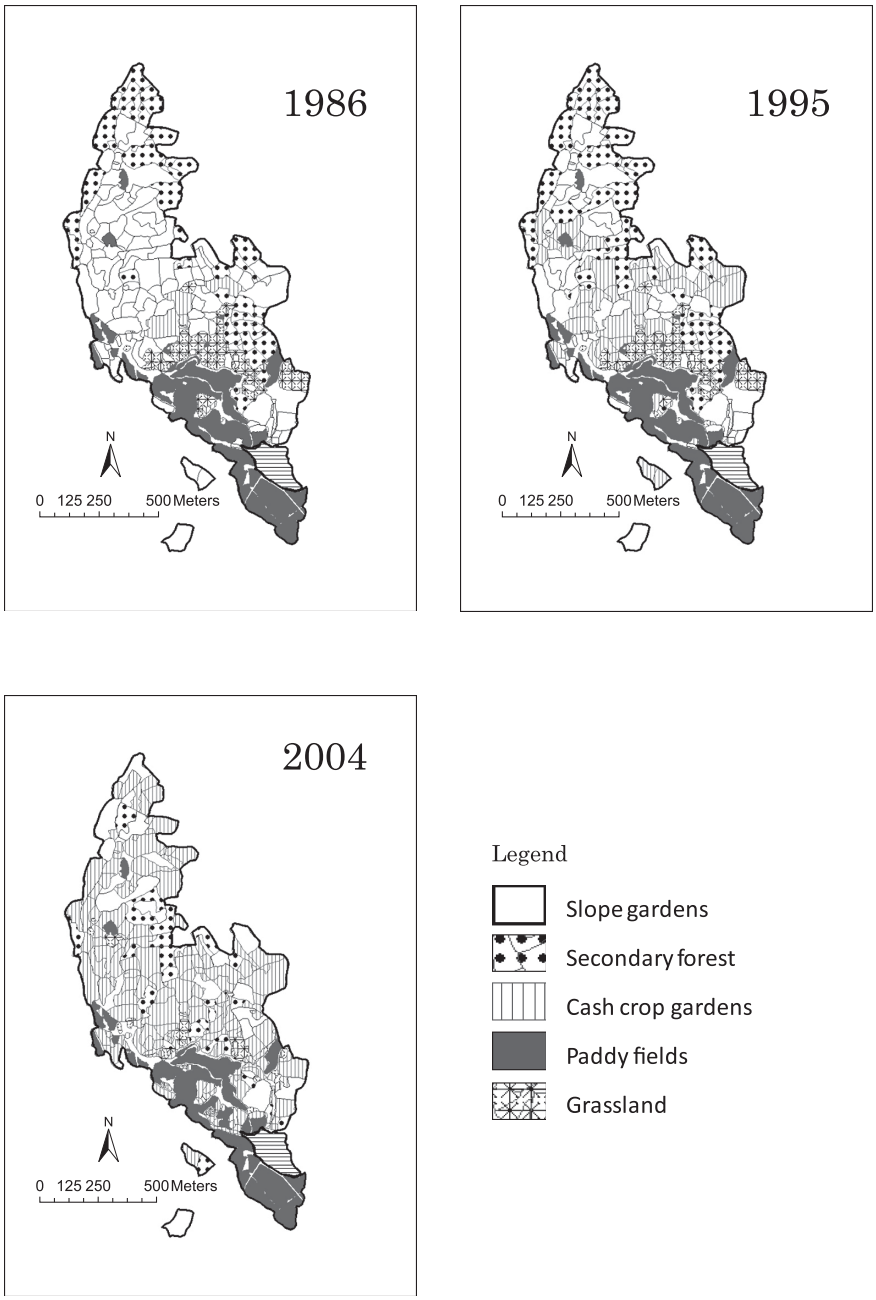


Fig. 4　Land Use Maps in Paori Village in 1986 (upper-left), 1995 (upper-right) and 2004 (bottom-left)

laws for environmental conservation and tourism promotion in Shuiman village as well as the villagers' adoption of cash crops in Paori village.

During our fieldwork in 2000–04, the adaptive strategies in Shuiman and Paori villages were still undergoing rapid transformation. The Government further intensified the policy to encourage re-growth of secondary vegetation around Shuiman village. The people could receive money depending on the area where they planted tree crops (e.g. the medicinal plant *Alpinia oxyphylla*, rubber, longan, or lychee). They will continue to receive the same amount of money each of the following years if the forest is managed well. This policy led most Shuiman people to plant tree crops in every part of their gardens on sloping land or secondary forest areas. Some of the people also planted tree crops in the customary lands of the village, which were then registered to those individuals. Understandably, inequality among the villagers in the amount of money received brought about some tension among the people.

The environment around the villages has also been affected in different ways. Secondary forest has grown on the previous grasslands and slash-and-burn gardens around Shuiman, while the exploitation pressure on valuable wild plants/animals has gradually increased due to tourism development. Indigenous species of crops grown in slash-and-burn gardens almost disappeared, while the edible plants around the paddy fields have been well preserved. In Paori village, all the areas where slash-and-burn gardening was previously conducted were converted to gardens for cash crops. Indigenous species of crops grown in slash-and-burn gardens also disappeared. Specific species of trees in mature forest were logged for money.

What this shows is that adaptive strategies in Shuiman village seemed to be more stable, sustainable and environmentally-sound than those in Paori village at present. However, any fluctuations in external factors can change the adaptive strategies in Shuiman either toward vulnerable outcomes or more sustainable ones. Paori people may or may not succeed in obtaining sufficient money from cash crops in the near future, depending on the price of crops and on future climatic conditions. The lesson that we learned from the Shuiman and Paori cases is that adaptive strategies were influenced by various factors such as conditions of the Hainan or Chinese economy, development ideas and decisions of the villagers, and resilience of the natural environment. Since the impact of government policy or development projects on adaptive strategies or land use/cover may, in nature, vary over time, only long term observation can lead to the formulation of paths for sustainably sound development.

Acknowledgement

This study has been conducted with financial support by Ministry of Education, Culture, Sports, Science and Technology (No. 21406021, 21650170, 20310146, 18310160, 15401037). The authors thank Drs Toru Shinohara,

Masaru Nishitani, Sheng-Min Yang and other members of the projects for support and encouragement. The authors also thank the people in Shuiman and Paori villages for their hospitality and kindness during fieldwork.

References

Jiang, H. W. 2004. Cash Cropping and Economic Development in Paori Village, Hainan Island. In *The Death of Slash-and-burn Agriculture on Hainan Island, China*, edited by T. Shinohara, pp. 139–164. Tokyo: University of Tokyo Press. [in Japanese].

————. 2006. Inter-household Variation in Adoption of Cash Cropping and its Effects on Labor, Diet and Nutritional status: A Study in a Li hamlets in Hainan Island, China. Ph.D thesis submitted to University of Tokyo.

Jiang, H. W.; and Umezaki, M. 2009. Land Use Change in Two Chinese Villages under Market Economy. In *GIS for Area Studies*, edited by T. Mizushima, and M. Shibayama, pp. 51–65. Tokyo: Kokon Shoin. [in Japanese].

Li, Y.; Hu, G.; Kai, Q.; and Huang, J. 2001. *Hainan Yearbook 2001*. Haikou: Hainan Year Book Press. [in Chinese].

Liang, J. Y.; Umezaki, M.; and Ohtsuka, R. 2003. Advantageous and Disadvantageous Impacts of Tourism Development on the Living of Li Ethnic Minority Villagers in Hainan Island, China. *Journal of Human Ecology* 32: 1–7.

Miyazaki, T. 2002. Plant Sociological Study for the Vegetation in Paddy Fields in Hainan Island. *Environment, Development and Culture in Asia-Pacific Societies* 4: 149–190. [in Japanese].

Nishitani, M. 2004. Ethnohistory of Li Ethnic Minority: Literature Review. In *The Death of Slash-and-burn Agriculture on Hainan Island, China*, edited by T. Shinohara, pp. 139–164. Tokyo: University of Tokyo Press. [in Japanese].

Odaka, K. 1944. *Economic Organization of the Li Tribes of Hainan Island*. [in Japanese; English/Chinese translation available].

Shinohara, T., ed. 2004. *The Death of Slash-and-burn Agriculture on Hainan Island, China.* Tokyo: University of Tokyo Press. [in Japanese].

South-Central Institute for Nationalities. 1992. *Social Investigation of Li Ethnic Minority in Hainan Island*. Guangxi: Guangxi Ethnicity Study Press. [in Chinese]

Stübel, H. 1937. *Die Li-stämme der Insel Hainan: ein Beitrag zur Volkskunde Südchinas*. Berlin: Klinkhardt & Biermann, Verlag. [in Germany; Japanese/English/Chinese translation available].

Umezaki, M. 2004. Environmentally-sound Subsistence in a Mountainous Li village in Hainan Island. In *The Death of Slash-and-burn Agriculture on Hainan Island, China*, edited by T. Shinohara, pp. 97–135. Tokyo: University of Tokyo Press. [in Japanese].

Umezaki, M.; Pahari, K.; and Jiang, H. W. 2002. Land Use of the Li-speaking People in a Mountainous area of Hainan Island, China. *Proceeding of 23rd Asian Conference of Remote Sensing*, Khatmandu.

『東南アジア研究』投稿規程

1）投稿原稿は，東南アジア地域研究に寄与するものとする。
2）投稿原稿は，レフェリー制度を通じて掲載の可否が決定される。投稿原稿は原則として返却しない。
3）原則として使用言語は日本語，英語のいずれかとする。特殊な文字ならびに記号の使用については編集室に相談のこと。邦文の場合には常用漢字，現代かなづかいを用いることを原則とする。使用言語にかかわらず8つ以内のキーワード（邦文の場合は日英併記）と200語程度の英文要旨を付するものとする。
投稿原稿の長さは，注，引用文献を含め，邦文の場合は400字詰め原稿用紙計算で80枚以内，英文の場合は15,000語以内を原則とする。なお，上記には図・表・写真を含めないが，特に多数の場合は編集室に相談のこと。
書評は，邦文の場合は約4,000字，英文の場合は約1,200語で執筆するものとする。
4）投稿原稿は電子文書とし，e-mailまたは郵送で受け付ける。郵送の場合は，電子文書（フロッピーディスク，MOディスクまたはCDR）とともに印刷した原稿を添付すること。
図は，そのまま印刷可能なものに限る。コンピュータで図表を作成した場合は，別ファイルとすること。写真，付図，付表などには希望の挿入箇所，大きさを指定するものとする。
5）掲載された論文等の著作権は原則として京都大学東南アジア研究所に帰属する。
6）稿料の支払い，掲載料の徴収は行わない。ただしカラーの写真や図（内容の理解に必要不可欠なものに限る）については実費を徴収する。別刷りを30部贈呈する。なお，それ以外にもあらかじめ注文があれば実費で製作する。
7）参考文献表記法が研究所ホームページ（http://www.cseas.kyoto-u.ac.jp）に掲げてあるので，投稿希望者は参照されたい。郵送を希望する場合は，編集室に請求のこと。
8）投稿に関する連絡先は次の通り。
〒606-8501 京都市左京区吉田下阿達町46
京都大学東南アジア研究所編集室
Tel. 075-753-7344
Fax. 075-753-7356
e-mail: editorial@cseas.kyoto-u.ac.jp

Notice to Contributors

(1) *Southeast Asian Studies* publishes the results of academic research contributing to the development of area studies of Southeast Asia.
(2) All manuscripts submitted for publication are accepted or rejected based on the recommendations of our referees. Submitted manuscripts will not be returned to the author.
(3) Manuscripts may be written in either Japanese or English. Before submitting manuscripts in other languages, please consult the Editorial Office. Manuscripts in English should not exceed 15,000 words (excluding figures, charts, maps, and tables). An English abstract of about 200 words and a list of no more than 8 keywords should be appended to each manuscript. Book reviews should be limited to about 1,200 words. Contributors should consult the Editorial Office if their manuscripts include special letters or symbols or a large number of figures, charts, or other material that may require special attention in the production process.
(4) Manuscripts must be submitted in an electronic format either by e-mail or by regular mail. Figures, charts and maps should be provided in a camera-ready format. The author should clearly indicate where to place all the figures, tables, and other material in the manuscript.
(5) Copyright of all manuscripts published in *Southeast Asian Studies* will be assigned to the Center for Southeast Asian Studies, Kyoto University.
(6) Authors will not be charged or remunerated for publication of manuscripts. But in case of using colored pictures or maps which are indispensable for understanding the content authors will be charged at cost price. Thirty reprints will be provided free of charge; additional copies can be ordered at cost price.
(7) Guidelines on the bibliographic format to be employed for references can be found on the center's homepage (www.cseas.kyoto-u.ac.jp) or can be requested from the Editorial Office.
(8) Manuscripts and editorial communications should be sent to the Editorial Office, Center for Southeast Asian Studies, Kyoto University, 46 Shimoadachi-cho, Yoshida, Sakyo-ku, Kyoto 606-8501, Japan.
Tel. +81-75-753-7344
Fax. +81-75-753-7356
e-mail: editorial@cseas.kyoto-u.ac.jp

東南アジア研究47巻3号　　平成21年12月31日　発行

編集・発行者　京都大学東南アジア研究所
〒606-8501 京都市左京区吉田下阿達町46
印　　刷　中西印刷株式会社
〒602-8048 京都市上京区下立売通小川東入ル

京都大学東南アジア研究所
CSEAS, Kyoto University, Kyoto Japan

47巻3号 2009/12

Land Use Changes in the Uplands of Southeast Asia: Proximate and Distant Causes