



Dynamics of Land Cover-Land Use in Villages of the Vietnam Northern Mountain Region: Impacts of Human Activities

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Abstract

This paper relates land cover-land use in three villages of the Vietnam's Northern Mountain Region to a variety of potential socio-economic 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 2000. The analysis has revealed the increase in agricultural land and decrease in forest land until the 1980s and the opposite trends afterward. This suggests a shift of determinant factors of the process of land use changes from population or subsistence economy to cash economy and land and forest resources governance. By presenting different patterns of land use changes in the three villages, this paper subjects this claim to an empirical test.

Note: Land cover refers to the physical condition of the ground surface, for example, forest, grassland, concrete pavement etc., while land use reflects human activities such as the use of the land, for example, industrial zones, residential zones, agricultural fields etc. Generally land cover does not coincide with land use. A land use class is composed of several land covers.

1. Introduction

In Vietnam, hills and mountains occupy 3 quarters area of the country. In mind of lowlanders, forest is abundant and can be seen everywhere in the mountainous regions. This home of 1/3 nation population has, however, undergone rapid changes in natural conditions induced by socio-economic developments. Forest and land, the main sources of local production system, have been severely impacted over the last decades. Forest cover of the whole country has reduced from 43.2% in 1943 to 28.1% in 1995 (Nguyen Manh Cuong, 1999). Processes of changes are, however, not well

understood. Understanding the changes in forest cover and land use is important for improving management and formulating development strategies of these resources.

Population growth is usually considered as the main cause of deforestation in a long period by replacing forest land by agricultural land. Deforestation leads to environmental degradation including soil erosion, reservoir sedimentation and un-stabilized river discharge. This causes low agricultural productivity and expansion of agricultural land followed by further decrease in forest land. The primary objective of this study is to examine the impact of population growth on forest cover and land use



at the three selected villages in the Vietnam Northern Mountain Region. We also preliminary considered the impacts of policies, economic development and introduction of new technologies, which functions both deforestation and conservation of forest resources.

Remote sensing has been proved as a source of detail, reliable and frequent data for the monitoring, mapping and management of natural resources. Studies of land cover-land use changes using remotely sensing data can take advantage of having consistent and comparable data.

This study used several types of remote sensing data including aerial photos, high-resolution satellite images of Corona, SPOT and Landsat TM for mapping and analyzing land cover-land use changes at the selected sites. Dynamics of land cover-land use based on the analysis of remote sensing generated maps/data is not only providing specific picture of each study site but also a “panorama view” of the Northern Mountain Region (NMR). Analyzing land cover-land use in the context of historical events has revealed their relationships with human activities including population growth, economy, policy and technology.

2. The Study Sites

The study villages are located in different parts of Vietnam’s Northern Mountain Region (Figure 1). Ngoc Quan is in the central part, while Tan Minh and Chieng Dong are in the northwestern part of the region.

Ngoc Quan Village is one of the 27 villages and town of Doan Hung District, Phu Tho Province. The village is located on the rolling hills of midlands. The village has been inhabited by Kinh and Cao Lan ethnic groups. In year 2000, 93% of the village’s households are engaged in agricultural activities including wet rice growing, dry land-cash crop cultivation, animal husbandry and industrial trees planting.

Tan Minh Village of Da Bac District, Hoa Binh Province, is located in the mountain valley on the left bank of Hoa Binh reservoir on the

Da River. The village has a lineal settlement pattern with houses built along the sides of the road on the lower slopes of a long and narrow valley. In 1995, it has 9 hamlets with the total population of 2,820 in 497 households. The Tay is the major ethnic group, occupying 8 hamlets, while the Dzao lives in only 1 hamlet. Local livelihood is mainly dependent on agricultural production which is a mixture of irrigated rice cultivation at the valley bottom, swidden farming (shifting cultivation) on the surrounding mountain slopes, and animal husbandry.

Chieng Dong Village is classified as a mountainous village of Yen Chau District, Son La Province. There are several ethnic groups living in Chieng Dong, among which the Black Thai is the major group accounting for 96% of the village’s population. Other groups include the H’mong, Kinh and Kho Mu. The village has settlements on the valley of Hit and Vat streams, a tributary of the Da river. Crop cultivation and animal husbandry are the major activities. Villagers have wet rice fields at the bottom of valleys and swidden fields on mountain slopes.

3. Materials and Method

The study adopted an approach combining the interpretation of remote imagery with socio-economic field research. The remote sensing data used in this study is summarized in Table 1.

The aerial photos were manually interpreted and classified into 6 land cover categories (closed-canopy forest, open-canopy forest, shrub, grass, upland field and paddy field). These land cover categories were transferred to the base map using recognizable topographic features (streams, roads, and mountains) and entered into a geographical information systems (GIS) database (ARCVIEW). The same base maps and land cover categories were applied for the analysis of the satellite images.

Field research included interviews with local officers and statistical data collections. Interviews with local people and officers at the village and district levels with focus on agricultural practices, forest uses and living

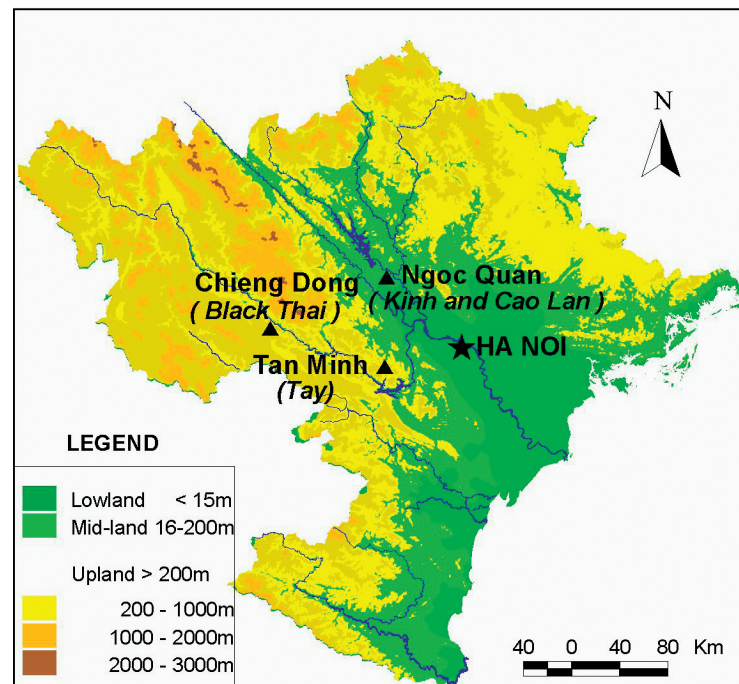


Figure 1: Location of the study sites in Vietnam Northern Mountain Region

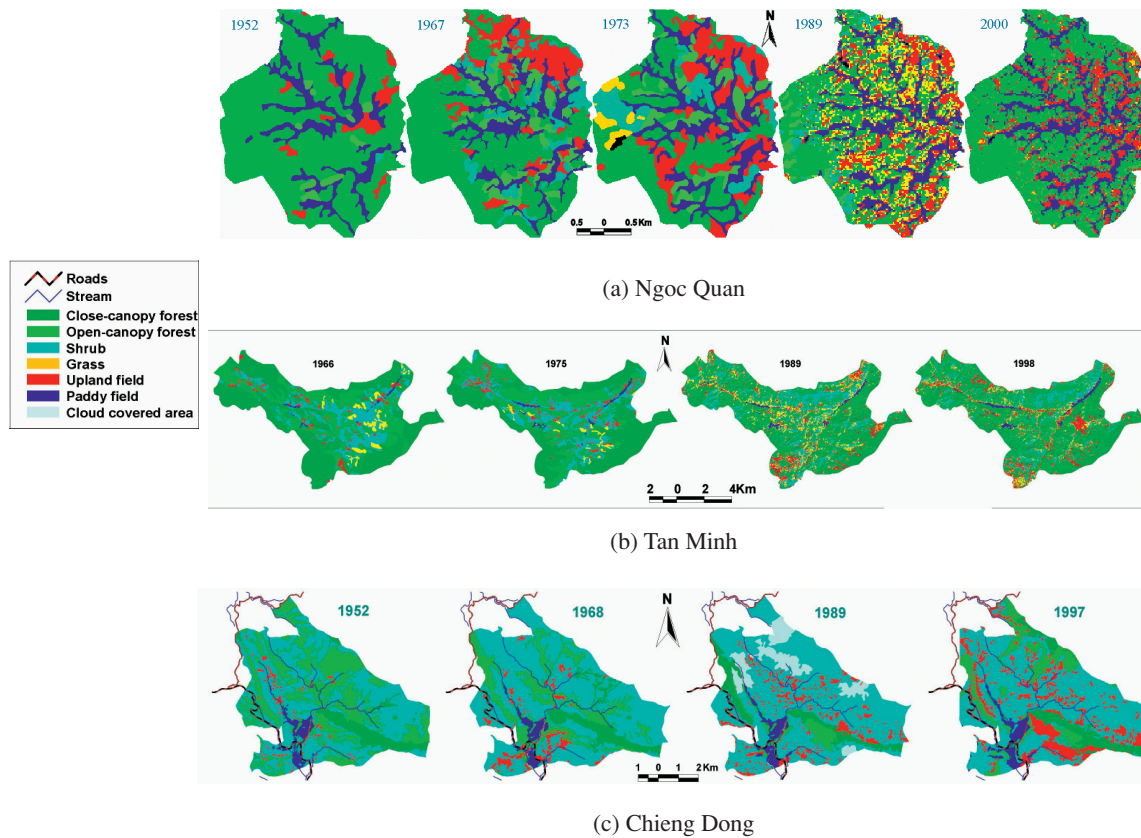


Figure 2: Land cover-land use of the study sites

Table 1: Land cover-land use data sources

Study sites	Type of data				
Ngoc Quan (Doan Hung dist.)	Aerial photo 1952	Corona 16-12-1967	Aerial photo 11-1973	Landsat TM 30-11-1989	Landsat TM 04-11-2000
Chieng Dong (Yen Chau dist.)	Aerial photo 1952	Corona 1968	Corona 30-03-1979	SPOT 1989	SPOT 1997
Tan Minh (Da Bac dist.)	Aerial photo 1952	Corona 03-02-1966	Corona 30-12-1975	Landsat TM 30-11-1989	Landsat TM 11-1998

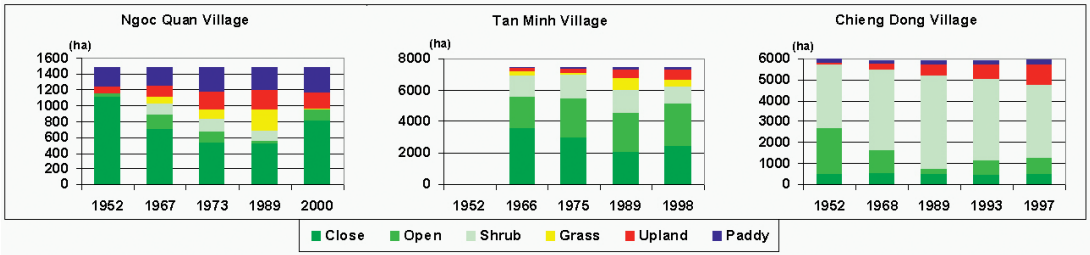


Figure 3: Changes in land cover-land use of the study sites

conditions have helped to understand and to identify major factors of land cover and land use changes.

4. Results

4.1 Land Cover-Land Use

Figure 2 shows the results of remote sensing interpretations. In Ngoc Quan Village (Figure 2(a)), forest was cleared in the northern part of the village since the 1960s for planting tea and industrial trees such as acacia, styrax and eucalyptus. This caused difficulties in separation between lands cleared for agriculture, upland field, and for tree plantation, though both lands are classified as upland field in Figure 2(a). These lands were re-classified as upland field

and grassland by the ratio of 20% and 80%, respectively, according to information obtained from field investigations. The composition of land cover-land use is calculated after this modification (Figure 3).

It is obvious that the study sites had richer forest vegetation in the 1950s than it is today.

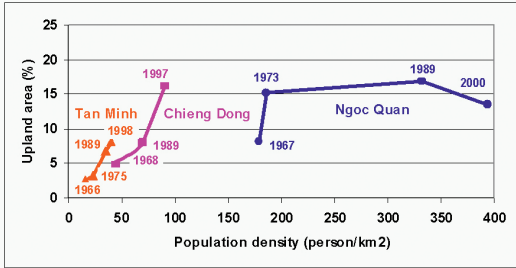


Figure 5: Relationship between population density and upland area

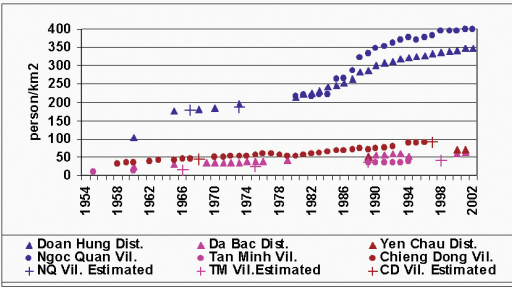


Figure 4: Estimated changes in population density

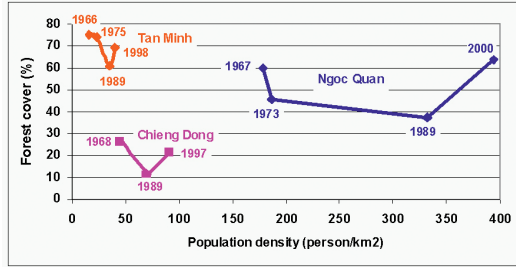


Figure 6: Relationship between population density and forest cover



Forest cover (close and open canopy) had decreased at all study sites, hit the bottom in 1989 (time of the images available) and has reverted after that, but do not recover at the level of the 1950s yet. Among the three sites, Ngoc Quan and Chieng Dong had higher rates of deforestation than Tan Minh. Forest cover of Chieng Dong in 1997 is only about 50% of what it was in 1952.

The area of paddy field was almost unchanged during the last five decades in all the study sites. This suggests that most of the suitable land for paddy cultivation was already reclaimed before the 1950s and little land was left for further expansion of paddy field. The major driving force of land use change has been dry land agriculture. The area of upland field has continuously increased in Tan Minh and Chieng Dong, while it increased and hit the maximum in the late 1980s and decreased after that in Ngoc Quan. This difference was caused by the introduction of tea and tree plantation in Ngoc Quan particularly in the 1970s. Matured tea and tree plantation areas were classified as open and close canopy forests in this analysis. Expansion of dry land agriculture is undoubtedly the primary cause of decrease in forest cover.

Differences in mode of agriculture also affected land use changes. Chieng Dong shows the smallest forest cover and the largest shrub land throughout the study period. This must be because the major mode of agricultural production in Chieng Dong has been swiddening and large area has been occupied as fallow land after cultivation, while Ngoc Quan has significant amount of paddy fields and the role of swiddening was limited.

4.2 Population

Population data is available at the village and district levels, but both of them are incomplete. After converting all the population data into population density, population changes were estimated using the village data when it was available and applying linear interpolation and fixed ratio of village population density to

district population density when it is not available (Figure 4).

Population density has increased since the mid 1960s to late 1990s from about 179 to 394, 16 to 40 and 45 to 91 person per km² with the annual increasing ration of 2.4%, 2.9% and 2.5% in Ngoc Quan, Tan Minh and Chieng Dong, respectively.

4.3 Impacts of Human Activities on Land Cover-Land Use

Our analysis shows a positive correlation between population density with area of upland field in the study sites (Figure 5). This indicates that population growth caused expansion of upland field. The exceptional case is Ngoc Quan after 1973. The population density of Ngoc Quan increased from 186 person per km² in 1973 to 394 person per km² in 2000, while the area of upland field decreased from 15.2% to 13.5% during the same period. One of the reasons for this reverse trend is thought to be the introduction of commercial tea and tree plantation since the 1960s due to the improvement of road network and emergence of paper industry. Income from cash-earning forest vegetation minimized the expansion of upland fields for upland rice and cassava cultivation. Intensification of paddy cultivation by introducing new varieties and chemical fertilizers with the increase of rice yields from 2 t/ha to 5 to 7 t/ha also decreases the demand for upland crop cultivation of the villages.

The analysis (Figure 6) also shows an inverse correlation between population density and forest cover in the three villages until 1989 as found in many studies (Brown and Pearce, 1994; Fox et al., 1995; Leisz et al., 2001; Sikor et al., 2004). This suggests a close relationship between population increase and deforestation. Deforestation was for the purpose of agricultural land expansion to meet food demand, and not for timber production because timber market was limited at that time.

After 1989, however, forest cover has increased, although population increased. The



opposite relationship between forest cover and population can be attributed to a wide range of factors.

1) Improvement of agricultural technology and marketing

Improved agricultural technology, particularly for paddy cultivation, was distributed after Doi Moi in the mid-1980s resulting in higher productivity and smaller demand for expansion of agricultural land. Introduction of cash crop and commercial tree plantation also released the demand.

2) Enforcement of forest conservation

The government regulations and projects were effectively implemented for forest conservation. These include Law of forest protection and development passed by National Assembly on 8th Dec. 1991, Government Decree 02/CP issued on 15th Jan. 1994 and Decree No. 77/CP issued on 29th Nov. 1996.

3) Transfer of land management to individual household

The 1993 Land Law, as one of the outcome of Doi Moi, regulated that household was the managing body of land resources and had to be responsible for his property including forest resource.

5. Conclusion

Changes in land cover-land use has been quantified from remote sensing imagery at the selected villages in the Northern Mountain Region of Vietnam. Deforestation caused by the expansion of upland fields including both for swiddening and permanent cropping is the major process of land use changes. This process is correlated with population growth until the 1980s. Forest cover has been, however, recovering since then in all the study sites, even though population growth continues. The new process of land use change is thought to be determined by a wide range of factors including improvement of agricultural technology and marketing, government intervention in forest management and effective resource management by local people.

This study also proves the effectiveness of remote sensing image analysis at the village level. The different natural settings and mode of agriculture of the study villages are reflected in the produced land cover-land use maps. This difference is essential when we examine the process of land use changes in combination with population, economy, policies and technology. Wider availability of high resolution imageries is expected to promote village-level studies which must result in effective and area-specific land and forest resource management.

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