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

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Abstract

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

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

I Introduction

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

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

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

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

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

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

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

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

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

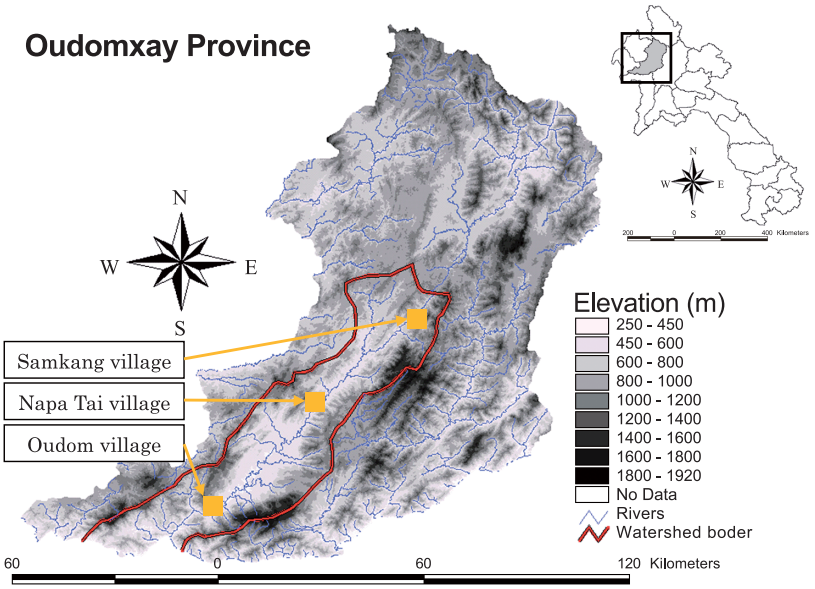

Fig. 1　The Study Area: Nam Beng Basin

Table 1　Outline of the Study Villages

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

Sources: Interview to the village headmen, Sep. 2002

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

II Methods

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

II.1 *Interpretation of Land Cover Changes*

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

1) *Base Maps*

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

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

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

2) *Air- and Satellite-Born Images*

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

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

3) *Image Interpretation*

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

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

II.2 *Estimation of Population Changes*

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

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

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

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

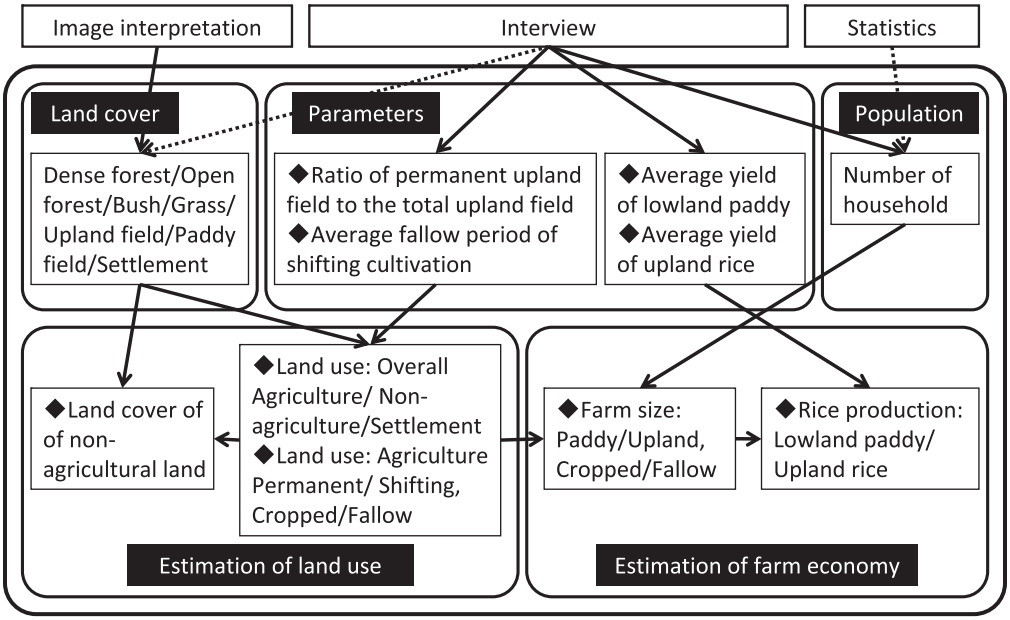

Fig. 2 Procedure to Estimate Land Use and Farm Economy

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

1) *Parameters*

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

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

upland rice production.

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

2) *Estimation of Land Use*

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

Area of permanent upland field (Aup) (%)

$$Aup = Au * Rp$$

Area of shifting upland field (Aus) (%)

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

Area of fallow land (Af) (%)

$$Af = Aus * Yf$$

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

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

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

$$An = 100 - Aa - As$$

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

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

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

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

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

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

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

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

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

3) *Estimation of Farm Economy*

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

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

$$Fp = At * Ap / H$$

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

$$Fup = At * Aup / H$$

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

$$Fus = At * Aus / H$$

Average area of fallow land (Ff) (ha)

$$Ff = At * Af / H$$

Average farm size (Ft) (ha)

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

Rice production per household is calculated as follows:

Lowland paddy production per household (Pp) (ton)

$$Pp = Fp * Ydp$$

Upland rice production per household (Pu) (ton)

$$Pu = Fus * Ydu$$

Total rice production per household (Pt) (ton)

$$Pt = Pp + Pu$$

III Changes in Population and Land Use of the Study Villages

III.1 *Napa Tai Village*

III.1.1 *Population*

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

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

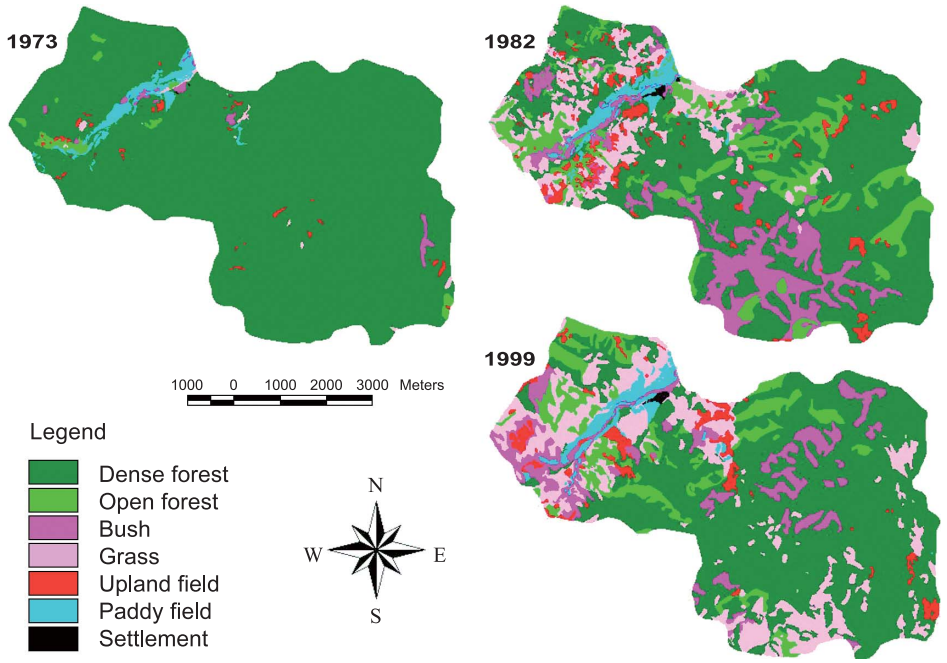

Fig. 3　Changes in Land Cover of Napa Tai Village

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

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

III.1.2 *Land Use*

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

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

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

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

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

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

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

III.1.3 *Farming System*

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

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

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

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

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

III.2 *Samkang Village*

III.2.1 *Population*

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

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

III.2.2 *Land Use*

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

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

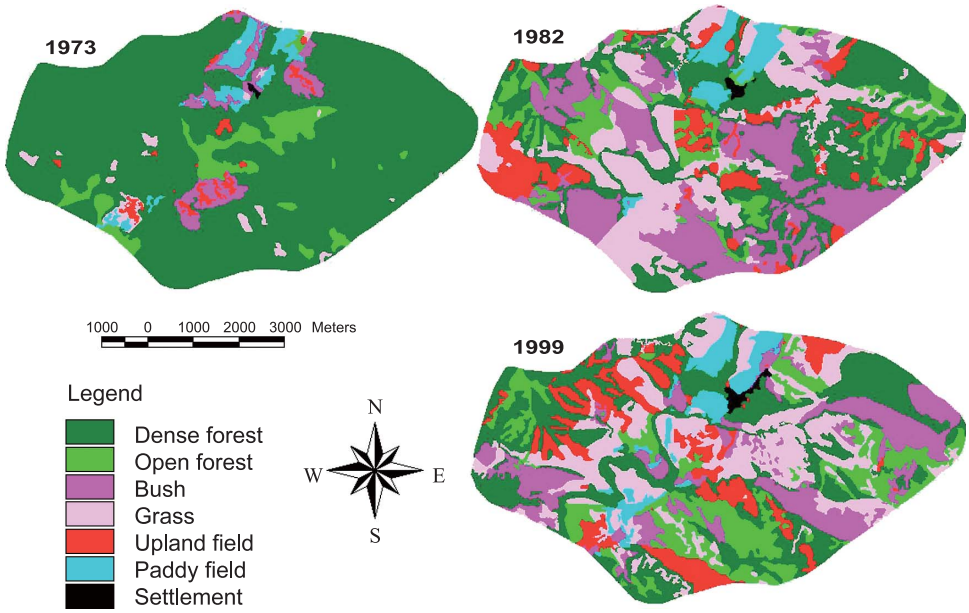

Fig. 4　Changes in Land Cover of Samkang Village

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

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

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

III.2.3　*Farming System*

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

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

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

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

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

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

III.3 *Oudom Village*

III.3.1 *Population*

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

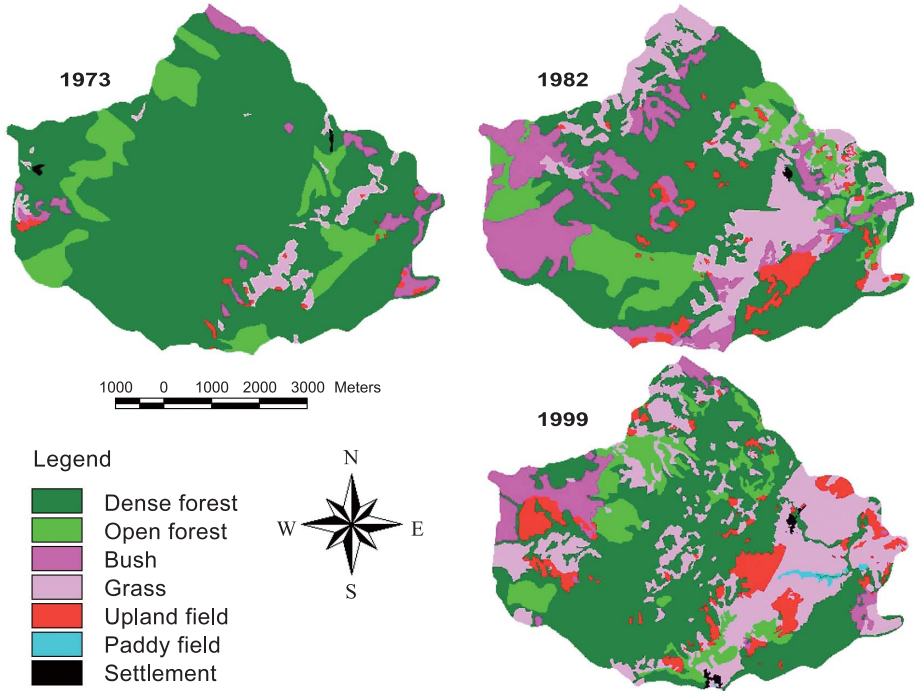

Fig. 5 Changes in Land Cover of Oudom Village

III.3.2 *Land Use*

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

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

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

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

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

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

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

III.3.3 *Farming System*

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

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

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

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

IV　Mechanism of Land Use Change

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

IV.1　*The First Period (1973–82)*

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

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

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

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

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

IV.2 *The Second Period (1982–99)*

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

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

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

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

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

V Conclusions

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

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

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

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

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

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