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## ABBREVIATIONS

|        |                                                                                 |
|--------|---------------------------------------------------------------------------------|
| 5MHRP  | Five Million Hectare Reforestation Program                                      |
| ADB    | Asia Development Bank                                                           |
| BNN    | Bộ Nông nghiệp và Phát triển nông thôn (MARD)                                   |
| CEMMA  | Committee for Ethnic Minority and Mountainous Areas                             |
| CIFOR  | Center for International Forestry Research                                      |
| CITES  | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| CLM    | Conditional logit model                                                         |
| DANIDA | Danish International Development Agency                                         |
| DARD   | Department of Agriculture and Rural Development                                 |
| DEM    | Digital Elevation Model                                                         |
| e.g.   | Latin <i>exempli gratia</i> , for example                                       |
| EKC    | Environmental Kuznets Curve                                                     |
| ETM    | Enhanced Thematic Mapper Plus                                                   |
| EURO   | European currency                                                               |
| FAO    | Food and Agriculture Organization of the United Nations                         |
| FARM   | Farmer's Action for Natural Resource Management                                 |
| FDD    | Forest Development Department                                                   |
| FFI    | Fauna and Flora International                                                   |
| FIPI   | Forest Inventory and Planning Institute                                         |
| FPD    | Forest Protection Department                                                    |

|       |                                                                                                                |
|-------|----------------------------------------------------------------------------------------------------------------|
| FREC  | Forest Resources and Environment Center                                                                        |
| FUV   | Forestry University of Vietnam                                                                                 |
| GDLA  | General Department for Land Administration                                                                     |
| GDP   | Gross Domestic Product                                                                                         |
| GIS   | Geographical Information System                                                                                |
| GPS   | Global Positioning System                                                                                      |
| GTOS  | Global Terrestrial Observing System                                                                            |
| GTZ   | Deutsche Gesellschaft für Technische Zusammenarbeit GmbH<br>(German Agency for Technical Cooperation)          |
| GSO   | General Statistics Office                                                                                      |
| GWDG  | Gesellschaft für wissenschaftliche Datenverarbeitung mbH<br>Göttingen, (Center for Scientific Data Processing) |
| ha    | Hectare                                                                                                        |
| HEPAP | Hunger Eradication and Poverty Alleviation Program                                                             |
| HYV   | High-yielding variety                                                                                          |
| ibid. | Latin: ibidem (in the same place)                                                                              |
| IFPRI | International Food Policy Research Institute                                                                   |
| IGBH  | International Geosphere-Biosphere Program                                                                      |
| IHDP  | International Human Dimensions Program                                                                         |
| IIA   | Independence of Irrelevant Alternatives                                                                        |
| IRD   | Institute for Rural Development                                                                                |
| kg    | Kilogram                                                                                                       |
| km    | Kilometer                                                                                                      |

|                 |                                                             |
|-----------------|-------------------------------------------------------------|
| km <sup>2</sup> | Squared kilometer                                           |
| ln              | Natural logarithm                                           |
| LR              | Likelihood Ratio                                            |
| LUC             | Land-use change                                             |
| LUCC            | Land-use/cover change                                       |
| LULC            | Land-use and land-cover                                     |
| LURC            | Land-use right certificate                                  |
| MARD            | Ministry of Agriculture and Rural Development               |
| MNL             | Multinomial Logit                                           |
| MOLISA          | Ministry of Labor, Invalids and Social Affairs              |
| MONRE           | Ministry of Natural Resources and Environment               |
| NA              | National Assembly                                           |
| NĐ              | Nghị Định                                                   |
| NGO             | Non-Government Organization                                 |
| NIAPP           | National Institute for Agricultural Planning and Projection |
| NTFP            | Non-Timber Forest Products                                  |
| PC              | People's Committee                                          |
| QĐ              | Quyết Định (Decision)                                       |
| RBC             | Red Book Certificate                                        |
| SD              | Standard Deviation                                          |
| SOF             | State Owned Farm                                            |
| SFDP            | Social Forestry Development Project Song Da                 |

|        |                                                                  |
|--------|------------------------------------------------------------------|
| SFE    | State Forest Enterprise                                          |
| SRV    | Socialist Republic of Vietnam                                    |
| TTg    | Thủ Tướng Chính Phủ (Prime Minister)                             |
| UBND   | Ủy Ban Nhân Dân (People's Committee)                             |
| UNDP   | United Nations Development Program                               |
| UTM    | Universal Transverse Mercator                                    |
| USD    | US Dollar                                                        |
| VBARD  | Vietnam Bank for Agriculture and Rural Development               |
| VBP    | Vietnam Bank for the Poor                                        |
| VICOFA | Vietnam Coffee and Cocoa Association                             |
| VLSS   | Vietnam Living Standards Survey                                  |
| VND    | Vietnamese currency                                              |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| WB     | World Bank                                                       |
| WHC    | World Heritage Convention                                        |
| WU     | Women Union                                                      |

## CHAPTER

### 1. INTRODUCTION

---

#### **1.1 Importance of Land-Use Change Research in Tropical Uplands**

Tropical uplands are the homelands of tropical rainforests which are considered to be the richest and most valuable ecosystems on the earth's land surface (Heywood, 1995; Myers, 1992). Furthermore, tropical forests play an important role in regulating the hydrological cycle of rainfall, evapotranspiration, and drainage of streams and rivers. Tropical forests have been vital supporters of the livelihoods of millions of forest dwellers who depend on the forests for their daily needs (Byron and Arnold, 1999; FAO, 2003; Wunder, 2001).

Excessive land-use/land-cover change (LUCC), in general, and tropical deforestation, in particular, lead to massive species extinction and degradation of the biodiversity (Brown and Pearce, 1994; Tucker and Townshend, 2000) and affect the atmosphere and climate at both local and global levels (Malhi et al., 2002; Malhi and Wright, 2004; Tucker and Townshend, 2000). Moreover, LUCC influences the functions of the ecosystem, agricultural productivity and socioeconomic situations (Cleuren, 2001; Grainger et al., 2003; Tolba and El-Kholy, 1992). Conversely, changes in the climate, agricultural productivity, and socioeconomic conditions affect to land-use and forest resources (Grainger, 1993; Lambin et al., 2003; Meyer

and Turner II, 1994). Forest timber and non-timber products can be partly substituted, but the tropical forests' ecological services for a functioning world cannot be replaced (Krishnaswamy and Hanson, 1999).

Sustainable development in the mountains was, therefore, brought to the fore of the international policy debate and agenda. In particular, LUCC in the tropical uplands has become the most important issues in the environmental management programs. Remarkably, the Mountain Research Initiative (MRI) was launched jointly by the International Geosphere-Biosphere Program (IGBP), the International Human Dimensions Program (IHDP), and the Global Terrestrial Observing System (GTOS) to investigate the causes and consequences of the LUCC.

Although numerous attempts have been made by the governments of tropical countries and international donors to *“reconcile economic development, poverty reduction, and environmental protection and some successful stories have been achieved”* (Gutman, 2001), LUCCs in the tropics have not abated but rather accelerated and diversified with the industrial development, technological innovation, the globalization of the world economy, the rapid population growth, basic subsistence needs, and political measures (FAO, 1997; FAO, 2003; Turner II and Meyer, 1994). Notably, tropical forests have continued shrinking at an alarming rate, although reforestation has taken place in some places and considerable protected areas have been established (FAO, 2001; FAO, 2005; Lambin et al., 2003; Wibowo and Byron, 1999).

It is fundamental that interventions in the dynamics of land-use/land-cover (LULC) systems, in general, and tropical deforestation, in particular, is impossible without a proper understanding of the driving factors in these systems and their behavior (Lambin et al., 2003; Leemans et al., 2003; Munroe et al., 2004; Nelson and Geoghegan, 2002; Verburg et al., 2005). Therefore, LUCC has attracted great deal of attention from numerous scientists, researchers, and planners from different disciplines over the past decade (Achard et al., 2002; Barbier and Burgess, 2001; Geist and Lambin, 2001; Geoghegan et al., 2004; Lambin, 1997; Nelson et al., 2004; Panayotou and Sungsuwan, 1994; Southgate, 1994; van Soest, 1998; Walker, 2004).

However, understanding LUCC has been hampered by a lack of data; methodological and analytical difficulties emerging from the complexity of integrating diverse phenomena, space-time patterns, and social-biophysical processes; and different disciplinary means of addressing them (Fox et al., 2003; Lambin et al., 2003; Liverman et al., 1998; Rindfuss et al., 2004; Veldkamp and Verburg, 2004).

Some recent comprehensive reviews of previous research conclude that the LUCC is the consequence of complex interactions between humans and the environment over time and space. They further suggest that no simple set of explanatory factors and single research method work across all cases (Agarwal et al., 2002; Geist and Lambin, 2001; Haughton and Counsell, 2004; Kaimowitz and Angelsen, 1998; Lambin et al., 2003; Walsh et al., 2004). Therefore, different research approaches originating from different disciplinary backgrounds and at different scales of analysis should be considered as a supplement to the others (Angelsen and Kaimowitz, 1999; Kaimowitz and Angelsen, 1998; Rindfuss et al., 2004; Verburg et al., 2002). Much remains to be learned before the researcher can fully assess and project the future role of LUCC in the functioning of the earth's system and identify conditions for sustainable development in the tropical regions (Angelsen and Kaimowitz, 1999; Geist and Lambin, 2001; Lambin et al., 2003; Lambin et al., 2001; Walker, 2004; Wibowo and Byron, 1999). Also, integration between the social and spatial sciences at different scales is still one of the challenges for LUCC research (Fox et al., 2003; Rindfuss et al., 2004; Verburg et al., 2005; Verburg and Veldkamp, 2005; Walsh and Crews-Meyer, 2002).

## **1.2 Background**

Vietnam is situated in the tropics in the centre of Southeast Asia with a total natural land area of 331 thousand square kilometers. Hilly and mountainous areas make up three-quarters of the country's natural land and are characterized by rugged terrains and the poor infrastructures. Vietnam is one of the world's ten most biologically diverse countries containing 50 percent of the plant species and over 80 percent land-dwelling vertebrate species, including many rare and endangered species found

nowhere else in the world (CBC, 2003; World Bank et al., 2002). The Vietnamese's economy is still largely dependent upon the agricultural activities. In 2003, seventy-four percent (or 60 million people) of the national population lived in rural areas (ADB, 2004; Glewwe et al., 2004; GSO, 2005). In the same year, the agricultural sector accounted for 65 percent of Vietnam's labor force (ibid.).

The upland regions are the home of 24 million people with the diverse ethnicity and a predominantly agriculture-based economy. Most of the upland inhabitants belong to ethnic minority groups and their livelihoods are strongly dependent upon shifting cultivation in the hillsides and forest resources (Cuc, 2003; Jamieson et al., 1998). In addition, poverty<sup>1</sup> and environmental degradation are interrelated and are widespread in the upland regions (ADB, 2002; Gomiero et al., 2000; Sunderlin and Thu Ba, 2005; World Bank, 1998).

The Vietnamese Communist Party decided to transform the country's economy from a centralized to a market-oriented form known as *Doi Moi* in the late 1980s. The process of *Doi Moi* (Economic Renovation) brought new inspiration to the national economy. The *Doi Moi* policies recognized the farm household as the main unit of agricultural production and shifted control over production assets from the agricultural collectives to the individual farm households. Land has been allocated to farmers for long-term use with 20 years for the agricultural uses and 50 years for growing perennial crops and forests (Bien, 2001; Morrison and Dubois, 1998; Ravallion and van de Walle, 2003; Sikor, 2004). In addition, the reformed policies freed farmers to purchase of the agricultural inputs and the sale of outputs (Grossheim, 1999; Ravallion and van de Walle, 2004; Sikor, 1999; Zingerli, 2003). The opening up of market relations made commodity agriculture both possible and profitable. The agriculture was gradually moved from the self-subsistence to the market-oriented production (Hardy and Turner, 2000).

In the forestry sector, *Doi Doi* policies also contributed to higher profitability of trading timber and non-timber forest products (NTFPs) both domestically and

---

<sup>1</sup> According to Vietnam Living Standards Surveys (VLSS), general poverty rate of ethnic minority population was 84 percent in 1993, 75 percent in 1998 and 69 percent in 2002.

internationally (Tuynh and Phuong, 2001). On the other hand, a great number of legislations and programs on natural resource protection, reforestation, and integrated rural development have taken place with invaluable support from international donors since the middle 1990s (Bien, 2001; MARD, 2000).

However, with a population of 81 millions in 2003 (GSO, 2005), Vietnam is one of the most populous countries in the world (Joint Donor, 2003), and the population continues growing at a high rate. In addition to limited off-farm activities and opportunities for agricultural expansion in the lowland areas, a burgeoning population put heavy pressure on upland regions, especially on residual forest resources. It was observed that a huge flux of people migrated from the populated delta provinces – whether spontaneous or planned migration<sup>2</sup> – to “sparsely populous” uplands that led to an abrupt change in the populations in those regions (Jamieson et al., 1998; Lang, 2001; Zingerli, 2003).

In addition to the above-mentioned migration programs, the construction of large-scale dams for hydropower and irrigation (e.g., Hoa Binh, Tri An, Dau Tieng, and Yali) significantly contributed to national economic development but led to socioeconomic disturbance and environmental degradation (Lang, 2001). Most of the dam-affected population was brought into the uplands. The rapid population growth and the migration were assumed to be major driving forces behind the land-use change in the upland territories (De Koninck, 1999; Hardy, 2000; Hardy, 2003; Sam, 1994). Jamieson et al. (1998) said of the Vietnamese uplands that “there are simply too many people trying to wrest a living from fragile environments with limited agricultural potential”. Furthermore, the expanding population pressures on uplands are generating tension and conflict among lowland migrants and ethnic minority people (Sikor, 1998).

---

<sup>2</sup> According to report of the Ministry of Agriculture and Rural Development (MARD) to the Economic and Financial Committee of the National Assembly in July 1998, the ratio of the spontaneous migration to the total migrated population was 0.6. As of 1997, about 212,000 households (1.03 million people) have migrated from lowland provinces to uplands and each household cleared about 0.4 ha forests for growing agricultural crops on average.

The economic innovation policies and development programs have led to significant changes in the agricultural production and socioeconomic and institutional conditions in Vietnam over the last two decades. The Gross Domestic Products (GDP) increased 7.7 percent per annum for period from 1989 – 2002 and GDP per capita rose from US\$ 222 in 1991 to US\$ 553 in 2004 (Glewwe et al., 2004; GSO, 2005; Tho et al., 2000; UNDP, 2005a). The average value added to the agricultural sector grew by 4.5 percent during the period between 1990 – 2000 (Tho et al., 2000). Vietnam was transformed from a food-deficit country to the second largest rice exporter in the world (World Bank et al., 2000). Also, Vietnam is now the second largest producer of coffee worldwide after Brazil (D'haeze et al., 2005; Lang, 2001). The overall poverty rate measured by the international comparable poverty line declined from 65 percent in 1990 to 29 percent in 2002 (Joint Donor, 2003; UNDP, 2005b).

LULC in the upland regions has dramatically changed during the past few decades. Forest coverage dropped from 32 percent (10.5 million hectares) in 1980 to 27 percent (9.2 million hectares) in 1990 but increased to 28 percent (9.3 million hectares) in 1995 and to 38 percent (12.3 million hectares) in 2004 (DFP, 2005; FIPI, 2000; MARD, 1997). Despite the increase in the forest coverage, forest quality has continuously decreased and deforestation was still severe in many places (Dzung et al., 2003; FIPI, 2000). As of 2000, rich forests accounted for only 19 percent of the natural forests (2.1 million hectares) and were mostly found in the Central Highlands and in areas along the border with Laos (FIPI, 2000). It is estimated that 28 percent of the mammals, ten percent of the birds, and 21 percent of the reptiles and land amphibians face extinction (CBC, 2003). Forest degradation, the loss of biodiversity, soil erosion, the reduction of groundwater, and siltation in the river downstream areas have become increasing problems in the upland regions (De Koninck, 1999; De Koninck, 2000; World Bank et al., 2002). Upland populations have been increasingly subjected to high levels of risk from frequent natural disasters such as flash floods, landslides, soil erosion, and drought (World Bank, 1998).

However, the great diversity of geographical conditions, cultures, livelihood strategies, institutions, and economic opportunities caused a variety of responses and

the resistance of farmers to economic innovation policies and shaped diverse LULC patterns in different upland regions of Vietnam (Castella et al., 2005; FIPI, 2000). That implies that there is no common set of factors that drive LUCCs in all upland territories of the country. Further, there is no policy measure can fit for all circumstances. It is crucial to thoroughly understand the determinants and processes of LUCC, and economic development in order to promote sustainable development in the upland regions as well as the whole nation.

### **1.3 Objectives of the Study**

This research aims at investigating the processes and major driving forces behind land-use changes in 335 villages in Son La Province, northwest of Vietnam by focusing on an economic reform period (1989-2002). The land-use responses of local agents to increasing population densities, the technological change, the improvements in the access to agricultural markets and land tenure security, and the government policies are examined. The integration of the data from various disciplines and the combination of different analyzing approaches could answer four basic questions: what, when, where and how of land-use change and in turn, to provide deeper insights into the land-use change in the research region.

Furthermore, the effect the land-use changes on three main objectives of the sustainable rural development: environmental sustainability, agricultural growth and human welfare and the synergies and trade-offs between these objectives are investigated.

A better understanding of the causes and processes of land-use change and the complex interactions between the driving forces behind the land-use change could enable Vietnamese decision-makers at regional and national level in the formulation the appropriate policies to achieve sustainable development in the country's upland territories.

### **1.4 Outline**

The theoretical background of LUCC research is thoroughly discussed in Chapter 2. There are two important components of any LUCC studies: 1) the detection of

LUCC, and 2) LUCC analysis. Two major LULC mapping techniques, namely direct survey on the ground and the application of remote sensing technology are introduced. However, the later is focused because it is very popular and widely applied today. Next, some different LUCC detection techniques and scale-related issues in LUCC study are presented. Furthermore, some major driving factors that are assumed to be relevant to the LUCC in the research region are presented. A variety of different approaches which has been developed for analyzing LUCC are reviewed; for example, behavior versus non-behavior, narrative exploration versus mathematic models, and spatially explicit models versus non-spatial models. Each of them has advantages and weaknesses. The conceptual framework for investigating LUCC in the research region is developed. Methodology for this study is chosen based on the above-mentioned review. The von Thünen-Ricardian land-rent theory and the induced innovation theory are the theoretical basis of this study.

First parts of Chapter 3 portray the macro-economic situation and institutional environment in Vietnam and in Son La province during the research time span (1989 – 2002). This information enables the readers to understand the research design. Next, the methodology for data collection is discussed, including the selection of the research time span and the unit of primary data collection. The land-use data from 1989, 1994, and 2002 were derived from aerial photographs and high-resolution satellite images. Geophysical variables are either collected from secondary data sources or are generated by using Geographical Information System (GIS) techniques. Primary socioeconomic data were collected at the village level by means of a semi-structured questionnaire. The method of data integration is also presented. The research applies a combination of a spatially econometric model at the disaggregated pixel level and the descriptive analysis at the aggregated village level to examine land-use change in the research region.

Chapter 4 deals with descriptive analyses of land-use change in the research region at the village level with the support of the Geographical Information System (GIS) techniques. The first section outlines the general geophysical and socioeconomic characteristics of the research region. The next sections are devoted exclusively to