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Negotiating Land Use Change in Upper Tributary Watersheds

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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 markets for new crops associated with both opium crop replacement programs and expansion of lowland agro-industry, led to extensive clearance of forest in mountainous areas. Increasing clearing size changed land use patterns from those formerly based on small clearings, with substantial impact on forest regeneration and watersheds in general. Land use constraints imposed by the Royal Thai Government (RTG) on highland areas, such as establishment of national parks, wildlife sanctuaries, and a watershed classification system, combined with political tensions, national security issues in border areas, and foreign pressure to stop opium production, to further influence the directions of agricultural development.

As part of these processes, a series of crop substitution-oriented projects were implemented during the 1980's, linked with efforts by the RTG to improve health service, education, 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 further affected agricultural systems in transition.

During the 1990's, concern with environmental issues grew rapidly. Initial concern focused on criticism of dam projects and state management of forest lands, leading to proposals for a community forestry law that would allow local participation in management of forest resources. But growing environmental awareness in lowland and urban populations was also associated with realization of the importance of upper watershed forests in the northern region for their future livelihoods. While a regular supply of clean water had long been taken for granted, now it was now becoming an issue of concern. This set the stage for growing debate and tension among upstream and downstream interests, which has intensified with recent flash flood and landslide disasters. Meanwhile, governance reform efforts led to a new national constitution and strengthening of local governance institutions.

Additional projects initiated by the Royal Family, the RTG and various NGO's to work closely with highland villagers have been responding to the challenges presented by these developments. As a result, locally-negotiated land use planning, combined with new tools, ranging from methods for local monitoring of watershed services to GIS and remote sensing technology, are coming together in a promising approach for addressing both local and societal needs. ICRAF Chiang Mai, working with the Royal Forest Department, Chiang Mai University, the Queen Sirikit Forest Development Project, Care-Thailand, and other partners, are conducting research on these issues and processes at their benchmark research site in the Mae Chaem district of Chiang Mai province in northern Thailand.

The focus of this research is on development and pilot testing of a comprehensive spatial information system to support participatory management of natural resources in upper tributary areas where national conservation concerns seek to constrain local land use practices. The system has four major components:

1. *Negotiation and articulation of local land use plans and agreements that incorporate local needs, as well as concerns of downstream communities and national society.*
2. *Spatial information tools that provide: a) a basis for formal recognition of local land use agreements; b) transparency and accountability in monitoring compliance; c) additional information that will enhance the capacity of local institutions to manage land use in a manner that can improve local livelihoods while sustaining environmental services.*
3. *Continuous monitoring and assessment of watershed services by local watershed management networks.*
4. *Analytical modeling to provide assistance for both local managers and the general public in interpreting information related to natural resource management issues.*

Field-testing of the overall system includes additional detailed information on land use history, local land use patterns, and other factors that will assist in assessing the effectiveness of the system and its various components.

Initial pilot implementation of these efforts began in 2001 in four sub-watersheds of Mae Chaem, which were selected to represent a range of current land use conditions found in upper tributary watershed areas. This paper reports on progress of these effortss, including evolution of land use patterns and local response to the tools and approach. It also discusses plans for further expansion of pilot tests, and potential for wider application and adaptation in the region.

I. Background

Most land in upper tributary watersheds is officially classified as reserved or protected forest, which severely reduces land available for agricultural purposes, and affects a range of other issues. This section briefly summarizes major forest policy concerns related to deforestation and watershed deterioration, as well as key forces driving land use change in upper tributary watersheds.

A. 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 watershed services, as well as 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 officially located in metropolitan areas.

Table 1. Land Use Change in Thailand and North Thailand, 1960-98

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

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

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 begun declining, but rates in the north are still above the national average. Types of deforestation found in northern Thailand may be broken into three major components:

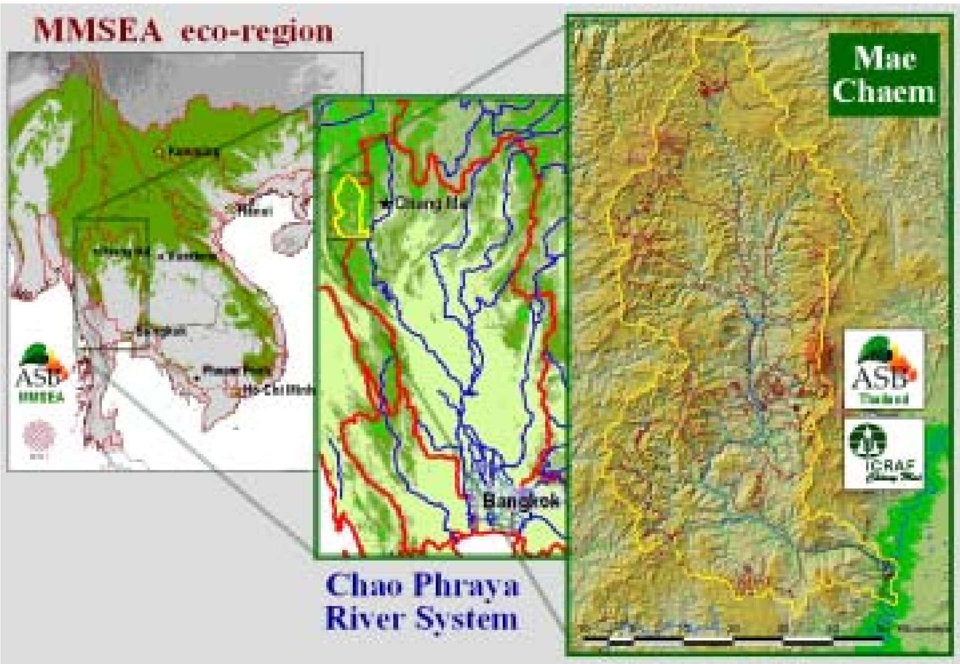
1. ***Conversion of forest.*** Initial conversion of forest after 1960 throughout Thailand was primarily associated with expansion of land for agriculture, both to feed the growing population and for export crops to fuel the growing economy. Conversion to agriculture was facilitated by heavy logging, and during the late 1970's, agricultural expansion combined with political and national security strategies to further encourage forest clearance. As agriculture expanded into increasingly marginal sites, overall population growth rates began declining while urban and suburban growth accelerated, and the economy began structural adjustments emphasizing industrial and service sectors. 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 seems to be expanding roughly in proportion to overall population growth. Some 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.

2. ***Logging of natural forest.*** Logging helped fuel economic growth initially, but with 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, this approach 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.

3. ***Farmers in the Forest.*** Issues associated with this component are much more complex and difficult. Various ethnic minorities have long lived in the mountains of north Thailand as ‘farmers in the forest’, as described in the landmark book of that name [Kunstadter 1978]. A web of often 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 [Thomas 2001]. 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 (Figure 1), which is located west of Chiang Mai valley across a ridge that includes Doi Inthanon, Thailand’s highest mountain.

Figure 1. Mae Chaem Upper Tributary Sub-Basin Benchmark Research Site



source: Pornwilai Saipothong, using ICRAF & WRI data

The 1997 distribution of mountain ethnic minority populations living in the midlands and highlands (above 600 m.a.s.l.) is indicated in Table 2, at national, northern regional, Chiang Mai provincal and ASB benchmark site levels. In addition, lowland Thais are about 16 percent of the population living above 600 m.a.s.l. at the national level, and about 11 percent in Mae Chaem.

Table 2. Mountain ethnic minority population above 600 m.a.s.l., 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	-
Lisu	33,365	31,040	13,201	431
Sub total	*350,483*	*333,728*	*70,634*	*4,061*
Midland traditions				
Karen	353,574	310,909	111,667	29,197
Lua	17,637	16,225	5,473	1,451
Htin	38,823	40,302	-	-
Khamu	13,674	10,567	21	-
Mlabri	125	125	-	-
Sub total	*423,833*	*378,128*	*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

While overall proportions of mountain minorities are quite low, they are frequently more than half of the population in upper watershed areas. Grouping of communities by highland, midland and lowland traditions correspond with 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 indicating how ethnic groups are now distributed among altitude zones in the ASB benchmark site, 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.

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	12	15	100
Karen/Lua	42,900	-	42	47	11	100
Thai	18,820	-	-	3	97	100
Overall	67,912	-	33	32	35	100
	Ethnic composition of altitude zones (percent)					
	Population	High peaks	Highlands	Midlands	Lowlands	
Hmong/Lisu	6,192	-	20	3	4	
Karen/Lua	42,900	-	80	94	19	
Thai	18,820	-	-	3	77	
Total	67,912	-	100	100	100	

Source: unpublished ICRAF and Ministry of Interior data

From an environmental point of view, important distinctions among traditional groups relate to their agroecosystem management approaches. Particular attention usually focuses on shifting cultivation (‘swidden’) components of their systems. 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 any form of 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.

While remote sensing can provide estimates of the proportion of an area that is cleared of forest at a given point in time, there are many additional issues and policy questions regarding the impact of changing ‘farmers in the forest’ practices on forest ecosystems.

B. Watershed Deterioration

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

1. *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]. Summary documents generally indicate impacts of shifting cultivation are modest, relative to impacts on stream flow, erosion and water pollution associated with permanent agricultural fields, road construction and human settlements. Bulletins tend to make more negative assessments of shifting cultivation impacts. Several team members became influential in shaping basic views – especially in downstream society – related to watershed policies and impacts of mountain land use on watershed services.

   As environmental interest in society grows, several of these issues are being further elaborated at a wider range of sites in Thailand. Forest department researchers led a team who summarized research findings for the watershed component of a proposed forest sector master plan [Royal Forest Dept., 1993], and a leading academic in watershed science published a more recent review on hydrology in highland watersheds [Tangtham 1999]. 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 overall impacts of rotational shifting cultivation systems, 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.

2. *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. During the 1990’s, concern with environmental issues grew rapidly.

Initial concern focused on criticism of dam projects and state management of forest lands, leading to proposals for a community forestry law that would allow local participation in management of forest resources. But growing environmental awareness in lowland and urban populations was also associated with realization of the importance of upper watershed forests in the northern region for their future livelihoods. While a regular supply of clean water had long been taken for granted, now it was now becoming an issue of concern. This set the stage for growing debate and tension among upstream and downstream interests, which has intensified with recent flash flood and landslide disasters.

These trends are projected to continue to build in coming years, as 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’.

Meanwhile, governance reform efforts led to a new national constitution and associated legislation that is shifting much responsibility for managing both natural resources and the associated growing conflict to local governance institutions. In order to assist these localized efforts, what appears to be urgently needed is a widely-acceptable and accessible set of criteria, indicators and measurement tools – 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 strengthening, along with information and support services. And, since action programs must proceed with less than ideal knowledge and tools, we need to strengthen systematic learning from such experience to improve action programs at each step along the way.

3. *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.

C. Incentives and Pressures for Land Use Change

In order to effectively address these types of forest policy concerns, we need to understand the processes that underlie changing land use patterns, and forces that determine directions and rates of change. The convergence of six types of incentives and pressures for land use change have been a major factor contributing to the complexity of these processes in northern Thailand:

1. *Demographic change.* High 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 in neighboring countries. Since many highland and midland ethnic minority communities are still being integrated into regular Thai administrative system, they are only included in more recent demographic data. Estimates of 1997 mountain minority populations living above 600 m.a.s.l. [Hilltribe Welfare Division 1998] are compared with total populations in Table 2. Comparison with estimates from the same source in 1972 [Kunstadter 1978], suggest 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.

2. *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 to replace 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, which now markets a range of products under their Doi Kham brand name. Lowland 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 are often endorsed by rural development and poverty reduction programs, investment requirements, risks and profitability vary 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.
3. *Government policies.* Forest policy has brought forest reserves, national parks, and wildlife sanctuaries, 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 communities have demonstrated long-term residency and met other requirements. The magnitude of reserved and protected area impacts 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.

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 restricting 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 later 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.

While proportions of land in classes with severe restrictions (1 and 2) appear modest at the national level, this changes as one moves to increasingly smaller upstream units. Although only 25 percent of the country is included, 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 use these maps in calls 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.

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

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. Additional provisions, including a community forestry law, are being considered by Parliament. Government agencies, including the forest department, must reform their policies and programs to conform with these new mandates.

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

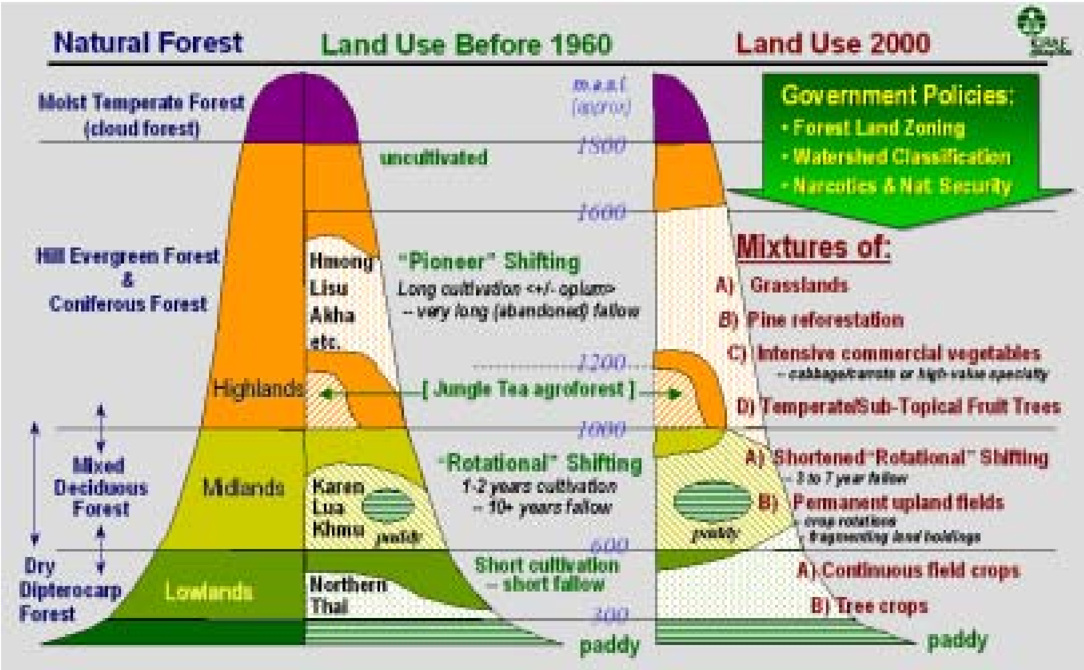
4. *Infrastructure & services.* Programs for opium eradication and national security further increased efforts to expand road infrastructure in mountain regions. In addition to their direct environmental impact, roads have brought market access for alternative cash crop production to many remote areas,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

5. *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.

6. *Environmentalism.* ·Rapid growth of environmental awareness in the general public has been associated both with a populist element calling for more local control over natural resource management, as well as with a more ‘deep green’ element that believes local communities should be excluded from protected areas for the longer term benefit of larger society. Tension between these elements is substantial, and occasionally breaks out into open conflict.

Figure 2 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.

Figure 2. Changing Land Use Patterns in North Thailand



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 midland zone from below.

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

4) *Overall*. Recently, projects have begun promoting more trees in landscapes of all zones, with emphasis on fruit trees and community forest. 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' agroforests in some lower highland areas, which continue to endure and seem to help protect at least nearby forest areas.

II. Negotiated Land Use Patterns to meet Local and Societal Needs

During the last two decades, many pilot projects, academics and development organizations have become involved in a process that has come to be known as participatory land use planning (PLP) (Tan-kim-yong 1994). In seeking locally-negotiated land use arrangements that can meet the needs of both local communities and larger society, various tools are employed, including village mapping. Indeed, most recent bilateral and multilateral projects in northern Thailand have sought to employ some form of 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 3-dimensional models made from plaster and cardboard showing past, present or future land use in a village area. Since the beginning of the 1990's many projects have also tried to employ remote sensing (RS) and geographic information system (GIS) techniques to generate land cover and land use maps. They have produced valuable information, but mostly for specific project needs, and very rarely have they been utilized for negotiations with the government. Reasons for this have included:

- 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 RS technologies, the process of precise mapping of current land use was tedious, 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 considerable data. Unfortunately, they are not used because they are not compatible with government mapping, and are thus rejected. Moreover, although localized land use zoning using PLP techniques has become widely accepted as a promising means for addressing some of the most hotly contested issues in protected watershed areas, progress has been seriously limited by the inability to interface localized zoning agreements with regional and national spatial information systems. ICRAF is now collaborating with natural resource management projects in our benchmark site area in efforts that seek to overcome these limitations.

A. Participatory Land Use Planning and Local Land Use Zoning

In 1994 Care-Thailand established a natural resources management project with an office in Mae Chaem and began experimenting with participatory land use planning in their target villages. During 1986-94, Care had already begun establishing relationships with villagers based on trust and mutual concern about agriculture, soil conservation and a range of other development issues. Various small development projects initially complemented larger government and Royal projects centered on opium crop substitution, before increasing attention to subsequently emerging local natural resource management issues. 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. Care's project areas are within the ASB benchmark site and research carried out under both organizations is designed to complement each other.

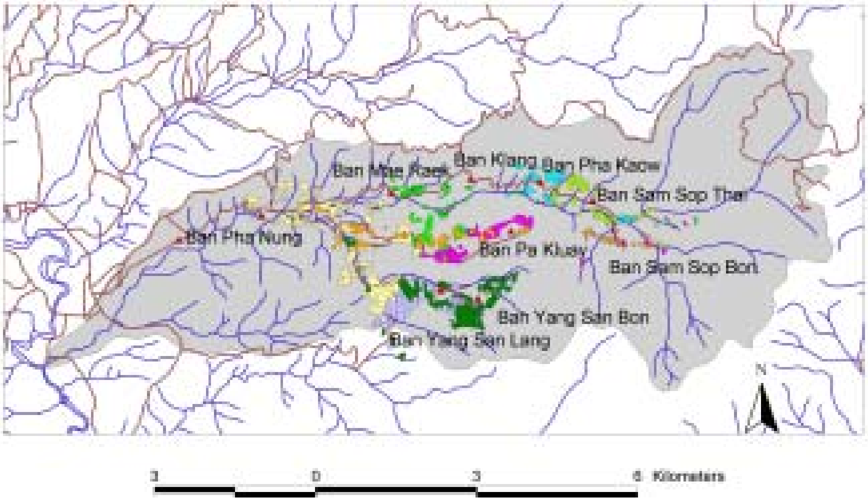
ICRAF also works with the Queen Sirikit Forest Development Project, under the Watershed Management Division of the Royal Forest Department (RFD). This project has been working with local communities for more than 15 years, and both Care and ICRAF are supporting their efforts in participatory land use planning with base maps and additional relevant information. We also coordinate with the Royal Project Foundation in areas under their responsibility.

Working together with the Geography Department at Chiang Mai University's Faculty of Social Sciences, most villages in Care's initial 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 land ownership data from a small sub-catchment in lower Mae Chaem. Mae Raek is part of a Care Thailand has conducted intensive land use mapping during the last 3 years. The color codes in the map refer to currently cultivated agricultural fields according to village. As one can see, agricultural fields are not necessarily in the vicinity of a single village. More likely, as elsewhere in the highlands in Thailand, they are scattered, and areas particularly suitable for paddy fields are shared among villages. Both traditional and economic reasons underlie such patterns, as villagers moved and married among villages, and field ownership is sometimes transferred. Paddy development is also very expensive and usually not conducted across a large area at one time.

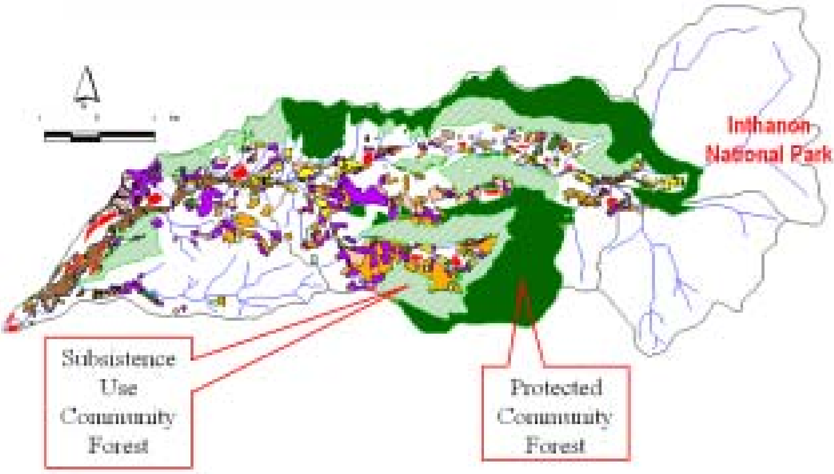
Rather, individuals will transform suitable land and prepare small paddy fields as resources are available to do so. Recent projects have used various technological and subsidy approaches to support further expansion of paddy fields in areas previously not available for paddy cultivation.

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



Map 2 is a general land use zoning map of the Mae Raek sub-watershed. Together with local communities, Care Thailand and Chiang Mai University staff conducted extensive mapping exercises that included land use zones that had already been developed and articulated using PLP processes. 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.

Map 2: Locally-negotiated land use zoning map of the Mae Raek sub-watershed



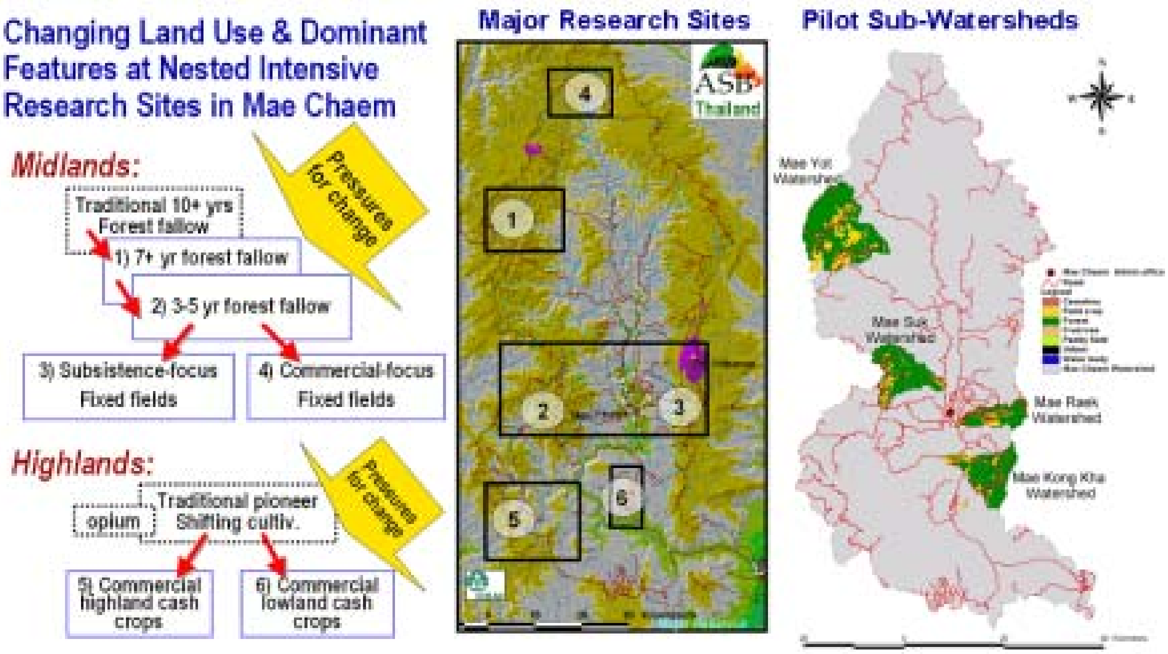
Areas delineated in Map 2 include: 1) community forest for subsistence use, as well as community-protected forest areas; 2) areas with fixed household agricultural fields (paddy, field crops, orchards, etc.); 3) "religious" or sacred sites (cemeteries). Each map entity (polygons, lines or points) was geo-referenced and verified by ground truthing in the field with a global positioning system (GPS) device. Through the use of recently available non-restricted signals, and 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.

By transforming locally-negotiated land use zoning derived through PLP processes into this type of georeferenced digital format, we hope to provide a framework under which local plans can serve as a basis for formal recognition through land use agreements. The legal basis for such agreements may be provided by community forestry legislation now pending in parliament.

B. Understanding Local Patterns of Land Use Change

In order to help deepen our understanding of local patterns of land use change, ICRAF Chiang Mai also acquired aerial photos for more than 1000 km^2 in Mae Chaem, covering 6 major research areas nested in the watershed. The rational for selecting these areas was to include a suitable sample of major variation in land cover and land use, as well as different ethnic groups, altitude zones, infrastructure, etc. Figure 3 indicates the location of the areas and aspects of land use change they represent, as well as four sub-watersheds where intensive applied assessments are being conducted to support pilot project activities that began during 2001 in collaboration with local watershed management networks and sub-district (tambon) governments. This work has included a set of historical assessments of land use change, based on a time series of aerial photos 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 1976, 1984 and 1995/6. The resolution of air photos varied, from 1:50,000 in 1954 to 1:10,000 in 1996.

Figure 3: Mae Chaem District, focal research areas, and pilot sub-watershed sites



The main focus of this first analysis was to assess historical changes in forest and forest fallow 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, 1976, 1984 and 1996. A more current land use cover map resulted from a Care Thailand land use assessment, which produced what can be considered the most accurate map in this procedure. Since this land use assessment was 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. Charts have been constructed to compare overall areas of land use from the different years of assessment.

The following sections summarize patterns of land use change in the Mae Raek and upper Mae Yot sub-watersheds, which reflect different trajectories of land use transformation.

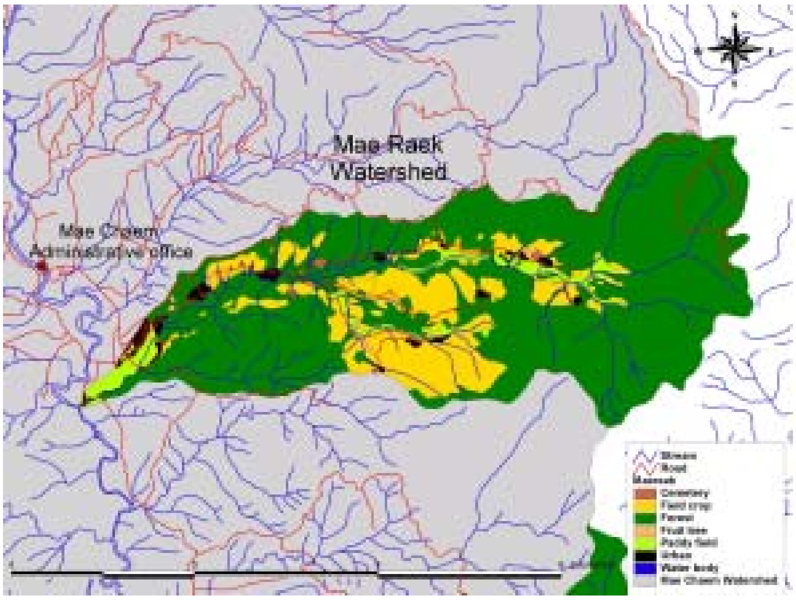
1. Mae Raek: Transformation to permanent fields near a National Park

Map 3 shows the current distribution of land cover in the Mae Raek sub-watershed, based on the Care-CMU land use maps, which were digitized, field checked and updated by ICRAF research staff. This map can be compared with Map 2 to see how current land use corresponds to land use zoning plans developed through PLP processes. But in order to more clearly understand the current status of land use in this area, it is useful to examine how it has changed during recent decades.

Map 4 demonstrates clearly how land cover in Mae Raek (circled in red) has changed during the past 50 years, and Figure 4 charts associated overall areas under different types of land use.

- In 1954, with literally no access or infrastructure, hill farming communities relied mainly on subsistence farming of upland rice and associated crops using rotational forest fallow agroforestry, wherein relatively large blocks of land were opened by communities in a rotational cycle. The ratio of upland fields to young and old fallow areas suggests a rotational cycle of about 10 years. Paddy fields were mostly limited to lower altitudes and wider valleys, mainly populated by northern Thai communities. As influences discussed in sections above increased, land use changed dramatically. In particular, as areas on the upper eastern slopes became part of Inthanon National Park during the 1960's, farmers began to be encouraged to move out of park boundaries so that their fields could be re-forested.

Map 3: Land cover map of the Mae Raek sub-watershed



- By 1976 we can see fragmentation of land use patterns, including old and young fallows, as well as development of some older fallows into forest. The ratio of upland fields to young and old fallow suggests the average rotational fallow cycle had dropped to about 7 years. Paddy land increased by about 20 percent, however, with much of the increase in higher valleys.
- By 1984, government opium crop substitution and rural development projects were beginning to have an impact. Former old fallow areas were becoming indistinguishable from forest, and government forest replanting programs were active in upper areas claimed for the national park. Land use patterns became more fragmented as communities began cultivating fixed fields in upland areas, which were still primarily focused on subsistence upland rice. Cultivated field to fallow ratios suggest that the overall average fallow cycle had dropped below 4 years, but development projects helped expand paddy area by another 10 percent along rivers and streams.

Map 4: Land Use in Mae Raek, 1954, 1976, 1984, 1996

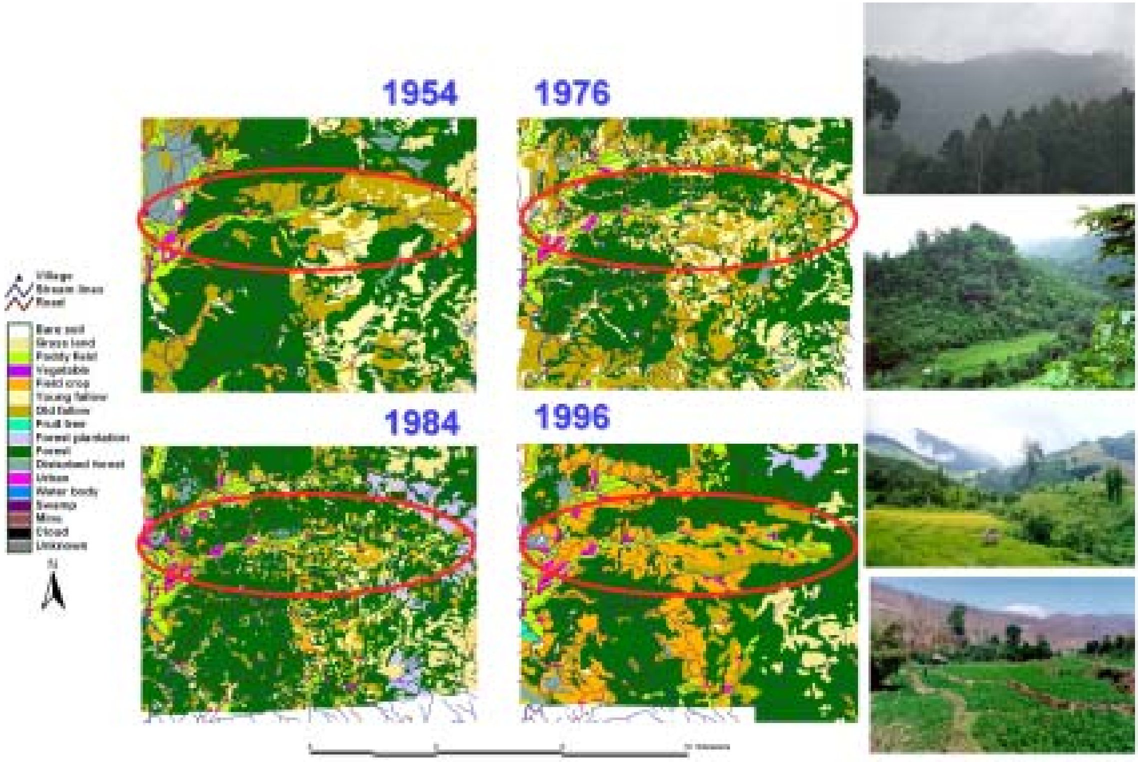
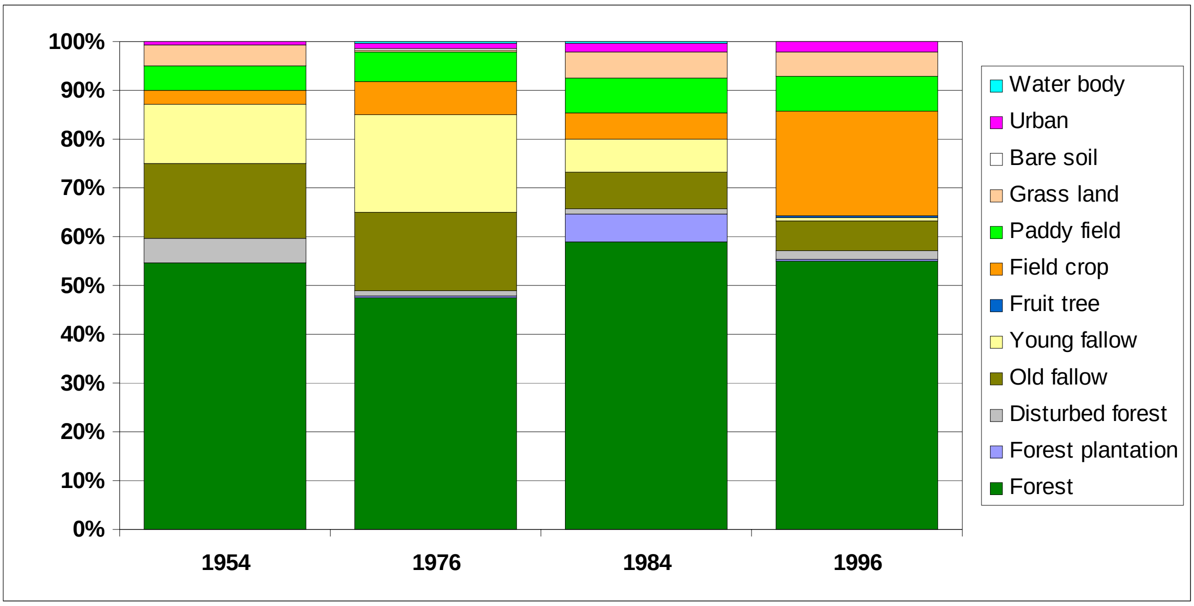


Figure 4: Area estimations of land use change in the Mae Raek sub-watershed



- During the 30 year period of 1960-90, opium eradication and national park programs were very effective in transforming large fields into either forest or restricted cultivation on small fixed fields. The 1996 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 ethnic group this can vary substantially) to a system where paddy and permanent 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.

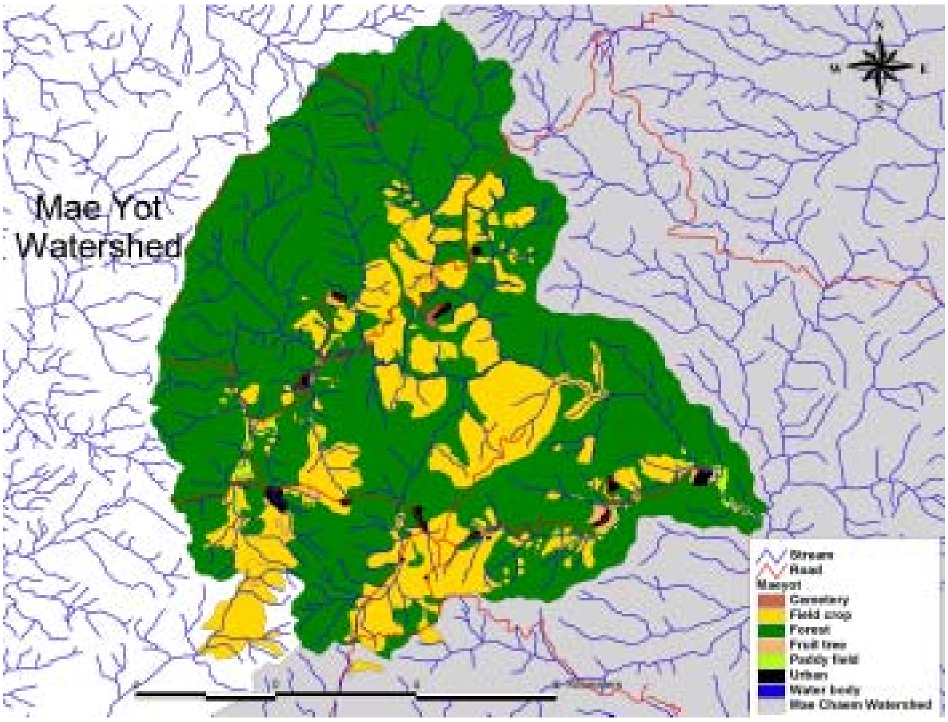
- The nearly four-fold increase in area under field crop cultivation during 1984-96 is associated with two factors other than population growth. The first is that upland rice cannot be continuously cultivated in permanent fields without experiencing serious yield declines. Villagers in Mae Raek adapted to this situation by rotating a crop of soybeans every third year, resulting in an approximately 50 percent increase in cropped area. The second is that cultivation on permanent fields has required purchased inputs, at least in the form of chemical fertilizer and herbicide to compensate for soil nutrient replenishment and weed suppression functions no longer provided by forest fallow cycles. Since upland rice is a subsistence crop, however, a source of cash for purchased inputs needed to be found. Thus, Karen communities have joined in producing upland soybeans and maize for sale to lowland Thai agro-industry. This has led to dramatic further increases in cultivated field area, as seen in Map 3.

Overall, the analysis clearly shows nearly complete elimination of forest fallow shifting cultivation systems, with only relatively small areas of old fallow and disturbed forest distinguishable from natural forest cover. This has been accompanied by a modest, but significant increase in paddy land, and a major increase in cultivated permanent fields as local communities have entered the commercial agriculture arena. Nearly two-thirds of the total land area is now under forest cover, and local land use zoning is being employed to assure its continued presence in the Mae Raek landscape.

2. Mae Yot: Traditional rotational fallow and intensive highland vegetables

Conditions in the upper Mae Yot sub-watershed represent a different recent history with a mixed set of land use trajectories. Whereas the Mae Raek sub-watershed is populated by lowland Thai and Karen villages located next to a major national park, the upper Mae Yot sub-watershed currently has a mixed population of midland tradition Karen and ridge-dwelling highland tradition Hmong communities. Map 5 presents the overall current land cover pattern of the watershed.

Map 5: Land cover map of the upper Mae Yot sub-watershed



In order to more clearly understand what this pattern represents and how it has come about, we need to examine land use change in different parts of the area populated by each ethnic group. Map 6 displays changing land use patterns during the last 50 years, in a parallel manner to those presented for Mae Raek. In this case, however, two areas are circled in each map – an area managed by Karen communities is circled in green, while an area managed by Hmong is circled in red. Figure 5 charts the overall distribution of area under each type of land use for the entire sub-watershed. Major points to be noted include:

Map 6. Land Use in Upper Mae Yot sub-watershed, 1954, 1976, 1984, 1996

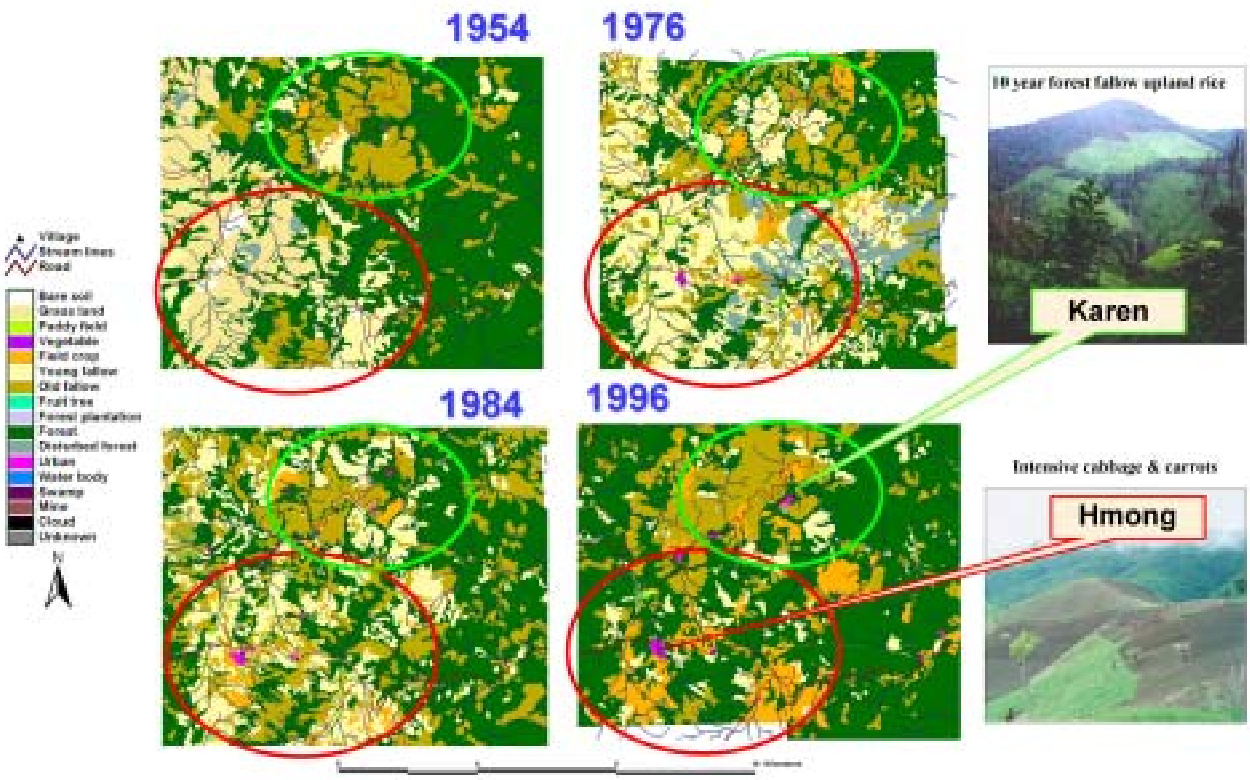
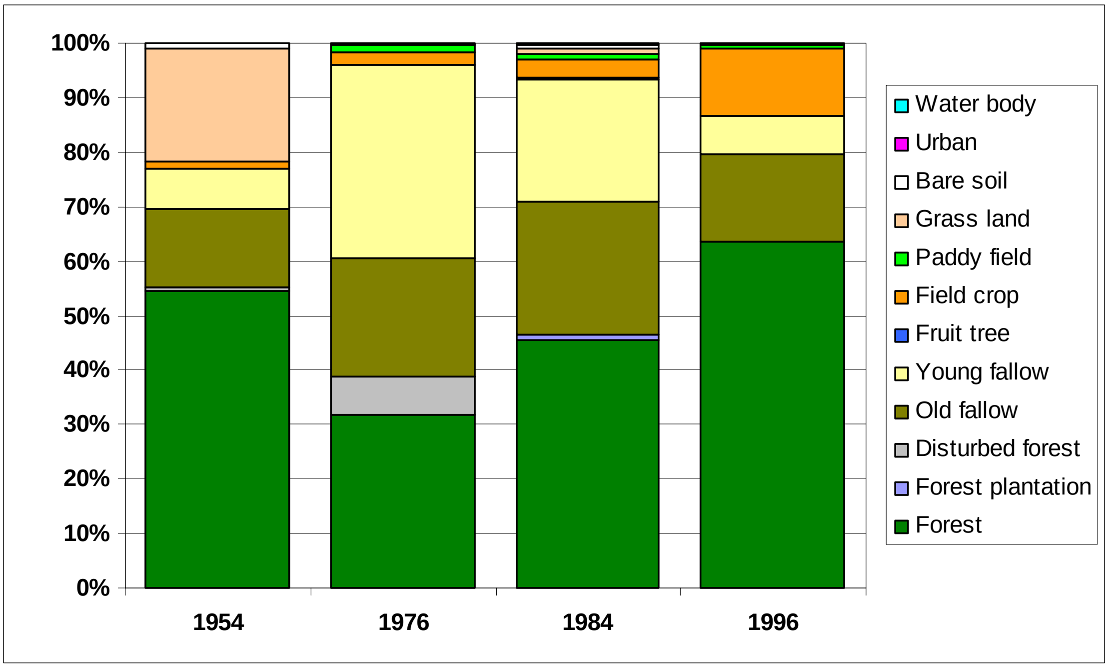


Figure 5. Area estimations of land use change in the Upper Mae Yot sub-watershed



- In 1954, land use is already very different in the two circled areas, although the Hmong community that now lives within the red circle was not yet present. A major feature of this period is the large area of grassland along ridges in the western portion of the map. It is not yet clear what caused this large area of grassland, but since most of the area has since returned to forest, it is probably safe to assume that it was once covered by forest. One possible hypothesis to explain this area is that there was some sort of natural event, such as a major drought followed by a very hot forest fire that devastated this area. Alternative hypotheses might be that imperata-type grasslands had already resulted from opium cultivation, or that Hmong communities may have previously used the area, but their settlements were located over the ridge beyond the western boundary of our air photos. As no other forms of documentation are available to help us accept or reject these hypotheses, we are in the process of trying to gain more information about this situation from older residents of nearby communities. Land use within the green circle of the Karen community, however, is very consistent with a traditional long forest fallow cycle rotational agroforestry system. Overall ratios of cropped land to young and old fallow land are consistent with a forest fallow rotation cycle of as long as 15 years. Only very small areas of paddy land are identifiable in valleys of this steeply sloping landscape.

- By 1976, permanent Hmong settlements are apparent within the landscape circled in red, land use became more fragmented, and overall forest cover was reduced substantially. Opium cultivation is known to have been substantial during this period. The overall area of young fallow increased substantially, and the significant area classified as disturbed forest may have actually reflected an increase in old fallow areas. Currently cropped areas in 1976, however, appear to be too small to be associated with increased young fallow. A more likely explanation is that much of the increased area classified as young fallow was in fact early stages of regeneration of the large grassland area identified in the 1954 photos. Paddy land was also being developed, particularly in the western half of the red circle. Within the green circle, there also appears to be a somewhat larger proportion of area in young fallow, suggesting a possible modest shortening of the previous rotational forest fallow cycle length.
- By 1984, more of the former grassland area has become old fallow or forest, along with some of the areas previously classified as disturbed forest, suggesting continued regeneration of portions of these areas. Opium production was coming under pressure from the government and crop replacement projects, which was probably associated with the significant increase in cultivated fields near Hmong settlements. Land use within the green circle retained a balance of cover types similar to the previous period. The overall ratio of cultivated fields to fallow areas was still consistent with forest fallow rotational cycles as long as 14 years.
- By 1996, a much larger proportion of the area is classified as forest, with much of the increase in areas previously classified as grassland or disturbed forest. The associated drop in land under young and old fallows, however, was also associated with a major increase in land under cultivation. This seeming paradox is explained by the fact that most of the major increases in cultivated area are in the vicinity of Hmong villages, where intensive production of cabbage and other high value crops had become a major enterprise. It is worth noting that Hmong had purchased paddy areas in the western portion of the red circle and converted them to irrigated vegetable production fields, which yielded much higher profits. Meanwhile, land use within the green circle retained a large proportion of forest and old fallow land, which is consistent with the 10-year rotational forest fallow system that still continues in this area.

Overall, this analysis shows an overall major increase in forest area since 1954 – 80 percent of the overall landscape is still under forest or old fallow cover. Much of this increase appears to have been associated with regeneration of forest in areas that were previously imperata grasslands. Within this context, Karen communities were able to maintain a traditional form of rotational forest fallow agroforestry that still has a cycle length of 10 years, rice yields of more than 3 tons ha^{-1} without chemical inputs, and relatively small proportions of the landscape in cultivated fields and young forest fallows. Meanwhile, Hmong settlements established in neighboring areas became engaged in intensive commercial production associated with opium crop replacement programs, resulting in relatively high profitability and very substantial increases in cultivated field areas.

C. Information support systems for managing agroforestry landscapes

Clearly, there are a variety of landscape management scenarios and trajectories that underlie current land use patterns in mountainous areas of northern Thailand. As we saw in the first section of this paper, major issues featured in debate and conflict over natural resource management include perceived impacts of changing mountain land use practices and patterns on forest resources, and especially on the volume, timing and quality of water in streams flowing to downstream areas.

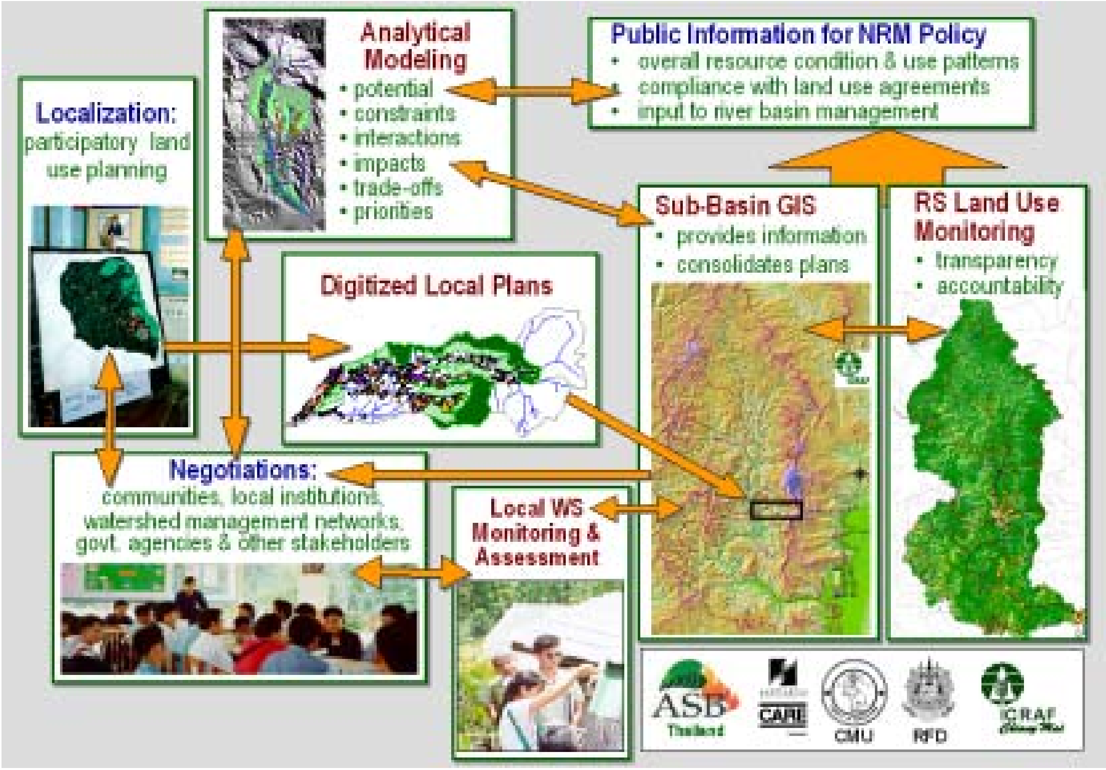
Despite the legal status of these lands, various projects have sought to help address growing land use conflict by collaborating with local communities in using PLP and associated mapping tools to demarcate local land use zones that seek a reasonable compromise aimed at meeting needs of both local livelihoods and national society. As in many other upper tributary watersheds, nearly all land in Mae Chaem only relatively small areas of paddy land, primarily in lowland Thai areas, have official land tenure recognition. All other agricultural and agroforestry land use is informal, and technically illegal. While informal local land use institutions have provided a basis for managing community land for generations, they are vulnerable to pressure and encroachment from more powerful outside forces. For example, forest fallow and protected forest areas of long-established midland Karen communities have become targets for use by neighboring villages, often of other ethnic groups, or for government forest programs. The absence of a legal framework for recognizing local land use rules and regulations remains an important obstacle for elected sub-district governments (TAO) and other local institutions to strengthen land use zoning and prevent encroachment by more powerful outside forces. Community forestry legislation pending in parliament could provide the legal basis for recognition of local land use zoning agreements based on the type of information presented in the previous section. But transparency and accountability in implementing and enforcing land use agreements is likely to be a major concern of skeptics.

Thus, the next step in improving the policy focus of ICRAF's collaborative activities has been to integrate spatial assessment tools into an overall approach for negotiating trade-offs and monitoring impacts of specific landscapes under the range of actual local conditions found in the region. Research findings summarized in this paper indicate the dynamic nature of mountain agroforestry landscapes and the diverse range of local conditions that underlie current land use patterns. As visions and local conditions continue to change, and management responsibility shifts to local institutions, a need arises for continuous feedback on impacts of actual agroforestry mosaic landscape patterns that can be used in continuing collaborative negotiations among institutions responsible for natural resource and development at both local and higher levels of society.

Our current efforts focus on a set of policy and action-oriented pilot activities that seek to improve science-based methods for continuously obtaining and integrating relevant information into a system that helps meet both local and national needs. Figure 6 diagrams the overall framework of this approach, which has also elicited interest from neighboring countries during presentations in the context of both MMSEA and the Greater Mekong Sub-region (GMS) (Thomas 2000). Work during 2001 focused on pilot tests in the 4 sub-watersheds identified in Figure 3, where we are collaborating with local watershed management networks and TAO.

Major emphasis of the system is on information useful in planning, managing and monitoring natural resource use at various relevant levels. Local information for this system comes from two types of sources: 1) pilot project efforts by our partner institutions to implement locally-negotiated land use zoning using participatory land use planning methods; 2) expansion of community-based monitoring and management activities. Major components of broader scale and higher level information are available in our project GIS, which we continue to supplement through additional remote sensing analysis, as well as other data acquisition methods and secondary sources. While some types of information can be used directly by stakeholders, we also seek to assist interpretations through analyses based on analytical modeling.

Figure 6. Pilot information support system for agroforestry landscape management



Participatory monitoring of local watershed services associated with the types of landscape patterns discussed in this paper are another key component of this approach. While watershed concerns and tensions are generally rising, local downstream feelings are still largely at the level of concern, apprehension or fear. Moreover, general priorities of these concerns are first with chemical pollution, followed by post-rainy season stream flow and heavy sedimentation of downstream water resources and irrigation infrastructure. One striking feature of most debates and confrontations has been the absence of any systematic efforts to use empirical data to help characterize and assess impacts of changing land use practices and patterns on key watershed functions. While there is a modest body of research on soil erosion and some hydrological properties of particular land uses, the net impact of the types of complex mosaic land use patterns found in most areas has generally remained unaddressed. Moreover, pollution from toxic agricultural chemicals is particularly difficult given their invisibility, the range of chemicals used, and the complexity and cost of methods to directly measure their presence at the often very low concentrations at which they may be chemically active. Thus, ICRAF and our colleagues have been exploring use of biological indicators of water quality that could be used by trained villagers to measure water quality in a manner that would be credible beyond their own local area or ethnic group. This work builds on and adapts methods articulated in publications of the Green World Foundation (2000).

The overall system seeks to meet three types of stakeholder needs:

- Local needs for information useful in land use planning, monitoring and management, which are being identified and refined jointly with local leaders, as well as through monthly field seminars and consultation with key stakeholders and our local development project partners. Monitoring provides dynamic data on the ‘bottom line’ quantity and quality of watershed services from locally managed landscapes, which should be helpful in identifying local successes and problems, and in managing tensions and conflict between upstream and downstream communities at various scales.

- Needs for improved policy-relevant information available to various levels of the policy making process. For example, local land use plans are being aggregated to demonstrate to resource management agencies the types of patterns and impacts on broader natural resource landscapes that are likely to result from localized zoning. If community forestry legislation is passed soon, we also hope to test use of these zoning arrangements as a basis for establishing official land use agreements in protected watershed areas.
- Needs for public access to information on the status and management of natural resources at various levels. In order to help assure transparency and accountability of localized land use zoning, we are testing use of remote sensing to monitor actual land use against locally formulated plans. This should be public information, along with overall status data.

Since floods and landslides during mid-2001 devastated several areas of northern Thailand, the Ministry of Agriculture and Cooperatives and various other agencies and organizations have been discussing approaches for strengthening local capacities to minimize the occurrence and impact of such events. We are now working to integrate these concerns into our pilot information support systems. We also understand that the Thailand Research Fund has recently approved a line of support for activities to develop information systems for local governments. These trends indicate that there is interest in and potential for expansion of approaches such as we are currently testing in Mae Chaem, and we are seeking ways in which our efforts can provide prototype experience for these larger policy formulation and development program activities.

III. 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.

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 deteriorating 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 stakeholder 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 and 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.

Acknowledgements

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