Journal of Agriculture and Sustainability
ISSN 2201-4357
Volume 12, Number 1, 2019, 124-151

INFINITY PRESS
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Land Use Change and Its Impact on Local People's Livelihood: A Case Study in Mountain Popa Area of Central Myanmar

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Abstract

This study was conducted to explore changes in land use and its impact on rural livelihoods in mountain Popa area of central Myanmar. Industrialization and land modification by the rural households have brought changes in land use of the study area. Results revealed that the percentage of forest area and water bodies were significantly decreased but the agricultural land area increased from 2008 to 2014. Land use change was detected by using Landsat ETM images. Both positive and negative effects of land use changes were found on the local people. Industrialization created job opportunities for the local people and increased accessibility and physical assets but the natural assets and financial assets of local people significantly decreased for the study period. Agroforestry was found to increase the social and natural assets of the local people. The challenges to improve the local people livelihood included lack of adequate capital, lack of trainings and inadequate technical support. The study recommends that the land use policy should consider local people's indigenous rights to balance the development initiatives of the government.

Keywords: land use change, industrialization, land modification, rural livelihood, agroforestry

JOURNAL OF AGRICULTURE AND SUSTAINABILITY

INTRODUCTION

Land use change (LUC) is closely related to socioeconomic development (Long et al. 2007; Lambin and Meyfroidt, 2010) and environmental changes (Msoffe et al. 2011) and thus has become a major area of research (Turner et al. 1995). LUC has become a serious concern in the world nowadays particularly in Asian nations (Young, 2000; Zhaoet al. 2006). People are the prime utilizer of land and an imperative maker of the social theories of the soil through their historial legacy (Geisler, 1996). LUC, soil contamination and land degradation are key environmental issues in the Asia pacific region. LUCs are triggered by various pressures and drivers and unsustainable land use practices have been recognized as one of the major problems in sustaining ecological capacity. Over the past half century, nations of South and Southeast Asia have seen a real move from subsistence farming to industrialized economies. These progressions have been joined by growing urban population and the development of enormous megacities around the area, frequently to the detriment of prime farmland. In determining future demand of land resource in Myanmar, demographic changes, economic transition and environmental issues are believed to be major factors.

The current trend of rapid population growth, large scale infrastructure development, agricultural expansion and foreign investment can directly influence Myanmar's rural people's livelihood. Expansion of agricultural land, building of dams and reservoirs, and increase in livestock rearing area has added to the socioeconomic development of local people. But, this development is the main driving force of deforestation in Myanmar. This contribute to unsustainable development due to extenstive use of natural resource base. In Myanmar, owning to the limitations of agro-climatic conditions with irregular rainfall, high temperature and frequent drought, agriculture is not viable for living. It is described that the deforestation rate from 1989 to 2005 within and outside of the Popa mountain

park area are reduced from 9,223 ha and 12,104 ha to 8,661 ha and 8,903 ha, respecitvely (Htun et al, 2010). LUCs and local climate changes are directly related with each other. The common livelihood in Popa area are agriculture and the main agricultural practices on the eastern parts are fruits, banana cultivation and other seasonal crops whereas on the west side the mainactivities are rain-fed paddy, palm-sugar production, smallscale fisheries and seasonal crops (Rao et al. 2002). In this context, the LUCs are substantial hazard to aboriginal peoples's livelihood.

The literature revealed that there is limited research on how the local people used their livelihood strategies with the limited land and other limited natural reources. The understanding of current and previous socio-economic conditions of local people before and after the LUC would enable the policy maker to explore the applicable land use policies for the sustainable development of Myanmar. Based on the above premise the objectives of this study were to 1) assess the LUCs for 2008 and 2014, 2) examine impacts of LUC on local peoples' livelihoods and to3) identify the factors affecting LUCs.

METHODS

Study Area

Mountain Popa was selected as study area. The relatively high elevation gives Popa mountains lower temperatures and higher precipitation than the encompassing focal dry zone of Myanmar. The mean monthly high and low temperatures for the period 2008–2014 were 34.6 and 8.3C and the mean yearly precipitation for the same period was around 1,000 m. The area was legally classified as a forest reserve in 1902. Popa mountain area consists of 45 villages with a total population of about 50,900. The main livelihoods sources of local people living in the eastern part of mountain Popa area were agroforestry

and agriculture (Referred to as case I) and those living in the northern part were agriculture and working as employee in the pozollan plant referred to as case II in this study.

Mountain Popa was selected as study area of the research because the land utilization of the area had been changed and has affected the livelihoods of the local people. The area witnessed good road access and perceived losses due to the compulsory land confiscation without compensation of government owned pozzollan plant constructed in 2000-2001. Popa reserve was proposed as a protected area (PA) by the nature conservation national park project conducted between1981 and 1984. The area was subsequently declared a PA in 1989. Major objectives were forest conservation, protection of the watershed of Kyet-mauk-taung dam located at the southern edge of the park, conservation of medicinal plants for sustainable use, preservation of existing religious sites and ensuring sustainability of water sources, including natural springs. The park covers an area of about 100 km^2, of which 88.7 % is covered by forests (Htun et al., 2010). Bananas are extensively planted in areas on the eastern boundary of the park and the practice is a major means of livelihood of people living in this area. The forest department regards banana cultivation as detrimental to surface water resources due to its high water consumption. The Forest Department provided seedlings to local people (Nature and Wildlife Conservation Division, 2008) but banana cultivators have not responded well as banana is the major source of their income and the initiative has not been very successful.

Data collection and sampling

This research was carried out mainly to explore the extent of LUCs and its impacts on the local people's livelihoods in the study area. Mixed methods of research were applied in this study. Both primary and secondary data were used (Table 1). The secondary data

were collected from USGS websites and forest department, related publications and literatures from various journals. The primary data was gathered through field observation, questionnaires survey, key informant interviews (KIIs) and Focus group discussions (FGDs). Field observation was performed to explore rural livelihoods and the land use conditions. The findings from observations were utilized to cross check the data acquired from the respondents. FGDs were held with selected household delegates and key informants. The FGDs examined about livelihoods in the study area, land tenure, landholding size in the study area and LUC in the study area.

Table 1: Data, collection methods and sources

S.No	Data	Methods	Source
1.	Landsat image 2008,2014	Geospatial technique	USGS
2.	Socio-economic condition • Household information • Land holding and tenure • Annual income and expenditure • Livelihood assets	• Household survey • FGDs • KIIs • Observation	Household level Village level Community level Township level District level
3.	Factors of LUCs • Land Law • Land Modification • Land holding and land tenure • Accessibility • Land ownership	• Household survey • FGDs • KIIs • Observation	SLRD, Household level, Village level, Township level, District level
4.	Local people's perception • Forest resource availability • Land holding size • Changes of land productivity • Pozzolan Plant	• Household survey • FGDs • KIIs	Household level Village level Community level SLRD

The KIIs provided the additional data on the social and economic impacts in accessing the changes of local people's livelihoods. The identified target informants in the study area was 8, namely village leader form each of the three villages, officer from Settlement Land Record Department (SLRD), district and township officer from DOA (Department of agriculture), Range officer from forest department, and responsible staff form non-governmental organization (NGO). Both stratified sampling and random sampling were used for the selection of respondents from the study area. The questionnaires contained questions concerning socio-economic conditions, factors affecting people's livelihood and factors of LUC. The structured interviews of households were conducted to collect the qualitative and quantitative information.

The sample size for each village was calculated by using Yamane's (1967) formula of $n=N/(1+N(e)^2$, where, N = Total number of households, e=Error of acceptance and n=Total number of sample size. The sample size calculated with 15% error of acceptance and 85% confidence level was 112 based on total number of 1,248 households. Further, the sample size taken from Nat Kan lel and Shaw Taw villages were 45 and 40, respectively which represented case I and 27 households were taken from Nga Yant Khon village which represented case II.

Data Analysis

SPSS was used for analysis of data collected. Percentages, frequencies, parametric and non-parametric tests were applied using SPSS. Geospatial techniques were also applied to prepare maps. The assessment of land use and land cover of the study area was done by using 2014 Landsat 8 ETM+ and 2008 Landsat 5 with 30 m resolution acquired from USGS, 2015. The study area is a small- scale area and satellite image interpretation was conducted precisely in order to get the detailed land use and land cover categories.

Supervised and unsupervised classification were used to classify the image that inquire form USGS. Regarding field observation, location of villages, village boundary, road network, agricultural field, crops, banana cultivation field, agroforestry, forest were recorded by using GPS (Global Positioning System) to check the confused land use ad land cover categories during supervised image classification and interpretation processes.

The satellite image interpretation was conducted precisely in order to get the detailed land use and land cover categories. Firstly, image segmentation was done to create vector layers based on the areas of connected pixels based on the same pixel Digital Number value (same spectral reflectance values). Either four or eight adjacent pixels were considered for the connectivity and also the minimum number of pixels that were proper for ETM image resolution. Secondly, the images were interpreted and manually assigned into respective land categories using the segmented vector layers in Arc GIS. The mountain Popa area was very small and the resolution of ETM image was only 30 m. In this context, Google earth image and field photos were taken during the trips as references to support the interpretation. The remote sensing data- images interpretation was used to produce land use map of 2008 and 2014. And then, GIS technologies were applied to convert raster to vector data for storing, manipulation, editing, and analyzing the change of land use. To identify the land use/land cover change between 2008 and 2014, firstly, overlying two images needed to be done. Then, analyzing of the change will be done by creating the attribute table of overlaid image and sum up the total area of changed values in the Arc GIS software.

Socio-economic data analysis

The chi-square test was used to analyze the socio-economic data collected and satisfaction level of local people on LUC. Descriptive statistics including frequency, percentage, and

chi square test was employed to describe demographic, education, socio-economic characteristics, income, and employment of rural livelihoods. The annual income, expenditure and land holding size was measured by Pair-sample t-test to compare the changes of land holding size, annual income and expenditures. To measure degree of satisfaction on pozzolan plant of local people, land holding size changes, forest resource availability, land productivity in terms of LUC and the perception of local people on the reasons of LUCs, weighed average index (WAI) was applied using five scale of measurements such as very dissatisfied (-2), dissatisfied (-1), neutral (0), satisfied (1) and very satisfied (2) as presented below. Formula below shows the way formulate WAI using level of satisfaction

$$WAI = \frac{f\,VTS(2) + fS(1) + fNe(0) + fDS(-1) + fVDS(-2)}{N}$$

Where: WAI=Weighted Average Index, fVTS=Frequency of very satisfied, fS=Frequency of satisfied, fNe=Frequency of neutral, fDS=Frequency of dissatisfied, fVDS=Frequency of very dissatisfied, N =Total number of observation

Analyzing the livelihood assets of local people, we used formula devised by Miah (1993) for calculating indices of each livelihood assets: Index=$\sum XiWi/N$, where: X_i is the individual level; W_i is the respective weight; and N is the number of respondents. When the index was calculated, firstly, used the above formula and then ANOVA F tests was used to calculate the individual each livelihood of each case. T-test, chi square test, ANOVA and weighted average index used depends on the need of the study. The statistical and analytical analysis utilized with Microsoft excels and SPSS for processing and analyzing data.

Results and Discussions

Socio-economic Characteristics of Respondents

All respondents were categorized in to three age groups of 25-40, 41-60 and 61-85. The majority of respondents were male (83%), whereas only 17% were female. Majority of respondents were over 40 age constituting 87% and 96.3% of respondents from case I and case II, respectively. However, there was no statistically significant difference among age groups from two study sites. Primary educations were the highest in two cases of study sites. Nearly 32% respondents from case I had completed middle to high school, where as more than quarter of respondents from case II were at Middle to High school. Almost 30% respondents from case II and 16.5% of respondents from case I was illiterate. Only 5.9% of respondents from case I reached to college/university level. However, there was no statistically significant difference among education levels of respondents from two study sites. The average household size was of 4 family members. Household size was classified in three levels of small (1-3), medium (4-7), and large (8-10). The study sites of case I have large household size with about 3.5% of household, whereas there was no large household in case II. Almost similar (67%) households in both case I and case II were of medium size households. There was no statistically significant difference of household size between two study sites.

There were three types of land use types; namely, le (rice production farm land), Ya (dry land, non- rice production land, e.g., groundnut, sorghum) and agroforestry. Regarding le, case I has 0.43 acre in average, whereas in case II was 0.148 acre per households. The average Ya farming in case I was 0.2 acre per households, whereas in case II it was 2.148 acre per households. There was statistically significant difference between the two sites for land use types at confident level of 0.05. The average land holding size of agroforestry in case I was 5.2 acre per households in case I, while in case II was only 0.22 acre per households. There was statistically significant difference at confident level of 0.05

between case I and case II regarding with average agroforestry land holding size of each households. Land holding size were classified into four groups; small (0.5-5 acre), semi-medium (5.1-10 acre), medium (10.1-20 acre) and large land holding size (20.1- 25 acre). Most of the household (92.3 %) in case II had small land holding size, while over half of the household (60.7%) in case II had small land holding size. There was no medium and large land holing size of household in case II. There was statistically significant difference among the land holding sizes of the two study sites.

LUC Assessment

Land use maps for the years of 2008 and 2014 were produced using remote sensing data combined with GIS technique that show specific land use types. Altogether, 9 land use classes were identified i.e., 1) Forest (close forest) 2) Bare land (no vegetation cover) 3) Settlement 4) Crops 5) Fields 6) Water bodies 7) Scrubs 8) Sand streams and 9) Roads. Figure 1 (a) show the land use map of mountain Popa for the year 2008. It shows that crop was the largest type of land use in the mountain Popa area with 55.16% in 2014. It can be explained that although the image interpretation used the ground truthing points to check the class of land use, the type of agroforestry and the agricultural crop fields could be separately classified because of the image that accessed was of only 30 m resolution. The second largest part was cultivated fields, followed by the forest area with 5.92 % in 2014. The other type of land uses were constituted with small percentages, specifically, 2.18, 1.09, 0.60, 0.64, 0.08 and 0.07 for settlement, water bodies, sand streams, scrubs and bare lands, respectively. Figure 1(b) shows the land use map of mountain Popa for the year 2014. It showed that the forest area was significantly decreased from 7.95 % in 2008 to 5.92 % in 2014. The percentage of settlements and roads was a bit increased in 2014.

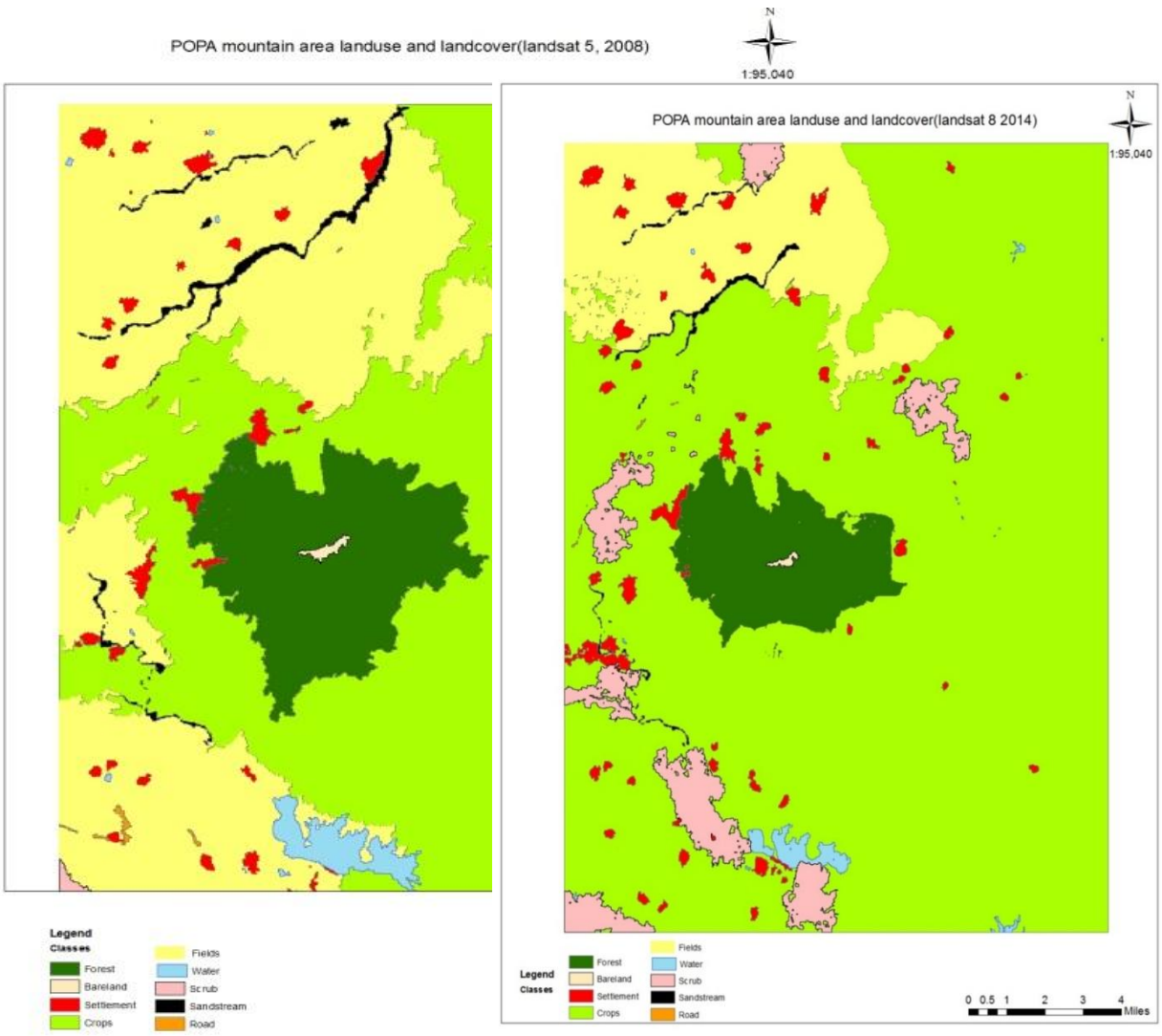

Figure 1(a): Land Use Map of mountain Popa in 2008: Figure 1 (b): land use map of mountain Popa area in 2014

Land Use Dynamics in Mountain Popa area

Table 2 showed that the percentage of land cover between the periods of (2008 to 2014) was not significantly changed. The largest part of land use was crops, followed by fields, forest area, settlement, water bodies, sand streams, scrubs, bare land and roads. It can be seen that the percentage of water bodies was significantly decreased from 1.09 to 0.51 % in 2014 that affected the livelihood of local people. According to the focus group

discussion, mountain Popa area was also affected by the irregular rainfall. The percentage of crops land was slightly decreased from 57.81 to 55.16% because of land acquisition and some of the lands that were used for road construction. In contrast, the percentage of bare lands decreased from 0.08 to 0.05% because the local people used the infertile lands to sustain their livelihoods.

Table 2: Land Use Dynamic in Mountain Popa Area

No	Land use and land cover categories	Area (acre) 2008	Area (acre)2014	% of land cover 2008	% of land cover 2014
1	Forest	14,582	10,863	7.95	5.92
2	Bare Land	141	84	0.08	0.045
3	Settlement	3,988	4,262	2.18	2.32
4	Crops	105,977	101,147	57.81	55.16
5	Field	54,070	5,7059	29.49	31.12
6	Water	2,000	947	1.09	0.51
7	Shrubs	1,179	8,059	0.64	4.4
8	Sand streams	1,279	677	0.69	0.36
9	Roads	132	250	0.07	0.13
10	Total	183,348	183348	100	100

Impact of LUC on Socioeconomic Conditions of Local People

Impact on agricultural land holding size

As shown in table 3, in 2008, the average land holding size of "le" by each family of case I was 0.205 was decreased to 0.148 acre in 2014. By using paired sample t test, there was no statistically difference between the two periods. In case of case II, the average land

holding sizes of three types of agricultural lands by each family did not show significant differences between the periods of 2008 to 2014.

Table 3: Land holding size between 2008 and 2014 by cases

Types of Land	Acre/HH				Paired sample t - test (sig. level)	
	Case I (2008)	Case I (2014)	Case II (2008)	Case II (2014)	Case I	Case II
	N=85		N=27			
Le (rice paddy farm land)	0.205	0.148	0.00	0.205	0.201	0.327
ya (non-rice producing dry lands)	0.229	2.214	2.111	0.229	0.676	0.898
agroforestry	5.365	0.222	0.00	5.365	0.488	0.247

Source: Field survey (2014)

Impacts on household income

The non-farm source income and total income of case I in 2008 and 2014 was statistically different by using paired sample t test at confident level of 0.05 (Table 4). The income from non-farm source in 2008 (304,204 Kyats) was increased to (617,550 kyats) in 2014. It can be explained that the road network was increased and the education status of local people was also increased. Some of the young people migrated out and sent money as remittance. Consequently, the income from non-farm source was increased. When the non-farm source income was increased, consequently the average total income of each household in case I was increased. Regarding with case II, there was no statistically significant difference between incomes for the years mentioned.

Table 4: Annual incomes for 2008 and 2014

Income source (Average)	Kyats/HH				Paired sample t test (significant level)	
	Case I (2008)	Case I (2014)	Case II (2008)	Case II (2014)	Case I	Case II
	N=85		N=27			
Farm	2,322,776	2,579,841	486,432	476,648	0.24	0.14
Non-farm	304,204	617,550	439,234	791,888	0.00	0.08
Total	2,626,980	3,197,391	925,666	1,268,537	0.01	0.86

Source: Household survey (2014) Note: 1US$= 1000 kyats

Impacts on household expenditure

The cost of transportation was increased, the reason was that in 2008 the openness was troublesome, the households utilized oxcart, while in 2014, family purchased motor bike to diminish the issue of time consumption and to be effectively access to market to their products (Table 5). The expenditure for agriculture (such as hire labor and crop) since the land use was changed from banana cultivation to agroforestry, so the local people need the new seed variety to improve the yield. Regarding to case II, there is significantly difference in religious and social, transportation, hire labor and operation on farming. The expenditure for operation on farming was increased because they changed to use the relay cropping to satisfy the needs households since the land use was changed, they spend more money to operate the farming two times in one year in 2014 than in 2008. The money spent for operation of farming was also larger than two times in 2008 (32,499 kyats) to (71,111 kyats) in 2014.

Table 5: Annual Expenditures of 2008 and 2014

	Case I	Case II	t-test (p)

Expenditure type	Average Kyats/HH				Case	Case II
	2008(N=85)	2014(N=85)	2008(N=27)	2014(N=27)		
Tot. expenditures	2,548,495	2,621,147	1,697,759	1,717,555	0.77	0.80
HFC	1,246,187	1,332,964	976,939	917,037	0.61	0.36
Education	266,593	191,541	264,801	191,111	0.35	0.51
Health	266,593	123,141	264,801	73,888	0.03	0.10
RSF	198,506	164,176	47,537	82,407	0.37	0.01
Transportation	23,445	134,776	9,264	44,222	0.00	0.00
Crop	10,237	27,782	24,932	44,592	0.01	0.19
Hired labor	122,924	200,904	57,723	94,444	0.00	0.03
Fertilizer	142,988	162,517	55,055	73,333	0.25	0.53
OOF	90,523	109,823	32,499	71,111	0.18	0.03

Source: Field survey (2014). Note: Home food consumption=HFC, Operation on farming= OOF, Household=HH, Religious & social Festivals=RSF

In this regard, the small amount of money was spent for home food consumption in 2008 while the large amount of money was spent for home consumption in 2014.

Changes in educational status

The highest percentage of household in both the cases had completed the primary school. The illiterate comprised about 10.6% and 29.9% for case I and case II, respectively. The chi-square test showed significant differences for educational status between the two cases in 2008 at 0.05 confidence level. The educational level of both cases in 2008 and 2014 were quite similar.

Changes in occupational status

There was no statistically significant difference between the two cases at confident level of 0.05 for occupational status of household heads in 2008 (Table 6). The occupation of most of the household heads was agriculture for both the cases in 2008. This was due to the reason that banana cultivation was dominant in case I and permanent agriculture in

case II. There was statistically significant difference between the household head's occupation of both the cases in 2014. Although the majority of household head's occupation was agriculture in both cases, the small percentage of household heads i.e., 1.25%, 3.5%, 4.7% and 1.2% were non-agriculture, unemployed, government staff and private employee, respectively in case I. For case II, nearly one fourth of the percentage of household head's occupation were non-agriculture, especially, pozzollan employee, 11.1 % of household head were unemployed and 3.7 percentages of household head were government employees. This may be due to the effect of land acquisition and because some of the household head (old age) could not migrate out and could not get the job in Pozzollan plant because they are non-educated.

Table 6: Occupation of Household Head in 2008 and 2014

Occupation	2008					2014				
	Case I		Case II		Sig. level	Case I		Case II		Sig. level
	f	% of HH	f	% of HH		f	% of HH	f	% of HH	
Agriculture	79	92.9	26	96.3		76	89.4	17	63.0	0.001
Non-agriculture	2	2.4	1	3.7		1	1.2	6	22.2	
Non-employment	2	2.4	0	0.0		3	3.5	3	11.1	
government officer	2	2.4	0	0.0	0.697	4	4.7	1	3.7	
Private employee	0	0	0	0.0		1	1.2	0	0.0	

Source: Field survey (2014), significance level at 95%

Livelihood Assessment of the two Cases

Information of livelihood appraisal was acquired in the field trip completed in 2014 by using structure questionnaires. Data on livelihood assets was collected for the years of 2008 and 2014. The acquired data were classified with five component of the pentagon of assets (Chambers and conway, 1992). The five livelihood assets were human, natural, financial, physical and social as suggested by DFID, CARE, Oxfam and UNDP. Each asset included two selected indices, each of which was based on a number of individual decision variables ranging from one to four. Indices were calculated based on formula devised by Miah (1993) as:

$$\text{Index} = \sum XiWi/N$$

Where X_i is the individual level; W_I is the respective weight; and N is the number of respondents.

With regards to natural asset index, this study applied two main variables including soil fertility and land holding size. The physical assets used in this study were also used by Pensuk and Shrestha (2007) in their studies. The four main variables were used to determine the physical asset were transportation access to sell the products to market, vehicle possession, electricity possession and ownership of houses. Financial asset consist of farm and non-farm income. Social asset is constituted of people's solidarity changes within the community due to LUC and relations with local administration. Human assets include skill and knowledge and kind of occupation of local people (Table 7).

Based on decision variables and indices listed in table 8, the five livelihood asset indices were significantly different between two cases, except human asset index. The ANOVA F-test showed that the four livelihood assets such as physical asset, social asset, financial asset and natural asset between two cases were statistically significant at the confidence level of 0.05. The social asset index, financial asset index, human asset and natural asset

of case II were greater than those of case I (Figure 2). In contrast, physical asset of case I was greater than that of case II. It can be explained that the study area of case I access to the electricity from National Grid and the road network were getting better and directly connected with Kyaut Pa Daung (Nearest township) since the Pozzolan Plant was constructed. In case of case II, the study area is situated in the eastern park of mountain Popa, the road network is getting easy but it is located far away with nearest town and Popa Market. There is no electricity from National Grid but some of the rich and middle class households buy and use the solar electricity and the government and INGOs and NGOs give them loan to buy the solar panel to access the electricity. But the poor household cannot access to the any kind of electricity.

Regarding with social asset, the social asset index of case I was greater than that of case II. There is statically significant difference between the two cases. It is to be noted that the households exchanged the new seed varieties within the community to get better profit.

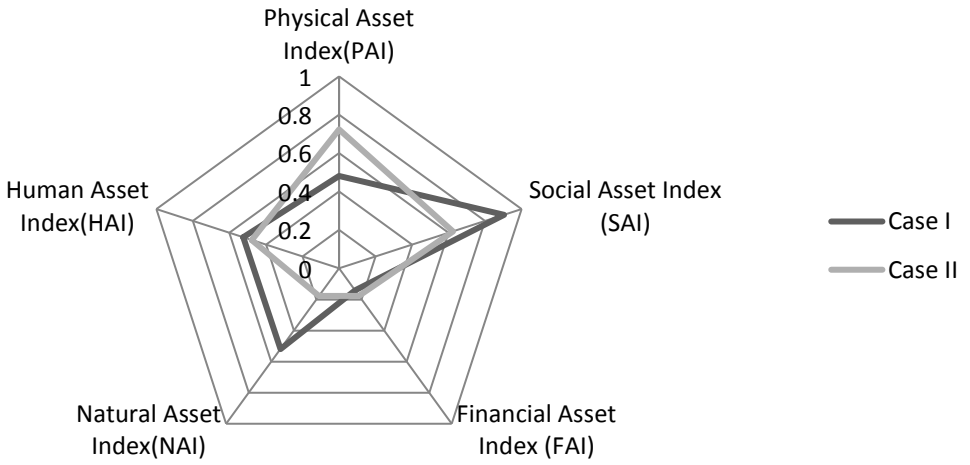

Figure 2: Livelihood Pentagon of case I and II

In this regard, their solidarity changes getting strengthened within the community. Other variable such as access to social asset is that relation with local administration. The rich

community gets favored by the local administration; the case I household had rich family than the household in the case II. Moreover, the study area of case I was located in the proposed buffer zone of Popa Mountain Park, and the land use had been changed due to forest department policy so the local people need to communicate with Forest department. In this regard, the local people in the case I get social asset score than that of case II. Those two variables were changed due to land use in the study area and that are important for the main livelihood of the study area.

Table 7: Livelihood Capital Assets, Decision Variables and Indices

Capital Asset	Decision Variables	Value Category
Human asset index	• X_1 Skill and knowledge index	Illiterate=0, primary=0.33,middle to high school=0.66, college/University=1
	• X_2 Occupation index	Non-employment=0, private employee=0.25, government staff=0.5, non-agriculture=0.75, agriculture=1
Natural asset index	• X_3 soil fertility	Very highly decline=0, highly decline=0.33, moderately decline=0.66, the same=1
	• X_4 Land holding size index	0.5-5acre=0,5.1-10 acre =0.33, 10.1-20 acre =0.66, 21.1-25 acre =1
Financial asset index	• X_5 Farm source income index	Annual farm income of respondents/highest annual farm source income
	• X_6 non-farm source Income index	Annual non-farm income of respondents/ highest annual non-farm income
Physical asset index	• X_7 accessibility index	Difficult=0, sometime difficult=0.33, easy=0.66, 1=very easy
	• X_8 housing index	Concrete house=1, wood house=0.5, bamboo house=0
	• X_9 electricity index	Government electricity=1,solar electricity=0.5, no electricity= 0
	• X_{10} transportation access index	Car=1, motor bike=0.5, bicycle=0
Social asset index	• X_{11} People solidarity index	Decrease=0, slightly decrease=0.33, normal=0.66, increase=1
	• X_{12} Relationship index	Decrease=0, slightly decrease=0.33, normal=0.66, increase=1

Source: Adopted from Udayakumara and Shrestha (2011)

The changes of financial resource may influence people livelihood. The financial asset index of case I was greater than that of case II. It can be explained that the household in the case I got surplus income from farm sources by selling good variety of mango and perennial crop but the land was reposed by the Pozzolan plant in case II, consequently; the agricultural land area and income were decreased. The natural asset index of case I was greater than that of case II and there is statistically significant difference at confident level of 0.05 by using ANOVA F-test. To note that, the land holding size of case I was greater than case II, the agricultural land of case I was reduced due to compulsory land confiscation by government for pozzollan plant. The local people in case I were using relay cropping in small farming size (two times within one year). Due to this fact, the soil fertility of agricultural land in the case I decreased.

Table 8: Livelihood asset index among two cases

Livelihood asset index	Case I	Case II	F-value	Sig- level
Physical Asset Index (PAI)	0.4814	0.7237	125.740	0.000
Social Asset Index (SAI)	0.9040	0.6244	119.475	0.000
Financial Asset Index (FAI)	0.1419	0.1772	6.417	0.013
Natural Asset Index (NAI)	0.5195	0.1772	129.249	0.000
Human Asset Index (HAI)	0.5244	0.4777	2.282	0.134

Source: Field Survey, (2014)

There were no statistically significant differences for the two cases, regarding human capital assets. It can be explained that the local people in both case improved education due to road accessibility. The main livelihoods of both cases were agriculture, so the occupation index to calculate the human asset index was similar between two cases.

It can be explained that the land holding size of study area case II was decreased by land acquisition of government for Pozzolan Plant. In response to the decreasing of land holding size, the young people migrate out to search the job and remit to the host family. In this regard, the percentage of income from non-farm source in case II was higher than case I. The average landholding size of household in case I was significantly larger than the case II, the main livelihoods of case I was agroforestry practice growing seasonal fruits, banana, and perennial trees (Cashew nut, good variety mango). By selling these commodities, the average percentage of income from farm source was higher than that from non-farm source in the study area of case I. Regarding social assets, the households in case I was easier to access forest products for their household consumption than the household in case II. The average land holding size of case I was larger than that of case II, the main livelihood of case I was agriculture and agroforestry. In this regard, the local people in the case I had better relation with extension staff from forest department and agriculture department. Some of the local people in the case I were employed in forest department as forest guard.

Factors Influencing LUCs

Result showed that several factors affect LUCs in the study area. These are discussed below

Land law and forest policy

The households that sold land in case I was only 15.3% while no households in case II sold any land. Results showed that almost 93% of households in case II lost their lands by land confiscation by the government. According to farmland Bill of Myanmar (2012), the farm land can be confiscated by the government for the development of public

whether the land use right are de fact to or de jure. In case I, the agricultural lands were located in the buffer zone of Popa Mountain Park and as a result only small percentage of household could sell their lands but in case II, there was no more land to sell. In this regards, the current farm land law and forest policy affect the LUC of the study area. The household in case II have more de jure right than that in case I. Therefore, the household could not get secure land tenure right (de jure) right if the lands were located in the buffer zone of Popa Mountain Park.

Land modifications

The trend of land modification and LUCs were completely different between case I and case II. In case I, most of the households changed from banana cultivation to inter-plant tree with perennial crops. However in case II, the permanent agricultural lands were converted to industrial area due to land acquisition. The land productivity indices were calculated for the two cases as weighted average indices. The land modification from permanent agriculture to industrial area for case I showed an increase in land productivity. This was due to the fact that these households were not affected by the land confiscation and impact of Pozzollan factory and they got better access to market and knowledge of agriculture. In case II, the land cover was changed from permanent agriculture to industrial area at WAI= -0.142, their productivity of land was declined. This is because most of the household lost their lands by compulsory land confiscation by the Pozzollan plant and the agricultural land were prohibited to expand into the buffer zone of forest area.

Technology

There was statically significant difference for purchasing agricultural equipments between case I and case II at 0.00 confidence levels. In case I, almost 37% households bought irrigation pumps to facilitate irrigating crops, whereas only 3.7% household in case II bought pumps for irrigation. It can be described that local people in case I earn surplus income because of changing land use from banana cultivation to agroforestry since they realize the benefit of agroforestry, consequently, they bought the new machine to facilitate their agricultural activities. However, due to loss of lands by local people in case II as a result of land confiscation, their incomes were considerably decreased, so majority of them

Accessibility

The procurement of infrastructure is an instrument influencing LUC. Accessibility helps farmers to earn more income by bringing their products to sell in market and attract middle men to sell their products whom come to the village rather than bring them to sell in Kyauk Pa Daung Market (nearest township) if the price of product is not quite different. Over 90% of household in both cases sold their products to middle men, only 3.5% of household in case I and 7.4% households in case II went directly to market to sell their products. There was no statically significant difference between the two cases for accessibility use.

CONCLUSION AND RECOMMENDATION

Land use has been defined as one of the major mechanisms influencing rural livelihoods. The research highlighted that the LUC enhanced economy, infrastructure and provided job opportunities to the rural communities. Most of the households in case I depended on the agroforestry and almost all of the households in case II depended on both farm

and non-farm activities. Rural household in case I depended on the agroforestry and perennial crops products such as good variety of mango, cashew nut, banana, sesame, papaya, dragon fruit, tamarind, custard apple, while the main livelihood of local people in case II were agricultural crops such as sunflower, peanut, chick pea, rice, some of the people are working the non-farm activities such as small broker, government staff and employee in Pozzolan Plant. The total income of household was not significantly difference between before and after LUCs while farm source income was significantly decreases in case II and the non-farm source income both case I and case II was significantly increased.

The study found that modifications of land and LUC had great effect on the livelihood assets of local people. The financial asset in case I was increased because of demand of products and the success of agroforestry practices, consequently, the human assets also increased. In contrast, the physical asset of case II was significantly increased by accessing the road and National grid electricity since the Pozzolan plant was constructed, however natural, human and social asset was seems to be worse. Large proportion of household lost their land, but they did not get the adequate compensation and did not access the any livelihood improvement schemes from the Government. Rural households in two cases adjusted with the resultant of the changes of land uses. Majority of respondents in case I changed to grow the market demand fruits with trees and the youth migrate out to search a job depend on the assets of livelihoods that they catch in case II. With the reaction specified previously, not all the households agreed that the strategies were possible to improve their livelihoods. To further enhance the livelihoods of the local people, land use right should be provided efficiently to stop land acquisition by the government and the land law should include the adequate compensation for the land acquisition. Development agencies that provide literate training to the local people should apply efficient tools to boost the adoption of new technologies. The government and

development agencies should take the urgent action to release the national land use planning to clearly recognize the land use zones for the sustainability of natural resources.

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