Impacts of population growth on land use in the Northern Mountain Region of Vietnam: A village-level analysis

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ABSTRACT

This paper relates land cover-land use in four villages of the Vietnam's Northern Mountain Region to population growth that is believed to have influences on the villages' land use practices. The villages are inhabited by different ethnic groups, including ethnic minority groups and the ethnic Vietnamese majority. Land cover-land use of the villages is drawn from satellite and airborne images from the 1950s to 2005. Population data was restored based on intermittent statistical data and village surveys. The analysis has revealed expansion rate of agricultural land was maintained during that last five decades and was not significantly affected by national-level socio-economic events. This implies the issue of food security of the subsistence-oriented livelihood system in the rural areas. The agricultural land expansion coincided with the decrease in forest land until the 1980s. This suggests population is a determinant factor of the process of land use changes. However, the expansion of cultivated land and forest had same direction after1980s. Preliminary assumptions are the decrease of bush and grass land and land use intensification. Further analysis on this issue will be presented in detail case studies. This paper subject is to provide empirical results.

1. INTRODUCTION

In 1943, Vietnam's forest covered 43.2% of the whole country land (Nguyen Manh Cuong, 1999, Vo Quy, 1994). The forest is mainly tropical forest with broadleaf tree forest, semi-deciduous forest, pine forest, mixed pine forest and mangrove forest. The forest cover reduced significantly to 27.7% in 1990. The reduction has been attributed to many socio-economic and historical events including wars and poor management (MARD 2002, FAO 2005). Recognizing negative impacts of forest destruction on the country's environment and economic development, Vietnamese government and people has made great efforts in minimizing the destruction and restoring forest resource. As the results, forest cover has increased at the rate of nearly 2% per year during the period between 1990 and 2005 (FAO 2005). In which, planted forest contributed 47%, 1.47 million ha out of 3.13 million ha, of the increase of Vietnam's forest cover (de Jong *et al.*, 2006).

The present study highlights these decreasing and increasing processes of forest area from the viewpoint of land use dynamics at the village level. The tendency of forest area changes found in the national statistics are the aggregate of a wide range of processes that occurred and are occurring at diverse bio-physical and socio-economic conditions. The forest area, in general, has increased in paddy-based villages and decreased in forest/upland-based villages in the 1990s (Castella et al., 2002a), but the changes also depended on farmers' motivations to maintain forests (Castella et al., 2002b). These findings indicate that the same socio-economic events could cause positive and negative impacts on village-level land use and forest area, reflecting the differences in bio-physical and socio-economic conditions.

One of the most fundamental questions on the mechanism of land use change is how population growth affects land use. Conversion of land use from forest land to agricultural land, particularly for subsistence food production, according to the population growth, is a widely-observed underlying mechanism of land use change through over Mainland Southeast Asia if not to say the world, and rural Vietnam is not an exceptional case. Forest area recovery since the 1990s in Vietnam, however, happened under the population-increasing condition. In this study, therefore, we aim at investigating the dynamic relationship between population, agricultural land and forest land at the village level to analyze the forest land recovery process.

We selected four villages in the Northern Mountain Region of Vietnam, considering its diversity in topography and landform, vegetation cover, ethnicity, access to market, mode of farming and environment conservation programs, and examined the impacts of population growth on land use and forest dynamics. The study period is for 54 years from 1952 to 2005, and the population and land use data during the period was restored. The data sources are statistics, interview data, aerial photos, and satellite images. These data made it possible to compare land use changes of selected villages under the different environments as a preliminary analysis of land use dynamics.

2. RESEARCH METHODS

2.1 Study sites

The villages selected as the study sites are Ngoc Quan (Doan Hung district, Phu Tho province), Tan Minh (Da Bac district, Hoa Binh province) in the Central North region, Chieng Dong (Yen Chau district, Son La province) in the Northwestern region, and Chau Khe (Con Cuong district, Nghe An province) in the North Central region (Figure 1). Population and land resources of the 4 villages are summarized in table 1.

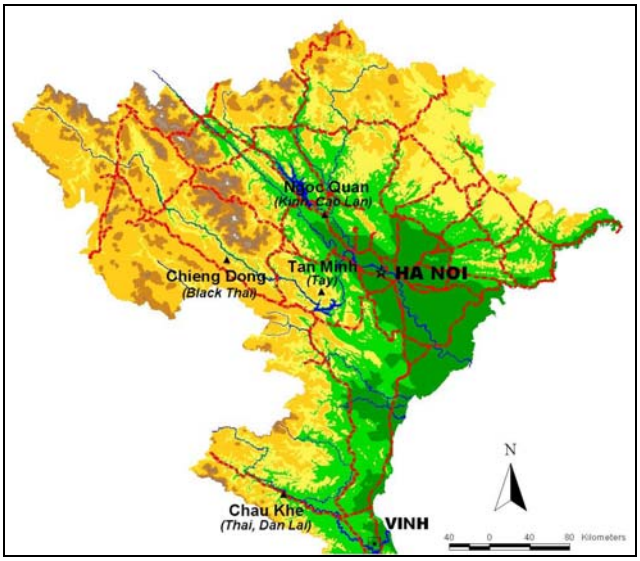


Figure 1: Locations of the study villages

Table 1: Population and land of the study villages

Village name	Population (2005)	Area (ha)	Slope distribution (%)			Population density (person/km2)
			0 – 10 deg.	10 - 20 deg.	> 20 deg.	
Tan Minh	3,519	7,412	11.2	31.5	57.3	47.5
Ngoc Quan	6,039	1,481	83.8	10.5	5.7	407.8
Chieng Dong	6,809	6,937	17.5	39.4	43.1	98.2
Chau Khe	5,510	44,096	14.4	21.6	64.0	12.5

Among four villages, NQ village has the most moderate landform condition dominated by flat land, the most convenient transportation condition, and the highest population density, followed by CD and TM villages. CK village is the most remote village and has the lowest population density, less than one thirtieth of NQ village.

2.2 Estimation of population growth rate

Population data was collected at the study village and respective district offices. There was a lot of difficulty to find out the data particularly before 1980 when the local administration system was not yet modernized.

Through visiting each village and district office several times, we obtained the population data of, on average, 26 years at the villages and 17 years at the district out of 54 years (1952 to 2005) of the study period. The data is scattered over years and is missing for more than half of the study period. Then, a complete set of population data was produced by the following method. First, a complete set of annual growth rate was produced. The missing data was estimated by interpolation when the date of both ends of the missing period is available, substitution when district data is available and extrapolation when both interpolation and substitution are not available.

2.3 Land cover/land use analysis

A combined approach of the interpretation of remote sensing imagery with the analysis of statistical data and information collected from field survey was adopted for the land cover/land use (LCLU) map making, in which LCLU is classified in to four types; “Paddy field”, “Upland field”, “Bush and grass”, and “Forest”. “Upland field” is a land cultivated in the particular year and does not include fallow land. The difference between “Bush and grass” and “Forest” is the absent of timber/woody tree cover.

Several types of remote sensing data including aerial photos, high-resolution satellite images of Corona, SPOT, Landsat TM and ETM were selected for mapping LCLU because single source of image can not cover the whole study period. The resolutions of these images are 6 to 9 feet, 20m, 30m and 30m for Corona, SPOT, Landsat TM and ETM, respectively. High resolution is a prerequisite for LCLU analysis of a small coverage such as the village level, so that low resolution images such as Landsat MSS were not used. The complete set of images could be collected at NQ village, six images of each 10 years from the 1950s to 2000s, while a image of the 1950s is missing in TM, the 1970s missing in CD (but, 2 images are available in the 1990s), and the 1950s and 70s missing in CK villages, resulted in 5, 6 and 4 images for the analysis, respectively.

Interviews with local people and officers at the study villages and districts provided information of agricultural practices, forest uses and living conditions, which particularly

helps to translate land cover to land use. Field survey with GPS measurement is used to identify the locations of specific land uses at the study villages.

3. RESULTS

3.1 Population growth

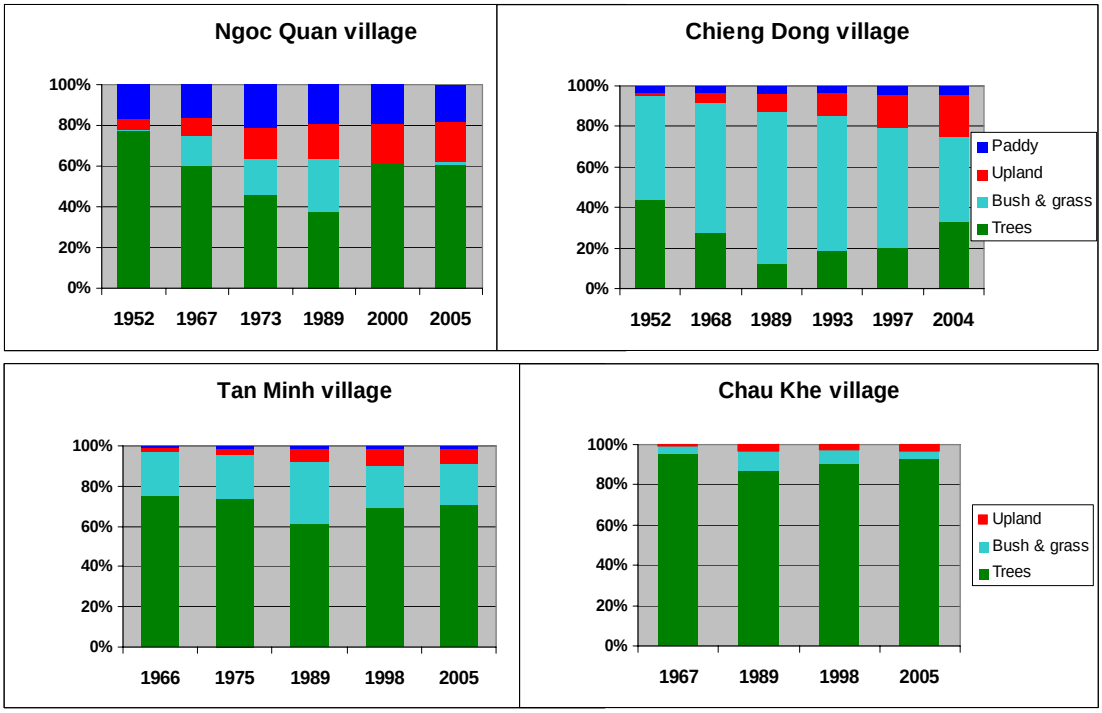
Population was estimated based on the original data and the estimated growth rate. During the study period from 1952 to 2005, CK village shows the highest increase, 12.6 times, followed by NQ (7.5 times), TM (6.2 times) and CD (3.6 times) villages.

3.2 Land cover/land use

After repeatedly checking the results of LCLU interpretation with information obtained from field survey, 6, 6, 5 and 4 LCLU maps of NQ, CD, TM and CK villages are produced to visualize the five decade changes. In NQ village, upland forest and lowland paddy field dominated land use in 1952. Upland use expanded in the 1960s and 70s converting "Forest" to "Upland field" and "Bush and grass", then LCLU of the village has been stabilized since 2000. Vegetation of CD upland was poor even in 1952. Villagers expanded subsistence rice production from valley-bottom paddy growing to upland rice swiddening through the period from the 1960s to 80s. The introduction of hybrid maize in the early 1990s stopped this tendency and polarized upland use to cultivated land and forest. Land use of TM and CK villages is rather stable compared to NQ and CD villages. Since the late 1960s, paddy field along valley bottoms and upland field on mountain slopes have gradually increased.

Numerical summary of LCLU changes clearly shows that the forest area in 1989 is the smallest at all the study villages (Figure 2). During the two decades from the late 1960s, forest area had decreased 37%, 56%, 19% and 9% at NQ, CD, TM and CK villages, respectively. This lost was already recovered at NQ and CD villages, while is going to be recovered at TM and CK villages.

Figure 2: Changes in land cover/land use



4. DISCUSSION

4.1 Agricultural land dynamics

Economy of all study villages is based on agriculture, and most of the villagers are farmers who primarily produce subsistence food, either or both of lowland paddy and upland rice. Farm land, therefore, is the fundamental resource for them. Population growth is supposed to inevitably cause expansion of farm land. Figure 3 summarized the relation between population and cultivated land, the sum of paddy field and upland field.

All the study villages show high correlation between population growth and the expansion of cultivated land. This suggests that, even though their livelihood has been seriously affected by major national-level socio-economic changes, from collectivized farming, war destructions and social disorder, to *doi moi*/renovation, introduction of market-oriented economy and environmental conservation programs, villagers have maintained their land use and farming as the livelihood basis of their survival during the last five decades. Per capita increment of cultivated land, however, differs between villages. It is about 0.2 ha in CD, TM and CK villages, while 0.04 ha, one fifth of the other villages, at NQ village. This difference is further analyzed by dividing cultivated land into paddy and upland fields.

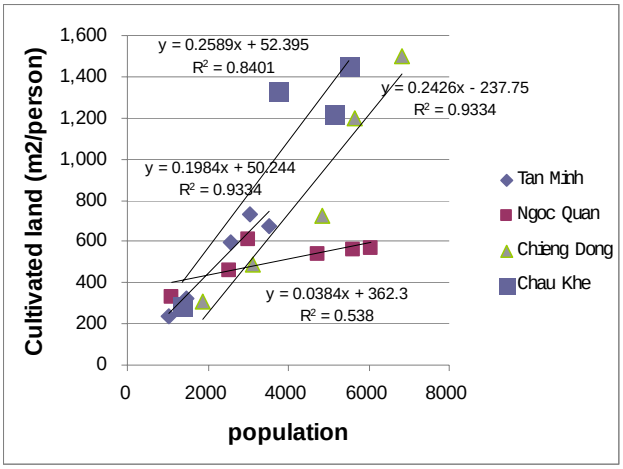


Figure 3: Pop growth and cultivated land area

The total per capita cultivated land area in the late 1960s was more or less the same, 1800, 1600, 2400 and 2100 m^2 at NQ, CD, TM and CK villages, respectively, of which the former two villages had both paddy and upland fields while upland fields dominated in the latter two villages.

In NQ village, both per capita of paddy and upland fields gradually decreased afterward and the total per capita cultivated land area dropped to 900 m^2 in 2005. In CD village, the area of paddy field decreased, while the area of upland field increased. The reduction of paddy field was compensated by the expansion of upland field, resulted in slight increase of the area to 2200 m^2 in 2005. In TM and CK villages, they maintained the areas to be 1900 and 2600 m^2 in 2005, respectively.

These differences among the villages can be explained by the landform conditions and the progress of reclaimation of cultivated land.

In NQ village, almost 20% of the gentle slope land (slope is less than 10%) had already reclaimed in 1952 as paddy field, and no suitable land was available for further expansion of paddy field. Upland field also occupied about 20% of the gentle slope land by 1973. These indicate that earlier progress of land reclamation and consequent shortage of arable land caused smaller per capita area of cultivated land than the other villages.

Reclaimation process of paddy field in CD village is similar to that of NQ village. Paddy field already occupied nearly 20% of the gentle slope land in 1952 and its expansion during the last five decades is limited, though it continued until the early 1990s. But CD village has large uplands to be reclaimed to maintain per capita cultivated land area.

In TM and CK villages, the occupancy of cultivated land is small throughout the study period, and they still have arable lands to be reclaimed.

These findings suggest that the common per capita of cultivated land area in the Northern Mountain Region is about 0.2 ha. This size of cultivation is required to maintain food self-sufficiency and is possibly an appropriate size in terms of labor requirement under the prevailing cultivation technology. CD, TM and CK maintained this size of cultivation until now, but NQ failed to do it due to lack of arable land. This indicates that population and land availability are the dominant determinant factors of agricultural land dynamics under the subsistence-oriented livelihood.

4.2 Forest, bush and grass land dynamics

The relation between population and forest land area is summarized as followed: at all study villages, forest land decreased, hit the bottom and increased according to the population growth during the last five decades. The land and population conditions when the forest land hit bottom, identified from the approximation curves. The estimations show that population density varies widely from 252 person/km^2 at NQ village to 8 persons/km^2 at CK village. The proportion of forest land to the total village land also shows a big difference among the villages, ranging from 14% at CD village to 84.8% at CK village. These suggest that, in terms of land and population ratio, there is no common condition among the 4 villages to cause the bottom of forest land area and to convert the decreasing trends of forest land to increasing ones.

On the other hands, bush and grass land, consisting of fallow and barren lands, having poorer vegetation than forest and being less productive than cultivated land, shows the opposite increasing and decreasing trends to forest land during the last five decades at all the study villages.

The population and, consequently, the time when bush and grass land hit the top are close to time when forest land hit the bottom. This coincidence indicates that the land source of forest recovery is former bush and grass lands, not cultivated lands.

5. CONCLUSIONS

Intensive land use study of four villages in the Northern Mountain Region of Vietnam revealed that, first, cultivated land expanded during the last five decades according to population growth. Although the expansion rate differs among villages due to the availability of arable land, the expanding trend in proportion with population growth was maintained during the last five decades and was not significantly affected by national-level socio-economic events. Subsistence-oriented rural livelihood systems have been strong enough to protect themselves from the external-originated disturbances. Second, it is commonly observed that forest land decreased until the end of 1980s, hit the bottom, and increased by replacing bush and grass land. The land use and population conditions when the decrease of

forest land stopped widely differ by village and no common conditions can be identified. Land use until the 1980s is characterized by expansion of “easy” reclaimable land.

What happened at the end of 1980s or early 90s in the Northern Mountain Region of Vietnam is intensification of land use. Intensification of land use is a process to specify and increase economic, social and environmental benefits produced from a piece of land. In agriculture, increasing number of crops a year or intercrop in the same land plot is one way of intensification that agricultural extensionist introduce to. Well-organized tree plantation, instead of simply waiting for natural vegetation recovery is typical processes of land use intensification in forestry. Agro-forestry practice is also a way of land use intensification toward sustainable system. These activities are extensively used in Vietnam since the renovation in agriculture to “Re-green baren land” program (known as 327 progam) and the Five Million Hectare of Forest program. In general, under the overall trend of land use intensification, the expansion of cultivated land and expansion of forest land are not alternatives, but, together with the decrease of “Bush and grass” land, are coexisting processes toward the same direction. This is what has happened since the 1990s.

Then, the next questions should be what kinds of land use intensification happened and how they functioned. The answers to these questions should differ from village to village reflecting diverse bio-physical and socio-economic environments. We will answer these questions in the following papers.

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