Effect of Paddy Area Conversion to Rubber Plantation on Rural Livelihoods: A Case Study of Phatthalung Watershed, Southern Thailand

Anisara Pensuk and Rajendra P. Shrestha

Abstract*— *This study examines the land use change, paddy to rubber in particular, for last three decades in Phatthalung watershed of Thailand to explore the effect of land use change on rural livelihoods. Land use change was studied using remote sensing data acquired over 1976 to 2006 where as livelihood assessment was done using household data collected through household survey. The study revealed that rubber plantation has been growing in the area with the decrease in paddy area and others and the driving factor is better income from rubber. Overall livelihood between two groups of households (rubber-based and rice-based) is although not significantly different, there are some differences at individual livelihood indicator level. The result however explains some important characteristics, such as poor status of natural asset compared to other assets, on which the sustainable rural livelihood resides.

***Keywords*— Land use change, Livelihood assessment, Thailand.**

1. INTRODUCTION

The modification of land use and land cover contributes to watershed degradation through important environmental consequences on soil and water quality, biodiversity, methane emission and reduction of CO_2 absorption [1]-[2]. There have been number of studies relating to land use changes in the past but are limited to understanding the causes and effects of land use changes on biophysical aspects. Studies on the effects of land use changes on rural livelihoods are still inadequate.

Land use is an important factor influencing livelihood of farmers. In the context of Thailand, land use issue plays an important role as majority area of the country is under agriculture [3] employing the majority of Thai population. The change in farming system, through land use change and modification can affect farmer livelihoods and also the livelihood strategies in changing circumstance [4]-[5].

Sustainable Livelihood Approach (SLA) developed by DFID [6] was applied in this study in order to assess farmers' livelihoods due to the change in land use system. According to SLA, livelihoods resources comprised of five different capitals or assets, namely, human asset, natural asset, financial asset, social asset and physical asset [6].

Human asset is skills, literacy, knowledge, ability to labor and health of household members which enable to achieve their livelihood objectives [6]-[7]. Natural asset is very important for livelihoods, especially for rural households in which most household activities are resources-based activities. Natural asset can be considered as the natural stocks (soil, water, air, genetic resources, etc.) and environmental services (hydrological cycle, pollution sinks, etc.) [7]-[8]. Financial asset includes financial flows and stocks [6] as well as cash, savings and credit are the basic needs for livelihoods. For example, livestock [4], [9]-[12], and remittances [8], [12] are the financial asset indicator. Social asset is rather complicated [6]-[7]. It can be networks and connections, memberships of formalized groups and relationships and the relationship of trust [8]. Density of active community and benefit from kinship could be other social asset indicators [9]-[10], [12], as well as the collective action and accessibility to knowledge [4]. Physical asset comprises of basic infrastructure and producer goods which are needed to support livelihoods [6]. Houses and occupational equipments are basic physical asset indicators [8], [10]-[11], as well as road and transportation [9]. Vehicles, machinery, shops and other agricultural implements can be also considered as physical asset [12].

This study was carried out in Phattalung watershed of Thailand where the agricultural systems are undergoing change driven by a variety of internal and external forces. The objective of the study was to examine effect of land use change, in particular paddy to rubber conversion, on rural livelihood.

2. THE STUDY AREA

The study area, Phatthalung watershed is located between 7º 5´-7º 55´latitute and 99º 44´ to 100º 25´longitute covers Phatthalung and Songkhla province of the Southern part of Thailand (Fig.1). The western part of the area is mountainous covered by evergreen forest. Rest of the area is flood plain with some rolling terrain. The watershed area is approximately 302,699 ha. and the elevation in the area ranges between 0-1200 m above m.s.l. The annual average rainfall is 1,853.5 mm with average annual rainy days of 154. Rainfall distribution is bimodal, with the long rains from September to January and the short rains from May to June. The average annual temperature is 28.14ºC [13].

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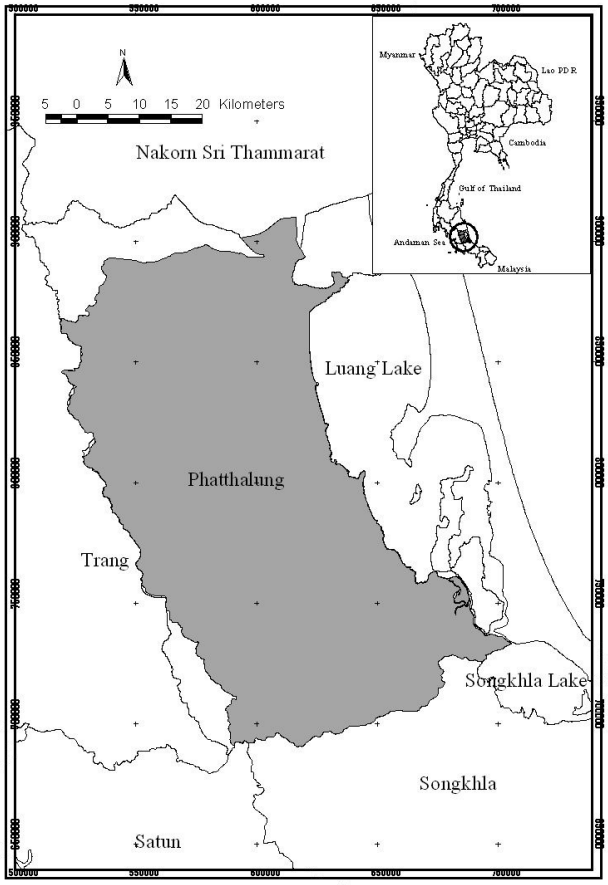

Fig.1 Map of Phatthalung Watershed

The estimated households (HH) and population of the study area are 140,618 and 500,000 respectively in 2006 [13]. Agriculture has been primary source of livelihood for the majority of population. Land use activities include rubber, rice, orchards cultivation and shrimp and livestock farming. The major farming system consists of a highland rubber plantation (*Hevea brasiliensis*), intercropped with pineapple, and a lowland rainfed paddy in some areas. Majority of population are smallholders with an average land holding size of 1.96 ha.

3. RESEARCH METHODOLOGY

Analysis of Land Use Change

In order to investigate land use change, the remote sensing data (Landsat images, Path/Row-128/55) were used. Landsat Multispectral Scanner (MSS) data acquired on 30 March 1976 was downloaded from http://glovis.usgs.gov/. Landsat Thematic Mapper (TM) acquired on 1 June 1990 was obtained from GLCF (Global Land Cover Facility) at http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp and Landsat Enhanced Thematic Mapper (ETM+) acquired on 27 August 2006 was purchased from the United States Geological Survey (USGS).

Remote sensing data was interpreted to produce land use maps of three time periods, i.e. 1976, 1990, and 2006. The interpretation was done using a supervised maximum likelihood classification procedure in ERDAS IMAGINE software. The maximum likelihood classification algorithm requires training area which represents the spectral behavior of every land use class for classes identification [14]. For this study, Level I of land cover classification as suggested by Anderson et al. was followed [15]. Seven major land use classes namely forest, rubber and perennials, paddy field, urban or build-up land, aquaculture, wetland and water body were classified as presented in Table 1.

Table 1. Description of Land Use Types

Land use/cover	Description
Forest	Deciduous forest, coniferous and evergreen forest, and mixed forest
Para rubber and perennial	Para rubber plantation, fruit trees including perennial trees
Paddy field	Paddy field and rice field
Urban and build up area	Cities, towns, villages, highways and transportation areas
Aquaculture	Shrimp farms, fish farms and other types of aquaculture
Wetland	Mangrove and swamp areas
Water body	Lake and man made reservoirs

The final land use classification of three time periods was examined against all available reference data and field information including author's own experience in the study area by constructing the confusion matrices, which compare on category-by-category basis, the relationship between known reference data and the results after classification [16].

Socio-economic and Livelihood Assessment

The secondary socio-economic data and the household survey were used in order to analyze the socio-economic and livelihood of farmers. The secondary socio-economic data e.g. numbers of households and population were obtained from the Ministry of Interior of Thailand (MOI) and were used for sample size determination. Out of 140,618 HH in the study area, a total of 140 HH was determined as sample size using the sample size determination technique given by Arkin and Colton [17]. A total of fifteen villages who have been practicing paddy and/or rubber cultivation were selected in the first step to draw those 140 sample HH. Out of 140 HH, 95 HH including those who changed from paddy field to rubber plantation, called as Group I in the paper. The second group of HH (Group II) consisted of 45 HH who have been growing rice throughout the study periods at least for last 30 years.

A household survey was conducted by administering structured questionnaire which included both close and open-ended questions to collect qualitative and quantitative data on households and their activities. The questionnaire was pre-tested and revised before conducting interview of sampled HH. The survey was

carried out in January and February 2007.

The surveyed household data were analyzed by using Statistical Package for the Social Sciences (SPSS). A three point rating scale with discrete value of 0, 0.5 and 1 was used for measuring and rating the livelihood indicators.

Natural asset index was computed from three indicators, namely, land holding size, soil fertility status and the availability of water. Households holding a larger plot of land were given the higher score than households which hold smaller land area. The soil fertility status and water availability indicators were derived from the perception response of households. The 'increase' perception in soil fertility and water availability was given the highest score of 1, the 'no change' was given a medium score of 0.5, and the 'decrease' was given the lowest score 0. Income from crop and livestock production and loan were used as indicators for computing financial asset index. In the rural area, since household income generally comes from crop and livestock production, both sources of income were used as financial asset indicators. Higher income was given higher score than lesser income whereas it was vise versa amount of loan. Human asset index was computed from three asset indicators, namely number of household member, working age labor (15-60 years old) and full time labor in agriculture. Higher score was given to high value in each indicator. Social asset index was derived from the accessibility to knowledge (literacy level) and benefit from kinship (remittance). High education level was given higher score and so was the remittance, i.e. higher the remittance higher the score. Physical asset can be defined as the basic necessary infrastructure which however does not vary considerably within the study area. However, accessibility to market was selected as only physical asset indicator for this study. Higher score was given to households which located near the market and the lower score to those located far from the market. Scores of all indicators in each asset were summed up and categorized into three classes with score values of 0, 0.5 and 1 in order to generate livelihood asset index of rural livelihood in the study area. A compared mean with independent T-test was employed at $p<0.05$ level to examine the difference in various livelihoods indicators between two groups.

4. RESULTS AND DISCUSSION

Land Use Change

The land use change analysis conducted for three time periods (1976, 1990 and 2006) and the results are presented in Table 2. The classification results were reasonably satisfactory in terms of classification accuracy as suggested by Anderson et al. [15]. In the past, paddy cultivation was dominant in lowland area of Phatthalung watershed while rubber plantation was mostly confined to the hill side of watershed. In the recent past, there has been decrease in forest and wetland area and even paddy field and area rubber plantation has tremendously increased.

Forest cover has been depleted from 15.30% in 1976 to 14.65% in 1990 and 12.96% in 2006. The forest reduction rate was higher in 1990-2006 (-11.56%) compared to the eriod of 1976-1990 (-4.22%). The depletion of forest was basically due to the encroachment, particularly rubber plantation (Table 2).

Table 2. Land Use Change between 1976, 1990 and 2006

Land use types	Year			%Change	
	1976	1990	2006	1976-2990	1990-2006
Forest	15.30	14.65	12.96	-4.22	-11.56
Rubber plantation	44.36s	44.65	61.20	+0.67	+37.05
Paddy field	36.23	37.23	23.76	+2.83	-36.24
Wetland	4.10	3.42	1.97	-16.62	-42.32
Water body	0.01	0.02	0.07	+50.71	+341.76

Similarly, wetland area has been depleted from 4% in 1976 to about 2% in 2006 (Table 2). The total gross depletion was observed higher in the later period compared to the former period under study, i.e. -16.62% during 1976-1990, and -42.32% during 1990-2006 and the reasons are encroachment of paddy field and wetland areas mostly under aquaculture due expanding rubber cultivation and infrastructure development.

At present, more than 80% of study area is under agricultural area, mainly paddy and rubber, whereas residential area is less than 1%. Paddy field occupied about 37% in 1976 and 1990 but has been decreased to 23% in 2006 (Table 2). During 1976-1990, nearly 25% of paddy field has been converted to rubber plantation. The conversion rate of paddy field was higher in the recent past (1990-2006) as more than half of paddy areas are replaced by rubber plantation compared to the period of 1976-1990.

Assessment of Rural Livelihood

The livelihood indicators are presented in Table 3. Mean comparison through independent T-test for two HH groups under study indicated that the three variables chosen to represent human asset indicator did not show any significant difference between the groups while comparing respective score means. So was the case with human asset index, calculated based on those three variables, however the calculated human asset index was slightly higher for Group II (0.5) compared to Group I (0.47).

In case of natural asset indicator, there was no significant difference between two groups as shown by natural asset index, however the computed index was slightly higher for Group I (0.47) compared to Group II (0.43). When considered the variables of natural asset indicators, water availability status was higher for Group II (0.58) as opposed to Group I (0.44). It was also observed that, means were significantly different at $p<0.05$. The other two variables, namely land holding size, and soil fertility status, scored slightly higher for Group I compared to Group II.

Table 3. Livelihood Asset Indicators

Livelihood indicator	Group I		Group II		Sig
	Average	SD	Average	SD	
Human asset					
Household members	0.61	0.41	0.60	0.38	0.944^{ns}
Working age members	0.54	0.37	0.59	0.43	0.465^{ns}
Agriculture as main occupation	0.47	0.35	0.47	0.34	0.912^{ns}
Human asset index	0.47	0.40	0.50	0.41	0.699^{ns}
Natural asset					
Land holding size	0.51	0.42	0.37	0.43	0.062^{ns}
Soil fertility status	0.51	0.28	0.50	0.30	0.919^{ns}
Water availability status	0.44	0.29	0.58	0.34	0.015*
Natural asset index	0.47	0.39	0.43	0.46	0.641^{ns}
Financial asset					
Income from crop production	0.38	0.41	0.19	0.32	0.007*
Income from livestock production	0.15	0.33	0.09	0.27	0.256^{ns}
Credit and loan	0.77	0.36	0.68	0.43	0.171^{ns}
Financial asset index	0.54	0.32	0.40	0.31	0.019*
Social asset					
Access to knowledge	0.53	0.41	0.50	0.41	0.723^{ns}
Kinship	0.04	0.18	0.33	0.16	0.913^{ns}
Social asset index	0.56	0.41	0.50	0.41	0.058^{ns}
Physical asset					
Access to market	0.89	0.26	0.99	0.07	0.020*

Source: Field survey (2006)
*ns = Non-significant at p>0.05, *Significant at p<0.05*

Financial asset index presented significant difference between two groups as indicated significantly higher by compared index of income from crop production (0.38) for Group I and 0.19 for Group II. When considered the other two variables, namely income from livestock and credit and loan, both indicators scored higher for Group I compared to Group II, however there was no significant difference between groups.

Social asset was assessed through two variables, namely access to knowledge and kinship. Group I has higher score in access to knowledge while Group II had higher score in kinship. However, those two variables, and also composite social asset index were observed to have no significant difference between two household groups although Group I (0.56) showed slightly higher in overall social asset index compared to Group II (0.50).

Accessibility to market, as social asset, was significantly different between two groups, Group II (0.99) had higher accessibility to market than Group I (0.89). However, the accessibility to basic infrastructure e.g. road, school, hospital, electricity, water and sanitation was considered as the important physical asset indicators and included also in this study due to its contribution of better livelihoods, but it was assessed and considered to be of same level for both groups.

The livelihood index of each livelihood asset derived from livelihood indicators are presented through radar diagram in Fig.2 in order to compare and differentiate better-off indicator of each asset over others. HH in Group I tended to be better-off in terms of financial asset due to more income generation, however Group II was better-off in physical asset due to easier market access. Human, natural and social asset were found not to be significantly different between the groups.

5. CONCLUSION AND RECOMMENDATIONS

The land use change study showed a dramatic decline in rice growing area due to expansion in rubber plantation area. The study revealed that, many rice growing farmers tended to convert their land to rubber plantation due to the higher income from rubber production. Land tenure

as such was not a major problem in the area since most of the farmers do own their lands.

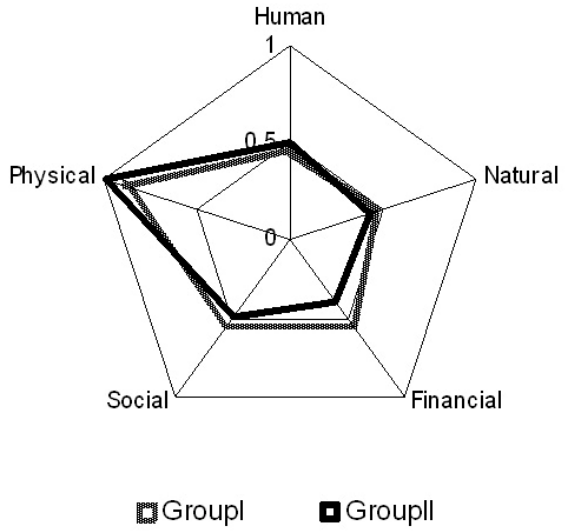

Fig.2. Livelihood Pentagons of Rubber-based HH (Group I) and Rice-based HH (Group II).

According to the statistical results, both HH groups have moderate level of livelihood for four out of five livelihoods assets (human asset, natural asset, financial asset and social asset). In general, rubber-based households are relatively better-off in financial asset than rice-based households due to higher price of rubber than rice. In order to improve financial asset of households, livestock can be an alternative source of income which should be promoted since livestock can generate the additional income for households. However, both household groups have low level of natural asset as indicated as the lowest score compared to others assets. This implies there is the need to take into account of these indicators, such as land holding, soil and water quality, for developing appropriate strategies.

Understanding the situation of rural livelihood is important for sustainable rural development. However, the assessment would be more effective when the most relevant livelihood indicators can be included in the analysis.

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