Links between Cultures and Biodiversity:

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NEGOTIATED LAND USE PATTERNS TO MEET LOCAL & SOCIETAL NEEDS

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Abstract

Current landscape mosaic patterns of land cover in Northern Thailand can be seen as resulting from adaptation of traditional agricultural systems over time. During the 1950's, little influence from the lowlands had been imposed on traditional systems in higher elevation zones. Subsequent outside influences, such as changing demand and new markets for crops like those associated with opium in the 1960's, led to extensive clearance of forest in mountainous areas above 1000 meters. Increasing clearing size changed land use patterns from those formerly based on small clearings, with substantial impact on forest regeneration and watersheds in general. Other influences imposed by the Royal Thai Government (RTG) on highland areas, such as the 1960 National Park Act and the national economic and social development planning process, combined with growing political tension, fears related to national security in border areas, and foreign pressure to stop opium production, lead to further shifts in agricultural development. As a result of these processes, a series of crop substitution projects were implemented during the 1980's, linked with efforts by the RTG to improve health service, infrastructure, and market access in the highlands. Population growth and in-migration further increased land use pressure, and by the late 1980's projects like CARE Thailand and the Sam Mun Highland Development Project (SMHDP) began developing an integrated approach that included Participatory Land Use Planning (PLP) to address the multitude of problems and develop strategies and solutions in partnership with highland communities. These efforts also had significant effect on agricultural systems in transition. During the 1990's, the now strong environmental movement began emerging, a community forestry law was proposed and became intensely debated, and environmental awareness grew in lowland and urban populations who began realizing the importance of upper watersheds in the north and the wider region for their future livelihoods. While a regular supply of clean water had long been taken for granted, now –for the first time in Thai history – it is an issue of concern. Other new projects were initiated by the RTG and the Royal Family to work closely with highland villagers, and now locally negotiated land use plans, combined with new GIS and remote sensing technology, are seen as a promising approach for addressing both local and societal needs. ICRAF Chiang Mai, together with the Royal Forest Department and Chiang Mai University, are supporting and conducting research on these issues and processes at their benchmark research site in the Mae Chaem district of Chiang Mai province in northern Thailand.

Background

Most land in upper watersheds is officially classified as reserved or protected forest, leading to pronounced land scarcity and a range of other issues. The following sections briefly explain these driving forces and general forest policy concerns focused on deforestation and watershed deterioration are explained.

Deforestation

Thailand entered its era of rapid economic growth in 1960 with the launching of its first national 5-year economic and social development plan. While considerable economic development has been achieved, one cost has been the loss of more than half of its natural forest resources, resulting in growing concern about loss of biodiversity and contributions to climate change. Table 1 summarizes three aspects of overall land use change since 1960 at the national level and for the northern region: (1) changes in proportions of land under forest, agriculture and other uses; (2) levels of each type of area per capita as the population has grown; and (3) the proportion of the population that has moved to metropolitan areas.

Although dramatic decreases in forest cover began later in northern Thailand than in much of the rest of the country, major losses occurred at both levels during the 1970's. Rates of loss appear to have recently begun to decline, but percentage declines in the north are still above the national average. Moreover, while most remaining forest is in the north, losses there are already greater than most portions of the MMSEA eco-region. Types of deforestation found in northern Thailand may be broken into three major components:

Conversion of forest. Initial conversion of forest after 1960 throughout Thailand was primarily associated with expansion of land for agriculture, as seen in Table 1, both to feed the growing population and for export crops to fuel the growing economy. Conversion to agriculture was facilitated by heavy logging, and during the late 1970's, agricultural expansion combined with political and national security strategies to further encourage clearance of forests. As agriculture began to expand into increasingly marginal sites, overall population growth rates began to decline, the economy began structural adjustments emphasizing industrial and service sectors, and urban and suburban growth began to accelerate. Further land use conversion became increasingly associated with cities, industry, housing, resorts, and more recently for land speculation.

As Table 1 indicates, farmland per capita appears to be slowly decreasing, while the overall proportion of farmland appears to be stabilizing. Other non-forest land appears to be expanding roughly in proportion to overall population growth. Some of these non-agricultural land uses, such as resorts and golf courses, can convert land directly from forest, while others displace agriculture at the periphery of urban or industrial areas, and may thereby lead to further conversion of forest to agriculture. Note that substantially more unregistered people actually live in urban areas than reflected in the official figures in Table 1.

Logging of natural forest. Logging helped fuel economic growth initially, but the combination of huge concession areas overlapping with protected forest areas and local communities, high official and unofficial harvest rates, low replanting rates, settlement and cultivation of logged areas, and slow expansion of plantation forests finally proved unsustainable [Pragtong 1990]. Although logging concessions were stopped in 1989, illegal logging is still a problem in reserved forest and protected areas. Large illegal operators make various efforts to conceal their operations, frequently including the hiring of villagers to cut trees for their operations. Forest department policy now emphasizes forest conservation rather than timber production, including strict enforcement of rules to address this open frontier mentality.

Table 1. Land Use Change in Thailand and North Thailand, 1960-1998

Land Cover		Year				
		1960	1970	1980	1990	1998
		Proportion of total area *(percent)*				
Forest Cover	National	54.0	46.0	32.0	27.3	25.3
	North	68.8	67.3	53.9	46.4	43.1
Farmland	National	20.0	29.0	37.1	41.2	41.5
	North	11.0	17.0	24.5	28.0	27.5
Other Non-forest	National	26.0	25.0	30.9	31.5	33.2
	North	20.2	15.7	21.6	25.6	29.4
		Area per capita of total population *(hectares)*				
Forest Cover	National	1.06	0.65	0.35	0.25	0.21
	North	2.04	1.44	0.95	0.72	0.60
Farmland	National	0.39	0.41	0.41	0.38	0.35
	North	0.33	0.36	0.43	0.43	0.38
Other Non-forest	National	0.51	0.35	0.34	0.29	0.28
	North	0.60	0.34	0.38	0.40	0.41
		Proportion of total population *(percent)*				
Urban Population	National	12.5	14.9	17.6	17.7	18.4
	North	6.4	5.8	7.0	7.6	7.4

Sources: Adapted from 1) Charuppat 1998 (Royal Forest Dept.); 2) Center for Agricultural Statistics 1994; 3) Center for Agricultural Information 1998; 4) Institute of Population Studies 2000

Farmers in the Forest. Issues associated with this component are much more complex and difficult. In the mountains of north Thailand various ethnic minorities have long lived as ‘ farmers in the forest’ , as described in the landmark book of that name [Kunstadter 1978]. A web of sometimes contested issues is associated with their land use practices, including opium production, shifting cultivation, rural poverty, and the impact of their land use practices on protected forest areas and environmental services. This component is the main focus of research in Thailand under the global CGIAR system-wide Alternatives to Slash & Burn (ASB) intiative. Work in Thailand is conducted under a multi-institutional consortium of research and development organizations known as ASB-Thailand. Research centers on the 4,000 sq km Mae Chaem watershed, which is located west of Chiang Mai valley across a ridge that includes Doi Inthanon, Thailand’ s highest mountain.The 1997 overall distribution of mountain ethnic minority populations living in the midlands and highlands (above 600 meters) are indicated in Table 2, at both the national and northern region levels, as well as for Chiang Mai province and the ASB benchmark site (Mae Chaem).

Table 2. Mountain ethnic minority population above 600 meters, 1997

	National	North	Chiang Mai	*Mae Chaem*
Highland traditions				
Hmong	126,300	119,768	19,011	3,630
Lahu	85,845	84,262	32,583	-
Akha	56,616	56,157	5,486	-
Yao	48,357	42,561	353	-
Htin	38,823	40,302	-	-
Lisu	33,365	31,040	13,201	431
Sub total	**389,306**	**374,090**	**70,634**	**4,061**
Midland traditions				
Karen	353,574	310,909	111,667	29,197
Lua	17,637	16,225	5,473	1,451
Khamu	13,674	10,567	21	-
Mlabri	125	125	-	-
Sub total	**385,010**	**337,826**	**117,161**	**30,648**
Mountain Minorities	774,316	711,916	187,795	34,709
- proportion of total:	**100%**	**92%**	**24%**	**9%**
Total Population	60,816,227	12,091,337	1,573,757	67,912
- mountain minorities:	**1%**	**6%**	**12%**	**51%**

Source: adapted from Hilltribe Welfare Division 1998

In addition, Lowland Thais make up about 16 percent of the total population living above 600 meters at the national level, and about 11 percent in the ASB benchmark site. While overall proportions of mountain minorities are quite low, they frequently make up more than half of the population in upper watershed areas. The grouping of communities into those with highland, midland and lowland traditions correspond with the altitude zones within which they have been most prevalent, and the types of agroecosystem management practices they have traditionally employed. Although such groupings are based on traditional distinctions widely applicable across the MMSEA ecoregion, altitude zones are approximate, geographic domains of ethnic groups overlap, and conditions change and traditions adapt over time. Table 3 presents estimates from the ASB benchmark site indicating how ethnic groups now distribute themselves among altitude zones, and resulting ethnic distributions within each zone. Note that 27 percent of highland tradition populations (Hmong) are now located in midland and lowland zones, whereas 42 percent of midland tradition populations (Karen) are located in the highland zone (usually near its lower boundary), where they outnumber traditional highland groups by a factor of four.

From an environmental point of view, the most important distinctions among traditional groups relates to their agroecosystem management approaches. Particular attention has usually focused on shifting cultivation, or 'swidden', components of their systems, where highland groups are associated with 'pioneer swidden', midland groups with 'established swidden', and lowland groups with 'northern Thai swidden' (T.C. Sheng 1979, unpublished report to FAO). There has never been a basis for official recognition of forest fallow fields as a component of agricultural land holdings, and clearing of fields in a shifting cultivation system are officially viewed as forest destruction. Critics of these official views claim that

when a new field is cleared – especially under 'established' or rotational swidden – an old field is returned to fallow, resulting in no net deforestation.

Table 3. Distribution of Ethnic Groups in the ASB Site by Altitude Zone

Distribution of ethnic groups among zones *(percent)*						
	Population	High peaks	Highlands	Midlands	Lowlands	**Total**
Hmong/Lisu	6,192	-	73.19	11.51	15.29	**100**
Karen/Lua	42,900	-	41.88	47.46	10.66	**100**
Thai	18,820		-	3.40	96.60	**100**
Overall	67,912		33.13	31.97	34.90	
Ethnic composition of altitude zones *(percent)*						
	Population	High peaks	Highlands	Midlands	Lowlands	
Hmong/Lisu	6,192	-	20.14	3.28	4.00	
Karen/Lua	42,900	-	79.86	93.77	19.30	
Thai	18,820	-	-	2.94	76.70	
Total	**67,912**	**-**	**100**	**100**	**100**	

Source: unpublished ICRAF and Ministry of Interior data

While remote sensing can provide estimates of the proportion of an area that is cleared of forest at a given point in time, there is still a substantial range of issues and policy questions regarding the impact of changing 'farmers in the forest' practices on forest ecosystems.

Watershed Deterioration

There are three main aspects of these important issues that are high priorities for ASB-Thailand:

Deteriorating Watershed Services. The northern mountains are the headlands of the Chao Phraya river system that nourishes Thailand's key 'rice bowl' production areas in the central plains, as well as the vast urban-industrial complex around Bangkok. Concern about deterioration of mountain area watershed services began in the 1960's when a group of academics from the Kasetsart University Faculty of Forestry began research at three small highland sub-catchments at Doi Pui in northern Thailand. Findings through 1980 are summarized [Chunkao 1981], and a series of university bulletins were produced, such as those on effects of clearing hill evergreen forest on soil organic matter [Lapudomlert 1974], physical properties [Chunkao 1974], chemical properties [Santudgarn 1974], and sediment [Aksornkoae 1977]. Subsequent research related to opium crop substitution is also summarized [Chunkao 1983]. Whereas summary documents generally indicate impacts of shifting cultivation are modest, compared to impacts on stream flow, erosion and water pollution associated with permanent agricultural fields, road construction and human

settlements, bulletins tend to make a more negative assessment of shifting cultivation impacts. Several team members became influential in shaping basic views – especially in downstream society – related to watershed policies and impacts of land use in the mountains on watershed services. As environmental interest in society grows, various of these issues are being further elaborated at a wider range of sites. Forest department researchers led a team who summarized research findings in Thailand for the watershed component of a proposed forest sector master plan [Royal Forest Dept., 1993]. An independent case study of water-related economic issues in an upper tributary of the Ping river broadened analysis of upstream-downstream issues, and identified several data gaps preventing adequate assessments of policy alternatives [Vincent 1995] that have yet to be addressed [Kaosa-ard 2000, unpublished WRI report]. While a few studies have begun comparing effects of practices by different ethnic groups, considerably more work is required to assess various water use technologies, to assess shifting cultivation impacts on a full-cycle basis, or to address effects of interactions and lateral flows among mosaic patches at larger landscape levels. Since one of the most immediate policy concerns in the northern region focuses on downstream impacts of upland land use on stream flow, reservoirs, and crop yields, such work is a priority concern.

Growing Upstream-Downstream Conflict. Growing environmental awareness and concern with nature, pollution and sustainability [Hirsch 1997], are converging with increasing demands for water by agriculture, cities and industry, to increase focus of attention on land use in upper watersheds. These trends are projected to continue to build in coming years. Moreover, increasing competition for water resources among a growing range of stakeholders combines with shortages of key data and limited access to existing knowledge, to fuel debate, conflict and confrontation that is frequently based more on emotions than reason. Various 'schools of thought' are developing, some of which appear to reject most all notions of 'scientific' analysis, while others cannot accept notions of 'local knowledge'. What appears to be urgently needed is a widely-acceptable and accessible set of criteria, indicators and measurement tools, that are based on appropriate calibrations with science and local knowledge, for empirical assessment and monitoring of watershed and related environmental services. Associated institutions to manage disputes at various levels also need to be strengthened, along with information and support services. Meanwhile, since action programs must proceed with less than ideal knowledge and tools, we need to strengthen systematic learning from such experience to bring improvement to action programs at each step along the way.

Relevance for the Larger Eco-Region. Although the impact of change may be greatest in north Thailand, processes underlying this change are already in motion elsewhere in the larger MMSEA Asia eco-region, which includes portions of the Hong (Red), Mekong, Salween, Irawaddy, Yangtze and Xi Jiang (Pearl) river systems [Revenga 1998; CMU 1996; Kaosa-ard 1995]. As these issues and processes are also important elsewhere, we hope linkages through the global ASB initiative can facilitate even wider relevant exchange.

In order to more effectively address these types of forest policy concerns, we must develop a more clear understanding of processes that underlie changing land use patterns, and forces that determine directions and rates of change. Incentives and pressures for land use change have been a major factor contributing to the complexity of these processes in northern Thailand.

Incentives and Pressures for Land Use Change

The first factor contributing to the complexity of land use issues in northern Thailand is the convergence of five types of pressures and incentives for change:

Demographic change. High population growth rates in mountain ethnic minority communities, relative to lowland rates, have combined with migration from neighboring countries to increase land pressure [Rerkasem 1994]. During recent decades, Thailand has been a safe haven and/or an economic magnet for many people in neighboring countries. Since many ethnic minority communities in the midlands and highlands are still being integrated into the regular Thai administration system, they are only included in more recent demographic data. Estimates of mountain minority populations living above 600 m.a.s.l. in 1997 [Hilltribe Welfare Division 1998] are compared with total populations in Table 2. Compared with estimates from the same source in 1972 [Kunstadter 1978], highland groups had an average increase of about 5 percent per year, whereas midland groups averaged less than 2 percent in the north and just over 2 percent in Chiang Mai province. This compares to an average annual growth rate of about 1.6 percent for total populations in Chiang Mai and north Thailand during this 25 year period. While some highland communities may not have been counted in 1972, rapid increase remains clear.

Commercial agriculture. Expansion and commercialization of agriculture has followed both from opium crop replacement efforts in the highlands, and from expansion of lowland agro-industry up hill slopes from valley bottoms [TDRI 1994]. Work in northern Thailand on replacement of opium with intensive commercial crops was largely pioneered by projects under the patronage of H.M. the King, followed by a range of publicly, privately and internationally supported projects in various northern areas. While some highland production activities, from cabbages to barley, ginger and some fruit crops, are now conducted through private channels, a range of Royal Project centers specializing in fruits, vegetables or ornamentals have come together under the umbrella of the Royal Project Foundation. Activities now even include marketing a range of products under their own Doi Kham brand name. Lowland-focused Thai agro-industry has been expanding into mountain valley areas, resulting in expansion of soybean, maize, potatoes, longan, mango, lychee and other crops, up slopes into the midland zone. While these efforts often have the blessing of government rural development and poverty reduction programs, investment requirements, risks and profitability have varied substantially, often in relation to fluctuating environmental and economic conditions. Although a small minority have been successful enough to move out of the lowest income categories, the vast majority of people in mountain areas remain poor.

Government policies. Forest policy has brought forest reserves, national parks, wildlife sanctuaries, and protected watershed forests, which preclude formal recognition of land use claims in most mountain areas. In some areas, land has been degazetted from reserved or protected status when local communities have demonstrated long term residency and met other requirements. The magnitude of the impact of reserved and protected areas on populations living above 600 m.a.s.l. are indicated in Table 4. Note that the ASB benchmark site (Mae Chaem) is well placed to study issues associated with communities living within reserved forest, planned reserves and parks, and de-gazetted areas.

Table 4. Status of land occupied by populations above 600 m.a.s.l., 1997

Land category	National	North	Chiang Mai	Mae Chaem
Reserved forest	611,400	589,279	174,224	30,794
National parks	39,421	37,877	15,742	311
Wildlife Sanctuaries	40,600	30,900	6,755	-
No hunting areas	2,001	1,957	1,895	-
De-gazetted areas	283,878	250,104	46,689	3,309
Planned reserves	8,322	8,322	8,322	4,615
Military lands	5,500	-	-	-
Total	**991,122**	**918,439**	**253,672**	**39,029**

SOURCE: ADAPTED FROM HILLTRIBE WELFARE DIVISION, 1998

The perceived importance of watershed issues has prompted another set of policies directly related to land use in mountainous areas of northern Thailand. A watershed classification system was developed and implemented throughout the country, initially under the aegis of the National Research Council, and subsequently under the Ministry of Science, Technology and Environment. Five categories of watershed classes have been overlaid on 1:50,000 scale topographic maps, and a set of restrictions on land use associated especially with categories 1 and 2 have official standing under a resolution of the ministerial cabinet. The distribution of land among these categories at several nested levels of resolution are indicated in Table 5.

Table 5. Distribution of Land by Watershed Class at Nested Levels of Analysis

		Distribution of land by watershed classification (percent)						
		class 1	class 2	class 3	class 4	class 5	water	total
Thailand	**Overall**	18.1	8.3	7.7	15.8	49.0	1.1	100
North	Overall	32.6	15.0	10.8	9.5	31.8	0.3	100
	Ping Basin	38.3	14.2	9.6	8.9	28.3	0.7	100
Mae Chaem	**Overall**	63.9	25.0	8.7	1.8	0.7	-	100
(ASB site)	High peaks	100.0	-	-	-	-	-	100
	Highlands	82.6	14.5	2.9	0.0	-	-	100
	Midlands	54.7	32.4	10.2	2.7	-	-	100
	Lowlands	17.7	41.9	28.2	6.0	6.1	-	100

Sources: (1) Chunkeo, 1996; (2) ICRAF unpublished data

While proportions of land in classes with severe restrictions appear modest at the national level, this changes as one moves to increasingly smaller upstream units. Although only 25 percent of the country is placed in class 1 and 2, the proportion doubles at levels of the northern region and major basins like the Ping, and climbs to about 90 percent in the Mae Chaem watershed, a major tributary of the Ping River. Thus, conditions at the ASB site are rather typical of conditions in upper tributaries. Since downstream environmentalists and other interests are using these maps in calling for severe restrictions and even relocation of communities out of mountain areas, related watershed policies need considerable careful analysis and exploration of options. Other forest land zoning exercises associated with specific policy initiatives have had various further effects on local communities and land use in the north.

Rural poverty programs in the mountains have largely been conducted through the Public Welfare Department, various special projects, or by missionaries [Renard 1988]. However, rural development decision making, is now shifting to elected local governments under the 1997 constitution and associated reforms. Various new provisions, including a community forestry law, are now being considered by Parliament. All government agencies, including the forest department, must now reform their policies and programs to conform with the many new mandates involved.

Since mountain areas are also the focus of other concerns, including illegal logging, narcotics and national security, the government has developed multi-agency development policies, plans and projects specifically for highland and midland areas. While opium eradication programs have made major progress, problems remain with rural poverty, illegal logging, illegal import of methamphetamine, and spillover effects of armed conflict in neighboring countries.

Infrastructure & services. Programs for opium eradication and national security further increased efforts to expand road infrastructure in mountain regions. In addition to their direct environmental impact, roads have brought market access for alternative cash crop production to many remote areas, as well as access for illicit logging and forest extraction operations. Expansion of services is another dimension of public policy, including registration of minority communities, as well as education and health services, electricity and media access, all of which help increase opportunities for integration of these communities into national society.

Urban industrialization and tourism. Expansion of tourism, resorts and recreational facilities are bringing new claims, pressures and opportunities to mountain areas [Dearden 1996]. Urbanization and industrialization have also begun affecting various aspects of life and decision making in areas of the north. These processes have encouraged land speculation in many areas, as perceptions of land shift from a production input into a financial asset; substantial areas are now in limbo after the Asian financial crisis.

Figure 1 displays the distribution of the highland communities across the altitude zones in Thailand. It compares the land use in the 1960' s, before all the above influences had an effect on highland communities and land use, with the present situation found in many highland areas of Northern Thailand and MMSEA. As a result of the trends discussed above, we now see changing land use mixtures in mosaic patterns of each zone

(1) Highlands. Pioneer shifting cultivation and opium have been largely replaced by commercial vegetable production that is now pushing into the midlands [TDRI 1994]. There is growing downstream concern about impacts on stream flow, erosion and pesticide pollution.

(2) Lowlands. Expansion of field crops, and in some cases orchards, into forested watersheds above paddies is now pushing into the middle zone from below.

(3) Midlands. Pressure from population growth, expanding lowland and highland systems, and government policy, has reduced land availability, often resulting in much shorter forest fallow cycles, and some conversion to fixed fields. Even sacred groves in their landscapes are now threatened.

(4) Overall. Recently, projects have begun promoting more trees in the landscape in all

zones, with primary emphasis on fruit trees and community forest. In addition to eliminating opium, many projects now seek to establish or strengthen locally protected forest areas, control fire, and restrict activity on steep slopes and watershed headlands. There is also renewed interest in 'jungle tea' complex agroforests in some lower areas of the highlands, which continue to endure and seem to help protect at least nearby forest areas.

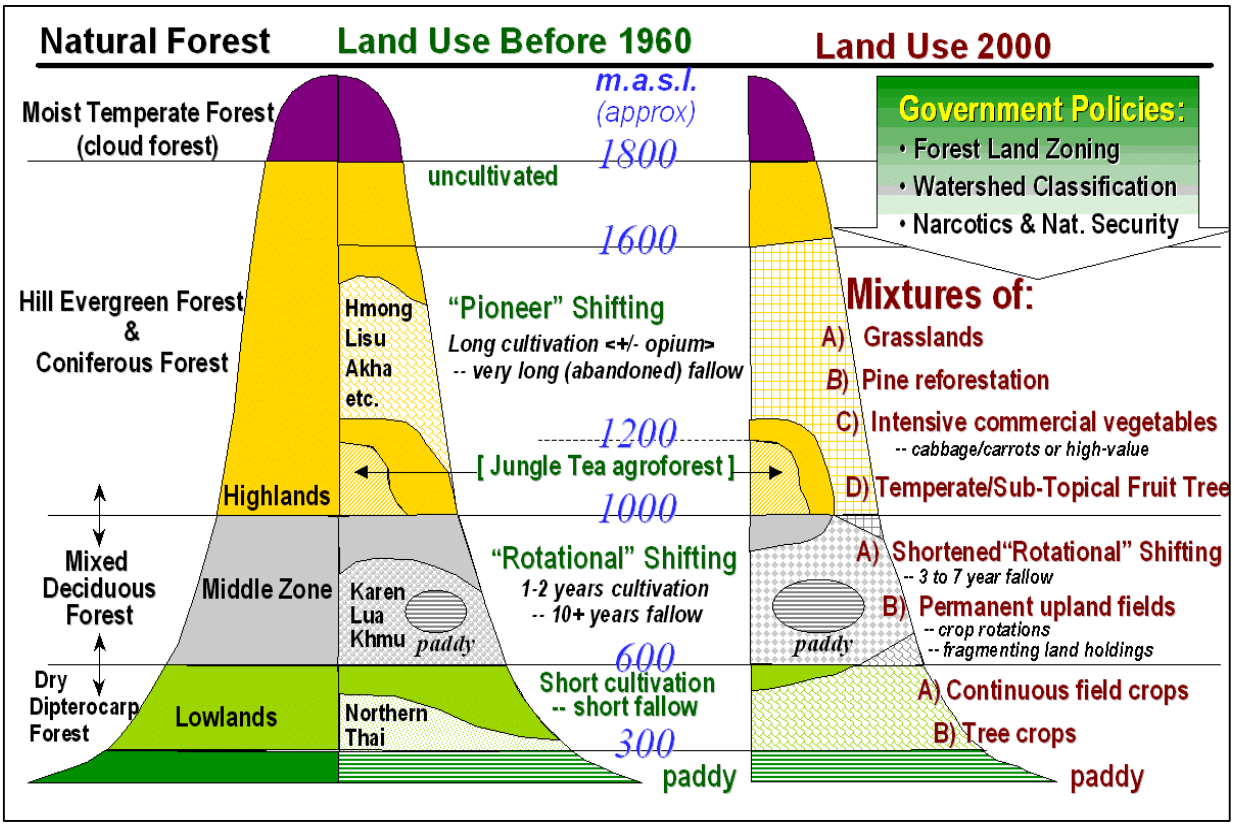


Figure 1. Changing Land Use Patterns in North Thailand

Negotiated Land Use Patterns to meet Local and Societal Needs

During the last two decades, pilot projects and many individuals from academia and development organizations became involved in the process of participatory land use planning (PLP) and village mapping. In northern Thailand most recent bilateral and multilateral projects sought to employ PLP in their project areas and develop village maps with local communities. In many villages, one can find everything from basic hand drawn maps, to primitive clay and sophisticated 3D Models made from plaster and cardboard showing past, present or future land use in a village area. Since the beginning of the 90's many projects have also tried to employ remote sensing and Geographic Information Systems (GIS) to generate land cover and land use maps. They produced valuable and important information, but mostly for specific project needs, and very rarely have they been utilized for negotiations with the government. Reasons for that were sometimes simply that:

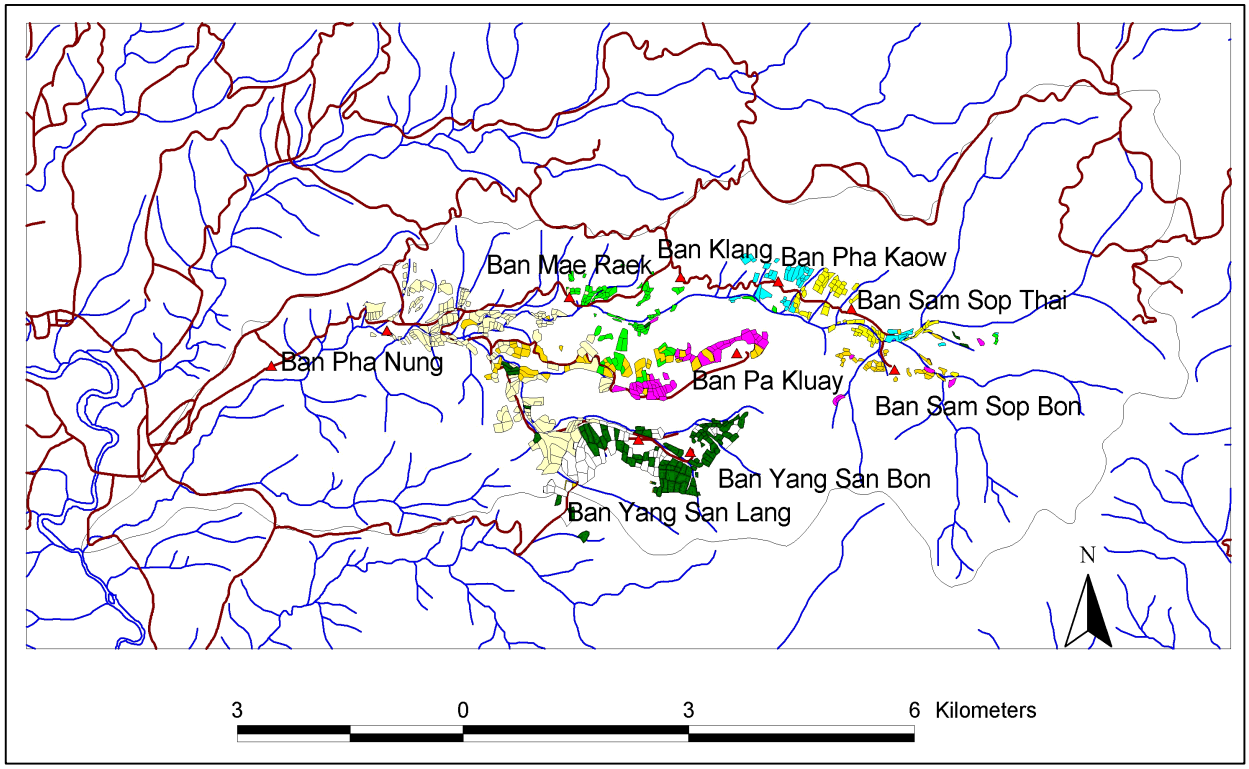
- different map scales were used, or the village maps had no scale at all
- many points were not geo-referenced and could not be found on government agency maps
- villages were sometimes not mapped at their present location

- plaster and clay models cannot easily be used for negotiations outside the villages
- unique, different or incompatible classification schemes were used, etc.

Prior to recent advancements in GIS and remote sensing (RS) technology, the tedious process of precise current land use mapping was hampered, and up-dating maps was very time consuming. Access to aerial photos for time series analysis was difficult, and historical assessments of land use change were usually limited to small areas. Thus, limited analyses were usually very site specific, inviting criticism that these methods and their results could not be replicated in other areas. Many land use assessments, inventories, and conventional and digital mapping projects have produced a vast amount of data. Unfortunately, they are not used because they are not compatible with government mapping, and are thus rejected.

Care Thailand and ICRAF Chiang Mai

In 1994 Care Thailand established a project office in Mae Chaem and began experimenting with participatory land use planning in their target villages. During earlier years, Care and other agencies already began establishing relationships with villagers based on trust and mutual concern about the environment, and supported small development projects in addition to land use planning.



Map 1: Land ownership of each village in upper Mae Raek sub-watershed

Working together with the Geography Department at Chiang Mai University's Faculty of Social Sciences, most villages in the project area were mapped, including all fields and agreed local forest areas (upland and lowland agriculture, community and community-protected forests, etc.). Each field has a double coding: *CODE I* for individual ownership, *CODE II* to assign it to a community for subsequent identification and demarcation of village and administrative boundaries. In addition to land use, infrastructure and historical and religious sites are also mapped.

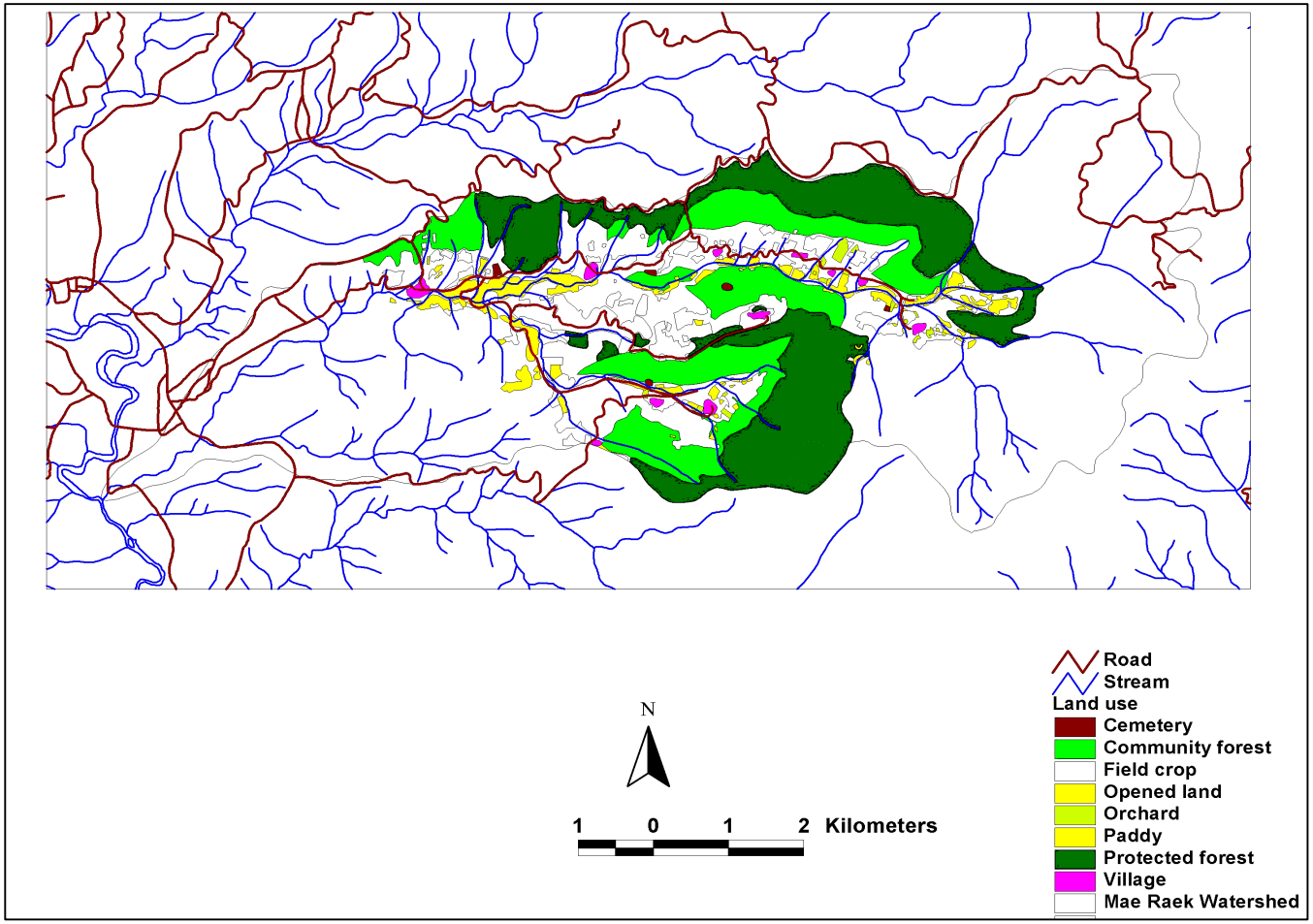
Map 1 shows such data from part of a small sub-catchment in lower Mae Chaem. The Mae Raek watershed is part of the Care Thailand project area, and during the last 3 years land use was extensively mapped. The different color codes in the map refer to agricultural fields under present cultivation according to village. As one can see, agricultural fields are not necessarily in the vicinity of a single village. More likely, and very characteristic of the highlands in Thailand, they are scattered, and especially suitable paddy field areas are shared among villages. This has traditional and economic reasons, as villagers moved and married among villages, and field ownership is sometimes transferred. Paddy development is also very expensive and is usually not carried out in one large area at the same time. Rather, whenever resources are available, individuals will transform suitable land and prepare small paddy fields. Recent projects have used advanced technology and small-scale affordable irrigation technology to support further expansion of paddy fields in areas previously not available for paddy cultivation.

Map 2 is a general land cover zoning map of the upper Mae Raek sub-watershed. Together with local communities, Care Thailand and Chiang Mai University extensively mapped the area and the classification system employed addresses local perceptions of land use, as well as government classification systems, in order to make the maps compatible with needs of both parties.

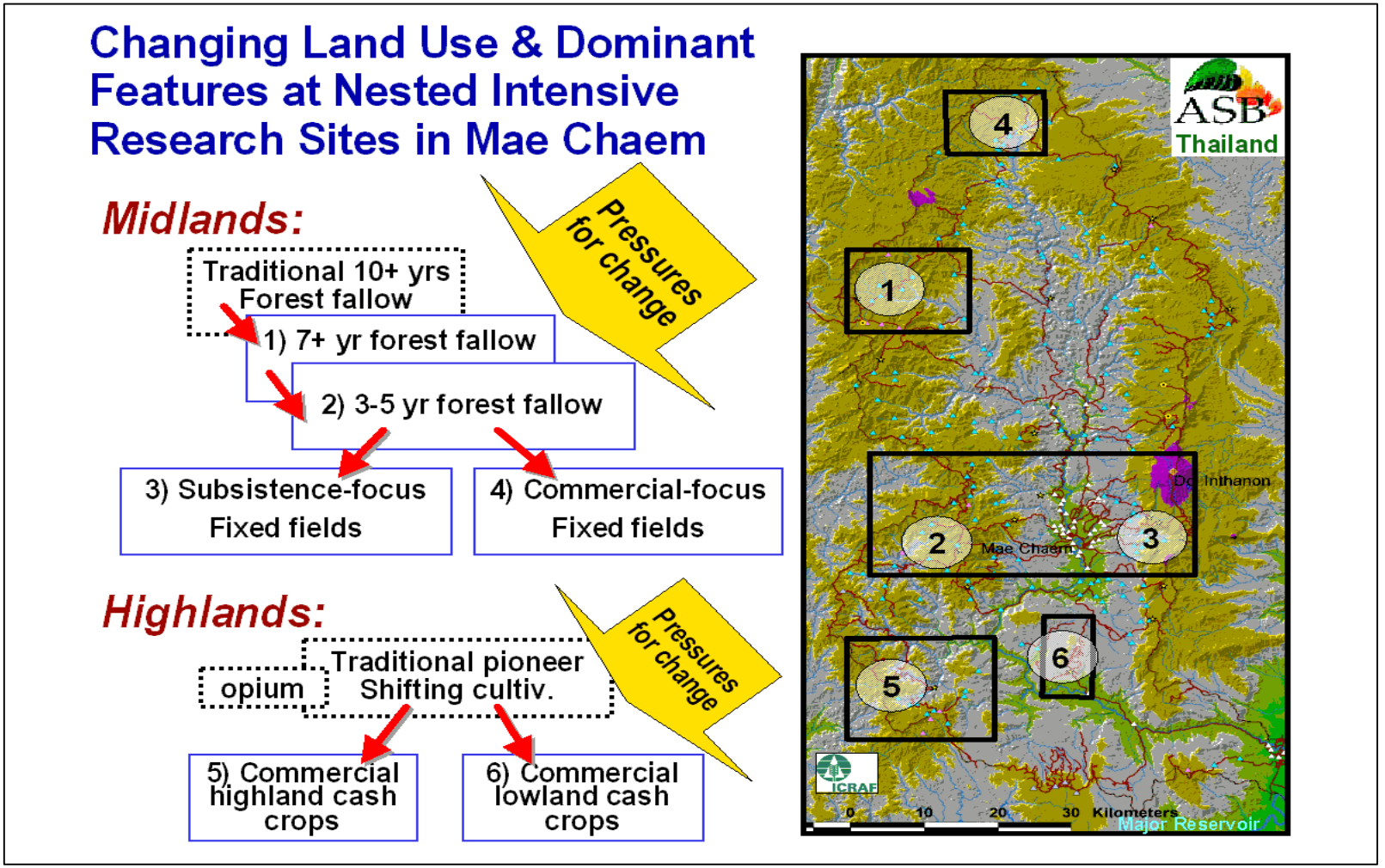
Areas delineated in Map 2 include: 1) Community Forest and Community-Protected Forest; 2) Agriculture (Paddy/Field Crops/Orchards, etc.); 3) "Religious Sites" (Cemeteries). Each map entity (polygons, lines or points) was geo-referenced and verified by ground truthing in the field with a Global Positioning System (GPS) device. Due to the recent availability of non-restricted signals, and by the use of Differential Global Position Systems (DGPS) with a permanent receiving station at Chiang Mai University, the accuracy is very high and considered sufficient for this kind of mapping at this scale.

ICRAF Chiang Mai is currently hosting and supporting Care Thailand GIS facilities in their office at Chiang Mai University, and supporting their efforts to establish a useful GIS node in Mae Chaem. All of Care's project areas are within the ASB benchmark site and research carried out under both organizations is designed to complement each other. In Mae Chaem, ICRAF is also working with the Queen Sirikit Reforestation Project, under the Watershed Management Division of the Royal Forest Department (RFD). This project has been working with local communities for more than 15 years, and both Care and ICRAF are supporting their efforts in participatory land use planning with base maps and additional relevant information.

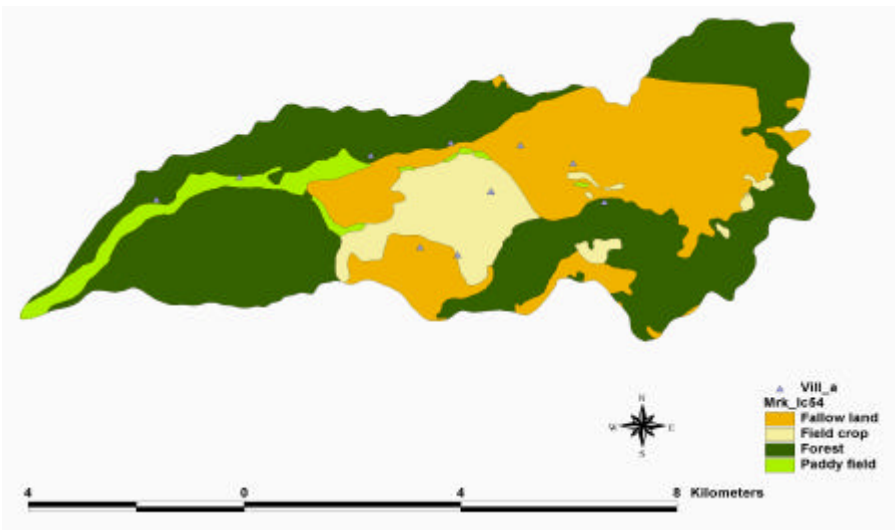
During the last 6 months ICRAF Chiang Mai has also acquired aerial photos for more than 1000 km^2 in Mae Chaem, covering 5 distinct areas. The rational for selecting five areas was to include a suitable sample of major variation in land cover and land use, as well as different ethnic minorities, altitude zones, infrastructure, etc. Mae Raek was selected as the first area for a historical assessment of land use change, and a time series of aerial photos was analyzed in collaboration with the Multiple Cropping Center of Chiang Mai University's Faculty of Agriculture. The series covers photos as far back as 1954, followed by photos from 1972, 1984 and 1995/6.



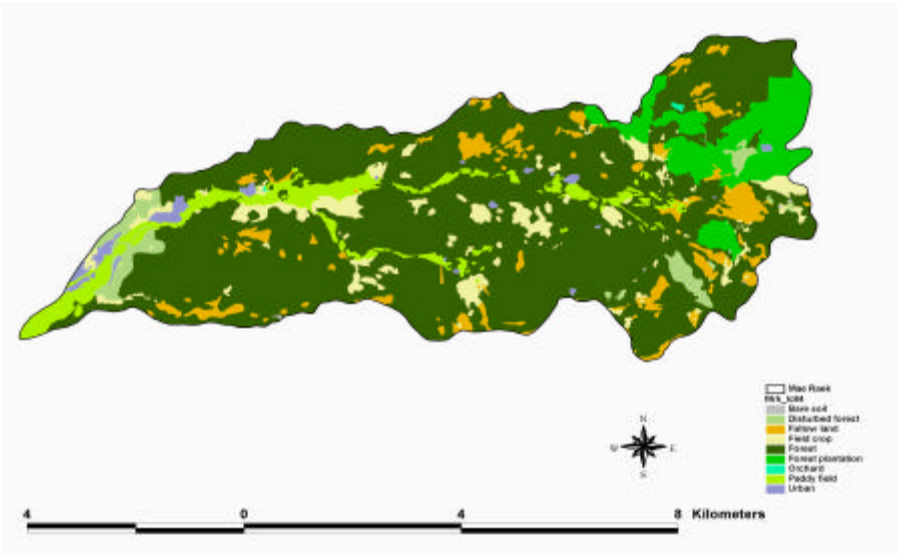
Map 2: Land cover map of the upper Mae Raek sub-watershed



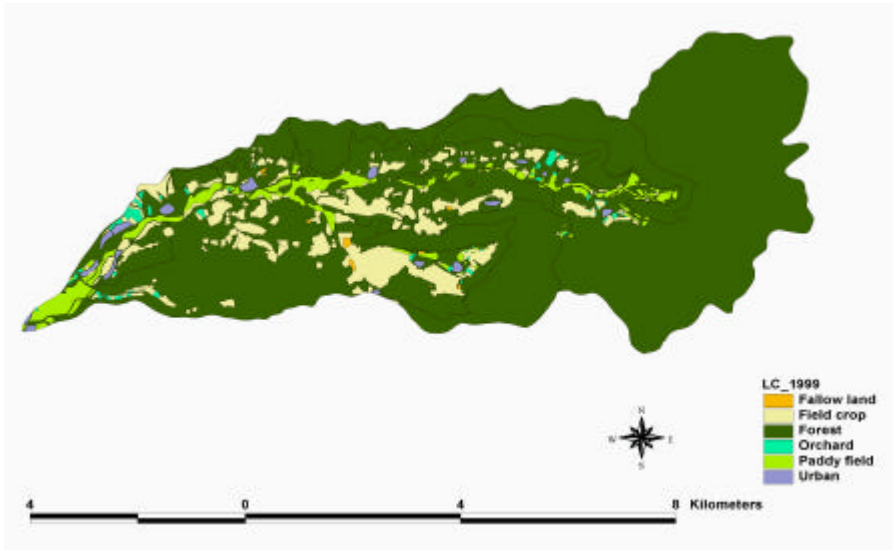
Map 3: Mae Chaem District and focal research areas (boxed)



Map 4: Land Use in 1954



Map 5: Land Use in 1984



Map 6: Land Use in 1999

Maps 4, 5 & 6. Changing Landuse over 50 years in Mae Raek

Maps 4, 5 and 6 demonstrate clearly how land use and land cover in this particular area have changed during the past 50 years.

In 1954, with literally no access and no infrastructure, hill farming communities relied mainly on subsistence upland farming, wherein large areas were opened either by individuals or communities, and upland rice was planted as their main crop. Paddy fields could only be found at lower altitudes and in wide valleys, mainly populated by northern Thai people. As the influences mentioned above and government presence increased, land use changed dramatically. Areas on the upper eastern slopes became part of Inthanon National Park, communities moved out, and their fields were re-forested.

During the 30 year period of 1960-1990, opium eradication programs were very effective in transforming large fields into either forest or restricted cultivation on very small fields. As a result of development projects, more areas were opened for paddy production along rivers and secondary streams.

The 1999 map shows basically a complete transformation of the previous land use system from large, community managed upland fields with minor paddy components (depending on the minority group this can vary substantially) to a system where paddy and permanent lowland agriculture become the main source of income, along with a very obvious focus on forest rehabilitation and protection. As can be seen clearly, many ridge and headwater areas have always been protected and not used for cultivation.

The main focus of this first analysis was to assess historical changes in forest cover and associated increases or decreases in agricultural land. This limited focus was necessary due to the time consuming analysis and extensive field verification required. Whenever possible, other information was also recorded, mostly during field verification. Each pair of aerial photos was analyzed under a stereoscope and land cover (forest, agricultural land, villages, infrastructure, etc.) delineated with felt pens on transparencies. This preliminary analysis was then verified by ground truthing with a GPS and up to 10 points for later geo-referencing were selected and referenced on each aerial photo. Back in the office the first analysis was verified and each transparency was digitized into ARC-View GIS. Each data set (transparency) was then joined with its pair, and each line and entity connected to develop a consecutive row of base maps. Each single row was then joined with its upper and lower row to develop an overall base map. The maps shown here are the final product of land use maps of 1954, 1984 and 1999. The 1999 map was the result of a Care Thailand land use assessment and can be considered the most accurate map in this procedure -- since all land use assessments were carried out by detailed field surveys, the error factor can be considered very low. Due to differences in aerial photo resolution, delineation of small areas was difficult, especially at scales of 1:50,000. By comparing 1954 photos with those from 1999, it became clear that areas estimated and delineated for paddy were too high in 1954, which can be attributed to the scale and sometimes bad quality of photos. Table 6 compares results from the different years of assessment.

Table 6: Area estimation for Mae Raek sub-watershed

	Land Use 1954	**Land Use 1984**	**Land Use 1999**
Scale of analysis	1:50,000	1:25,000	1:10,000
	Area [in hectares]		
Disturbed forest	-	150	-
Fallow land	1,669	335	8
Field crops	535	316	509
Forest	2,751	3,602	4,401
Forest plantation	-	413	-
Orchards	-	3	39
Paddy fields	255	322	207
Settlements	-	65	45
Total	5,210	5,207	5,210

It can be seen that difficulties associated with interpretation of small map scales of older photos resulted in some errors in computing area estimates. The pronounced decline in paddy area is not credible, and the aerial photo analysis will be repeated again in these areas. Overall, however, the analysis clearly shows significant increase in forest cover and a strong decrease of fallow land, due to the transformation of upland fields back to forest.

Conclusions

Assessments of aerial photos and satellite images can provide valuable information about an area. With the historical assessment approach described above, differences in development and land cover of focus areas can be assessed fairly rapidly and with reasonable costs and human resources. The combination of time series analysis and detailed land use planning, as carried out by Care Thailand, gives invaluable insights into the past and present development of communities and their changing land use patterns, and provides a basis for better assessing current and future change

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Looking at different areas and comparing their past development can assist researchers investigating driving forces and processes underlying different types of development and land use change. Such assessments can help address questions such as why forest in one area is destroyed, resulting in soil erosion and detoriating land fertility, whereas other areas with similar conditions are still covered by forests and communities “prosper and live in “harmony” with the environment.

Moreover, lessons learned from this type of analysis can also be used to provide support for a wide range of purposes, such as:

- Development of a national/regional data base on natural resources
- Assessment of forces driving land use change.
- Management of growing upstream-downstream tension and conflict
- Information for elected local governments [Tambon Administration Organisation (TAO)] to use in their expanding roles in natural resource management.
- Negotiating land use rights and recognition with government agencies Future monitoring and evaluation of compliance with land use agreements, by identifying **Hot Spots** (employing satellite images) to direct early interventionImprovement of agriculture (irrigation, introduction of better suited crops, etc.),

- Forest management (protected areas, plantations, etc.) Recreation and tourism management and development

One important pre-requisite in all such applications, however, is to have accurate geo-referenced maps, rather than "out of scale" village sketch maps. This is not to criticize efforts by many researchers, organizations and agencies working with other forms of village mapping. But it is imperative to derive or formulate maps upon which all stakeholders can agree, and which are at least comparable to government mapping scales and classifications. Without such consensus, land use plans cannot be negotiated, and will most likely fail to provide support for participatory resource management and future planning efforts that involve stakeholders beyond the local community. Moreover, official recognition of land use rights cannot be issued on the basis of sketch maps or clay models with no reference to scale whatsoever.

Local negotiations linked with careful mapping can provide crucial support to future resource planning and management activities of all stakeholders. Their use in the planning process justifies the effort and resources put into the process. These maps are currently being utilized in northern Thailand as a key tool in the negotiating process, and organizations and pilot projects are constantly improving their mapping skills to cover larger areas. Analyses of historical change during the last 50 years have increased, and great efforts are being made to apply the lessons learned from assessments of forces driving land use change and the associated impacts on local livelihoods and fragile highland environments.

In order to address the pressing issues associated with deforestation -- including the ongoing loss of forests due to logging and urban development -- all stakeholders must work together to establish and maintain up-to-date databases for decision support. And, it is particularly important for highland communities to play a more active role in present and future negotiations. Thai society is focusing strongly on those communities, and water supply and environmental destruction are now major issues for all political parties. Upstream-downstream conflicts at local to national levels must be addressed, and equitable solutions need to be found. This problem is not limited to Thailand – many areas of Mountainous Mainland Southeast Asia face similar challenges that will sooner or later need to be addressed.

As the land use maps in this paper have shown, local communities are able to make efforts to protect important watershed headlands, and have sometimes been very successful in carrying out this task, even under the pressures imposed on them in the past. Such efforts need to be acknowledged by authorities, and successful local protection of watershed headlands must be encouraged and supported in the future. Processes of mapping and database development such as those described in this paper can provide invaluable information for future development of more sustainable land use in the mountain environments of northern Thailand and MMSEA.

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