

SMALLHOLDERS, MOUNTAIN AGRICULTURE AND  
LAND CHANGE IN LAMJUNG DISTRICT, NEPAL

by

MILAN K. SHRESTHA

(Under the Direction of Robert E. Rhoades)

ABSTRACT

The goal of this dissertation is to investigate mountain smallholders' land-use strategies and examine how the changes in their land-use strategies are linked to the broader land-cover change patterns. Using a cross-disciplinary, multi-scalar approach that integrates ethnographic and survey data with remote sensing and geographic information system (GIS) applications, this study: (1) analyzes the household conditions and the community context of the changes in land-use strategies in Lamjung district, Nepal; and (2) identifies the district-level land-cover change patterns between 1976 and 2003 from multi-temporal satellite images (i.e., Landsat data of 1976, 1984, 1990, 1994, 1999, and 2003). In doing so, the processes of land-use and land-cover change (LUCC) and their social drivers are discussed in relation to the patterns of land-cover change.

An in-depth analysis of the land-cover change trajectories illustrates dynamic transitions between forest, agricultural land and shrubland and suggests that there is no linearity in land-cover change as is generally assumed. One significant change, however, is the loss of shrubland coverage to agriculture and forest over the years, decreasing from 37,825 ha (22.33% of the total

area) in 1976 to 16,717ha (9.86%) in 2003. Although forest coverage steadily decreased from 75,582ha (44.2%) in 1976 to 64,453ha (38.02%) in 1990, it was no “massive deforestation” as claimed in the “Himalayan Environmental Degradation” debate. Forest in fact gained in areas in subsequent observation years to reach 71,582ha (42.22%) in 2003. Agricultural land also expanded from 30,3360ha (18.1%) to 42,048ha (24.8%) between 1976 and 2003.

The context of smallholdings also changed in Lamjung during this period. The most notable changes were in the resource allocation rules, local economy, labor management and agricultural system. Combined, these mediated the effects of population pressure and poverty and influenced smallholders’ land-use decisions. Understanding the context of changes in agricultural strategies also explains the dynamic transitions observed between different land-cover categories.

The results of this study help establish general relationships underlying the subsistence behaviors of mountain smallholders, their dependence on agricultural and forest resources, and the extent to which their behaviors are influenced by the changing local demography, expanding market economy, shared cultural knowledge and institutions.

**INDEX WORDS:** Ecological anthropology, agricultural anthropology, smallholders, mountain agriculture, Lamjung, Nepal, the Himalaya, Gurungs, cultural ecology, ethnoecology, farming, land-use, land-use strategies, land-use and land-cover change, land change science, human dimensions, agricultural change, agricultural intensification, deforestation, GIS and remote sensing

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## **DEDICATION**

To Bimu, whose love, courage and patience made this dissertation possible

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My interest the people and environment of Lamjung began in 1993, when I was assigned there to implement a community-based development project. This assignment turned out to be a life changing experience. Lamjung's amazing cultural and biophysical diversity have captivated me ever since. Over the years, I have regularly visited the district and each visit has unfolded many interesting and challenging issues for me, forming my understanding of the coupled human-ecological system. Along this long winding path of learning and sharing, I have been helped by the numerous guides, friends and colleagues. I take this opportunity to thank them personally here.

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## TABLE OF CONTENTS

	Page
ACKNOWLEDGEMENTS .....	v
LIST OF TABLES .....	xi
LIST OF MAPS .....	xiv
LIST OF FIGURES .....	xv
CHAPTERS	
1 INTRODUCTION: SMALLHOLDERS, LAND CHANGE AND NEPAL .....	1
1. Research questions .....	5
2. Theoretical foundations and gaps.....	8
3. Research methodology .....	19
4. Lamjung and fieldwork: social embeddedness, challenges and limitations.....	25
5. Dissertation overview.....	30
2 LAMJUNG AND ITS COUPLED HUMAN-ECOLOGICAL SYSTEM.....	33
1. The setting .....	33
2. Research sites .....	43
3. Ethnohistory of Gurungs and their socio-cultural contexts.....	47
4. The political economy of land resources and Gurungs .....	56
5. Recent environmental changes and concerns.....	61
3 LAND-USE AND LAND-COVER CHANGE TRAJECTORIES.....	65
1. Land change science.....	67

2.	Remote sensing data acquisition and reference data .....	71
3.	Image processing procedures .....	72
4.	Accuracy assessment .....	81
5.	Land-cover change detection.....	87
6.	Results .....	94
7.	Conclusions and significance .....	96
4	<b>SMALLHOLDERS AND MOUNTAIN AGRICULTURE .....</b>	<b>104</b>
1.	The verticality concept and land-use strategies in the mountains .....	105
2.	Explaining changes in mountain agriculture .....	120
3.	Smallholding and land-use strategies in Lamjung .....	126
4.	Labor management, cooperation and scheduling .....	130
5.	Recent changes in mountain agriculture and livelihoods .....	135
5	<b>ETHNOECOLOGY OF AGRICULTURE AND THE LANDSCAPE.....</b>	<b>141</b>
1.	Perceptions of smallholding: interdependence and interconnectedness.....	143
2.	Agricultural land-use strategies.....	149
3.	Crop choices and agro-diversity.....	157
4.	Livestock and pasture management .....	163
5.	Agricultural priorities and constraints .....	169
6.	Landscape level change .....	174
6	<b>THE HOUSEHOLD CONDITIONS AND COMMUNITY CONTEXT OF THE</b>	
	<b>CHANGES IN LAND-USE STRATEGIES .....</b>	<b>178</b>
1.	Integrated land history .....	178
2.	Forest and other institutional arrangements .....	184

3. Changes in the household conditions .....	189
4. Demographic factors and other socioeconomic issues .....	196
5. Accounting for land-use dynamics .....	201
6. The scale issue in linking land-use with land-cover change patterns .....	203
7 CONCLUSION AND SIGNIFICANCE .....	208
1. Findings and conclusions .....	208
2. Significance for anthropology .....	217
REFERENCES .....	218
APPENDICES .....	244
A Glossary, pronunciation guide and conversion factors .....	244
B Inventory of commonly found tree species.....	247
C Common farm tools, cultural attributes of crops and seasonal calendar .....	248
D Image resampling and projection system.....	261
E Indices for Lamjung GIS dataset .....	262
F Maps produced for the study.....	264
G Interview questions, training sample form and survey questionnaires .....	274
H Freelisting results .....	290

## LIST OF TABLES

	Page
Table 2.1 Area of agroclimatic zones .....	38
Table 2.2 Profile of research sites.....	44
Table 3.1 Characteristics of the Landsat data .....	72
Table 3.2 Land-cover classes and definitions .....	74
Table 3.3 Land-cover change for Lamjung as derived from a time series of Landsat images .....	81
Table 3.4 Results of accuracy assessment of the 1984 land-cover map, showing confusion matrix, kappa statistics and tau coefficient .....	84
Table 3.5 Results of accuracy assessment of the 1999 land-cover map, showing confusion matrix, kappa statistics and tau coefficient .....	85
Table 3.6 Land-cover change matrix (1976 to 1984) .....	91
Table 3.7 Land-cover change matrix (1984 to 1990) .....	91
Table 3.8 Land-cover change matrix (1990 to 1994) .....	91
Table 3.9 Land-cover change matrix (1994 to 1999) .....	92
Table 3.10 Land-cover change matrix (1999 to 2003) .....	92
Table 3.11 Land-cover change matrix (1976 to 2003) .....	92
Table 4.1 Verticality: The conventional vs. the new paradigm .....	112
Table 4.2 Descriptions of Lamjung altitudinal land-use and crop production system .....	114
Table 4.3 Number of land parcels owned by the sample households in research sites .....	118
Table 5.1 Main forest products utilized by sample households.....	146

Table 5.2 <i>Baari</i> classification .....	151
Table 5.3 <i>Khet</i> classification.....	152
Table 5.4 Changes in the area of irrigated land, as perceived by the sample respondents, comparing 2004 to 1994 and 1994 to 1984.....	154
Table 5.5 Changes in the area of non-irrigated land, as perceived by the sample respondents, comparing 2004 to 1994 and 1994 to 1984.....	154
Table 5.6 Main crops cultivated in 2004-2005 .....	158
Table 5.7 Freelisting of most important crops, sorted by frequencies.....	159
Table 5.8 Pile sorting of preferred crops and the justifications .....	160
Table 5.9 Rice varieties and landraces for different level of water availability .....	161
Table 5.10 Freelisting of rice varieties and landraces.....	161
Table 5.11 Respondents comparison of two different types of agricultural systems .....	170
Table 5.12 Work relations among the landowner and the tenant .....	171
Table 5.13 Freelisting of major constraints and issues .....	171
Table 5.14 Freelisting of major factors for increasing forest coverage between 1984 to 2003..	174
Table 6.1 Major historical institutional factors of land-use.....	182
Table 6.2 Descriptive statistics from the research sites .....	189
Table 6.3 Primary occupations/income source in sample households.....	190
Table 6.4 Number of harvests per year in <i>baari/paakho</i> by villages.....	191
Table 6.5 Number of harvests per year in <i>khet</i> by villages.....	191
Table 6.6 Fallow months by villages .....	191
Table 6.7 Fallow period trends (1984-2004) .....	193
Table 6.8 Patterns of productivity by villages .....	193

Table 6.9 Trends in decreasing agricultural productivity .....	194
Table 6.10 Reasons cited for decreasing agricultural productivity.....	194
Table 6.11 Patterns in subsistence .....	195
Table 6.12 Population trend.....	197
Table 6.13 Population density and absentee population comparison with country .....	197
Table 6.14 Outside (non-farm) employment sources .....	199
Table 6.15 The reasons for seeking outside (non-farm) employment .....	199

## LIST OF MAPS

	Page
Map 2.1 Lamjung district.....	34
Map 2.2 Village development committees (VDCs).....	35
Map 2.3 Elevation zones.....	35
Map 2.4 The perspective view of Lamjung terrains .....	36
Map 2.5 Banjhakhet VDC showing sample households.....	46
Map 2.6 Maling VDC showing sample households .....	46
Map 3.1 Land-cover (1976).....	78
Map 3.2 Land-cover (1984).....	78
Map 3.3 Land-cover (1990).....	79
Map 3.4 Land-cover (1994).....	79
Map 3.5 Land-cover (1999).....	80
Map 3.6 Land-cover (2003).....	80
Map 3.7 Forest coverage loss and gain (1976-2003).....	90
Map 3.8 Agricultural area loss and gain (1976-2003).....	90
Map 3.9 NDVI (1976).....	93
Map 3.10 NDVI (2003).....	93

## LIST OF FIGURES

	Page
Figure 1.1 Schematic diagram of linking “process to patterns” .....	24
Figure 2.1 Marsyandi river valley landscape.....	36
Figure 2.2 Major ethnic/caste groups and major languages .....	41
Figure 2.3 A portion of the Dumre-Besishahar road .....	43
Figure 2.4 Besishahar.....	43
Figure 2.5 Southern slopes of Banjhakhet .....	45
Figure 2.6 Maling landscape.....	45
Figure 2.7 Gurungs in their traditional costumes.....	47
Figure 3.1 Land-use in Lamjung (LRMP 1986) as reference data .....	75
Figure 3.2 Land-cover categories .....	75
Figure 3.3 Land-cover changes (1976-2003) in Lamjung district .....	94
Figure 4.1 Zones of land-use as represented in a simplified version of verticality .....	107
Figure 4.2 Verticality model with ecological/ecotonal focus .....	107
Figure 4.3 Overlapped patchworks in an Andean landscape.....	110
Figure 4.4 Lamjung landscape profile showing historical altitudinal land-use zones.....	114
Figure 4.5 Agricultural landscape of the Marsyandi Valley.....	116
Figure 4.6 Four major theories to explain agricultural change.....	121
Figure 4.7 Main agricultural land-uses .....	128
Figure 4.8 Roads in Lamjung.....	136

Figure 5.1 Smallholding based on the agriculture-livestock-forest interrelationships .....	145
Figure 5.2 Local interpretations of land-use as seen in air photo (1996) of Maling VDC .....	151
Figure 5.3 Herds of sheep and goats .....	164
Figure 5.4 A typical transhumance calendar among Gurungs in Lamjung and Kaski .....	166
Figure 6.1 Integrated land history approach in relation to other alternatives .....	179
Figure 6.2 Crop rotation in <i>khet</i> and <i>baari/paakho</i> lands between 1984 and 2004 .....	191
Figure 6.3 Number of family members living in the household in 1984, 1994 and 2004 .....	198
Figure 6.4 Land-use change in Maling VDC (1979 to 1996) .....	205

**CHAPTER 1**  
**INTRODUCTION: SMALLHOLDING,**  
**LAND CHANGE AND NEPAL**

Agricultural land-use strategies involving socio-cultural, economic and ecological factors are a major force contributing to global land-cover change. In this ecological anthropology study, I investigate mountain smallholders' land-use strategies in Lamjung district, Nepal and examine how changes in their land-use strategies are linked to the broader land-cover change trajectories<sup>1</sup>. In doing so, I focus mostly on the human dimensions of smallholder land-use change. The main research questions addressed in this study are: (1) under what household conditions and community contexts do mountain smallholders change their agricultural land-use strategies? (2) how are land-use strategies linked with the broader patterns of land-cover?

Among land change scientists, there is a growing recognition of the need for an integrative, multilevel approach to study the relationships of agricultural 'modification activities' and global land-use and land-cover change (LUCC) (Moran 2005; Rindfuss et al. 2004; Walsh et al. 2004). This new development comes as a crucial step to move beyond the primary area of change (i.e., conversion of forests) to study the changes in agricultural areas, mainly the land-use strategies resulting in different agricultural intensification levels (Lambin et al. 2000). While these

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<sup>1</sup> 'Trajectories of change' is defined as the spatial and temporal trends in the relationships between the factors that shape the changing nature of coupled human-ecological interactions and their effects (see Kasperson et al 1997). Land-cover change trajectories, hence, refers to the paths and patterns of changes and successive transitions in land-cover categories over the observation years.

modification activities have a significant impact on LUCC, these are also subtle and dynamic to be detected with remote sensing and ecological models alone (Liverman et al. 1998; Turner et al. 2003). In other words, we lack sufficient knowledge of the extent to which agricultural land-use strategies contribute to LUCC and *vice versa* (Lambin et al. 2000). The need for such knowledge is even greater for the mountain areas, which are one of the most understudied fragile ecosystems and where agricultural practices heavily rely on forests, livestock, pastures and cultural-ecological adaptations (Netting 1981; Rhoades 1997). A growing body of literature on agricultural anthropology, ethnoecology of mountain environment and most importantly land change science<sup>2</sup> can provide a research framework to address this need.

This dissertation is based on a cross-disciplinary, multi-scalar approach that integrates household and community data with remote sensing and geographic information system (GIS) applications to investigate the relationships between the finer scale agricultural land-use strategies and the broader scale land-cover change trajectories for the period between 1976 through 2004. The goal is to study when and under what circumstances human behavior and land-cover are related (Rindfuss et al. 2003). In doing so, it examines three themes relevant to the LUCC of the district and beyond: (1) the process of change in land-use strategies, (2) patterns of land-cover change, and (3) the spatial and temporal linkages between land-use strategies and land-cover change.

Similar to any other Himalayan areas, Lamjung is also believed to have witnessed in the last five decades rapid changes in terms of population growth, deforestation, disruption of customary

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<sup>2</sup> Termed as land change science only in recent years (Rindfuss et al 2004; Gutman et al 2004), this interdisciplinary research theme has been referred to in the past as ‘integrated land-change science’ or “land-use and land-cover studies” (Turner and Meyer 1991, 1994; Lambin et al 2001, 2003). It seeks to understand the human dimensions of land-cover (biophysical conditions) and land-use (human uses) as a coupled human-ecological system. This research theme is discussed in detail in Chapter 3.

rules and penetration of market economy (Gurung 2004). The reported impact of these include deforestation, declining pasture coverage, overgrazing, changing forest structures and species composition and landslides (ICIMOD 1996). These reports on Lamjung represent a typical widely-held view of the Nepal's deforestation discourse, which was very much influenced by the so-called 'Theory of Himalayan Environmental Degradation' (HED) that dominated environmental debates of the 1970s-1990s (Ives and Messerli 1989; Blaikie and Brookfield 1987; Jodha 1995; Scoones 1999). It was perceived that massive deforestation was taking place in Nepal, mainly caused by an ever-increasing population of smallholders and their 'irrational' agricultural practices, which was invariably having a disastrous impact on coupled human-ecological system and long-term sustainability.

Over the years, many key assumptions of the HED eventually turned out to be complicated, if not dubious or erroneous (Ives and Messerli 1989; Thompson et al. 1986), even though Nepal received the attention of conservation organizations and subsequently benefited from interventions and development projects (Guthman 1997). There is a growing recognition that the HED was overgeneralized and to some extent exaggerated, but it is anything but a 'myth' (Ives 2005), as there is adequate evidence of environmental change; more careful and contextualized analyses are necessary to match the highly diverse and dynamic mountain ecosystems (Forsyth 1998; Price and Thompson 1997).

One of the major problems, I argue, with the HED and related environmental reports on Nepal was that they focused too much on deforestation alone, ignoring all other important types of LUCC in this region. In other words, as Hamilton and Pearce (1988) reports, the term 'deforestation' was used too loosely and to some extent too ambiguously that it overgeneralized Nepal's environmental change issue and smallholders' agricultural practices (i.e., intensification

and extensification) as its primary cause. Deforestation was a term applied to widely differing human impacts on forests, which ranged from collecting fodder and grasses to swidden farming and forest grazing to converting forests to agricultural fields or pastures.

For Lamjung and many other mountain communities, which depend mainly on very complicated smallholders agriculture well supported by proper maintenance of livestock, forest and common pool resources and socio-cultural adaptations, contextual analyses of different types of LUCC are important. While much of LUCC analyses have focused on gradual conversion of forests to a different type of vegetation, there is also need for focusing on modification activities, such as grazing on forests, harvesting fuelwood and fodder, and collecting minor forest products. Only through the understanding of the socio-cultural contexts (or human dimensions) of such agricultural land-use or even deforestation practices, does it become possible to capture the real essence of the environmental changes taking place in Nepal.

Land-use changes involving socio-cultural, economic and ecological factors are often attributed to agricultural intensification (Boserup 1965 and 1981; Brush and Turner 1987; Netting 1993; Kates et al. 1993). Although micro-level in-depth examinations are often deemed necessary to verify such claims (Bilsborrow and Geores 1994), agricultural intensification and land-cover change subsume numerous socioeconomic, cultural and ecological factors (Boserup 1965; Conklin 1967; Geertz 1963; Brookfield 1972) that some have acknowledged as intertwined (e.g., Guillet 1987; Brondízio and Siqueira 1997). Much uncertainty, nevertheless, still exists regarding the extent to which agricultural intensification contributes to LUCC or *vice versa*.

Lambin et al. (2000) argues that systematic and in-depth knowledge of agricultural land-use strategies is essential to analyze the processes and patterns of LUCC. Development of such in-

depth knowledge is possible only with thorough understanding of contextual histories of human-environmental relationships and by studying the way such relationships evolve, spatially and temporally. Anthropologists in particular have successfully integrated household and community ethnography with remote sensing in their studies (Conklin 1980; Guyer and Lambin 1993; Moran 1993; Fairhead and Leach 1996; Brondízio et al. 1994). This dissertation aims to contribute to this emerging anthropological literature.

## **1. Research questions**

The central questions and related working hypotheses for this research were:

- A. Under what household and community contexts do mountain smallholders change their agricultural land-use strategies?
  - Land-use intensification in Lamjung district over the last forty years is the result of changing population pressure, increasing accessibility (transportation and contact with outside world), changing institutions of common property and shifting agricultural preferences (agropastoralism to cereal-dominated agricultural system).
  - Cultural (shared knowledge and institutions) and ecological factors (verticality, inaccessibility and fragility) common in the mountains mediate mountain smallholders' responses to economic and demographic forces of agricultural intensification.
- B. How are agricultural land-use strategies associated with the patterns of land-cover?
  - The changes in land-use strategies have induced statistically significant trade-offs between the major land-cover categories (forest, shrubland, cultivated land) in the last four decades.
  - Forest transitions, manifested in the form of successive forests or fragmented forests, have significant relationships to remote-sensing derived indices of forest coverage.

C. Null hypothesis: Change in land-use strategy depends directly on local demography, accessibility and market opportunities (i.e., intensification processes in the mountains are not different from those in the plains).

In operationalizing these research questions and the related working hypotheses, the meaning of certain terms needs to be clarified. ‘Land-use’ is defined as the human use of land (e.g., cultivation, pasture), which essentially indicates human activity on the earth surface and vegetation. Land-cover means the biophysical form of vegetation and artificial constructions covering land surface: the types and the quality of land, surface vegetation and earth material (Turner and Meyer 1994:5). Household is a functional—although not homogenous—family unit in which its members often share common goals, priorities and resources (e.g., land, labor, capital) and organize consumption and reproduction. The definition of smallholder is adapted from Netting (1993). Smallholders are rural cultivators practicing intensive, diverse range of agriculture in relatively small or fragmented parcels of land. Community contexts are implied as the shared rules or norms, markets, transportation, communication and most importantly, institutional arrangements of land and forest resources. Modification activities in this research refer to different types of agricultural land-use strategies and forest resources utilization and management. These, for instance, include but are not limited to thinning of forests, afforestation, successional forests and change of dry slopeland called *paakho* to irrigated slope land.

To address the two central research questions of this research, it is necessary to integrate household and community data with geo-spatial data with broader coverage. While the first question requires an ethnographic assessment of mountain smallholders’ land-use strategies, the second question involves a multi-temporal analysis (i.e., 40 years) of the relationships between

the processes and patterns of LUCC in both time and space. The reason for examining LUCC for the last forty year period is that it is difficult to understand the dynamics of LUCC at a point in time if these are not analyzed within the context of longer histories of human-environmental interactions (Batterbury and Bebbington 1999). These contextualized histories may also help debunk ‘policy orthodoxies’ (Fairhead and Leach 1996; Scoones 1998) and identify factors in resource use and degradation that are consistently important across the long run. The reason for linking micro-scale household and community level analyses with macro-scale analysis of patterns of LUCC and comparing the relationships between two scales over time is that it can help identify key driving forces of land-use change (e.g., land-use policies, institutions and population). In other words, the detection of land-cover changes at the district level is practical—changes can be best detected at this scale, as well as imperative—to link the processes with verifiable LUCC patterns. It is, however, important to realize that such relationships can be ‘scale-dependent:’ the notion that explanatory factors appear to change as the scale of analysis changes (Walsh et al. 1999). Micro-level analyses of resources, for example, mostly tend to identify social relations and institutions as key driving forces of change, yet in analyses conducted at a macro-scale these factors become secondary to the pressure on resources created by demographic and market demand (Turner 1997).

Following Bennett’s (1969:14) use of the adaptation concept, I consider smallholders’ changes in agricultural land-use strategies as ‘adaptive processes’—the long-term changes that result from the choices they make, rather than as ‘adaptive strategies’—those patterns formed by the many separate adjustments of people to obtain and use resources. Fricke (1986) used this concept in his study of ‘Himalayan Households,’ stressing that the necessity for distinguishing between adaptive strategies and adaptive processes lies in the realization that demographic and

household processes shape the nature of adaptation to the specific environment and each culture's response depends on the available resources that are relatively beneficial over others.

Literature on common pool resources and common property management elucidates that the availability of and access to resources is not only defined by the cultural and resource endowment, but also by how informal and formal institutions govern access to resources (Ostrom 1990; Ostrom et al. 1999; Ruttan 2002; McCay 2002). It is also important to know the way the relationship is defined between the social control of institutions governing access and the dominant ideas regarding how resources should be used (Scott 1998; Blaikie 1997; Batterbury and Bebbington 1999). Similarly, as McKean (2000) argues, the differences in access and endowments within and between communities are not static; they are rather dynamic in the sense that property regimes and the associated operational rules also change spatially and temporally. An assumption made in this research, hence, is that smallholders' decisions regarding how they want to change agriculture land-use strategies and more broadly, their livelihoods are inextricably linked with these property regimes or the rules of resource allocation and broader level land-cover patterns. Historical analysis of the ways in which smallholders have adapted to pressure on their resource base can also be very helpful in identifying policy options with more (or less) potential (Netting 1981).

## **2. Theoretical foundations and gaps**

Three bodies of knowledge or disciplines provide the theoretical framework for this study: (1) smallholder agriculture in agricultural anthropology, (2) ethnoecology of mountain resources and environments, and (3) land change science. The study LUCC in the mountain environment, more specifically the changes in smallholders' land-use strategies, directly relates to one of the

fundamental science questions asked by the LUCC project of International Geosphere-Biosphere Programme (IGBP) and the Human Dimensions Programme (HDP): "What are the major human causes of land-cover change in different geographical and historical contexts?" (Lambin et al 1999:12). In spite of such rich ethnographic knowledge of the human-environmental relationships in the mountain environments (e.g., Wolf 1972; Netting 1976), anthropological studies often tend to shy away from making cross-cultural comparisons (but see Rhoades and Thompson 1975 for a notable exception) and contributing valuable ethnographic knowledge to such broader scale issue as LUCC that demand interdisciplinarity. Ironically, despite sharing the common interest in finding the anthropogenic forces of environmental change, the theoretical and methodological linkages between ecological and geographical studies of LUCC and ethnography of agriculture and environment remain starkly limited. In addition to having different academic traditions focus at different scales (i.e., anthropology focusing on individual and household behaviors, whereas ecological and geographical studies focusing on broader, regional scales), the meaning of scale is also not shared (Gibson et al. 2000). This is why combining ethnography and remote sensing is central to this research.

### *2.1 Agricultural intensification and the human dimensions of LUCC*

The proposed research builds from recent advances in the agricultural intensification thesis that rejects the conventional view of intensification as a 'linear process' (Stone 2001; Brondízio and Siqueira 1997). In contrast to the famous agricultural intensification thesis of Boserup (1965 and 1981), some researchers believe that both intensification and disintensification may occur within an area in the given time period, as smallholders tend to adopt a wide variety of land-use strategies to match the variability of their resources and their needs (Brookfield 1972; Guillet

1987). This revelation is a significant departure from the Boserupian thesis, which focused exclusively on how demand created by population pressure on resources led to technological change and intensive agriculture (Grigg 1969). A surrogate measurement of intensification emphasizes the frequency of land-use—the ratio of the ‘cultivated and fallowed areas’ (Turner and Dolittle 1978). Critics disagree with the primacy of population-based explanations in the Boserupian thesis. Some urge consideration of ‘innovation’ (Brookfield 1984) as an alternative explanation, while others argue for the incorporation of broader socioeconomic and ecological conditions (Padoch 1986; Stone and Downum 1999).

Some others still argue for the inclusion of exogenous factors, such as market incentives (Brush and Turner 1988), land tenure (Moran 1993), class, or impoverishment (Turner and Ali 1996), because intensification processes are intrinsically linked to LUCC through the conversion, modification, or maintenance activities (Moran et al. 1994; Turner and Meyer 1991). The underlying forces of LUCC may well exist outside of a community. While ‘conversion’ process of land-cover has been a main interest for many years, much is not known about modification activities, which tend to be highly variable—culturally, spatially and temporally. In response, the linking of finer scale agricultural modification activities with broader scale land-cover change patterns has increasingly been emphasized since the former provides more accurate explanations of the processes and their driving forces (Lambin et al. 2000, and 2003).

There have been some attempts in the recent years to identify cultural effects on land-use and deforestation (Fairhead and Leach 1996) by ‘distinguishing the influence of socio-cultural factors from that of economic, demographic and ecological factors in environmental management’ (Atran et al. 2002). It implies that ethnoecological knowledge is somewhat independent of institutional aspects for managing the commons. While dominant institutional

theories have assumed that actors uniformly share local knowledge, Atran (1999) emphasizes the crucial asymmetries in local knowledge and how they influence commons management.

## *2.2 Ethnoecology of mountain agriculture and the environment*

An increasing recognition to address the relationship of land-use intensification strategies and LUCC signals a call for an in-depth look at long-term agricultural change (Stone 2001; Dorsey 1999), forest transition processes (Rudel et al. 2002) and other domains where the smallholders have direct interactions. This study, hence, investigates agricultural and environmental change from the perspective of land users' cognition of land resources, as it serves as the interface to land-use decisions that change land resources (Conklin 1967; Brush 1992; Nazarea-Sandoval 1995; Sillitoe 1996). Depending on how effective the shared or dominant cultural knowledge and institutions in operation are, land-use decisions are often influenced by the rules embedded within a cultural domain of how the land should be used within a household and community (Atran 1999; McCay 2002). Exploring smallholders' land-use strategies in this sense provides an emic perspective of LUCC (Gragson and Blount 1999). This study, hence, contributes to LUCC by providing insights onto mountain smallholders' land-use practices.

In spite of its long history of championing smallholders' land-use strategies and agricultural intensification research (e.g., Geertz 1963; Conklin 1961), anthropological engagement in LUCC studies is still limited. It is important in the sense that some recent LUCC studies (Liverman et al. 1998; Walsh et al. 2002; Fox et al. 2003) have recognized the importance of the processes involved in modification activities that are diverse in cultures, time and place.

LUCC in mountain environments is complex. Mountain agriculture scholars (Netting 1993; Rhoades 1997) suggest that the socio-cultural and ecological processes of mountain agricultural systems are not simple to understand, since a host of factors complicate the issue influence these: verticality, multiple zones of production, fragmented parcels of land and common pool institutions. One must also consider cultural-ecological adaptation unique to the mountains: apart from intensification and diversification, mountain smallholders also adopt cooperation/regulations, expansion and scheduling (Netting 1981; Rhoades 1997). This means that intensification processes in the mountains demand more complex sets of explanation than that of the ratio of cultivated land and fallow land. Agricultural intensification in the Andes, for instance, is part of an overall diversification of livelihoods and crop resources, rather than specialization of a single enterprise, as is commonly assumed (Brush 1992). Also, agricultural strategies cover diversification of crop resources through innovation and incorporation to risk reduction and efficient use of land and labor resources (i.e., economic reasons) and adaptation to diversity, resilience and stability (i.e., ecological reasons) (Rhoades and Bebbington 1990).

Given the role of verticality and historical isolation, analyses of mountain areas focus mainly on the ‘self-sufficiency concept<sup>3</sup>’ (Murra 1988; Orlove and Guillet 1985). With the increasing influence of the market economy in the mountains, however, the consideration of ‘highland-lowland linkages’ and their environmental impact has become crucial (Allan 1993; Jodha 1995). Such linkages include the flow of resources (e.g., water, minerals), services (e.g., labor, tourism) and products (e.g., timber, non-timber forest products) exchanged between the mountains and the

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<sup>3</sup> This concept is discussed in a greater detail by Netting (1981), in which he describes Törbel located in the Swiss Alps as a self-sufficient, closed corporate community. Törbel formed much of its economic base until the 1960s and the economy was based on communal control over the production process (e.g., communal ownership and scheduling on the agricultural calendar). Other references on the self-sufficiency concept include Cole and Wolf (1975), Netting (1993), Brush (1976) and Mayer (2001).

plains. In other words, these ideas of cultural-ecological adaptation of the mountain environment are, however, not absolute but they are conditional and they are always subject to human agency at different scales. This is the reason that the simplistic or romantic notion that mountain agriculture is ‘ideally adapted to micro-climatic conditions’ hides the more sophisticated scientific questions of how agricultural systems have had to adapt to complex political, social and economic conditions (Rhoades 1997). Adaptation, here, is not just to micro-and macro-climates, but rather to powerful regional pressures that mold natural conditions and often provoke considerable and differential destruction on socially differentiated residents. Zimmerer (2003) proposes that the mountain smallholders’ perceptions of production zones are based on their cognition of topography, political influence and spatial distance. Their uses are based on overlapped patches that are expanded in different microclimates, which made it possible to maintain great agro-biodiversity in the Andes. Not all mountain areas are, however, the same—some have more serious environmental problems than others do. Their socio-cultural, economic and ecological settings provide different contexts of LUCC. The deforestation case of Nepal is one such example, which provides a good background to the proposed dissertation research’s focus on LUCC in mountain environments.

### *2.3 The ‘Himalayan environmental degradation’ debate and ecological anthropology of Nepal*

The deforestation case of Nepal was once dramatized as a ‘classic example’ of smallholders’ mismanagement of land and forest resources (Eckholm 1975 and 1976). While there are uncertainties in terms of reliability and validity of the data associated with such claims (Thomson and Warburton 1983), this high-altitude and high-energy region certainly depicts the raising concerns for supporting both livelihood and ameliorating environmental impact (Ives and

Messerli 1989; Jodha 1995; Metz 1992). It is also because prime lands are limited in the mountains (Turner and Benjamin 1994) and in effect, there is always a long-term pressure of land scarcity (Brush 1976; Guillet 1983). Smallholders of Nepal face the pressure on forests and land stress (Blaikie et al. 2002; Bajracharya 1983a; Mahat et al 1987). Economists (Jodha 1995; Bluffstone 1995; Kanel et al 2000) believe the smallholders in such circumstances have no viable options other than intensification to make efficient use of the available land and labor resources, which in turn puts pressure on forest resources in the absence of effective rules and technologies. In general, the deforestation debate dominated by ‘environmental orthodoxies’ influenced by neo-Malthusian perspective presents a very bleak picture of ecological collapse in Nepal.

There is now a growing realization that the concept of rapid deforestation and erosion leading to imminent ecological collapse is simplistic, if not simply wrong. Rhoades (1997), Price and Thompson (1997) and Forsyth (1999) share an alternative vision that a simple model of unidirectional change does not explain the variety of institutional responses to either the biophysical or socioeconomic surprises which such mountain communities experience. In this sense, one must understand the human impact on forests in their specific contexts as shaped by historical, ecological, socio-cultural and economic factors. This also requires temporally and spatially explicit accounts, as they define human and ecological relationships, synchronically at multiple scales.

#### *2.4 The integration of ethnography and remote sensing in LUCC research*

Rindfuss and Stern (1998:1-25) argue that “linking remote sensing with social sciences can help understanding and controlling human impacts on the biophysical environment as well as anticipating and responding to environmental impacts on humanity.” Remote sensing helps

analyze the context of social phenomena, measures social phenomena and their effects on the environments, provides additional measures for social science, allows multi-scalar analysis, and creates time-series data on socially relevant phenomena. Additionally, social science helps validation and interpretation of remote observations, and remote sensing can learn so much from social science about data confidentiality. Unlike conventional remote sensing techniques, such linkages recognize that biophysical and socioeconomic variables and their interactions are the result of multiple actors and structures combining in complex synergistic ways (Geoghegan et al. 1998:61). Such linkages invariably try to account for heterogeneity in environments and their social drivers. This means critical variables considered in LUCC may change in incidence and importance through time and across scales of analysis.

One of the key challenges in linking social science and remote sensing is finding a ‘common scale of operation’ (Gibson et al. 2000). Scale effects have been widely discussed in the ecological sciences, particularly after the ecosystem concept was challenged by studies on hierarchical, nested, but non-equilibrating system (Holling 1998; Price and Thompson 1997; Scoones 1999; Zimmerer 2000). While data availability may influence the choice of scale or aggregation, problems arise in most cases when scales and timing of remotely sensed data do not correspond with the similar spatial and temporal scales. Unlike remote sensing and other spatial sciences, the decision on where to georeference individual or other social units vary significantly in social sciences.

Within anthropology, there is a dilemma or dichotomy between the concepts of place and space. The majority of anthropologists tend to use the concept of place (e.g., a sense of place) to describe human’s consciousness of surroundings as a fundamental human experience. It also widely relates the location with cultural identities. However, we often fail to understand the

importance of including spatial information more precisely, which requires us to be familiar with the concept of space, instead. The significance of integrative studies is, in this sense, high within anthropology, as these allow studying culture and human behavior through time and space. In addition, latent opportunities exist, when combined with spatial analysis, to build on anthropological strength in ethnographic research and in narrating the complexity of human-environmental relationships in a landscape, ecological system, or beyond.

One of the main criticisms of the cultural-ecological adaptation concept has been that in spite of strong and detailed descriptions of agricultural intensification processes and the associated changes, spatial dimensions of such changes are still scant (Lambin et al. 2000). Specifically, it is not often explicitly mentioned whether there are any spatial variations or whether such processes are independent of locations. Also lacking is where exactly are the processes more recognizable than others? This is precisely the reason the focus of examining agricultural intensification processes in the recent years has gone beyond the conventional research to view it as part of broader land-use and land-cover change by recognizing the complexity of processes (and their association with other variables) and applying integrative assessments (Lambin et al. 2001; Turner et al. 2001). It shows a way of combining micro-level data with broader level spatial data, while recognizing the effect of scale on the outcomes (Gibson et al. 2000; Walsh et al. 1999). It also means understanding the dynamics of land-use and land-cover is not adequate without thorough understanding of agricultural processes that shape them.

One of the fine examples of detailed knowledge of smallholder agriculture is Conklin's *Ethnographic Atlas of Ifugao* in which he integrates an impressive array of data set with balanced use and presentation of ethnoecology, ethnographic survey and aerial photographic (or cartographic) analyses. He presented an example of systematic organization of the complex

understanding of Ifugao had for different landforms. He was able to characterize each of the major culturally significant land categories. The eight basic landform concepts did not only reflect contemporary patterns of land-use, but also captured the Ifugao perception of an ‘ideal’ sequence of landscape modification and transformation in relationship to human management. In both cases, he successfully applied ethnoecology of plant and landforms categorizations followed by their cultural interpretations, Ifugao uses of different land and plants, close observation of socio-cultural organizations affecting labor and land allocation decisions, collection climatic and soil data and use of aerial photographs. His interpretations were very useful to understand the complexity of human adaptation in irrigated terraces (rice fields) and other agricultural practices (i.e., woodlots for timber and medicinal plants and swidden fields to grow sweet potato) that actually provided ‘insurance’ and much-needed nutrients lacked from rice cultivation. It is very important to stress here that his work seeks to understand these types of farming system and ethnoecological knowledge of these cultural groups within the local context, mainly for their ‘internal coherence’ and ‘adaptive significance’ (Nazarea 1999).

One of the areas where anthropological studies can contribute to is the analysis of ‘human impact’ or ‘social drivers.’ Consideration of the human impact, however, is often varied and very much contested, since there are significant differences in the understanding of nature-culture/society dichotomy or human-environment relations (Blaikie and Brookfield 1987; Ellen 1996). Central to this dichotomy or opposition is the question whether or not humans are constrained by the ‘limits’ set by the environment and forced to make appropriate adaptations (i.e., environmental determinism). Interpretation followed from these two distinctive views essentially lead toward different strategies to deal with issues of ‘nature’ or ‘environment.’

The nature-culture/society dichotomy is based on an underlying assumption that culture is divorced from nature and hence, there are biophysical limits in the cultural adaptation of nature. Influenced by environmental/geographical determinism, biological scientists (Ehrlich et al. 1993; Hardin 1968) often use Malthusian perspectives to justify preservation of nature, implying that growing population outstrips food production level with serious adverse implications on the nature (e.g., tragedy of commons and land degradation) and wellbeing of humans. Known as 'deep ecology' that exclusively focuses on 'wilderness preservation,' this bio-centric view holds that "intervention in nature should be guided primarily by the need to preserve biotic integrity rather than by the needs of humans" (Guha 1989:74). This means that preserving nature has an intrinsic value quite apart from any benefits that preservation (or foregone benefits of human use) may convey to future human generations. Moreover, culture (e.g., rituals, social structure) is highlighted to function only as homostat or regulator with respect to environmental stability, precluding dynamic aspects of culture (i.e., social relations, rules of resource allocation and institutions). Many assumptions of this view are contended, if not rejected, by cultural anthropologists who believe in cultural construction of nature and assert that human activities do not necessarily lead toward degradation, these rather contribute to regulating the system stabilization.

Similarly, there has been growing emphasis on anthropological literature to avoid romantic essentialism—the persistence image of traditional society existing in harmony with nature, which precludes any analysis of social differentiation and agrarian change, or understanding of rural communities' linkages to a larger-political economy. Besides, market integration and the dislocation of customary forms of resource management rather than adaptation and homeostasis are becoming the lodestones of critical alternative to the older cultural and human ecology (Peet

and Watt 1996). Anthropologists must recognize unequal relations of power and how they relate to access to land and other resources. This would help explain social origins of environmental degradation, the plurality of perceptions and definitions of ecological problems and political ramifications of environmental alternations.

### **3. Research methodology**

This ecological anthropology study uses the methodological advantages of integrating ethnographic data with remote sensing analysis (cf. Guyer and Lambin 1993). The reason for including remote sensing data is that they provide an additional means of gathering contextual data, particularly in describing the biophysical context within which the smallholder manage their agricultural and forest resources. Apart from providing a synoptic view of significantly large coverage of the earth, remote sensing also yields regular, repetitive data from a single, consistent source. However, given that remote sensing is fundamentally being a science of inference, information content represented in the pixels requires further interpretations to infer social meanings that are often hidden deep within the analysis of the imagery (Moran et al. 1994). In other words, the conventional spectral, spatial, temporal, geometrical and polarization clues to earth resources should be supplemented by configuration, syntax, structure and function—the social meaning components. This is where the ethnographic assessment component of this research involving household and community data plays a significant role.

I conducted an eight-month long fieldwork in Lamjung (September 2004 to April 2005), which benefited from my pre-dissertation research in the same district for two months in 2002.

The types of collected data for the study were:

- Land-use history on the types of agricultural land-use strategies practiced over the years

- Ethnoecological knowledge of agricultural land-use strategies practiced by a variety of people (stratified by settlements, ethnic groups and gender)
- Household and demographic characteristics affecting types of agricultural land-use practices
- Rules and institutions affecting land-use decision making over time
- Distance to markets and existence of market opportunities
- Inventory of sample forest and cropped land plots to determine their characteristics
- Detection and quantification changes in land-cover over time and space

Based on the nature of data collected for the research, these data were categorized into two groups: 1. ethnographic assessment; and 2. remote sensing and GIS. While the ethnographic assessment part focused on the individual, household and community levels, the spatial analysis goes beyond them to include the whole district; however, the household is the main unit of socioeconomic analysis.

### *3.1 Ethnographic Assessment*

- Selected research sites and conducted structured observations: Two villages—Maling and Banjhakhet—provided representative cases of existing agro-ecological zones and smallholder agricultural practices. Banjhakhet is a lower altitude site with easy access to road and a cereal dominated agricultural intensification system. Maling, in contrast, is a relatively remote, high-mountain area with the mixed-mountain agricultural system (see Chapter 2). Structured observations examined and recorded scheduling, settlements, interactions and land modification activities.
- Determined household and demographic processes affecting land-use intensification practices through a multistaged stratified random sampling frame created from the household

reference numbers used in the ICIMOD case study (ICIMOD 1996). The sample survey included 66 households: 35 samples in Maling and 31 samples in Banjhakhet village were stratified by ward numbers and households. The survey helped determine ethnic groups, demographic characteristic, labor allocation patterns, land and livestock holding, land-use portfolio, crop rotation, fallow periods, on/off farm income portfolio and the degree of dependence on forests (Appendix III). Community survey complements household data.

- Assessed key respondents' ethnoecological perceptions and knowledge of crops and agricultural practices. Using semi-structured interviews, freelistings and pile sorts (Appendix IV), I examined how cultural knowledge of agriculture and land-use is shared and how the knowledge influence land-use decisions: why they choose particular crop or land-use practices over others. Freelistings and pile sorts of major crops, varieties and their local uses described by the respondents in terms of their cultural, ecological and economic significance complement land-use modification activities (e.g., thinning of forests, changing dry slopeland to irrigated slopeland). The collected data helps create a list of local interpretations of different land-use strategies. I also worked with knowledgeable sources in the village to trace the land-use history, focused on the coverage and patterns of settlements, agriculture and forests.
- Documented community contexts with the help of key respondent interviews to report on both past and present rules/institutions, including land ownership, forest management, labor exchange network and 'cultural agencies' (e.g., kinship, beliefs) affecting land-use over time. With the help of graphical representation, this form would also document the distance to markets, existence of market opportunities, the patterns of flow of resources and services.

- A ‘training sample survey’ form of cultivated lands and forest plots, adapted after CIPEC’s own training form, helped me document structural and compositional characteristics (e.g., elevation, land-use type, soil features, crop rotation, spatial distribution of land parcels, key tree and vegetation species, canopy cover and forests patch type). With the help of aerial photographs, 12 cropped land and up to three forest patches were selected in each site. Such samples provided ‘ground-truthing’ to corroborate in supervised classification of satellite images. A handheld Global Positioning System (GPS) unit and a compass with altimeter were used to record exact horizontal positions, azimuths, altitude and slope of the terrain.
- Analysis: All the household questionnaires were coded and the data were entered into a database management program. Using SPSS 14.0 the household database were analyzed for frequency, mean distribution and a bi-variate analysis, which look at the relations of socioeconomic and cultural strategies with agricultural intensification processes.

All the intensive interviews were tape recorded and subsequently transcribed and entered into N-Vivo. Qualitative data analysis, particularly key words or sentences indexing were done by coding the transcriptions in N-Vivo. Anthropic is used for analysis of the data generated by freelisting and pile sorts. These two help analyze testing cultural knowledge shared by different cultural groups and how they perceive the processes of agricultural and LUCC.

### *3.2 Remote sensing and GIS*

The remote sensing and GIS component includes the use and interpretations of aerial photographs, land-cover classification and extraction of land-cover classes from the satellite imageries and the detection of land-cover change by overlaying the results of the remote sensing

analysis of GIS layers (mostly vector layers related to district and village boundaries, contours, land system and road networks). The specific procedures involved in this part are:

- Acquisition, enhancement, classification and analysis of satellite images to analyze spatial and temporal variability of land-cover changes (use of multi-temporal data: 1976, 1984, 1990, 1994, 1999 and 2003). Land-use and land-cover classification scheme used in Land Resources Mapping Project (LRMP), which is Nepali equivalent of the United States Geological Survey (USGS) classification (Anderson et al. 1976), was used as the reference scheme for land-cover classification of the project (Appendix E). The training samples collected from the field provide train land-cover classes during the classification.
- Detected and quantified changes in land-cover over time and space with the use and interpretation of air photos, satellite images and spatial data layers (e.g., DEM, district and village boundaries, road networks, land capability, land system). After adequate image enhancement, radiometric correction and hybrid (unsupervised-supervised) classification of multi-temporal Landsat images (1976, 1984, 1990, 1994, 1999 and 2003) in ERDAS Imagine 8.7, spatial and temporal variability of land-cover changes was detected in the form of a set of LUCC maps and a matrix by properly overlaying them with other spatial data layers in ArcGIS 9.1. The Spatial Autocorrelation technique was later used to compare corresponding values of locations and attributes of cropped land, forest patches and settlements as compared to their spatial distance from the select markets. Similarly, to ensure the validity of the measurement, total vegetation coverage patterns of the district for the given time period were calculated using the Normalized Difference Vegetation Index (NDVI):  $\text{NIR}-\text{R}/\text{NIR}+\text{R}$  (where NIR is the near-infra red band and R is the red band reflectance). In addition, thematic accuracy of the land-cover change map was checked employing a stratified random

sampling method. A confusion matrix together with both Kappa statistics and Tau coefficients (Congalton 1991; Ma and Redmond 1995) were calculated.

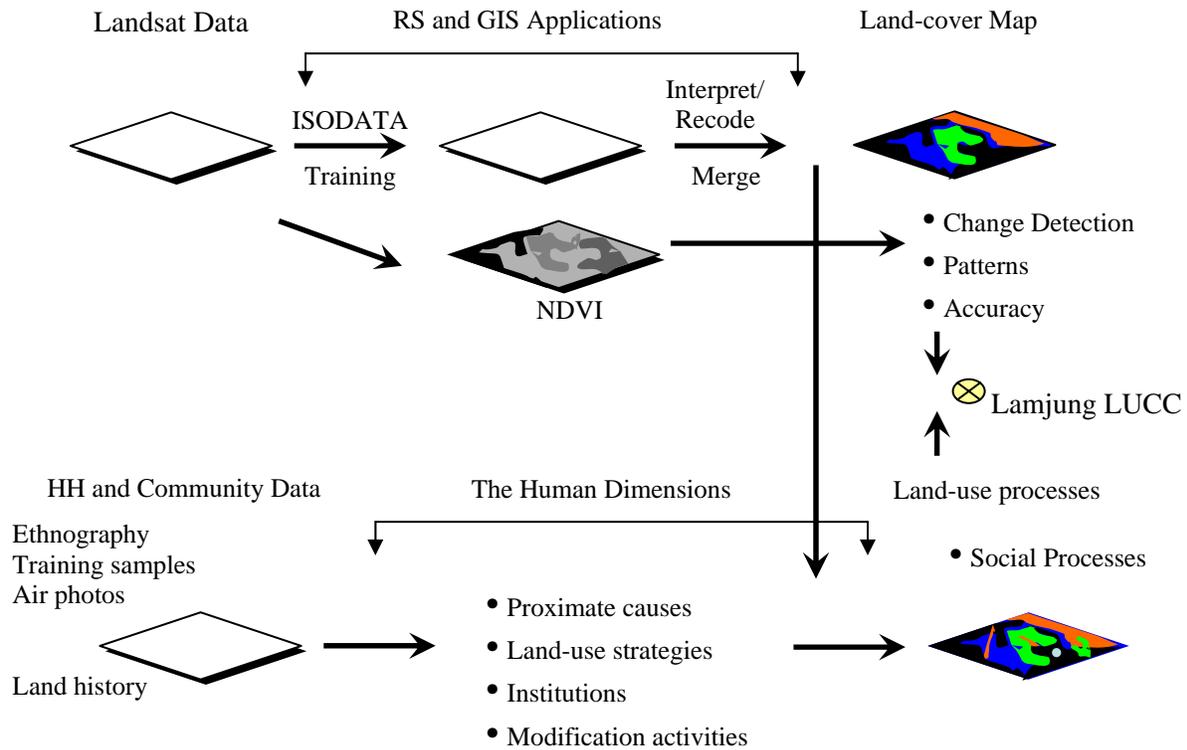


Figure 1.1 Schematic diagram of integrating household and community data with remote sensing and GIS applications

As shown in Figure 1.1, ethnographic data together with household and community survey data provide exhaustive listings of land-use modification activities (i.e., agricultural land-use strategies) and their prevalence in each research site. With the help of in-depth examinations of changes in agricultural land-use strategies in two representative villages and quantifying district level changes in land-cover for the last 40 years, I contextualize and analyze the relationships between land-use strategies and other modification activities.

The final result of the research is a multi-scale, spatially explicit integrative analysis of land-use strategies adopted by mountain smallholders and their relationships exhibited at multiple scales. A multi-scalar analysis of the proximate causes and their driving forces of LUCC can now be accomplished by relating these modification activities with the trade-off percentage among land-cover categories for 40 years. In doing so, while processes can be understood in the light of dominant modification activities, LUCC patterns can be inferred by detecting spatial and temporal change in land-cover percentage. Hence, it is now possible to establish the linkages of land-use modification activities with the broader patterns of land-cover change in Lamjung.

#### **4. Lamjung and the fieldwork: social embeddedness, challenges and limitations**

Born in Tanahun district, I grew up in Chitwan District—both are southern neighboring districts of Lamjung, but my first visit to Lamjung came only in 1993 when I was assigned to go there and work with the most marginalized communities to help implement an action research program of the Institute for Integrated Development Studies (IIDS). It was perhaps the majestic beauty of the Annapurna and Lamjung Himal that I grew up seeing everyday that always kept me curious about Lamjung and other mountain areas.

Walking continuously up and down the hills for months throughout the district, I noticed diversity in the people and landscapes of Lamjung. With a few more years of experiences in Lamjung, I realized how incredible it was for such a small district to have different micro-climatic environments within 50km or less, rising from the sub-tropical climate to the temperate, high mountain climate.

It was fascinating to see all those nicely carved out and relatively well-maintained farming terraces stretched from the bottom of the valley to steep hill slopes and even in higher mountain

areas. Fresh out of college with a degree in agriculture and also growing up on a family farm, I was familiar with rice-based intensive agricultural practices in *Pahad* (the mid-hills) and *Tarai* (plains), but nothing in my ‘expertise’ had prepared me for the kind of smallholder agriculture that I was about to see and learn. It was a completely new experience for me.

Back in 1993, Lamjung was still relatively inaccessible—the major road to connect Besishahar, the district headquarters, with Dumre of Tanahun district—a major market hub along the Prithvi Highway, was still incomplete, so we had to walk five hours to reach Besishahar. Even to this date, the majority of villages, except for the southern part of the district, are without roads, electricity and other common public utilities. It, nevertheless, took me a while to understand the interdependence of all the components of the smallholder agriculture that was fundamentally based on the principle of livelihood diversification—something very different from the kind of training I received at the college promoting and replicating the ‘green revolution’ in Nepal.

There in rugged terrain and cold climate, I found smallholders working so hard round the year just to ensure sufficient food supply and income. I came to appreciate this kind of agriculture only after realizing that I, as an agriculturalist, had more questions than answers to such a complex agricultural system with its interdependence and interconnectedness of migratory (seasonal) sheep herding, livestock, off-farm income, forests and pastures.

After a few more years of field experiences between 1993-1994 and 1997-2000 in Lamjung, I was able to see a bigger picture of the agriculture-forest interrelationships. On the one hand, there was a growing concern about the impact of the constant pressure agriculture was placing on forest and pastures, which often led to issues like deforestation and land degradation. Smallholders, especially the ones cultivating marginal lands were blamed for their primitive

agricultural techniques and tools. On the other hand, working with these marginal, disfranchised groups helped me see the hardship and the dilemma they face in everyday life. They endure not only the harsh environment with cold winter, steep slopes and difficult trails, but also many significant socio-cultural and economic changes that transformed or replaced their customary rules of resources allocation, labor pools, access to and control over resources and so forth.

With this background, I went back to Lamjung for two months on my NSF ethnographic research training grant in 2002 and for the dissertation fieldwork in 2004-2005. The preliminary fieldwork done in 2002 had helped me tremendously to design my dissertation fieldwork. After collecting some secondary data and recruiting and training three field assistants, I was off to Maling and Banjhakhet VDCs and started collecting data in early October. The history and the diversity in landscape and culture of Lamjung provide interesting scenarios for anthropological study. Besides being home to two distinct ethnic groups: Gurungs and Duras, Lamjung also provides an interesting case of agriculture transformation—a change from the agro-pastoral system to market-based economy in recent decades, which can have significant impact on forests and pastures.

One major challenge I faced during fieldwork was to readjust my research schedules after some unprecedented political developments that took place in Nepal following the King's proclamation on February 1, 2005 and the subsequent politically troubling events, which curtailed civic and restricted public's mobility. This aggravated the situation that was already affected by the growing Maoist insurgency, which swept through Lamjung as early as 2001-2002 and made the district one of the most severely affected districts in the country. I had completed significant parts of my fieldwork (i.e., household surveys, collection of training samples and seven in-depth interviews) before the declared state of emergency.

Even during my fieldwork in these two villages, we experienced fear and stress caused by regular movements of both the army and the Maoist militia. Some villagers were constantly threatened by the warring sides for allegedly supporting the opposite side. I had no choice but to shorten my fieldwork to eight months when I believed I had adequate data for my dissertation. I wanted to avoid unnecessary risks that would jeopardize the ‘complicity’ and trust held between my collaborators and me for so many years. In other words, I also found myself with the kind of dilemma that Marcus (1997) describes that the role of anthropologists is shifting in recent years from ‘rapport’ to ‘complicity.’ This is especially crucial in periods of conflicts of different nature.

The only part of my original research restructured significantly was the application of some ethnographic techniques that required a relatively long stay in the field. Specifically, although I wanted to do as much as I could, I could complete only seven in-depth interviews and I had to be very cautious of conducting ‘participant observations,’ which otherwise would have been conducted in a more informal, relaxed fashion to record more candid observations.

Despite the political turmoil that forced me to readjust my research tasks, I managed not to deviate from the original proposal and core research methods. My familiarity with these villages for the last 13-14 years helped me enormously to get through the difficult periods of political uncertainties and unrest in Nepal.

The second set of challenges was related to conducting remote sensing and GIS analysis in the mountainous landscape of Lamjung, where relative inaccessibility, rugged terrains, slopes and relief, diversity and marginality make it all the more hard to find and/or collect ‘ground truth’ data to complement with remotely sensed data. In Nepal, GIS and remote sensing data are very limited and even the ones (e.g., aerial photographs and topographic maps) available are very

hard to access publicly. I was fortunate enough to have access to ICIMOD (1996) vector dataset: administrative boundaries, roads, contours, population density, land-use and land-system base maps derived from the LRMP inventories and drainage system. These saved me from spending a couple of months in digitizing them and provided me with the much-needed base maps to work further on remote sensing and GIS analysis.

The ICIMOD dataset has concerns or ‘limitations’ regarding data accuracy, since some of “the main features of the database were digitized on different scales” (ICIMOD 1996:14). For instance, all the LRMP land resources dataset (i.e., land-use, land-system and land-capability) were of 1:50,000, whereas contour lines (drawn in 100m intervals), spot heights and drainage systems were from the Indian Survey’s ONE INCH topographic Maps (1960) of the 1:63,360 scale. As a precautionary step, I scanned and georeferenced the topographic maps of 1998 and aerial photographs of 1996, which would allow me eventually in the accuracy assessment.

Another simple and yet frustrating set of problem was that the vector layers did not match with the standard datum and projection systems used in the satellite data acquired here. My colleague at ICIMOD provided the details of projection parameters and those helped me bring all GIS, aerial photographs, scanned topographic maps and Landsat imageries into the same, standard ‘Transverse Mercator’ system of Nepal, which apparently was listed as ‘Modified Universal Transverse Mercator’ in topographic and other base maps of Nepal.

This coordinate system used in Nepal is quite confusing and even puzzling to many, but it is believed to have the best presentation of the extent and shape of Nepal on maps. However, as much as detailed discussions on how datum/spheroids, projection system and other parameters of coordinate systems were used in this process are well worth to discussing in GIS and cartographic sciences, it is beyond the scope of my dissertation. For convenience sake, I have

simply listed a few points and specific parameters used for this coordinate system in Appendix D.

Availability of the moderate resolution satellite data, particularly the Landsat series, and 90m Satellite Radar Topographic Mission (SRTM) was perhaps the only part of remote sensing that was not so time consuming and frustrating. While I had to purchase the 2003 Landsat ETM+ image, the Landsat MSS (1976), Landsat TM (1990) and Landsat ETM+ (1999) images were provided by the Global Land-cover Facility. The Landsat MSS (1984) and Landsat TM (1984) images were already available through ICIMOD (1996). The use of Landsat images, however, has its downside as well: multi-spectral bands of the TM and ETM+ series have about 30m resolutions and such moderate resolutions have their limitations in the mountainous terrains. The case of the Landsat MSS series with coarse resolutions (80m) is even worse. Nevertheless, the Landsat series was perhaps the only choice I had for its affordability, coverage and availability.

## **5. Dissertation overview**

Chapter 2 provides a general introduction of Lamjung district and its peoples. It presents a historical overview of the human-environmental interactions, specifically the ways mountain smallholders historically responded to ecological, cultural and socioeconomic changes. After discussing the ethnohistory of Gurungs, detailed information on the two field research sites selected for this study are provided. Finally, placing Lamjung as a representative case example, this chapter also relates to the much broader debate of the HED theory, which dominated the environmental discourse in the 1970s through 1990s.

Chapter 3 starts with the theoretical framework for conducting LUCC research and it discusses the methodology, data requirements and results of the LUCC analysis. After discussing

the classification scheme and thematic accuracy, I present maps and the LUCC matrix produced for this research, followed by discussions on the limitations and challenges faced in the analysis. With these I am hoping to provide not only the patterns or trajectories of land-cover change that had occurred in Lamjung over the last 30 years, but also the insights into the potential benefits and pitfalls of using such LUCC analysis in an anthropological research.

Chapter 4 and 5 are exclusively focused on the ecological and agricultural anthropology of Lamjung. Chapter 4 contextualizes the theoretical discussions of the anthropology of mountains, agricultural intensification and environmental discourses within the human-ecological histories of Lamjung. Chapter 5 takes it further by providing ethnoecological data on agriculture, crops, land-use and landscape level changes. Overall, these chapters provide discussions of three key questions of Lamjung's agricultural system: (1) how smallholders have managed their agricultural portfolios in rugged terrains and harsh environments; (2) what are the key characteristics of their agricultural systems (i.e., agropastoralism, mixed-mountain agriculture and rice-dominated agricultural intensification); and (3) how the changes in agricultural systems resulted in transformation of mountain smallholders livelihoods. These are supported by ethnoecological data on smallholders' memory, perceptions and priorities with regard to crops, agricultural choices, dependence of forests and overall landscape level change.

Chapter 6 addresses the question of under which household conditions and community contexts mountain smallholders change their land-use strategies. Using the integrated land history of the district and region as a baseline, it discusses the results of household and community level surveys within the broader framework of agricultural intensification and their relationships with broader shared cultural knowledge and institutional arrangements in use. It also relates the socioeconomic and cultural factors of the agricultural change with LUCC that

had occurred over the last 30 years. In doing so, it builds on the insights of the chapter four and five to identify the proximate causes of LUCC and links these social drivers with LUCC patterns detected in Chapter 3, which focuses on analyzing land-cover change trajectories. The issues of scale and modifiable aerial unit problem, which are perhaps the two biggest challenges of integrating social data with remote sensing applications, are discussed with emphasis on how to take these two different types of data into consideration while conducting an integrative, multi-scalar studies looking at the human dimensions of LUCC.

This dissertation concludes in Chapter 7 with the recapitulations of the major points derived from each chapter and the detailed discussion on theoretical and practical significance of conducting such an integrative, multi-scale study within anthropology and what are the specific areas that anthropologists can contribute to land change science.

## CHAPTER 2

### LAMJUNG AND ITS COUPLED HUMAN-ENVIRONMENTAL SYSTEM

Lamjung is the representative mountain landscape selected for this study, because it presents a general and particularly interesting scenario of a complex coupled human-ecological system. Located in the north-central part (officially Western Region) of Nepal, it covers three distinct ecological zones: Middle Hills and Mountains (*Pahad*) with 43%, High Mountains (*Lekh*) with 39% and Himalaya (*Himal*)<sup>4</sup> with 18% of the total land. The district has 61 village development committees (VDCs) and rises from approximately 500masl to about 7,690masl within a short distance of about 50km (Map 2.1, 2.2 and 2.3b), which makes it one of the three districts in Nepal with the maximum elevation variation. To the north is the Himalaya bordering with Manang district, while the eastern, southern and western borders are shared respectively with Gorkha, Tanahun and Kaski district.

#### **1. The setting**

In Lamjung, the climate ranges from subtropical in the south to temperate in the north. The physiography of the southern side is fertile alluvial plains, while the northern side is very rugged with permanent snow-covered peaks. The district partly covers two of the major Himalayan

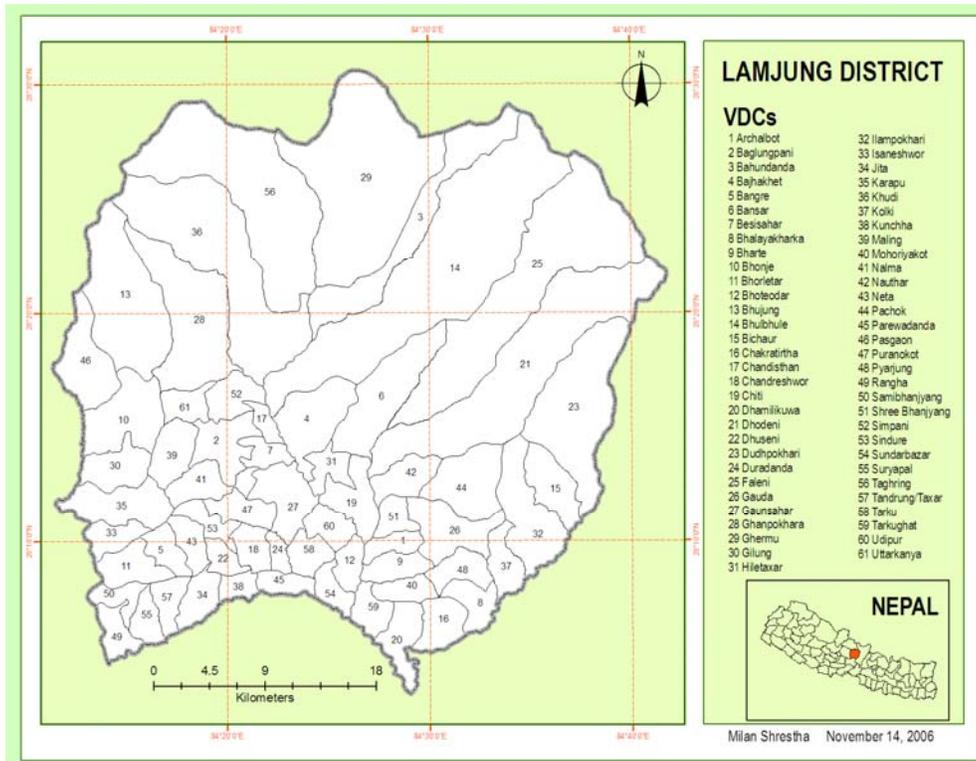
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<sup>4</sup> Harka Gurung (2004:15), a well-respected Nepali geographer, maintains that the terms *Pahad*, *Lekh*, and *Himal* capture the local epistemology of land-use and geo-physical characteristics of Nepal better than their widely used counterparts in English: middle mountains, the transitional and the High Himalaya, respectively.

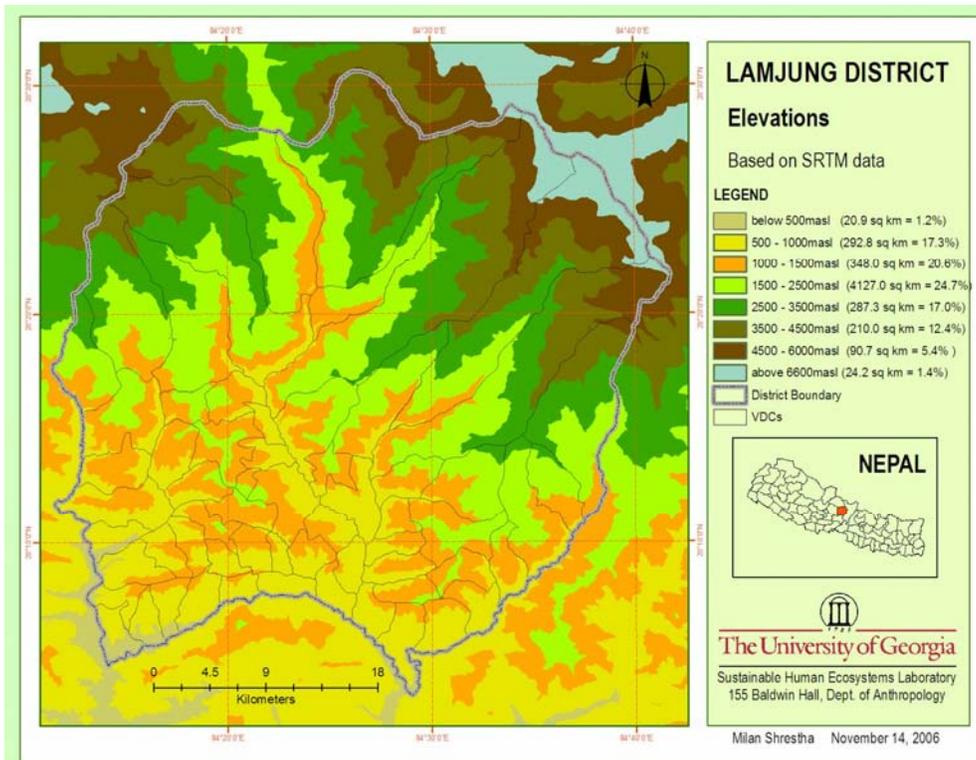
ranges: Manaslu and Annapurna-Lamjung Himal: the Nyaagdichuli (7,513m), Himalchuli (7,893m), Buddha Himal (6,672m) and Lamjung Himal (6,986m) are the major peaks. Dudhpokhari (Milk Lake), two sacred glacier lakes are located in the base of these peaks—one in the east and the other in the west. Locals go on pilgrimage to these lakes on *Janai Purnima* (around July), where they bathe in the holy water. These peaks are also the source of rivers, such as the Nyaadi or Ngadi, Khudi, Dordi, Midim, Maadi and Chepe Khola. Marsyaandi, however, is the biggest river of Lamjung, which originates in adjoining northern district of Manang and enters the district through the deep gorge between the Nyaagdichuli and the Lamjung Himal, dividing the district almost into two halves. The Marsyaandi and Maadi valleys have landforms with thick deposits of diluvial and alluvial materials suitable for agriculture.



Map 2.1 Lamjung district



Map 2.2 Village development committees (VDCs)



Map 2.3 Elevation zones

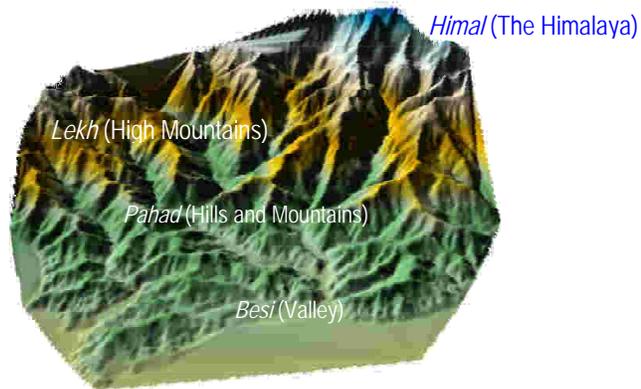


(a) Bahundanda Photograph by Hans Speijer



(b) Near Bhotewodhar

Figure 2.1 Marsyandi river valley landscape  
(a. facing south and b. facing North with the Lamjung Himal in the background)



Map 2.4 The perspective view of Lamjung terrains

Of the total 1,691 sq km area of Lamjung, the 1000 to 2,500masl elevation zones cover about 43% of the land surface, followed by the elevation zones of 2,500 to 6,000masl with 34.8%. The elevation zone of 500 to 1,000masl has only about 17.3% area, whereas the lowest elevation zone (i.e., below 500masl) occupies an area of about 20.9 sq km area and the highest elevation zone (i.e., above 6,000masl) cover 24.2 sq km (Map 2.3).

According to the ecological maps created by Dobremez and Jest (1970) for the Annapurna-Dhaulagiri mountain regions at the scale of 1:250,000, the south-facing slopes (*paharaa*) usually have drier plant species, while the north-facing slopes (*sinyalaa*) have a wide arrays of shade-long plants. *Saal* (*Shorea robusta*) is the most dominant tree species in the lower river valleys (*Besi* and *Taar* areas) with sub-tropical climate of Marsyaandi, Dordi, Maadi and Chepe Nadi. This hardwood species dominated forests were around 46sq km in the early 1990s (ICIMOD 1996). Similarly, mixed hardwood species forests were of the total 183sq km (located above 1,000masl). Deciduous mixed broad-leaved tree forests were found in temperate zones covered about 389sq km. Coniferous forests with the dominance of fir trees, which are considered rare, covered about 45sq km and the forest patches with this particular species were reported in the northern villages, such as Bhulbhule, Ghermu, Taghring, Dudhpokhari and Ghanpokhara (ICIMOD 1996:39). In recent decades, fodder tree species like *Koiraalo* (*Bauhinia variegata*), *Chutraa* (*Berberis nepalensis*) and *Ghangaaru* (*Berberis crenulata*) have become very popular to compensate for the fodder scarcity.

In the upper sub-tropical wet forest zone, which covers the most of Lamjung's *paahaad* area, *Chilaaune* (*Schima wallichii*) and *Katus* (*Castanopsis arboretum*) are common species. The most common fodder trees in the *Pahad* area are *Uttis* (*Alnus nepalensis*), *Laankuri* (*Fraxinus floribunda*), *Chaanp* (*Michelia champak*) and *Okhar* (*Juglans regia*). Likewise, *Guraans* (*Rhododendron arboretum*) and *Phalaant* (*Quercus lamellose*) are the most commonly found trees and shrubs in the higher elevation zones. Mat patches, alpine meadows and rhododendron scrublands dominate the natural vegetation of the area below the permanent snow and rocks.

Lamjung usually has warm temperatures with an annual average of 20° Celsius during the summer; the temperature, however, varies significantly from the lower valley (*Besi*), particularly

in the villages located southern part of the district, to the upper *Lekh* and the base of the Himalaya (Map 2.3). Except for the area above 2,000masl and the occasional snowfalls in northern villages and, winter is generally mild with an annual average of 10° Celsius in the whole district. Adequate monsoon rain and a brief shower in winter make year-round crop cultivations possible. Occasional frosts, hailstorms during the spring and autumn and floods/landslides caused mostly by heavy monsoon season are the three key natural calamities.

In terms of agricultural landscape, Lamjung has nine agroclimatic zones (Table 2.1). Characterized by different cropping patterns, moisture regimes and climatic conditions, the major features of these agroclimatic zones include: (1) humid climate in the subtropical, southern belt of the district, (2) humid climate in warm temperate and cool temperate zones, and (3) perhumid climate with more than eight wet months a year in the alpine area.

Table 2.1 Area of agroclimatic zones (in sq km)

Agroclimatic zone	ICIMOD (1996)		LRMP (1986)	
	Sq Km	%	Sq Km	%
Subtropical/subhumid	1.4	0.1	306.3	18.1
Subtropical/humid	207.2	12.2	-	-
Warm temperate/humid	546.7	32.3	579.0	34.2
Warm temperate/perhumid	22.2	1.3	4.1	0.2
Cool temperate/humid	283.8	16.8	1.6	0.1
Cool temperate/prehumid	68.6	4.0	359.5	21.2
Alpine/humid	53.5	3.2	3.9	0.2
Alpine/perhumid	295.3	17.4	330.2	19.5
Arctic	215.6	12.7	109.9	6.5
Total	1,694.5	100	1,694.5	100

Source ICIMOD (1996:48)

According to LRMP (1986), a benchmark study of land resources of Nepal, the agricultural lands covers an area of approximately 42,742ha in Lamjung, which is about 25% of the total area

and the 89.1% of this area (38,092ha) is located in the *Pahad* (Middle Mountains) region.

Cultivation is possible in moderate to steep sloping terrain with slope gradient of 30° or less and there are four different types of agricultural terraces: (1) sloping terraces (74.5sq km), level terraces (257.9sq km), footslopes (87.4sq km), and valley floors (7.7sq km). Among them, lands in valley floors and footslopes are the 'prime lands' and, hence, are more expensive, as these are considered to have the highest agricultural productivity per unit area. As the agricultural system is highly intensified and specialization on staple and cash crops are preferred in these lands, rice is the most dominant and preferred crop followed by maize, wheat, oilseed (e.g., mustard, sesame), potato and pulses. Households that depend on these lands enjoy two harvests of rice and a combination of rice with other crops. They share many similar characteristics with wetland rice cultivation prevalent in plains. Southern VDCs like Bhorletar, Dhamilikuwa, Karapu, Sundarbajar, Bhotewodhar and Tarkughat have major concentration of such lands. Access to and control over these 'prime lands' found mostly along the major rivers (i.e., Marsyandi, Maadi, Chepe, Dordi, Paudhi, Khudi) define livelihood choices of each family and cropping patterns. Their significance within larger historical context of socio-cultural change is discussed later in this chapter as well as in Chapter 4.

At the higher elevations above 700masl with relatively steep slopes are level and sloping terraces. While these terraced lands are not as highly valued as the valley floors and footslopes, these two agricultural land categories cover about 78% of the cultivated lands and stretch throughout the northern part. Even though only two harvests per year is the average for such lands, these support very diverse agriculture and support livelihoods of the majority of inhabitants. Cultivated lands in level terrace category usually have bunds and risers to hold water for paddy cultivation; even in sloping terraces bunds and risers are common, mainly to space for

growing secondary crops, such as pulses, soybean, fodder trees and so forth. Major crops grown in these lands include maize, rice, millet, potato, pulses and legumes, soybean, wheat, citrus fruits and oilseed (see Chapters 4 and 5).

In the *Lekh* (Higher Mountains) region, crops like potato, millet, buckwheat, maize and in some cases, barley are grown. This is also the region with relatively high concentration of forests and shrublands. Because of the zone's short growing season, agriculture is often supplemented with sheep herding, livestock and other off-farm income sources. About 227sq km was identified as pastureland in 1986 and those are mostly found in the northeast of the district on the very steep slopes of the Manaslu Himal range. Some of these pasture lands are located in the warm temperate zone of the *Lekh*, *Pahad* and the valleys of the Marsyandi and Nyagdi Khola.

The last, but perhaps the most important component of Lamjung's landscape is its impressive socio-cultural diversity found in different elevations zones. Relief contrast makes this landscape very challenging to study; however, equally impressive, if not more, is the diversity within the human landscape. With a population size of 177,149 reported in 2001 census (CBS 2001), the district has eight major ethnic and caste groups<sup>5</sup> and five distinct language groups (Figure 2.2).

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<sup>5</sup> Because of their roots belonging to two different language groups: (1) Tibeto-Burman, and (2) Indo-Aryan linguistic families, some Nepali social groups are referred to as 'ethnic' and others as 'caste' groups in Nepali ethnographic profiles. The word 'ethnic group' refers only to a social group with its own mother tongue (mostly one of the languages of Tibeto-Burman linguistic families), native area and religious traditions (Gurung 2003:3). In Nepal, they are now recognized as *Janajaati* and *Aandhibaashi* (native people). Among 68 of such nationalities, Tamang, Magars, Gurungs, Sherpa, Limbu and Rai are the major ones. Some of them adopted Hindu religion over the last 200 years. In contrast, the word 'caste' applies only to a social group within the Hindu caste system, in which Nepali language (or *Khas Bhasa*) with its roots in the Indo-Aryan language group is common. This Hindu Caste system is based on a vertical stratified ritual status: 1. *Brahmins* (priestly) being the most superior, 2. *Chhetri* (warriors), 3. *Baisya* (merchants and workers) and 4. *Sudra* (untouchables) include, but not limited, to *Dalit* (oppressed) castes, such as Kaami (blacksmith), Damaai (tailors), and Saarki (blacksmith). This complex ethnic and caste mosaicking in Nepal is indicative of the waves of migrations that have occurred for over 2000 years from both the north and south. The case of Newar, for instance, shows how complicated the issue is: while they fall under the *Aandhibashi*, Newars did have a vertical hierarchy identical to the Hindu caste system and have profound impact of the Hindu religion in their rituals and festivals. For general introduction of different ethnic and caste groups see Bista (1991), for their interactions Höfer (1979) and Levine (1987), and for social demography see Gurung (2003).

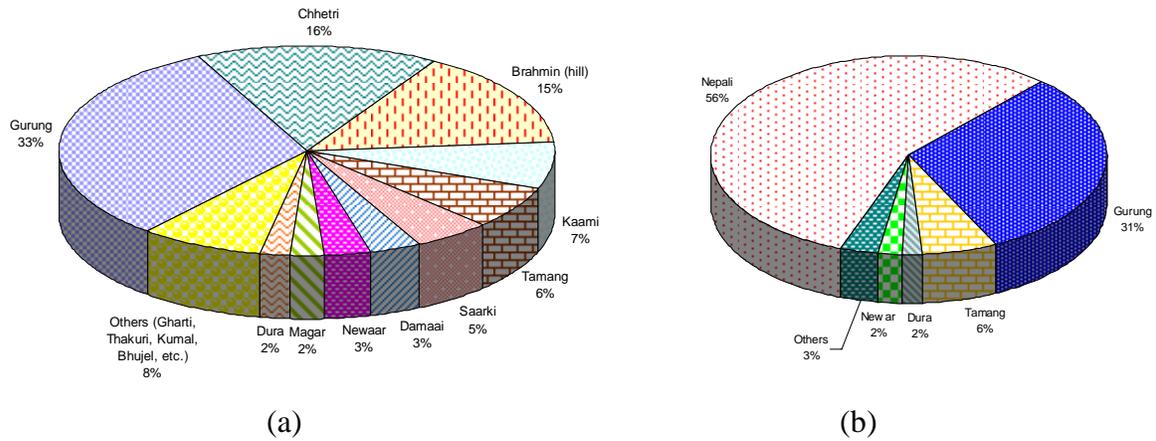


Figure 2.2 (a) Major ethnic and caste groups (b) Major languages (based on CBS 2001)

The census data of 2001 report that Gurungs<sup>6</sup> are the dominant ethnic group in the district (56,140 or 33%), followed by Chhetris (16%) and Brahmins (15%) castes. Dalits (i.e., occupational caste groups, such as Kami, Sarki and Damai combined) are about 18%. The other major ethnic and caste groups are Tamangs (6%) and Newars (3%). Duras, who are a native ethnic group of the district, constitute about 2% of the total population (CBS 2001). Although a generalization is hard to make anymore with increasing diffusions, Gurungs settlements are dominant in the northern side of the district. The southern part, in contrast, is heterogeneous in terms of ethnic composition.

Nepali (56%), which was originally called '*Khas Bhasa*' or '*Parbate Bhasa*,' is by far the most widely spoken language in the district, is followed by Gurung language or *Tamu Kyui*

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<sup>6</sup> The surname 'Gurung' is commonly used for this distinct ethnic group, even though an increasing number of 'Gurungs' now want to identify themselves as *Tamu*, which is the singular of '*Tamu-mai*' in their native language '*Tamu Kyui*.' I use the word Gurung purely for its simplicity and convenience; not to concur with the possibly imposed term or labeling by Hindu rulers.

(31%). Other major language groups are Tamang (6%), Dura (2%) and Newari (2%). It is important to note that all Brahmins, Chhetris and Dalits do speak Nepali. Significant populations even within ethnic and indigenous groups, who came in to contact with the Hindu ideology earlier in the twentieth century or have had outside contacts, also speak Nepali. This is not surprising, because the *Khas Bhasa* has received nation state's exclusive patronage and promotion as the national language over the last 200 years.<sup>7</sup>

The most important socio-cultural and economic changes shaping the landscape of Lamjung is in the livelihood system over the past 50 years. Traditionally, agropastoralism was the main livelihood source of Gurungs for centuries, which they complemented well with off-farm income sources, particularly by serving as mercenary soldiers in the Indian and British Gurkha regiments and as seasonal traders. Agropastoralism has virtually disappeared, albeit with some exceptions in remote northern Gurung villages, in favor of mixed-mountain agricultural system in the *Pahad* region and rice-dominated agricultural intensification in the footslopes and valley floors. Many migrated to the *Tarai* after the eradication of malaria during the 1960s. In recent years, while agriculture remains the main source of income and employment (83% of total employment), many are working as laborers in the Gulf countries, India, Malaysia and beyond.

These changes in the livelihood system have profoundly altered Lamjung's landscape and its coupled human-ecological system. Settlements along the Marsyandi River and the roads (i.e., the Dumre-Besishahar and the Damauli-Bhorletar roads) have increased, paving the way for

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<sup>7</sup> Anthropologists, who have worked with some of these ethnic groups, argue that the impact of the Hindu rules over the last few centuries has been progressive '*sanskritization*,' (i.e., imposition of Sanskrit and the values and norms associated with it on different ethnic and indigenous groups through state patronage) (Bista 1991). It also paved the way for the declaration of Nepali (then *Khas Bhasa*) as the *lingua franca* of the country. The impact such state-sponsored *sanskritization* has on ethnic cultures are well-documented (Caplan 1970 on Limbus) and (Gurung 1988 on Duras).

emergence of new towns and markets. Although the downward movement of settlements from high altitude temperate region to sub-tropical towns began long before the road building, it certainly has intensified with the increasing accessibility, penetration of wider market economy and shifting agricultural preferences.



Figure 2.3 A portion of the Dumre-Besishahar road (the Manaslu Himal in the background)



Figure 2.4 Besishahar (The district headquarter and a major market)

## 2. Research sites

Banjhakhet and Maling are the two villages selected as representative cases of existing agro-ecological zones and smallholder agricultural practices for this study. The main settlement of

Banjhakhet is located in the lower altitudes with easy access to roads and markets (Map 2.4). It has a cereal dominated agricultural intensification system. The main ethnic and caste groups are Gurungs, Tamangs, Chhetris, Brahmins and Dalits. The interest in vegetable and cash crop production to serve Besishahar market has been growing in recent years as the result of expanding agricultural extension services provided by governmental parastatal and non-governmental organizations (NGOs). In recent years, there is also a growing trend among youth to seek jobs abroad, mainly in India, the Gulf countries, Malaysia, Hong Kong and beyond.

Maling, in contrast, is a relatively remote village characterized by a mixed-mountain agricultural system with remnants of agropastoralism found among existing agricultural practices. The village is predominantly Gurungs, who live in settlements spread out along the ridge top. Cultivated lands are located mostly at the bottom of the hill. Forest area also stretches along the western side as well as on the northeastern slopes.

Table 2.2 Profile of research sites

Factor Details	Maling	Banjhakhet		
Coordinates	84° 17' 21" E, 28° 14' 6" N	84° 23' 54" E, 28° 15' 18" N		
Elevation ranges	718masl to 1,604masl	686masl to 2,495masl		
Major ethnic and caste groups	Gurungs (54.6%), Kamis (12.2%), Magars (9.4%), Damais(6.6%), Tamangs (3.6%),	Gurungs (35.3%), Tamangs (20.6%), Chhetris (14.4%), and Sarki (3.4%). Brahmins (2.6%)		
Access (nearest market)	6 – 8 hours to Besishahar	1 – 4 hours to Besishahar		
Total population	2,325	3,619		
Population density	114.36	108.66		
Total number of households	361	645		
Family size (Lamjung = 5.86)	6.43	5.23		
Landholding size (mean)	5 ropani (approx. 0.25ha)	4 ropani (approx. 0.2 ha)		
Household food self-sufficiency*	<3 months	86 (23.8%)	<3 months	213 (33.3%)
	3 – 5 months	108 (29.9%)	3 – 5 months	150 (23.4%)
	6 – 8 months	107 (29.6%)	6 – 8 months	165 (25.8%)
	9 – 12 months	56 (15.5%)	9 – 12 months	91 (14.2%)
	>12 months	4 (1.1%)	>12 months	21 (3.3%)
Agricultural land (in ha)*	745.5ha (49% of the total 1521.3ha)	337.9ha (6.9% of 2,909.89ha)		
Forest area (in ha)*	546.38 (35.9%)	1251.34 (25.4%)		

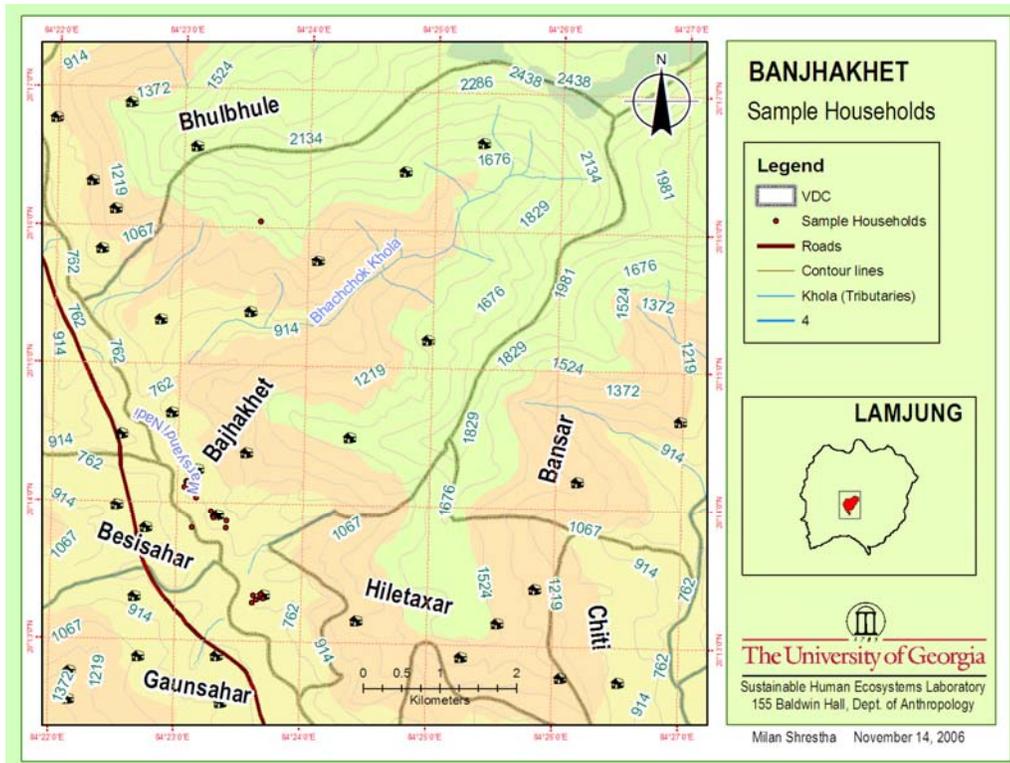
(Source: Fieldwork 2004-2005, \* ICIMOD 1996)



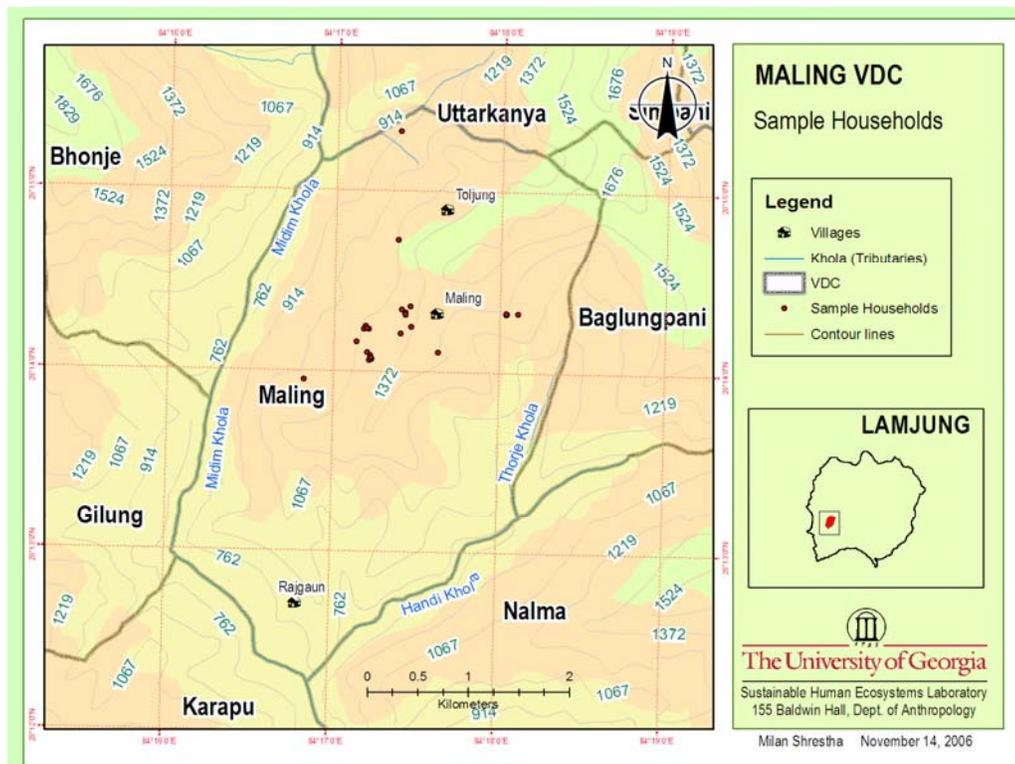
Figure 2.5 Southern slopes of Banjhakhet (facing north)



Figure 2.6 Maling landscape (facing south)



Map 2.5 Banjhakhet VDC showing sample households



Map 2.6 Maling VDC showing sample households



(a)

(b)

Figure 2.7 Gurungs in their traditional costumes

(a. a man wearing *bhangra* and carrying a *doko*, on his way to *lekh* with fellow *gothaalaa*)

(b. a woman wearing *cholo*, *patuka* and *lungi* with *shyakhu* on her back on a rainy day)

### 3. Ethnohistory of Gurungs and their socio-cultural contexts

The foothills of the Annapurna and Manaslu Himal ranges—stretched from the eastern part of Gorkha district to the western part of Syangja district, covering Lamjung and Kaski districts in between—have been the home to Gurungs for centuries. Small pockets of Gurung population are scattered around Nepal, North-east India and Bhutan. There are approximately 450,000 Gurungs in Nepal, making up about 2.43% of the population.

The majority of the Gurungs in Lamjung still speak the Gurung language (they call it *Tamu Kyui*) even though many Gurungs living in the southern part of Lamjung have absorbed Nepali elements in their language and dialect. *Tamu Kyui* is a Tibeto-Burman language with no written scripts and no standard orthography to this date. In recent years, Gurungs are adopting a standard script for their language (see Glover 2003 for a discourse and the controversy surrounding these issues).

Gurung migratory histories preserved in oral traditions known as *Pye-tan-lhu-tan* narrates how the ancestors of Gurungs migrated to the foothills of the Annapurna region. Gurungs in Lamjung have told me they believe their ancestors came from the region only known as *Chong* or *Chongnash* (which means the Earth), which is located in the southwestern China, near the Mansarobar mountain<sup>8</sup>. A different version also exists, which links Gurung ancestors with western China and even with the Changez Khan dynasty. Although much remains unknown about the origins claims, my oral history research in Lamjung clarifies some details.

Because of the rising population density in their ancestral place, Gurungs started to move down south toward the present day Nepal. They first settled in a place called Chyaangthaang Namruchwo in the Kolsomur region, popularly known among Gurungs as Kohla<sup>9</sup>. There were two brothers, namely Chhirithwanaa and Thwon Kueedu, in Kohla. The younger brother later moved down south to the Upper Ghanpokhara hill area, named Khyola and eventually ruled the principality from in the adjacent hill Ghale Gaaun (then known as Koyamle). He and his successors are in fact the popular Ghale Raja mentioned in many Gurung legends.

Chhirithwanaa, the older brother, appears to have headed west to the area now known as Sikles in Kaski district, which shows diversion in the Gurung migration. Some respondents of my fieldwork traced their ancestral roots to Ghalegaun. Dharma Raj Thapa (1984), an expert on folk cultures in Nepal, had collected some folklores and verses that connect Gurungs with Kohla and Khyola.

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<sup>8</sup> The Mansarobar holds a special place in the Hindu religion, because it is the home for Vedic deity Mahadev (Lord Shiva). The Mansarobar Lake, located at the base of the mountain is sacred to Hindus both and Buddhists. Thousands take pilgrimage there every year to take holy dips.

<sup>9</sup> Gurung leaders and their national associations have started exploring and excavating the ruins found in the Kohla area with the help of British archaeologists/anthropologists (Pettigrew and Tamu 1999).

Around 1500 AD, Lamjung appeared as one of the major Gurung principalities, mainly because it controlled the major portion of the trade route between Tibet and India that went through Bandipur of Tanahun—the major commercial hub of western Nepal. There also seems to be some deep divisions and political maneuverings between the Ghale Raja and his subjects, especially the recent *Khas*-speaking Hindu migrants (Ghimire, Thapa and Raut) and local Duras. They apparently went to *Khas* (Thakuri) King Kulmandan Shah of Kaski Durbar and requested him to send his second son Kalu Shah to rule the Ghale Raja's principality. The *Ghale Raja*, however, killed Kaalu Shah in an apparent plot covered up as a hunting trip.

These *Khas* migrants under the leadership of Kusmakar Ghimire again went back to Kaski and brought younger brother Yasobramh Shah in 1548 A.D. and the Ghale Raja was brutally killed. His son, Drabya Shah, later ruled Gorkha and a few other adjacent principalities in the late 1500 AD, which ultimately led to the unification of Nepal and the formation of a unified nation-state by Prithvi Narayan Shah.

It is very significant to note in terms of this ethnohistory to land management in Lamjung is that the district had also become a land of contest between the indigenous ethnic groups and *Khas*-speaking migrants arriving from the west. This is consistent with the fact that waves of *Khas* migrants came to the central hills of Nepal after the Moslems invaded India.

With their knowledge and skills in field terracing and irrigation technology, these *Khas* migrants had advantages in settling in the valley bottoms of the Marsyandi and other river valleys suitable for paddy cultivation. Gurungs until this period believed to have practiced only hunting, pastoralism and *Khoriya* agriculture. This is in fact only one of many unknown or seemingly contradictory claims in Gurung cultural history, which has puzzled even experts like Harka Gurung. He questions:

Many aspects of Gurung traditions and life-style appear to be somewhat puzzling, if not contradictory. Thus the picture reflected by epics and legends, which suggest a society of semi-nomadic shepherds is inconsistent with the tradition of Gurung kings and ministers, and the alleged shifting cultivation of early days cannot be reconciled with the present well developed agriculture, the general use of ploughs, the terracing and irrigation of fields, and the complex system of double cropping with the same fields being alternatively used for the growing of wheat and wet rice (Gurung 2004:38)

Traditionally, Gurungs predominantly practiced their ancient Bön religion, which is shamanistic and animistic in nature; however, an increasing number of Gurungs have adopted Tibetan Buddhism, mainly in the last two decades. Gurungs of eastern Nepal are generally more influenced by the Hindu religion and the majority of them use Nepali as their *lingua franca*. The impact of Hindi ideology on Gurung culture and their livelihood preferences has been very profound, which I discuss in the latter part of this chapter, Chapter 4 and 5.

In the Gurung belief system, *Teeje*, the clan goddess (also known as *Uttar Kanya*) established by the Ghale Raja of Koyemle, holds a special place. Gurungs of Maling still worship this goddess, known to many only as *Ban Devi* (Forest Goddess), on special occasions. In contrast to many of such known goddesses elsewhere in Lamjung, Gurungs prohibit offering any sacrifice, but pigeons are untied and songs are performed. Important festivals are the *Lhosar* and *Push Pandhra* (new year), *Manghi Tyeh* (*Maghe Sankranti* in Nepali), *Khe Ku Tyeh* (*Phalgun Purnima, N*), *Toh Tehñ* (3<sup>rd</sup> Tuesday in the Chaitra month), *Kheku Mañgi Theba Tohye* (*Baisakh Purnima, N*), *Kwohidulu Mara* (*Shrawan Sankranti, N*) and *Khyodo Mhañmai Tehye* (*Bhadau Purnima, N*). Some Gurungs, who have had influence of Hinduism, also celebrate *Dashain*, a Hindu festival.

Perhaps the most important part of the Gurung cosmology is their deep faith in ancestors and ancestral places, which they recite during the *pae* (mortuary rite). This is not surprising because the Gurung faith is largely concerned with the relationship between the living and the dead (Pignede 1993; Messerschmidt 1976b; McHugh 2001; Macfarlane 1976). The spirits of dead

person are believed to take an interest in their surviving kin and their power can work for good or for evil, depending on how the surviving family members follow the *pae* and the *arghau*—the final memorial service done after the certain period of mourning.

The dead are either cremated or buried and the deceased's family usually observes mourning for six months or more, although I have observed a few cases in which the mourning lasted only a few weeks. My respondents told that shorter mourning time is due to the increasing influence of Buddhism, which does not encourage the belief system to mourn for extended period, rather celebrate the life of deceased persons. During this period, the son neither eats meat nor takes liquor of any kind. A year or more after the death, a final and expensive *arghau* is performed and all the clan members join the family in a big feast. An effigy representing the deceased is draped with a white cloth and ornaments and is taken around the village.

Gurungs believe only *Klehpre* (known as *Ghyaabri* in Lamjung) and *Pochyu* (or *Poju*) can guide these spirits to rest eventually in their ancestral home (*Chong* or *Chongnash*). These shamans and priests are capable of establishing contact with spirits and local deities and their aid is sought in funeral rites as well as in simple suffering from illness or other misfortune. During the *pae*, first a *Ghyaabri* addresses the spirit of the deceased and then with the help of a *Pochyu*, *Ghyaabri* is able to send the spirit off to a final resting-place (*Chong* or *Chongnash*), which is comparable to the 'heaven.' To avoid troubles and misfortune to family members possibly caused by the spirit between the death and the *arghau*, the kin often construct a small shrine called *chhorten* on a ridge top and offer food to the spirit. Once the *arghau* is performed and the spirit reaches the heaven, the surviving family members need no longer worry about it. Then, the *Chhorten* is pulled down and the offerings of food are discontinued.

Another controversy within the Gurung society is the apparent social divisions recorded in Gurung ethnographies (Pignede 1983; Macfarlane 1976; Messerschmidt 1976b). There are two endogamous divisions called ‘four clans’ (*Carjat* or *Charjat*) and ‘sixteen clans’ (*Sohrajjat*) within Gurungs. *Carjat* includes *Ghale* (King), *Lama* (*Pochyu* or Priest), *Gotane* (Ministers) and *Lamchhane* (administrative staffs). Similarly, *Sohrajjat* division includes *Thimje*, *Telme*, *Lehge*, *Kromje*, *Lamme*, *Eujme*, *Lohnme*, *Lainme*, *Tohrje*, *Sarbuja*, *Mhobje* and so on. The *sohrajjat* divides into various sub-groups with different surnames, which are more than 100.

The main controversy centers on the claim that *Chaarjjat* is reported as superior to *Sohrajjat* in some books (e.g., Pignede 1993, Messerschmidt 1976b), the Gurung-Nepali-English dictionary published in 1977 (edited by Warren Glover and his colleagues) and so on. The clans belonging to the *Sohrajjat* opposed this notion of ‘vertical ritual status’ so vehemently that there was even a court case—this case is being settled outside of the court with an agreement that there will be no mentioning of those ‘troubling terms’ from all the future publications on Gurung culture (Glover 2004). Nevertheless, this controversial issue seems to have diffused in recent years, as more and more Gurungs have moved to cities and towns and the differences between these groups have decreased. Even the custom that prohibits the marriages between the two divisions is now fast disappearing. As Warren Glover stresses (2004:6):

As well-to-do Gurungs have moved, just in the last generation, from the hardships of village life to settle in towns like Pokhara-or the city of Kathmanbdu—they do not want to be reminded of the social barriers of village life. Consequently, the objection was raised to the ‘upper’ and ‘lower’ implications in the two offending entries

Despite all these new developments and controversies, a few features that characterize socio-cultural contexts of Gurungs are well documented by anthropologists (e.g., Pignede 1993; Macfarlane 1976; Macfarlane and Gurung 1990; Messerschmidt 1976a, 1976b). Gurung villages are usually concentrated on the top of ridges, at altitudes ranging from 500m to 2500m. Many

traditionally Gurung villages in Lamjung, such as Bhujung, Ghanpokhara, Pasgaun and Ghalegaun, are densely populated. The average Gurung village contains about 100 to 300 houses. Characteristic features of these villages are long flights of stone steps leading from the village to the fields in the valley floors and typically, houses are built on terraces paved with large stone slabs, which are also extensively used to pave the trails inside the village. Until galvanized tins became available in markets in the early 1990s, most of the houses are built of stones with a binding of mud and the roofs are covered with stone slates or with thatch.

Buckwheat and barley have cultural and symbolic meanings to Gurungs. They believe their ancestors would have starved without them; however, their uses are now limited to rituals and festivals. They prefer to grow millet, maize and potato on the higher hill-slopes and around homesteads. In terraced irrigated fields, they cultivate rice, mostly between May to October.

Historically, livestock herding of sheep and goat influenced every aspect of Gurung life. These traditionally Gurung villages normally had two to five herds and each of those herds consisted of 150 to 600 sheep and goats. These herds were looked after by five professional *prochhe* (*bhendi-gothala* in Nepali or shepherds) and their dogs. In the early spring, these sheep herds were migrated to different *kharka* located in the *lekh*, kept there to forage all summer long and until the mid-October and brought back to lower altitudes and near the village, where they could feed on crop stalks and produce manure. Besides meat, these sheep produced coarse wools, which were used to produce blanket, sweater, carpet and so forth.

These Gurung villages also maintained large herds of cows, bullocks and buffaloes. Livestock provided not only employment, but also provided traction power and manure to agriculture. Although sheep has a limited role in the present economy, sheep are still preferred

today on special occasions. Livestock numbers have also declined significantly in recent years. I discuss details of sheep herding and other agricultural management practices in Chapter 5.

Gurungs are also widely known for their military service in the British and later the Indian Army. The British Army in India began to recruit Gurungs and other Nepali ethnic groups into the Gurkha regiments in the 19<sup>th</sup> century. Apart from the prestige of being a Gorkha, the earnings of those serving in the army and their retirement pensions have played an important role in the budgets of many families. A steady cash income, however small, is an invaluable asset to a subsistence cultivator, and hence, complemented well with existing agricultural strategies. In some villages like Bhujung, Pasgaun, Ghalegaun and even in Maling, as much as 40% of men between the ages of 19 and 45 served in the British Gurkha regiments. There is significant reduction in the number of the British Gurkha recruits since the handover of Hong Kong, but the attraction toward foreign jobs (e.g., Gulf countries, Malaysia) has not ceased.

One demographic impact of young people living outside has been an unbalanced gender ratio in the local labor pools. Many villages consist mainly of women, children and old men. This explains why women play a very active economic role in Gurung households and why their gender roles and mobility are not as restricted as in the Hindu caste groups.

Gurung economy and lifestyle have considerably changed within the last two or three generations, beginning with the disappearance of the agropastoralist way of life in favor of rice-based agricultural intensification and other livelihood activities (e.g., wage earning). As a result there have been a steady shift of settlements to lower ecological zones, beginning with a primary move out of the northern forest (cool temperate) and mountain meadow (subalpine and alpine) zones and eventual resettlement in the lower valley bottom (subtropical) zone (Messerschmidt 1976a). This migration and settlement movement trends increased tremendously in the last five

decades with many leaving for cities and Tarai. One of the respondents of my in-depth interview series (a 56 years old female) provides a native perspective on this:

Q018: What are the reasons do you think motivated Gurungs to move down from *Lekh*?

B02: (Laughing)... maybe in the search of comfortable life. In those days, they could cultivate nothing but barley and buckwheat there (*Lekh*). Talking about those hardy barley and buckwheat reminds me of a folklore that I should tell you. There used to be a period when the in-laws would force their daughter-in-law they disliked to grind barley (being hardy grain). She would weep a lot, but had no choice but to obey the order and keep on grinding. So, you can tell how tough was the life there back then. The problem was that it was really hard to separate the husk from the barley grain. One day, while grinding the barley, her tears dropped on the grain and it instantly separated the husk. Then, all came to know that water was essential to grinding. They soon started to move down in the search of a place where water was abundant and crops could grow better... There, it's hard to see greenery for more than six months, here it's green all the year...

Change in Lamjung, especially those during the Post-Rana period (1951-1990), cannot be studied in isolation of overall changes in Nepal<sup>10</sup>. After the democratic revolution in 1951, the Ranas were desposed and multiparty democracy was established in Nepal. This opened Nepal to the outside world. Nepal also started planned development initiatives and attracted significant foreign aids. The post-Rana period also witnessed malaria eradication in the Tarai region and deforestation of thick forests for resettlement of recent migrants, who mainly came from adjacent hill and mountain districts like Lamjung.

At the same time, government services like education, road, public health, administration started to reach out to hinterlands, so did the cash economy, which replaced the traditional mountain barter and trade system. Gurungs and other social groups of Lamjung also started to feel the pressure to earn cash to access and use these new services. Over the year, especially after

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<sup>10</sup> The history of Nepal becoming a nation-state has five major periods: (1) pre-unification period (before 1743), (2) unification period (1743-1885), (3) Rana rule period (1885-1951), (4) post-Rana rule (1951-1990), and (5) democracy (1990 to present). In spite of the significance each of these periods holds, it is beyond the scope of this dissertation to discuss them all (see Whelpton 2005 for a concise overall historical account of Nepal, Stiller 1973 for the history of unification, Regmi 1971 and 1976 for economic history). Nevertheless, I discuss many of these historical events and policies relevant to Lamjung in subsequent chapters.

the road and transportation became accessible, economic activities were no longer limited to old towns like Bandipur, Bhorletar and Kunchha. New markets developed along the road, such as Besishahar, Bhorletar and Bhotewodhar. Rising incentives to cultivate 'high value' crops like rice and wheat, cash crops and citrus orchards were so high that it enormously affected traditional agricultural practices and the way locals viewed the use of forests and pastures. There has been a steady rise in the price of 'prime lands' along the Marsyandi and Madi Rivers and the Dumre-Besishahar road.

#### **4. The political economy of land resources and Gurungs**

Land ownership is the prime source of wealth and has historically implied prestige, affluence and power. Throughout Nepal's history land has been the only major source of revenue and every regime placed special importance on it. As Stiller (1973:17) points out, "it was his control of the land and the fruits/harvests of the land that constituted the real power of the prince." The politics of control over land and land resources are quite evident in the long history of Lamjung as well.

I mentioned earlier that *Khas*-speaking migrants assisted the Shah King to defeat the Ghale Raja and conquer neighboring principalities. These *Khas* or Parbatiya migrants received many *birtaa* and other forms of land grants from the Shah King in return, allowing them access to the valley bottomlands suitable for paddy cultivation. For instance, Kusmakar Ghimire, a Brahmin leader helped Yasobramh Shah establish himself in Lamjung and once guided the King on the Muktinath pilgrimage, was later rewarded a *birtaa* from Simalchaur village to Ghermu village in Marsyandi Valley (Thapa 1984:357). The displaced Gurungs of Ghermu were allowed to return there only after offering an annual tribute of nine 'doko' (basket load) and nine bundles of brine-

salt. This shows the way land-grant system worked and it extended preferential treatment to the King's allies, mostly the *Khas*-speaking groups. The traditional pattern of land occupancy evolved in such a way that sub-tropical valleys were primarily occupied by *Khas* migrants, whereas Gurungs were still living in the higher elevations.

In Nepali economic history, land revenues and various forms of land grants have played an important role in the expansion of the Gorkha Kingdom, the unification of Nepal and the maintenance of subsequent state apparatus (Regmi 1971, 1976). Throughout the history of Nepal, the military establishment was directly supported by land grants; in other words, the state worked under the norm that the greater the land revenue that could be assigned to the military, the stronger the army that could be assembled.

The Governments of Nepal of the pre and post-unification period as well the Rana rule regulated the forest policy based on the assumption of unlimited abundance (Bajracharya 1983a: 232). Successive governments used land ownership to consolidate and widen their power base. Some 'principles related to land tenure' prevalent in Nepal are summarized in the work of Stiller (1973:15), which are:

1. all land was understood to be the property of the state;
2. land, as the principal source of wealth, could not be allowed to remain non-productive;
3. the possession of a free-hold right to the land was the sole means to rise to a position of wealth and prestige

The principles particularly encouraged bringing forestland into cultivation whenever conditions for cultivation and human habitation are favorable. There large extensive clearings were allowed so that the 'depredations of wild animals are reduced and the climate improved'. Forest clearing for crop cultivation was encouraged, as only nominal revenue applied on *paakho*

land (Regmi 1976). The state would allow any ‘productive activities’ that could generate revenue to help maintain the state apparatus. The state systematically enforced its ‘rent-seeking tendency’ through village overlords to collect rents and control the peasantry. Similarly, the village overlords, who are mostly the Shah Kings’ allies, acquired the political backing provided to legitimize their landholding. Furthermore, what made it worse is that these overlords converted the authority into a symbolic power that allowed them to reproduce their dominant position and discriminate against certain social groups.

In the case of Lamjung, historical evidences that are specific to Gurungs and Lamjung are hard to find, because Gurungs have no written script and the official legal documents on revenue-generating resources like land are generally not accessible to the public. Mahesh C Regmi, an expert on the economic history of Nepal, nevertheless, has been able to gain access to some records and use them in his publications. In one of his regular updates on economic history of Nepal through the Regmi Research Series, there is evidence of how the state strictly imposed taxes in Lamjung. The tax records found in the archive indicate that taxes were strictly collected from Lamjung as early as 1934AD. The people of Lamjung also managed to renegotiate the state taxes. The tax system also differentiated between *khet* and *baari* or *paakho*

In 1934AD, a *sarpat* survey was conducted on *khet* lands in Kaski and Lamjung. The survey resulted in an enhancement of taxation, either because the actual area of holdings was found to be in excess of the previously registered area, or because the amount of tax was increased. The incidence of taxation consequently rose so high that in some cases it exceeded the actual income. The local landholders paid their taxes at the enhanced rates for one or two years for fear of arrest, but in 1937 they threatened to Kathmandu that many landholder would be affected if the property of the defaulter was auctioned to realize the arrears, and if they were placed in detention.... (Regmi Research 1984:55-57)

In Gurung land history, a number of socio-cultural, ecological and economic factors (e.g., water scarcity, population pressure, hardships related to agropastoralism, etc) seem to have played a role in moving Gurungs to the lower valleys. Most importantly, their settlement

movement to the valley also represents their economic transition from dry farming to irrigated paddy (Messerschmidt 1976a, 1976b), which started diffusing the exclusive use of eco-zones by ethnic and caste groups. Since arable lands in the valleys were already under cultivation, Gurungs must have acquired lands from *Khas* peoples and other ethnic groups. Another plausible explanation is that, as Macfarlane (1976) notes in his study of Gurungs in Kaski district, an increasing population pressure on limited resources prompted cropland expansion with deforestation. Notably while new settlements of Gurungs in the lower altitudes began early in the 19<sup>th</sup> century, the major movements occurred mainly in the post-Rana period, especially after the major events like Pokhara developing as a major commercial hub and the regional headquarter in the 1960s, the opening of Tarai for resettlement, the expansion of the Dumre-Besishahar road and so forth.

A more subtle, but perhaps more crucial, social driver that motivated, along with population pressure, shifting of Gurungs settlement is the political economy of land ownership. Change in rules of resource allocation played a key role that profoundly transformed Gurungs' livelihood system. Specifically, the Private Forest Nationalization Act of 1957 abolished traditional, customary rights on forests. Similarly, in the case of *kharka* (pastures), Gurungs had traditional, customary rights in a form of pasture monopoly known as '*kharchari rakam*' (pasture tax). In this arrangement, lowlanders could send their sheep, goats and cattle to those *kharka* by paying fees. This arrangement, however, was abolished with the Kharka Land Nationalization Act 1973, effectively ceasing Gurungs' management rights to one of their key resources<sup>11</sup>. Although the

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<sup>11</sup> The impact of the Nationalization Acts on customary rights of indigenous and ethnic groups are discussed elsewhere (Bajracharya 1983a, 1983b; Steven 1993; Mahat et al 1986; Caplan 1970; see Ives and Messerli 1989 for a summary of various cases)

Act did not stop their migratory sheep herding practice, it did have considerable impact on their agropastoralist way of life and labor pool management by changing Gurungs' perceptions of access to and control over resources that are important to them.

The real tragedy, however, was not the Nationalization Acts and other policies of the nation-state, but what followed afterward. Neither was the state effective in the strict implementation of the Acts to achieve their original goals nor could it stop from deforestation and degradation (Messerschmidt 1987; Blaikie 1987; Griffin et al. 1988). Ironically, these resulted in some profound unintended consequences. Examples include people cutting down trees from their private property fearing the state's claim; traditionally deputed guards/managers could do nothing to stop over-extractions; and people could not afford to spend days in district headquarters to get permit to chop down trees in their private property (Ives and Messerli 1989). So, in sum, the exact policies that were supposed to 'preserve forest and pasturelands from further degradation' did just the opposite—they created an 'open-access' regime in which there was virtually no governance, no accountability and no sanctions<sup>12</sup>. Deforestation and over-extraction of resources occurring during this 'open access' period received considerable attention in world media especially after publications of Eric Eckholm (1975, 1976), Piers Blaikie (1987) and Ives and Messerli (1989). While I elaborate the issue of forest and common pool resources governance, including the implementation and sporadic success of community forestry program, in Chapter 5 and 6, the point here is that these inept state policies did erode the capabilities of existing management systems while failing to replace them with new systems.

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<sup>12</sup> Contrary to what is suggested in "*Tragedy of Commons*" (Hardin, 1968), 'open access resources' are resources (i.e., forest and pasture) that no one owns and where it is impossible to exclude individuals who want to have access to it. There are no rules and governing institutions or collective-choice to regulate and govern the particular resources as in "common property regimes" (see McCay and Acheson 1987; Ostrom 1991, 1999; Feeny et al 1990 for the criticism of Hardin's theory).

## 5. Recent environmental changes and concerns

The most visible historical event or ‘development plan’ that transformed Lamjung’s landscape in recent decades is the upgrading of transport infrastructure, which includes improved suspension bridges, introduction of mule transport and extension of the vehicular road (Gurung 2004:47). In the past, Khudi and Bhulbhule were two major centers in Lamjung for winter trade of mountain products from Manang, but towns like Kunchha and Bhorletar were the administrative centers and markets. The upgrading of the trail along the Marsyandi river as a mule track began early in the 1970s and the extension of the road from Dumre to Besishahar—the most important change happened in terms of transport development—was completed in 1993, eventually motorable road reaching towns like Khudi and Bhulbhule around 1993-1996.

Although the roads were open mostly in the winter dry season, transport costs for consumer and construction materials significantly reduced, making them readily available in local markets. Cheaper transport of goods such as food grains, salt and kerosene and their instant availability in local markets made them attractive alternatives. Apart from expanding the new settlements in the *Besi* area, the availability these goods brought changes in villages, such as cement structure and corrugated tin roof replaced traditional architecture of house mentioned earlier. Food imports led to a decrease in dependence on local products, while cheap kerosene provided an alternative to fuelwood.

The type of changes in Lamjung over the last five decades represents a case of ‘modernization’ that other hill districts witnessed much earlier, mostly around 1960s through 1980s. The modernization or development policies of the country came with a development package: new agricultural inputs are being introduced, roads are being constructed, new markets

for agriculture produce and for labor opened up and access to schooling in Nepali expanded. At the same time, the nation-state increasingly penetrated the once inaccessible and uncontrollable hinterlands (Ashby and Pachio 1987:195; Metz 1991; Zurick 1988). To be precise, in the face of the growing cash economy, the traditional 'consumption production system' experienced significant influences of 'commodity (commercial) production system' (Brush and Turner 1987). Several studies carried out elsewhere in Nepal found a similar pattern (Gurung 1989:354; Steven 1993; Johnson et al. 1982:117; Seddon 1987:103; Zurick 1988).

On the impact side, changes in traditional 'consumption production system,' for instance, dairy production definitely created more income opportunities, but it also brought new inequalities in gender roles and ethnic relations along with deforestation (Thomas-Slayter and Bhatt 1994). The main concern, hence, is not so much with smallholders shifting to commercial production under conditions of market development and rapid population growth *per se*, but with the possible adverse impact of such transitions (e.g., deforestation, soil loss, loss of adaptive capacity, vulnerability of livelihoods, etc). Jodha (1995) presents several case examples collected from different parts of the country, in which such shifts to 'commodity production system' found to be exacerbating 'negative trends' relevant to mountain agriculture (e.g., farmers bringing more steep lands into cultivation, decline in livestock, replacing cattle with goats and other small animals, decreasing fallow periods, etc). He believes the results are 'irrational patterns of resource allocation and unsustainability.'

Jodha (1995) believes that in mountain communities where poverty or impoverishment is already a major issue, the decline in forest and pasture resources reduces livelihood flexibility and narrows agricultural options, which in turn push smallholders to accept inferior quality of options, and thus, perpetuate more resource extractive strategies to maintain their survival. To be

poor in the mountains means not only having smallholdings, but also having lower productivity and more susceptibility to stress or shocks (e.g., landslides, crop failure and food shortage) (Bohle and Adhikari 1998). Since they have limited, if any, access to risk management systems, environmental stresses, natural hazards and land degradation may jeopardize their livelihoods.

These scenarios certainly present the characteristics of ‘impoverishment,’ which is the condition in which current human uses and levels of well-being appear to be environmentally unsustainable over the middle-to-long term future and in which the ‘options available in the future are being significantly narrowed by current draw down of natural capacities’ (Kasperson et al. 1997). Furthermore, the impoverishment of farmers may interact with existing vulnerabilities and eco-system fragility to produce ‘spirals of impoverishment and degradation’ (Blaikie and Brookfield 1987:103).

These environmental concerns capture the main essence of the HED, even though the explanations of the HED varied tremendously, ranging from individual farmer's decision-making processes to population pressure, to regional political ecology. The main problem with the HED was that there were many contradictory claims, uncertainty of data and even myths (Thompson et al. 1986; Ives and Messerli 1989; Rhoades 1997; Ives 2005).

Nevertheless, understanding issues like ‘deforestation’ and ‘land degradation’ cannot be complete without considering natural conditions in their social context (Blaikie and Brookfield 1987). The HED and related environmental discourses on Nepal had ‘tendency to highlight the physical grandeur and ignore human endeavour’ (Gurung 2004:1). These issues can be better understood only with ‘more rigorous field investigations based on a temporal perspective’ (Gurung 2004:51). This is where the study of LUCC is useful, as it takes both spatial and

temporal factors into consideration when it combines human ecological knowledge with remote sensing applications to analyze land-cover change trajectories.

The challenge that lies ahead is to analyze not only the percentage change in particular land-cover type in a place and time, but also identify the proximate causes and the driving forces behind such changes. In order to do so, one must be able to 'situate' the environmental concerns in their own spatial and historical contexts. We also must address the questions: (1) what are the changes in rules of resource allocation that have modified livelihoods and land-use types; (2) what are the exact changes in terms of access to and control of resources that shifted local's preferences and priorities? (3) how vulnerable are farmers in terms of their exposure as well as resilience capacity to environmental stress/pressure? (4) what is the status of adaptive capacities within the landscape for land-cover maintenance and environmental sustainability? These are some fundamental questions that underlie the long-term sustainability and the coupled human-ecological system of the Nepal Himalaya.

## **CHAPTER 3**

### **LAND-USE AND LAND-COVER CHANGE TRAJECTORIES**

With increasing advancement and sophistication in computer technologies and remote sensors, the uses and integration of satellite data with other spatial data in the GIS environment are in constant rise. Their uses have been so ubiquitous recently that the conventional methods of land inventories and surveys are now tools of the past. As remote sensing data and applications are becoming more affordable and accessible, they are also used with greater efficiency and effectiveness in LUCC studies. They communicate spatial trends more clearly and quantify key variables involved in LUCC with statistical analyses, which in turn, can be used to check the accuracy and reliability in LUCC studies.

In this study, I use remote sensing and GIS to detect LUCC trajectories by integrating them with household and community level data. For me the integration of remote sensing with anthropological and other social sciences methods is the key to (1) detect the patterns of LUCC and quantify them for further analysis; (2) identify social drivers (i.e., the proximate causes and driving forces) of LUCC; and (3) link these two components to establish scale dependent relationships of the human and environmental dynamics.

Having a synoptic view of a large coverage of the Earth's surface, remote sensing data can cover relatively large areas for LUCC studies. Remote sensing also provides regular, repetitive data from a single and consistent source. Not only can remote sensing provide an alternative to costly ground-based inventories and deliver highly aggregated data at less cost, but also such

data are available with greater spatial and temporal resolutions than data from other sources. Remote sensing together with GIS can help social sciences characterize the rate, pattern and composition of earth systems dynamics. Specifically, their uses can be very effective in identifying spatial patterns in social data in the sense that they reveal issues and trends otherwise missed by social science data aggregation. Similarly, social science can help remote sensing find associated drivers of environmental change by relating socioeconomic, demographic, geographic and environmental dynamics. Social sciences can also offer ‘ground-truth’ data and procedures or validation of remotely sensed data<sup>13</sup>.

The use of satellite remote sensing for LUCC depends upon an adequate understanding of landscape features, imaging systems and information extraction methodology employed to meet the study objectives (Lo 1986). As remote sensing data are only indirect measures of the reflectance of those landscape features, land-use/cover maps produced from those data are also dependent on the map producers’ accuracy in interpretations and classification of the features. Errors can propagate and have unintended consequences when such maps are used by the users who may be unaware or ignorant of land-cover information origin and its meaning (Comber et al. 2005). One of the main challenges within remote sensing, hence, is to minimize errors and gaps in classification and data quality/accuracy. Standardizing image meta-data protocol, which can address the issue of differences in perceptions of the data producers and the users is one way to address this issue. In addition, most LUCC studies integrate the land-cover error matrix and accuracy assessments to minimize the errors.

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<sup>13</sup> For more insights on the integration of remote sensing with social sciences see Liverman et al. (1998), Walsh and Crews-Meyer (2002), Fox et al. (2003), Turner et al. (2003), Walsh et al. (2004) and Moran 2005. For examples in anthropological studies, aside from archeological applications, see Conklin (1980), Guyer and Lambin (1993), Sussman et al. (1994), Brondizio et al. (1996), and Moran et al. (2003).

## **1. Land change science**

Ecological and geographical information sciences have a long tradition of modeling. Land change science, being a closely related discipline, is no exception to this tradition despite its short history. A number of guiding theories and models have emerged in land-change science in the last 10-15 years (Agarwal et al. 2002; Lambin 2003). As in any interdisciplinary theme, land-change science also has been influenced by different disciplines, namely social, natural and geographical information sciences (Rindfuss et al. 2004). Each discipline has developed different ways to address LUCC issues and each tends to treat the spatial and temporal variables differently. This also explains why there are different LUCC models.

One of the widely used, mostly by economists, is the Van Thünen model (Van Thünen 1964), which explores the relationship between road expansion and agricultural intensification and their ultimate impact on deforestation (Comitz and Gray 1996; Angelsen and Kaimowitz 1999). This model predicts where economic activities occur. The idea is simple. Land-uses tend to array across the landscape, according to the relative value of the activity. This means higher valued uses arrayed closer to the 'center' and lower values radiating outwards. There is always economic trade-off between different land-uses, measured in value of production and area/coverage of particular land-use. Although it is often criticized for its deterministic approach, this simple proposal by Von Thünen explains economic rationales of land-use change and trade-off between different land-use categories, including intensification.

With an attempt to move away from assuming any 'deterministic' idea, the human/cultural-ecology concept in anthropology and cultural geography has thrived on the fundamental assumption that cultural maneuverings (e.g., rules, network) provide options for human

adaptations in different biophysical conditions. The basic premise of this concept is that human action in the primary form of modifications of land and other environmental ‘resources’ has been central to the agricultural base and human subsistence and that agricultural intensification and other agricultural land-use strategies are related to LUCC through conversion, modification and maintenance. Having a thorough understanding of these land change activities in their own contextual history can better explain the nature of LUCC and their trajectories (Turner and Meyer 1991; Klepeis and Turner 2001), because land-cover change are the product of anthropogenic forces.

In general, land-use involves both the manner in which the biophysical attributes of land are manipulated and the intent underlying that manipulation or the purpose for which the land is used. There are three types of LUCC processes: conversion, modification and maintenance (Turner and Meyer 1991). ‘Conversion’ refers to a change from one class of land-cover to another (e.g., forest to cropland), whereas ‘modification’ is a change of condition within a land-cover category, such as the thinning of a forest or change in its composition. ‘Maintenance’ (e.g., making bunds, irrigation trench, plowing) is limited to land-use activities. Land-use affects land-cover with various implications, including some serious environmental implications, such as soil erosion and degradation, biodiversity loss and water flow and water quality changes.

In terms of explaining LUCC patterns and trajectories, however, it is necessary to differentiate between ‘social drivers’ or ‘human driving forces’ and ‘proximate causes.’ Both are related to LUCC, but the roles are significantly different. Turner and Meyer (1991) argue that various ‘social drivers’ or ‘human driving forces’ (e.g., population, technological capacity, affluence, political economy, beliefs/rules) are ultimately responsible for the manipulations of existing environmental conditions or contexts (e.g., deforestation, migration, settlement

relocations), which lead to a change in the intended land-use of an existing land-cover.

Commonly referred to as 'proximate causes' or 'proximate sources of change,' these manipulations are the most immediate activities that create change and directly alter the physical environment. Through proximate sources, the human goals of land-use are translated to changed physical states of land-cover. In this sense these proximate sources represent the point of intersection between physical processes and human actions.

Land-use conversions also signal changing structures in cultural ecology that suggest something about the nature of rising demands on land resources and the adaptive capacities of the environment to adjust to the human impact. Turner and Meyer (1991: 672) further suggest that LUCCs are essentially the products of changes in patterns of human production and consumption. The human driving forces of LUCC fall into five categories: population, level of affluence, technological capacity, political economic forces and rules or institutions. The first three also make the I=PAT formula, in which the environmental impact (I) is the function of population (P), affluence (A) and technological capacity (T). This formula once was widely used to determine the 'carrying capacity' of a particular ecological system (Brush 1975).

Because LUCC is about the human use of land, mainly for agricultural use, it subsumes the human/social drivers of agricultural change. Changes in the patterns of human production and consumption may result in agricultural change with considerable impact on LUCC. Turner and Brush (1987:18) suggest that in subsistence agriculture or 'the consumption production system,' the amount of production sought, and hence the land-use and labor employed, is strongly related to the local demographic conditions. In market economy influenced agriculture or commodity production, local demographic conditions may not directly affect production goals, but they may play an important role in crop scheduling, selection of cultivars and so forth.

Aside from the classical I=PAT formula, a growing body of literature came out in recent years to highlight the role of institutional arrangements on LUCC (e.g., Leach et al. 1999; Moran and Ostrom 2005; Chaudhury and Turner 2006). The main idea behind this notion is that communities with different institutional arrangements may have different environments leading to differences in land-use practices and land-cover trajectories. At more micro-scales, an attempt has been made to establish the causal pathways that determine how cultural ideas or cognitive models result in behaviors that affect the environment, common management and beyond (Atran et al. 2002).

These studies on the relationships between institutions and LUCC reemphasize the fact that conventional social drivers, such as the I=PAT formula, are inadequate to explain LUCC under different circumstances. While some may share commonalities in their institutional settings, they are also shaped differently as the outcome of different historical events and episodes. Consideration of what Klepeis and Turner 2001 call the ‘integrated land history’ can offer provide insights into the historical factors influencing the LUCC trajectories and their driving forces. Linking these institutional and historical antecedents with the results of remote sensing, however, is one of the greatest challenges facing land-change science (Rindfuss et al. 2004).

An increasing number of LUCC studies now combine both social science and remotely sensed data, as both natural and social scientists are now finding a common interest: how physical and social data can be linked to better understand the complexity of human-environmental relationships (Turner 1997; Walsh et al. 2004). It is evident in recent surge in compiled volumes related to ‘linking people and pixels’ (Liverman et al. 1998; Walsh et al. 2002) or ‘linking household and community data to remote sensing’ (Fox et al. 2003; Mertens et al. 2000).

Although the significance of remote sensing, particularly of aerial photographs, to explain the physical and social relationships has long been realized (e.g., Green 1957), only in the recent years social scientists also have also stressed the explicit considerations of linking ‘social processes to changes in land-cover’ (Axinn 2003). As Lambin et al. (2003) view, integration of remote sensing with social sciences can provide a clear and systematic understanding of changes in pattern of earth resources and their so called ‘drivers’ (or social phenomena). While by having a synoptic view of significantly large coverage of the earth surface, remote sensing provides regular, repetitive data from a single consistent source (Curran 1987), social sciences can offer ground-truth or validation of such remotely sensed data (Rindfuss et al. 1998:10). It is, however, very important that one must understand the context and meaning of such integrations.

## **2. Remote sensing data acquisition and reference data**

Six Landsat images covering Lamjung between 1976 and 2003 were acquired (Appendix F). Although it was not planned so, there are two scenes from each of the Landsat sensors; 1976 and 1984 are MSS, whereas 1990 and 1994 are TM and 1999 and 2003 are ETM+ data (Table 3.1).

Ideally, near anniversary satellite images are preferred in LUCC studies, mainly to minimize the effects of seasonal phenological variations. Unfortunately, satellite data for Nepal are hard to find and availability of cloud-free is even rarer. The images used for this study were taken in winter season (November–February), except for the 1994 image, which was taken in May. Some of these images have clouds, but they are still more usable than others. This is one of the disadvantages of analyzing remote sensing data of sub-tropical mountain regions. Similarly, classification of land resources in mountains is still a problem due to variations in the elevation differences, illumination variations, and the effect of topographic shadow and parcel size (Millet

et al. 1995; Shrestha and Zinck 2002). This is the reason the accuracy of land cover mapping is often increased by integrated processing of remote sensing and ancillary data in a GIS. Satellite data, nonetheless, are invaluable resource for mapping land resources of mountainous areas, where accessibility is limited and carrying out land inventories is costly.

Table 3.1 Characteristics of the Landsat data

Date	Landsat Mission	Sensor	Spatial Resolution (m)	Path/row
3 December 1976	1	MSS	79	152/040
3 February 1984	4	MSS	79	142/040
10 November 1990	5	TM	30	142/040
13 May 1994	5	TM	30	142/040
13 December 1999	7	ETM+	30	142/040
6 January 2003	7	ETM+	30	142/044

In this study, LRMP produced land-use map, aerial photographs of 1979 and 1996, and topographic map (1:25,000 and 1:50,000 scale) of 1998 were used as reference data. I also collected 12 ‘training samples’ from the research sites, which were used as ‘ground truth’ data. Based on an unsupervised satellite image and aerial photographs, six training samples in forest area and six in shrubland and agricultural land were selected to collect information in ‘training sample form’ (Appendix G), which were later used in clustering and supervised classification.

### 3. Image processing procedures

These satellite data have four to seven bands in each. Using ERDAS Imagine 8.6, these bands for each were stacked into one image—the band 6 of Landsat TM and ETM+ data was discarded, as this study does not use thermal information and properties in the analysis. Subsetting of the area of interest (AOI), which is about 1691 km<sup>2</sup>, was subsequently done for each image to cover only the study area.

### *3.1 Image enhancement and geometric rectification*

The satellite images were further enhanced in ERDAS Imagine 8.6, mainly to ensure adequate contrast in the image so that the visual interpretation and identification of features become easy. Geometric corrections of each image were ensured following standard processing methods (Jensen 1996; Lillesand and Kiefer 2000; Jensen 2002). To minimize the effect of illumination differences on the surface reflectance, spectral bands were normalized by the total intensity. Using ArcGIS, 100 control points were collected from a 1:25,000 topographic map. All the vector and satellite images were then brought to the same datum and coordinate system—the universal transverse Mercator (UTM) Coordinate System (44-N in MSS and 45-N in TM and ETM+). This eliminated the chances of misregistration of these spatial data sources. The nearest neighbor resampling method was used, which kept the original digital numbers intact in images.

One of the concerns that had emerged during image processing was whether to resample MSS imagery data into the same resolutions of TM and ETM+ data (30meters). Since each image was going to be classified individually without any computer-assisted automatic classification process, the original spatial resolutions were left intact. However, the sensor parameters of 1999 ETM+ were taken into consideration and were used as a reference map to match the extent.

### *3.2 Classification scheme*

The LRMP's Land-use Classification Scheme, which is modified from the USGS Anderson's Classification Scheme (1976) and is considered the standard classification system for Nepal, was used for this study. Ten different classes are defined in the LRMP reference data (Appendix F).

The LRMP land-use map is based on aerial photographs of 1979. It has four different categories for agricultural lands (i.e., level terraces, sloping terraces, valley floors and footslopes).

Similarly, forestlands are differentiated by cover types, such as coniferous, hardwood, shrub and other combinations. Grazing lands are, however, problematic. Gurung (2004:33) points out that ‘grazing lands’ are often mistaken in LRMP classification, as it included all grass and scrubland adjacent to forests.

In this study, it was challenging to differentiate between those four types of agricultural lands entirely based on satellite images. The very coarse resolutions of Landsat MSS made it even harder; in other words, the resolution of MSS data is not ideal for separating the Level II land-use types. Based on their spectral characteristics and dominant presence in each of the satellite data, five land-cover classes were selected for this study (Table 3.2).

Table 3.2 Land-cover classes and definitions

No.	Classes	Definitions
1.	Forest	Areas 75% or more of all coniferous, hardwood and all other combinations of tree species
2.	Agricultural land	All level terraces, sloping terraces, valley floors and footslopes; often covers settlements and exposed land
3.	Shrubland	Shrubs, pastures, grasslands and scrubs; shrub vegetation which may include hardwood regeneration and transitions
4.	Snow	All snow-covered area, including ice, rocks and slopes above 4,000m
5.	Cloud	Cloud, cloud shadows

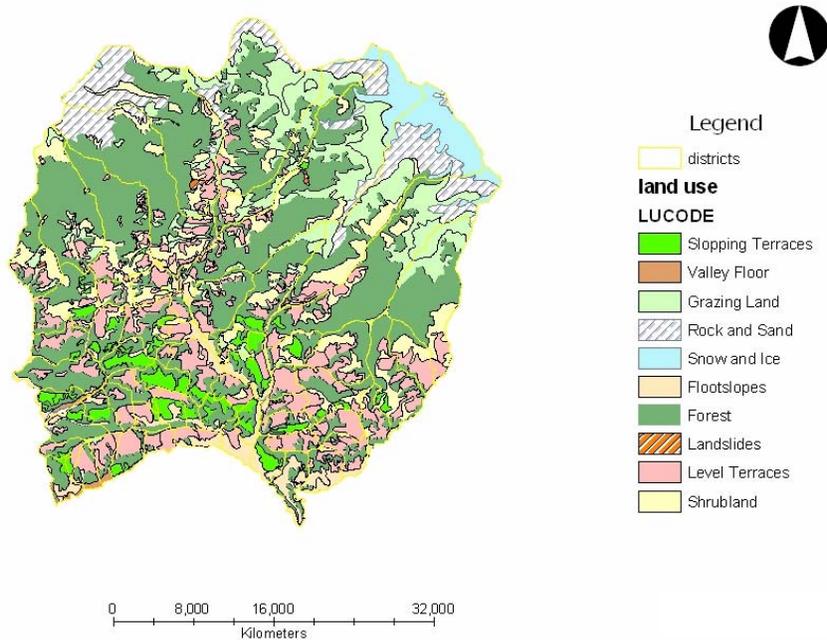


Figure 3.1 Land-use in Lamjung (LRMP 1986) as reference data

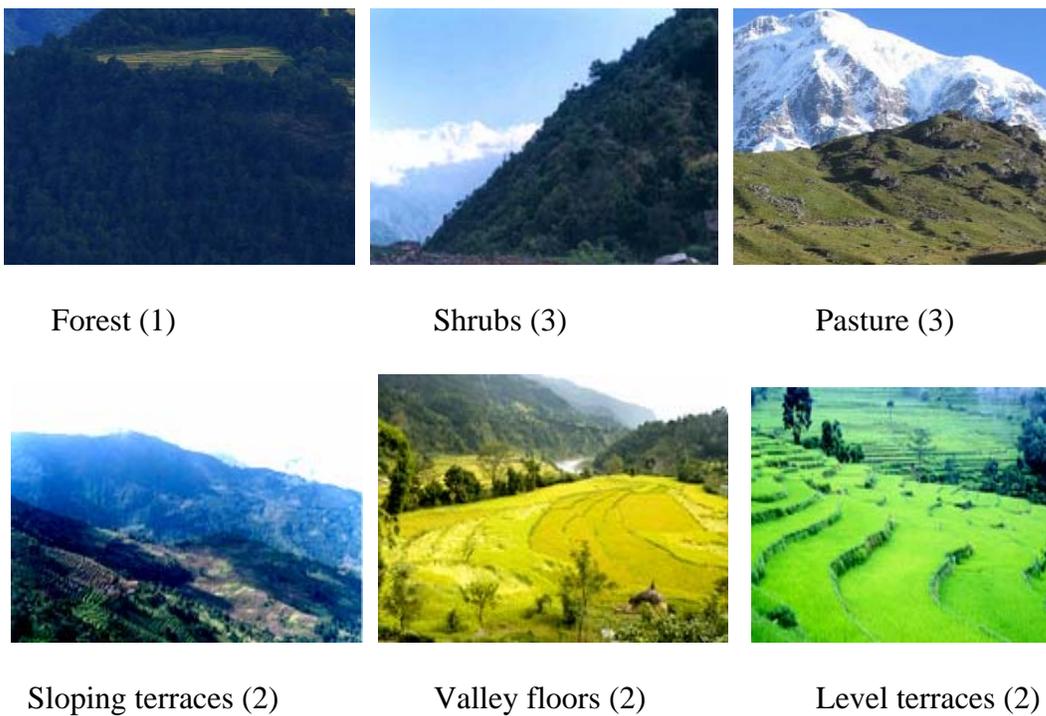


Figure 3.2 Land-cover categories

Although it is possible to create a mask (e.g., temporal logic) to separate features like cloud, cloud shadow and terrain shadow from LUCC analysis, two or more than two images of same periods are usually required to do so (Lillesand and Kiefer 2000). In this case, however, this option was not only expensive, but also not feasible due to data unavailability. For this reason, the original five classes were retained. These classes are also consistent with the ICIMOD case study (1996), which uses a similar classification.

### *3.3 Image classification, clustering and reclassification*

A hybrid approach of image classification, combining both unsupervised and supervised classification<sup>14</sup>, was employed in this study. This approach enables: (1) analysis of the spectral properties of various surface features (e.g., crops, forests, settlement) in the Landsat data into spectrally similar categories by the use of predefined, numerical decision rules, (2) clustering and reclassification based on the ground truth data and the knowledge of Lamjung's environment.

In the unsupervised classification, a set of predefined number of 'clusters' are identified on the basis of their image properties (i.e., pixel DN values) that represent a spectral group. The algorithms used in unsupervised classification assign each pixel composing the data set of interest to one of the training class categories.

For the purpose of this study, the bands 3 (visible red), 4 (near infrared) and 5 (mid-infrared) of the Landsat ETM+ image of 1999 were used in the unsupervised classification, which involved two steps: the self-iterative module for cluster seeding and cluster labeling. The

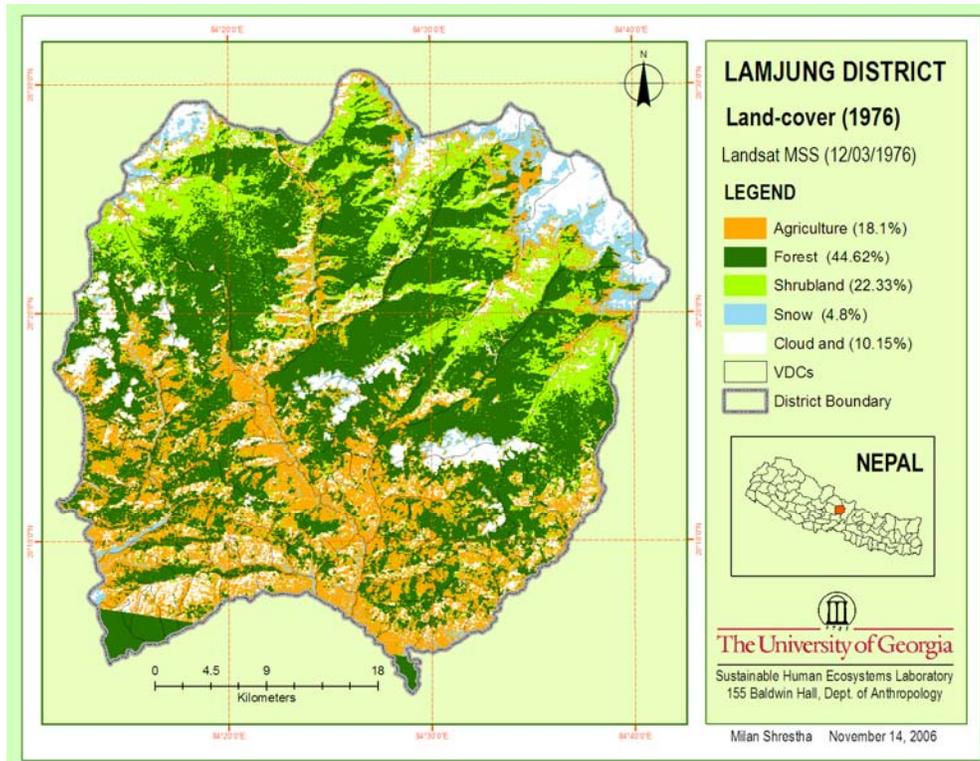
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<sup>14</sup> The most commonly used classification methods are supervised, unsupervised, spectral mixture analysis, fuzzy set analysis, and spectral angular analysis (Lillesand and Kiefer 2000). Each has their own merits and demerits. Ideally, fuzzy set analysis would give better results, but it would require reliable ancillary data and often is time-consuming. Unsupervised and supervised classifications are the two most commonly used methods (Jensen 1995 and 2002).

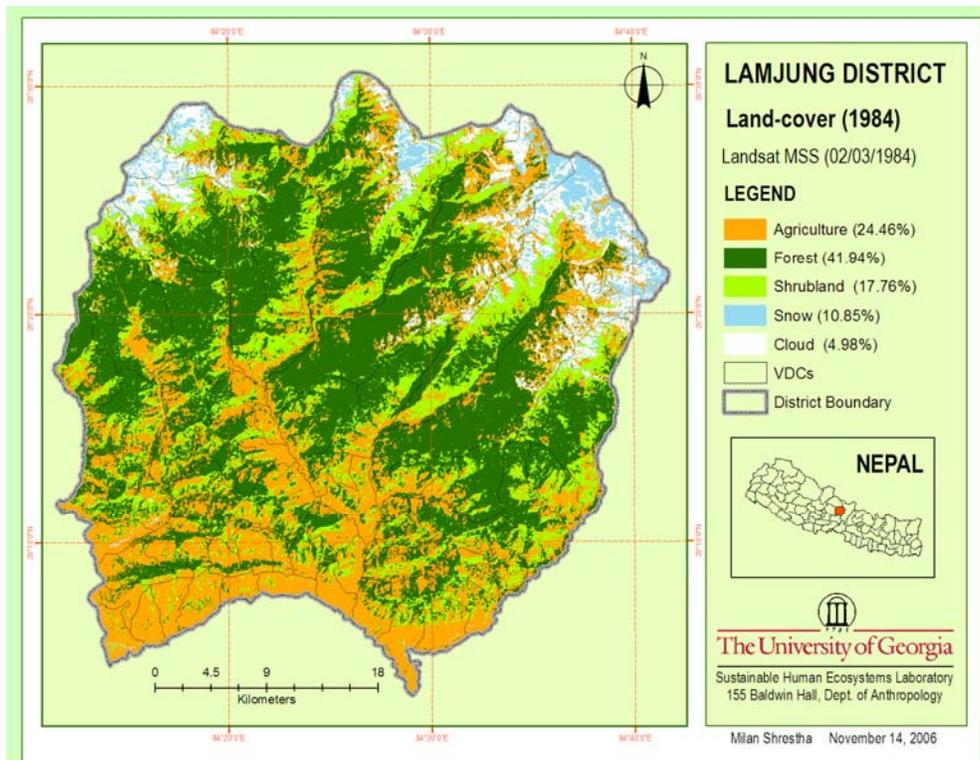
ISODATA (Iterative Self-organizing DATA Analysis) algorithm separated different spectral clusters into 12 classes. In the process of doing so, the convergence value was specified as 0.950 and the maximum number of iterations was specified as 6. The color scheme option was selected as approximately true color to help relate the image derived from the unsupervised classification with the original image. Once clusters were established and classes were identified, each of the resultant clusters was labeled and aggregated into the five major classes.

This resultant image was taken to the research site where ethnographic fieldwork was carried out between October 2004 and March 2005 to help collect ‘ground truth’ data or ‘training samples. Collection of such ‘ground truth’ data is important, because accurate detection of land-cover classes of the mountain areas is conditioned by several factors, such as relief, shadow, clouds and so forth (Millet et al. 1995) and adequate understanding of the effects of such factors is useful to minimize their effects (Lillesand and Kiefer 2000). With the help of a handheld GPS and a short survey of 12 ‘training samples’ distributed within the research sites, detailed observations of land-cover types, characteristics and structures were carried out. The information collected for ‘training samples’ and the knowledge of Lamjung’s environment assisted tremendously in reclassifying and labeling ‘clusters.’

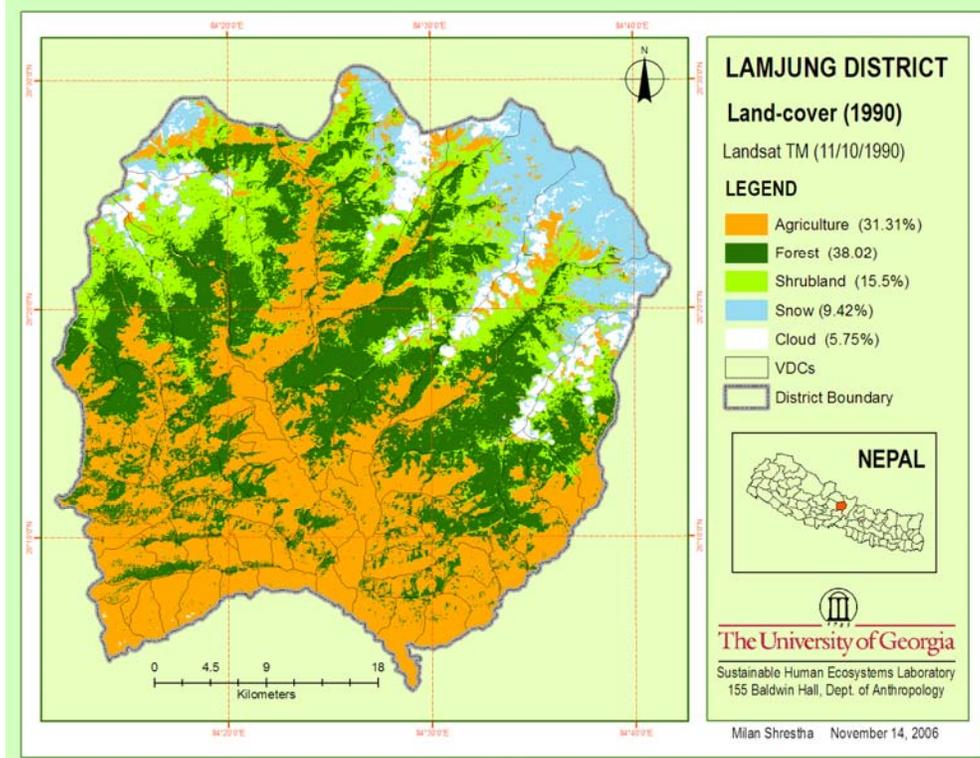
In the second stage of classification, supervised classification of all the satellite images was done. First, the areas of known cover type in the image were selected and were specified to the computer as ‘training signatures.’ Minimum of five polygons of each training areas with at least 40 pixels were selected. These training signatures were evaluated by checking signature histograms, followed by applying the ‘signature file’ to classify each pixel individually into the class it most closely resembled. This pixel categorization process resulted in specifying algorithm and numerical descriptors of the various land-cover types present in the image.



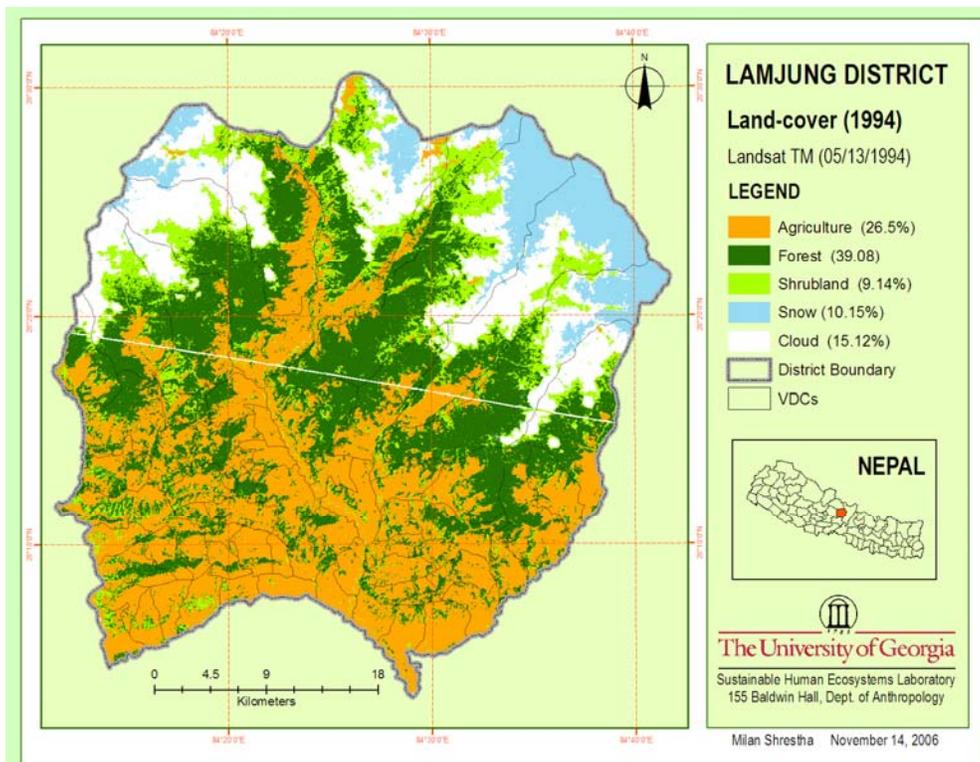
Map 3.1 Land-cover (1976)



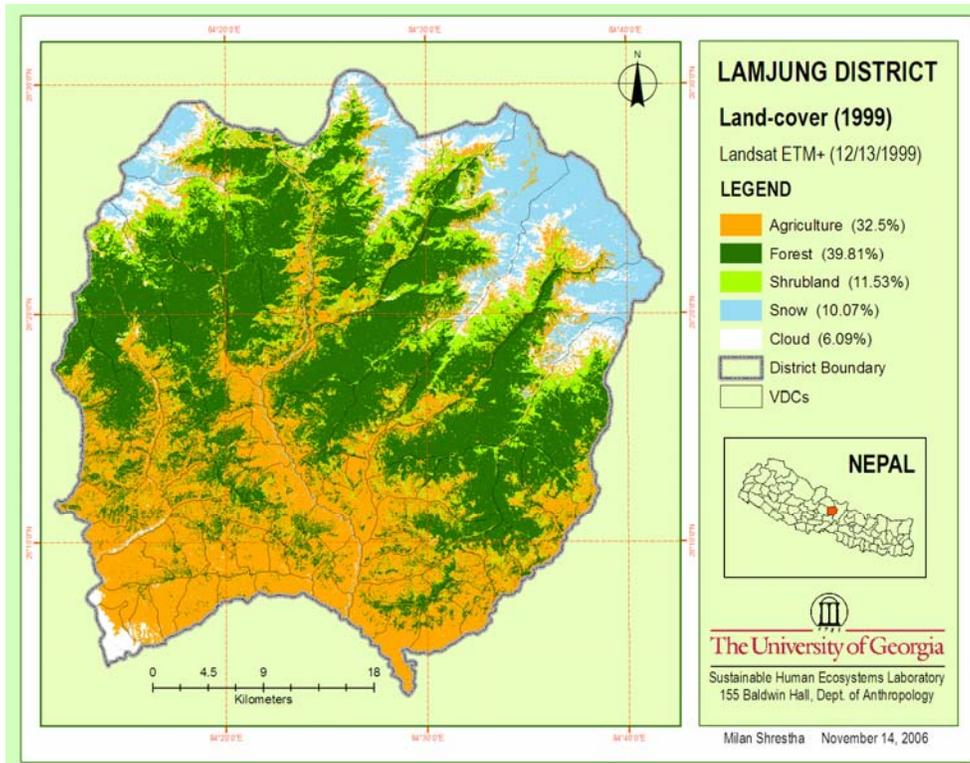
Map 3.2 Land-cover (1984)



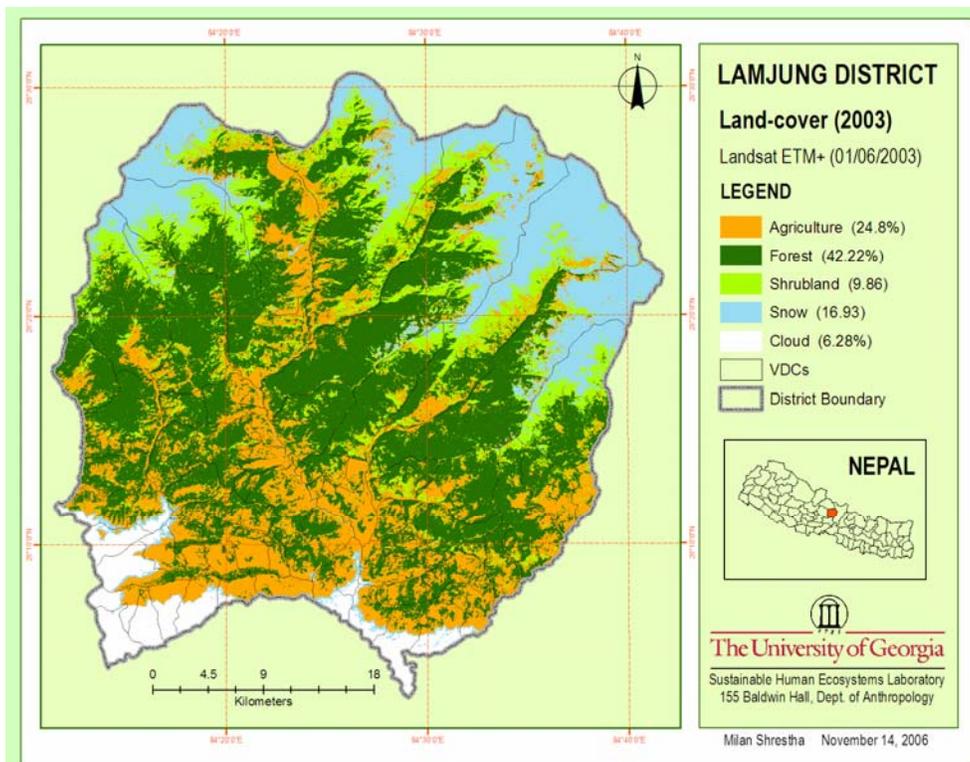
Map 3.3 Land-cover (1990)



Map 3.4 Land-cover (1994)



Map 3.5 Land-cover (1999)



Map 3.6 Land-cover (2003)

The third and last step was ‘output stage,’ in which land-cover maps (Map 3.1 to 3.6), tables of statistics (Table 3.3), digital data files were prepared. In this classification, the Gaussian Maximum Likelihood system, a parametric rule, was preferred as the classifier. This rule incorporates both variance and covariance of spectral response patterns into classification. It is assumed that the distribution of the points is Gaussian (normal distribution). Training samples are described by their mean vector and covariance matrix. Hence, the probability density functions are calculated for each training category. This can set threshold for lowest probability to use in the classification.

Table 3.3 Land-cover change for Lamjung as derived from a time series of Landsat images

		Forest	Agriculture	Shrubland	Snow	Cloud	Total
3 December 1976	(ha)	75582.66	30659.93	37825.21	8130.81	17193.28	169391.88
	(%)	44.62	18.10	22.33	4.80	10.15	100.00
3 February 1984	(ha)	71078.22	41453.82	30098.93	18388.14	8439.90	169459.01
	(%)	41.94	24.46	17.76	10.85	4.98	99.99
10 November 1990	(ha)	64453.68	53078.50	26276.49	15969.32	9747.73	169525.72
	(%)	38.02	31.31	15.50	9.42	5.75	100.00
13 May 1994	(ha)	66221.08	44904.26	15487.73	17199.18	25620.85	169433.09
	(%)	39.08	26.50	9.14	10.15	15.12	99.99
13 December 1999	(ha)	67330.33	54961.48	19494.12	17021.68	10301.38	169108.99
	(%)	39.81	32.50	11.53	10.07	6.09	100.00
6 January 2003	(ha)	71582.57	42047.55	16717.29	28551.65	10647.53	169546.59
	(%)	42.22	24.80	9.86	16.84	6.28	100.00

#### 4. Accuracy assessment

Accuracy assessment of the land-cover maps extracted from the 1984 and 1999 satellite data was carried out in ERDAS Imagine 8.6. Only two land-cover maps were selected as reference data were available for only these two maps. Even in the case of the 1999 map, there were some challenges. Only the topographic maps of 1998 and the aerial photographs of 1996 were available. The problem was that the topographic maps were on two different scales (1:25,000 for

the southern side of Lamjung and 1:50,000 for the northern part) which had to be scanned in 250dpi, mosaicked and georeferenced to the UTM coordinate system (45-N). My familiarity with the different land-cover properties in Lamjung and the knowledge of Lamjung environment provided clues to resolve the confusions with regard to verifying select land-cover type.

Accuracy assessment allow quantifying the data quality so that map users can evaluate the utility of the land-cover maps for their intended applications. Significant progress has already been achieved in developing statistically rigorous assessment techniques, which set the accuracy standards for scientific investigations (Congalton 1988a, 1988b, 1991). The results of such assessments are useful for both the producer and the user of land-cover maps to achieve higher level of data accuracy and integrity.

In general, land-cover classifications from the land-cover or thematic maps are compared to reference classifications, and the extent to which these two classifications agree is defined as map accuracy (Stehman and Czaplewski 1998). The two common measures of thematic accuracy are (1) binomial probabilities and (2) classification error matrix and the associated Kappa coefficient of agreement (Lunnetta et al. 1991). Binomial probabilities are based on the percent correct and therefore do not deal with what are known as ‘producer’s accuracy’ or ‘error of omission’ (i.e., elements omitted by the data producer in the data) and ‘users’ accuracy’ or ‘error of commission’ (e.g., unwanted elements included by the user in the data). A classification error matrix typically presents the overall accuracy, the accuracies of each class and the omission and commission errors (Congalton and Green 1993). It is the product of a discrete multivariate technique, which allows the comparison between land-cover classifications to test if one is statistically better than the other (Congalton 1985).

A kappa coefficient provides a difference in measurement between observed agreements of two maps and the agreement that is contributed by chance. In other words, a kappa means how much the calculated coefficient is better than the random assignments of classes (Congalton 1988a; Lunetta et al. 1991). Some critics, however, believe that a kappa coefficient overestimates the proportion of agreement due to chance and underestimates the overall classification accuracy (Ma and Roland 1995:435). A kappa may not be as accurate as a tau coefficient, since the former only considers the post-classification conditions, while the latter is still based on *a priori* 'equal probabilities' and 'unequal probabilities' group memberships (Ma and Roland 1995; Næsset 1996). In either case, it should be noted that classification systems could be a significant source of error in itself, as classification and delineation schemes play a significant role in determining the level and nature of thematic accuracy on the maps. Some examples include poorly defined or ambiguous class definitions, inability of classification system to categorize mixed, fuzzy classes.

In this study, the accuracy assessments of both the 1984 and 1999 maps were based on a stratified random sampling design. A total of 256 points with the minimum of 10 points for each of the five land-cover classes were selected, which is more than what the 'thumb of rule' applies (i.e., 50 sample points for each class). There were 1024 search counts and all of the stratified sample points were forced within the AOI, so that the reference data could be checked. The land-cover maps were linked subsequently with original Landsat MSS image and reference maps. Each of the sample points was manually assigned to a particular class based on the spectral training signature.

Finally, error matrices for both maps were created based on the number of correctly identified classes out of the total number of sample points (Table 3.3 and Table 3.4). The sums of

main diagonal values were also noted, which allows computing of kappa and tau Coefficients.

Using the following formula, Kapp coefficients and Tau coefficients were computed:

**Kappa coefficient**

$$k = \frac{p_o - p_c}{1 - p_c} \quad [ \text{where } p_c = (\text{row sum}/n) * (\text{column sum}/n) \text{ } p_o = \text{main diagonal sum}/n ]$$

**Tau coefficient**

Equal a priori probabilities:

$$T = \frac{p_o - p_r}{1 - p_r} \quad [ \text{where } p_r = 1/M \text{ in which } M \text{ is total number of classes and } p_o = \text{main diagonal sum}/n ]$$

Unequal a priori probabilities:

$$T = \frac{p_o - p_r}{1 - p_r} \quad [ \text{where } p_r = (\text{column sum})^2 / (n * n) \text{ and } p_o = \text{main diagonal sum}/n ]$$

Table 3.4 Results of accuracy assessment of the 1984 land-cover map, showing confusion matrix, kappa statistics and tau coefficient

Classified Data	Reference Data					Row Total	Users Accuracy (%)	Kappa*
	Forest	Agriculture	Shrubland and Pastures	Snow and ice	Cloud and others			
Forest	<b>92</b>	5	7	0	2	106	86.79	0.7731
Agriculture	4	<b>55</b>	6	5	3	73	75.34	0.6712
Shrubland	11	4	<b>28</b>	1	2	46	60.87	0.5230
Snow and ice	0	0	0	<b>13</b>	1	14	92.86	0.9215
Cloud	0	0	5	4	<b>8</b>	17	47.06	0.4353
Column total	107	64	46	23	16	<b>256</b>		
Producer's accuracy (%)	85.98	85.94	60.87	56.52	50.00			

Number of points correctly classified = 196; Overall Classification Accuracy = 76.56%

\*Overall kappa index of agreement = 0.6719

Equal a priori probabilities: Po = 0.7656 ; Pr= 0.2000; Tau coefficient= 0.707031

Unequal a priori probabilities: Po = 0.7665; Pr=0.2815; Tau coefficient=0.6738

Table 3.5 Results of accuracy assessment of the 1999 land-cover map, showing confusion matrix, kappa statistics and tau coefficient

Classified Data	Reference Data					Row Total	Users Accuracy (%)	Kappa*
	Forest	Agriculture	Shrubland and Pastures	Snow and ice	Cloud and others			
Forest	<b>88</b>	4	9	0	0	101	86.27	0.7860
Agriculture	8	<b>69</b>	3	2	0	82	88.46	0.7720
Shrubland	5	0	<b>26</b>	0	0	31	68.42	0.8106
Snow and ice	0	1	0	<b>23</b>	2	26	63.89	0.8657
Cloud	1	4	0	11	<b>0</b>	16	0.00	0.0079
Column total	102	78	38	36	2	<b>256</b>		
Producer's accuracy (%)	87.13	84.15	83.87	0.00	88.46			

Number of points correctly classified = 206; Overall Classification Accuracy = 80.47%

\*Overall kappa index of agreement = 0.7259

Equal *a priori* probabilities: Po = 0.8047; Pr= 0.2000; Tau coefficient= 0.7559

Unequal *a priori* probabilities: Po = 0.8047; Pr=0.2935; Tau coefficient=0.7236

For the 1984 land-cover map (Table 3.3), the result shows an overall accuracy of 76.56% with the overall producers' accuracy of 67.86% and the overall users' accuracy of 72.58%. It is clear from Table 3.3 that the classification of shrubland and cloud was problematic, compared to forest and agriculture. It is important to reemphasize here that the reference data of LRMP's land-use map (1986) were actually extracted from aerial photograph. Cloud being a temporary feature, classification had be based on the neighboring land-cover class, which may or may not be a correct classification. Similarly, the shrubland could be mixed up with forest. Nevertheless, this map has a kappa index of agreement of 0.6719. The equal *a priori* tau coefficient is 0.7070 and the unequal *a priori* tau coefficient is 0.6738.

The result of the 1999 land-cover map (Table 3.4) shows an overall classification accuracy of 80.47% with the overall producers' accuracy of 68.72% and the users' accuracy of 61.41%.

Again, there were cloud cover and snow features were substantially fewer (no cloud) in reference

map, which resulted in considerably low users' accuracy. Forest and agriculture, on the other hand, were accurately classified. This map has an overall kappa index of agreement of 0.7659. The equal *a priori tau* coefficient is 0.7559 and the unequal *a priori tau* coefficient is 0.7236.

These results indicate that the 1999 land-cover map derived from the Landsat TM gave better accuracy than the 1984 land-cover map based on Landsat MSS data. Except for the temporary features like cloud and snow or ice, major land-cover classes like forest and agriculture were accurately classified. The higher spatial resolutions of ETM+ data might have helped correctly identify those classes; the case also well may be that the ground data collected through 'training sample' survey helped differentiate between forest, agriculture and shrubland. The significance of these results is that it is now possible to know exactly the accuracy level of the land-cover maps developed in this study. When the accuracy of the data generated by such classification and data processing techniques are not known or at least not well documented, it is likely that the errors resulted from these can also be embedded in the final land-cover mapping (Congalton and Green 1993).

Accuracy assessment of land-cover maps of mountain areas can be quite challenging. Aside from the challenges and issues dealt with elsewhere (Millet et al. 1996; Heywood 1994; Shrestha and Zinck 2002), it is also hard to find the correct reference maps of the mountain areas, mainly because very little attempts has been made so far to develop such maps and such studies are even rarer in Nepal. Beside, the reference map used for the 1984 data has also suffered from some errors (i.e., grazing land mixed up with forest and other land-cover types, identification of landslides, which have relatively smaller areas than a possible land-cover as a class). This can certainly be misleading because when reference map is perceived to be correct, 'errors in the interpretation would then be blamed on the digital classification' (Congalton 1991). It clearly

shows the need for high accuracy in the reference data in the first place. Adequate meta-data about the classification schemes, hence, is useful to ensure that both producers and users have the same data model consistency.

The two key challenges faced in satellite image classification in this study were: (1) existence of cloud cover in satellite images and (2) the challenge to identify land-cover classes fallen under the shadows created by high relief. Although the second level polynomial transformation was done to georeference those satellite images, it was very hard to assign classes for those shadow areas purely based on their spectral signatures. Theoretically, it is possible to do what Lillesand and Kiefer (2000:513) call ‘spectral ratioing,’ in which digital numbers of two different bands were compared and contrasted to see the differences, but one has to take a few issues into consideration, such as the spatial resolutions and the accuracy and reliability of the method.

## **5. Land-cover change detection**

This study uses the ‘post-classification’ change detection approach, which uses the multi-temporal satellite images to evaluate differences in land-cover (Singh 1989)<sup>15</sup>. This technique is based on the principle of map-to-map comparisons: it compares two independently produced classified land-cover maps derived from multirate images and produces a full matrix of land-cover changes. It identifies, pixel by pixel, detailed information about the land-cover status and reveals land-cover change patterns in ‘from-to’ direction, providing the area gain and loss for each land-cover type for different years (Tables 3.6 to 3.11). The ability to characterize the ‘from’ and ‘to’ direction is essential to establishing LUCC change trajectories.

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<sup>15</sup> General reviews of the change detection technique are available in Singh (1989) and Lu et al. (2004). Different methods and algorithms used in change detection techniques are discussed elsewhere (Jensen 1995; Yang and Lo 2002; Walsh et al 2001)

The main requirement for this technique is that these two maps are produced accurately to have the same extent and cell size. This technique depends heavily on the high accuracy of land-cover classes, which is one of the disadvantages of this particular technique (Jensen 1996:269). To minimize the problem, different land-cover classes are often aggregated into a binary map (e.g., forest and non-forest) and matrices of changes between two land-cover classes are developed (Mertens et al. 2000). In this study, however, all five land-cover classes were kept separated, mainly because it focuses not on the net deforestation, but more on the spatial and temporal changes in forest, agriculture and shrubland to identify land-cover change trajectories.

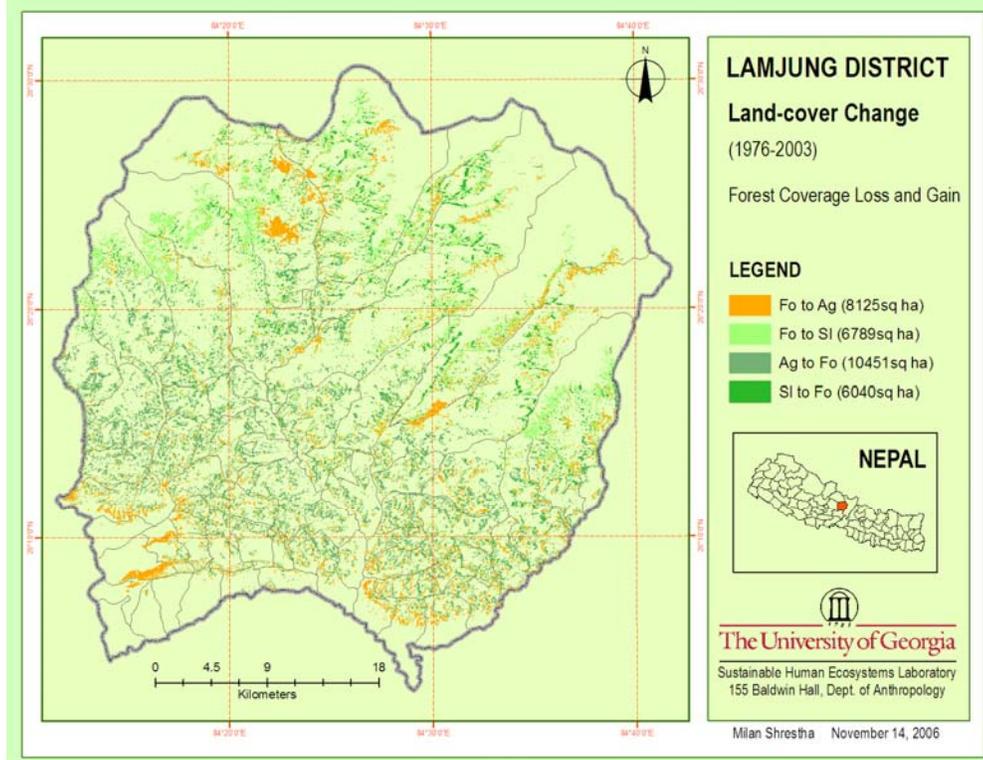
Map 3.7 and Map 3.8 show the area gain and loss for forest and agricultural lands between 1976 and 2003. Similarly, more detailed information on the trade-offs between each land-cover class for different periods are given in Tables 3.6 to 3.11. One of the most visible changes is the significant loss of shrubland and pasture coverage, decreasing from 37,825ha (22.33%) in 1976 to 16,717ha (9.86%) in 2003. What is so significant about this particular pattern of change is that shrublands decreased regularly in each observation year, except for a slight gain of about 2% in 1999. From 1976 to 1984, for instance, shrubland lost about 27,408ha (21.48%), while this class gained only about 30,116ha (17.77%) in the same period. It lost significant area, approximately 10,684ha (6.30%), to forest between the years 1994 to 1999; this is higher than the overall loss of 6,041ha (3.56%) to forest from 1976 to 2003. It lost only 49,0271ha (2.80%) to agriculture during the same period. The overall area gain in shrubland between 1976 and 2003 was 22,442ha (14.03%), of which 9,738ha (5.57%) was intact as shrubland and 6,789ha (4.79%) was gained from forest.

Overall forest area slightly decreased from 75,582ha (44.62%) in 1976 to 71,583ha (42.22%) in 2003. Forest coverage was the lowest in 1990 with only 64,453ha (38.02%) and it started to

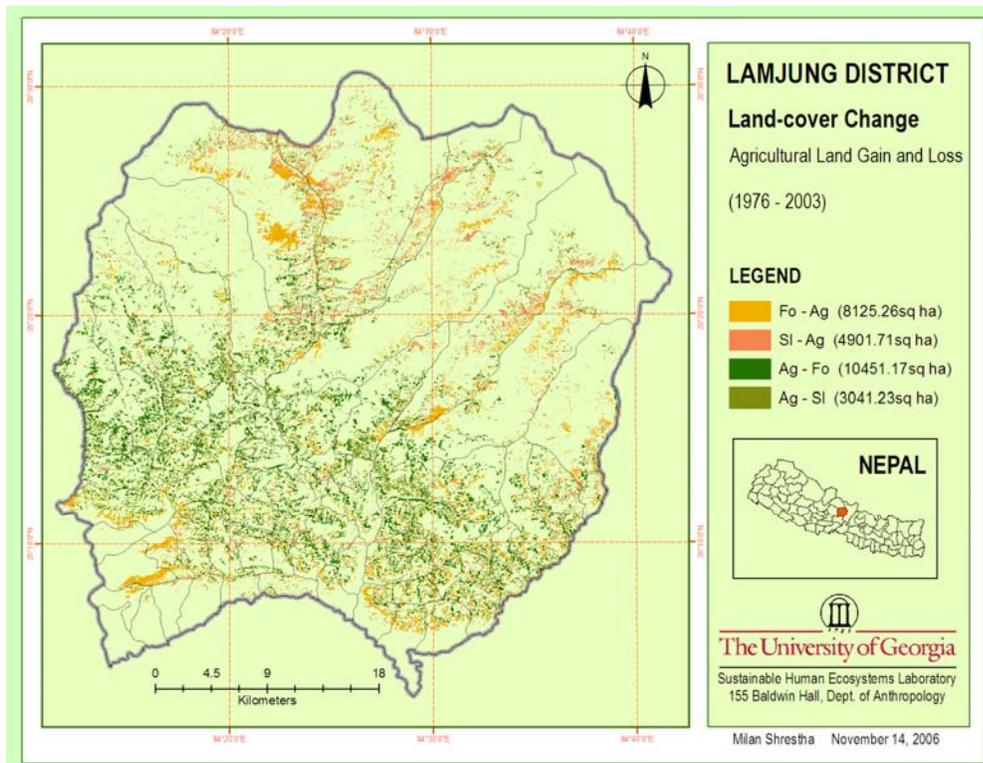
rise slightly but steadily in the subsequent observation years; forest coverage was 66,221ha (39.08%) in 1994, 67,330ha (39.81%) in 1999, and 71,583ha (42.22%) in 2003. In terms of the area gain and loss, there was no significant change for forest coverage, as it gained 71,575ha (42.23%) and lost 70,334ha (41.50%). As for the forest area in each of the observation years, the major loss of 15,658ha (9.24%) to agriculture occurred between the year 1976 and 1984, which is quite significant when the same category is compared for the period 1976-2003. Only about 8,125ha (4.79%) of forest was converted to agricultural land in this period. The spatial expansion of forest between 1976 and 2003 came mainly from agriculture and shrubland, 10,451ha (6.17%) and 6,041ha (3.56%) respectively, even though the cloud cover of 5,553ha (3.28%) in 1976 appears to be converted to forest in 2003.

Another significant and visible change is the gain in area coverage for agricultural lands, which increased from 30,660ha (18.10%) to around 42,048ha (24.80%). It is noteworthy that the 1994 and 2003 images have considerable area under cloud cover in the southwestern part of the district and these are presumed to be under agricultural areas—all other images of 1984, 1990 and 1999 confirm the pattern. Similarly, the 1976 image leaves out a small portion of the southern Lamjung, where agriculture land is noticeably the dominant class. These certainly have slightly reduced agricultural land coverage shown for those years and it slightly affected both the total gain and loss. While agricultural lands expanded from 30,660ha (18.10%) in 1976 to 41,454ha (24.46%) in 1984 and to 53,079ha (31.31%) in 1994, it also lost the total of 40,369ha (23.81%) from 1976 to 2003, mainly to forest as mentioned above.

The results of NVDI detection (Map 3.9 and 3.10) also support the fact that despite some indications of vegetational changes in the last forty years, deforestation did not occur at the rate and patterns as reported in the HED. In fact, vegetation seem to have consolidated in 2003.



Map 3.7 Forest coverage loss and gain (1976-2003)



Map 3.8 Agricultural area gain and loss (1976-2003)

Table 3.6 Land-cover change matrix (1976 to 1984)

		1984					
		Forest	Agriculture	Shrubland	Snow	Cloud	Area Lost
1976	Forest	42432.51	15658.01	9757.17	1003.42	1483.23	70334.33
	(%)	25.04	9.24	5.76	0.59	0.88	41.51
	Agriculture	11063.99	19562.37	7136.78	1122.17	1483.48	40368.77
	(%)	6.53	11.54	4.21	0.66	0.88	23.82
	Shrubland	9629.64	6499.33	7959.20	1262.59	2057.07	27407.83
	(%)	5.68	3.83	4.70	0.74	6.53	21.48
	Snow	1413.80	2469.67	632.75	1646.90	2004.76	8167.88
	(%)	0.83	1.46	0.37	0.97	1.18	4.81
	Cloud	6541.67	5738.96	4629.60	3185.47	3091.96	23187.66
	(%)	3.86	3.39	2.73	1.88	1.82	13.68
	Area Gain	71081.60	49928.33	30115.50	8220.54	10120.50	169466.47
	(%)	41.94	29.46	17.77	4.84	11.29	

Table 3.7 Land-cover change matrix (1984 to 1990)

		1990					
		Forest	Agriculture	Shrubland	Snow	Cloud	Area Lost
1984	Forest	37886.26	16839.36	14210.21	1256.36	889.40	71081.60
	(%)	22.35	9.94	8.38	0.74	0.52	41.93
	Agriculture	7856.20	32169.73	5036.49	3564.10	1302.06	49928.58
	(%)	4.64	18.98	2.97	2.10	0.77	29.46
	Shrubland	6703.43	13400.48	6002.77	1674.96	2333.86	30115.50
	(%)	3.96	7.91	3.54	0.99	1.38	17.78
	Snow	242.80	913.64	881.49	4579.17	1611.20	8228.31
	(%)	0.14	0.54	0.52	2.70	0.95	4.85
	Cloud	373.17	1120.71	1492.10	4902.26	2241.19	10129.44
	(%)	0.22	0.66	0.88	2.89	1.32	5.97
	Area Gain	53061.86	64443.93	27623.06	15976.86	8377.72	169483.43
	(%)	31.31	38.03	16.29	9.42	4.94	

Table 3.8 Land-cover change matrix (1990 to 1994)

		1994					
		Forest	Agriculture	Shrubland	Snow	Cloud	Area Lost
1990	Forest	29946.17	11928.98	7252.83	199.05	3734.84	53061.86
	(%)	17.67	7.04	4.28	0.12	2.20	31.31
	Agriculture	12927.20	42158.71	5612.78	690.97	3038.51	64428.17
	(%)	7.63	24.87	3.31	0.41	1.79	38.01
	Shrubland	7619.85	1717.84	7831.25	825.95	9628.17	27623.06
	(%)	4.50	1.01	4.62	0.49	5.68	16.30
	Snow	227.34	126.08	1305.71	10215.62	4102.12	15976.86
	(%)	0.13	0.07	0.77	6.03	2.42	9.42
	Cloud	308.00	124.17	751.28	1959.39	5234.88	8377.72
	(%)	0.18	0.07	0.44	1.16	3.09	4.94
	Area Gain	51028.55	56055.78	22753.84	13890.98	25738.52	169467.67
	(%)	30.11	33.06	13.42	8.21	15.18	

Table 3.9 Land-cover change matrix (1994 to 1999)

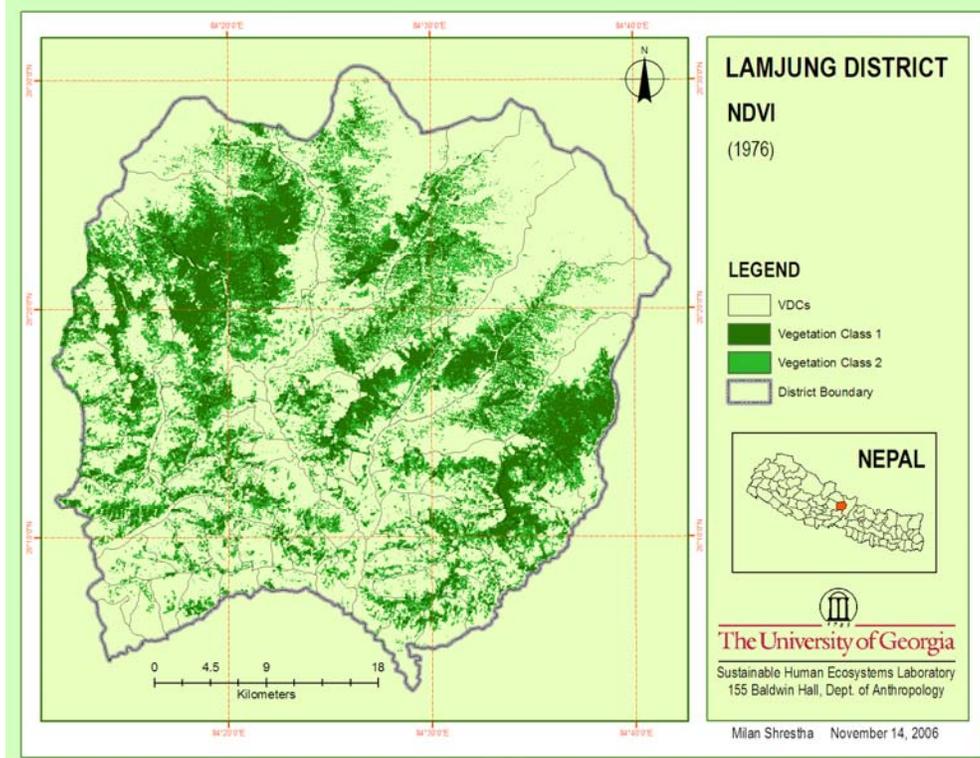
		1999					
		Forest	Agriculture	Shrubland	Snow	Cloud	Area Lost
1994	Forest	34971.99	10523.92	4969.46	84.67	478.51	51028.55
	(%)	20.63	6.21	2.93	0.05	0.28	30.10
	Agriculture	14446.41	34829.26	4802.82	412.98	1564.31	56055.78
	(%)	8.52	20.55	2.83	0.24	0.92	33.06
	Shrubland	10684.04	5266.94	4493.30	636.22	1673.33	22753.84
	(%)	6.30	3.11	2.65	0.38	0.99	13.43
	Snow	119.02	542.07	84.23	11750.61	1395.06	13890.98
	(%)	0.07	0.32	0.05	6.93	0.82	8.19
	Cloud	7168.34	3884.62	5282.83	4165.36	5237.39	25738.52
	(%)	4.23	2.29	3.12	2.46	3.09	15.19
	Area Gain	67389.80	55046.81	19632.63	17049.83	10348.60	169467.67
	(%)	39.75	32.48	11.58	10.06	6.10	

Table 3.10 Land-cover change matrix (1999 to 2003)

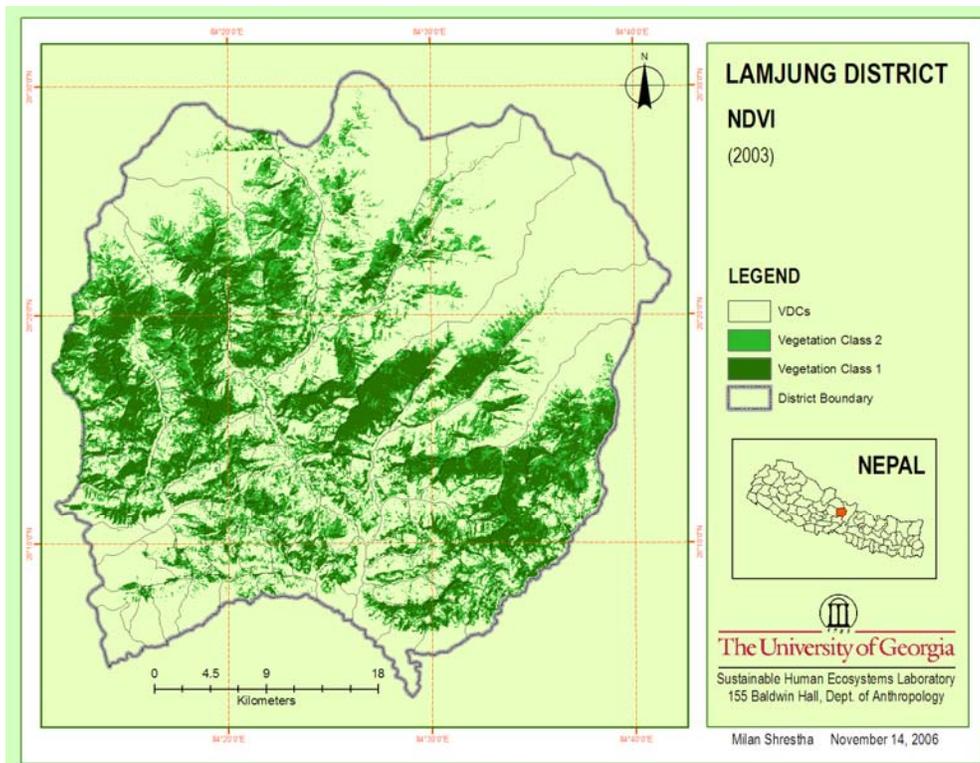
		2003					
		Forest	Agriculture	Shrubland	Snow	Cloud	Area Lost
1999	Forest	51881.42	6108.19	8131.94	1142.20	126.05	67389.80
	(%)	30.61	3.60	4.80	0.67	0.07	39.75
	Agriculture	14004.74	25634.91	4399.07	4029.94	6993.84	55062.50
	(%)	8.26	15.13	2.60	2.38	4.13	32.50
	Shrubland	5190.96	4817.96	7453.50	2138.36	31.89	19632.66
	(%)	3.06	2.84	4.40	1.26	0.02	11.58
	Snow	229.70	919.51	661.97	15144.66	94.02	17049.85
	(%)	0.14	0.54	0.39	8.94	0.06	10.07
	Cloud	268.66	832.69	1795.32	6238.67	1213.28	10348.62
	(%)	0.16	0.49	1.06	3.68	0.72	6.11
	Area Gain	71575.48	38313.26	22441.80	28693.82	8459.07	169483.43
	(%)	42.23	22.60	13.25	16.93	5.00	

Table 3.11 Land-cover change matrix (1976 to 2003)

		2003					
		Forest	Agriculture	Shrubland	Snow	Cloud	Area Lost
1976	Forest	48454.81	8125.26	6789.04	4090.25	2874.97	70334.33
	(%)	28.59	4.79	4.01	2.41	1.70	41.50
	Agriculture	10451.17	17938.22	3021.23	5122.55	3835.60	40368.77
	(%)	6.17	10.58	1.78	3.02	2.26	23.81
	Shrubland	6040.53	4901.71	9437.54	6847.35	180.71	27407.83
	(%)	3.56	2.89	5.57	4.04	0.11	16.17
	Snow	1075.49	1066.95	333.09	4928.12	764.23	8167.88
	(%)	0.63	0.63	0.20	2.91	0.45	4.82
	Cloud	5553.48	6281.12	2860.90	7688.60	803.55	23187.66
	(%)	3.28	3.71	1.69	4.54	0.47	13.69
	Area Gain	71575.48	38313.26	22441.80	28676.87	8459.07	169466.47
	(%)	42.23	22.60	14.03	16.92	4.99	



Map 3.9 NDVI of 1976



Map 3.10 NDVI (2003)

(Differences in vegetation cover between 1976 and 2003 are visible in the form of 'forest area consolidation' in the 2003 image)

## 5. Results

The results of the change detection method exhibit three district-level land-cover change patterns (Figure 3.3). First, there was a steady decline in shrubland coverage in each observation year because the substantial expansion of forests occurred in remote parts of northern VDCs like Ghermu, Bhulbhule, Bahundanda, Bansar, Faleni and Dhodeni. This particular pattern of land-cover change, however, did not contribute much to the overall forest coverage expansion, because the forest area in fact decreased from 1976 to 1990 before gaining the area at regular intervals.

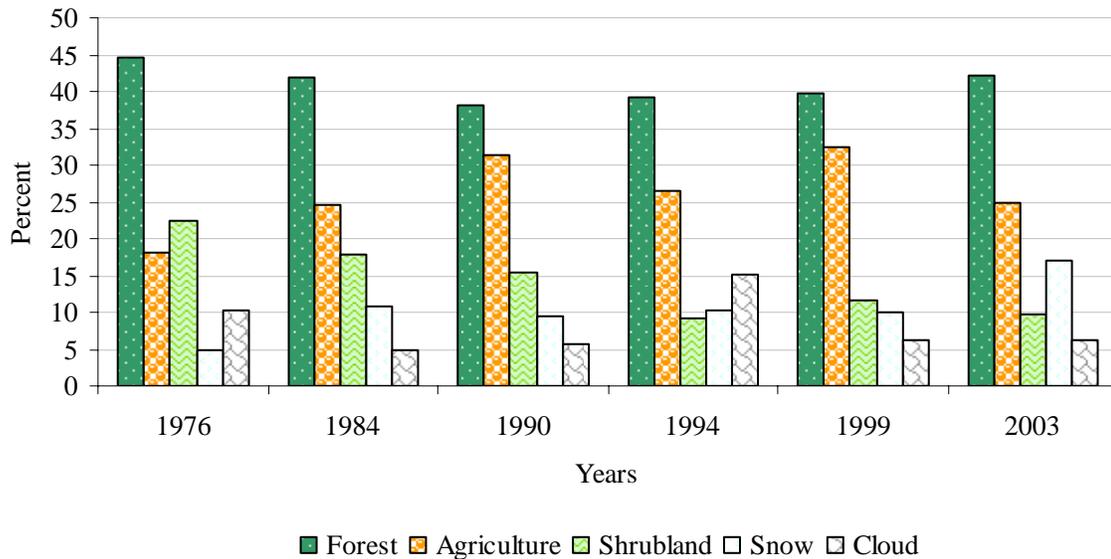


Figure 3.3 Land-cover changes (1976-2003) in Lamjung district

The second land-cover pattern is the dynamic changes in the forest cover. Although the overall forest coverage slightly decreased during 1976 -2003, there were significant changes in-between. There were subtle and dynamic trade-offs between forest, agriculture and shrubland, as noted in the land-cover change matrices (Table 3.6 to Table 3.11). On the declining trend in early observation years, especially from 1984 to 1990, forest coverage started to gain after 1990. In the

early period (1976–1994), most of the forest loss was mainly due to the expansion of agricultural lands in Bhoje, Bangre, Khudi, Faleni and Dhodeni VDCs. All of these VDCs except Khudi experienced deforestation in the foot slope and valley floors. Forest loss in lower valley areas, such as Besishahar, Bhotewodhar, Sundarbazar, Dhamilikuwa, Gaunshahar and Hiletaxar is due to the newly built Dumre-Besishahar Road. Nevertheless, this deforestation trend does not match the widely-reported deforestation processes in other parts of Nepal. In other words, overall deforestation in Lamjung occurred at much slower rate than the national average in this period.

In recent years, especially after the initiation of the community forestry program in the mid-1990s there has been a growing trend of ‘forest consolidation.’ Aside from existing forests, any shrubland, grassland, wasteland, or any public land in slopes was now under the interest of the community forestry program. The major concentration of forests in recent years has been in the middle part of the district, mainly in the lower part of Bansar, Faleni, Bhanjhakhet, Ghanpokhara and Khudi. The highest proportion of VDC area under forest in 2003 was recorded in Bansar (68.76%) and the lowest in Parewadanda (9.5%).

The third and perhaps the most important trend is the gradual expansion of agricultural land in each observation year from 1976 to 1994. In this period, agricultural area expanded mostly in the upper slopes of Khudi, Bhoje, Bangre, Faleni and Dhodeni VDCs. Around the early 1990s, valley floors and footslopes along the Dumre-Besishahar Road and major rivers like Marsyandi, Madi, Midim, Dordi, Nyagdi and Chepe were recorded to have expanded. Although the 2003 image shows decreasing agricultural land coverage, it should be attributed to the significantly large portion of cloud cover in the southern part and snow cover in the upper parts of Faleni, Bhulbhule and Dudhpokhari VDCs.

## 6. Conclusions and significance

Within land change science, remote sensing plays such a pivotal role that it is improbable to address one of its main objectives—document and monitor land-cover changes—without applying remote sensing data and techniques. Remote sensing is by no means a panacea, so the users must be aware of the potential as well as the limitations of each data and technique included in the analysis. Several remote sensing analysis issues have been recognized and documented in the land change science, such as scale, accuracy assessment, different data collection and linking methods and spatial autocorrelation (Rindfuss et al. 2004). One of the main limitations of remote sensing is that the “ontological aspects of determining what features are to be included in each of land-cover classes” have not been adequately addressed (Comber et al. 2005). Ideally, the producers and the users should have the same standard information to land-cover classifications. Given that this is often not the case in the real world, one way to minimize the error is to realize that “the potential bias may arise when ancillary data used to improve a spectral classification are also used to explain land class variability” (Rindfuss et al. 2004:13979). This is the reason proper documentation of land-cover classes and meta-data has been stressed so highly in the land change science.

The interpretation of land-use classes was difficult, mainly because high relief could lead to topography-related image distortions as topographic slope and aspect influence the natural spectral variability within any particular land-cover classes. Simply put, the reflectance in mountainous areas is dependent on many vegetative and terrain features. To address these limitations related to land-cover classifications, accuracy assessments of two land-cover maps of 1984 and 1999 were carried out, which confirmed that the image classification procedures

followed in this study were not perfect—given the challenges one faces in conducting remote sensing of mountain areas, but these still were effective in extracting land-cover maps.

As mentioned in the accuracy assessment section, separating fragmented forests and forest edges from shrublands in the Landsat MSS satellite images with coarse resolutions was a challenge. In addition, the presence of cloud cover, cloud shadows and snow caused some problems. Nevertheless, the same patterns of land-cover change were also found in the ICIMOD (1996) and LRMP (1986) for the periods included in this study.

To recapitulate the results of land-cover change detection in this study, the most significant change from 1976 to 2003 is in the dynamic transitions in forestland against shrub and grassland and the expansion of agricultural land in early periods. It exhibits a highly dispersed land-cover change pattern. The increase in forestland can be attributed to the overgrowth of shrub vegetation into forestland due to the declining pressure from grazing and the initiation of community forestry. In addition, there are evidences that the abandoning of some cultivated land also contributed to gain in the forest area after 1994. In all these, what is very important to note is that deforestation in Lamjung did not occur at the rate and pace as claimed in the HED. In fact, there have been in the reversals in deforestation, especially after the 1990s.

The significance of this study is that the major land-use inventories carried out in other *Pahad* and *Himal* regions of Nepal also reveal similar patterns of land-cover changes. LRMP study (1986) presents the most comprehensive picture available to date on the extent of forested area and the loss of forest cover in the different geographic regions of Nepal since 1964. A comparison of aerial photographs dating from 1964 to 65 and 1973 to 79 suggests a loss of 42,000 ha (1.5%) of the forest in the *mountains*. This represents an annual loss of 0.11% over thirteen years, which is a significant figure. In spite of the likely occurrence of some degree of

error in the identification and measurement, the LRMP figures do provide the most reliable existing data on land-use and land-cover in Nepal. Besides, many other case studies confirm the conclusions of the LRMP study that little or no land was converted from forest to cropland expansion (Macfarlane 1976; Mahat et al. 1987; Metz 1991; Schroeder 1977; Zurick 1988). Major losses of forestland have occurred in the lowland part of Nepal, the Tarai and the Inner Tarai of the Siwalik mountains.

Similarly, Schreier et al. (1995) reports that after the late 1960s forests are either 'stable' or gaining in total area cover. Even where deforestation occurred, the losses have been reversed in both forest areas and tree density; however, the quality of the existing forest is suspect. Most of the increased forest areas, however, are reclaimed mainly by pine tree (*Pinus roxburghii* and other *Pinus spp*) and similar types of fast growing trees (Gilmour 1987; Gilmour and Fisher 1991). During the same period, evidently, the total shrublands and grazing land cover decreased (LRMP 1986; Schreier et al. 1995). Shrublands and grazing lands/pastures are vital components of subsistence farming especially for land poor farmers. The total cover and quality of grassland/pastures and shrublands were also decreasing, mostly converted to crop lands. In 1978, 49.8% of the Himal, 68% of the *Pahad* and 48% of the entire country's potentially productive forest and pastureland were in poor condition.

While the forest cover was not decreasing at the presumed rate, modifications in forest use and cover with degradation of forest resources have been taking place significantly (Carson et al. 1986). An important observation was that the total crown cover of forests, which signifies the quality of forest, was also decreasing. Major decreases in crown cover occurred in all areas during 1965-79, suggesting forest resources degradation.

It is clear that the HED dramatized deforestation in Nepal so much that many important changes and trade-off within land-use categories were overshadowed. Oversimplification and overgeneralization of deforestation took the attention away from the changes occurring in grasslands and shrubs—these two land-cover categories that are vital components of mountain smallholding in Nepal. In this study, hence, the emphasis was given to identify and quantify the trade-off between different land-cover categories because it helps better understand the complexity of smallholders' land-use strategies and their consequences on land-cover.

The trajectories of land-cover change in Lamjung showing dynamic transitions between forest, agricultural land and shrublands over the last four decades suggest that there is no linearity of land-cover change as generally assumed (i.e., irreversible conversions of forest and shrublands to agricultural land). These land-cover changes are in fact non-continuous in space, leading to complex landscape mosaics and overlapped patchworks in the district. The results also reiterate the basic premise of this study that we must look beyond the popular notion that conceives land-cover change as simple and irreversible conversions from one cover type to another.

The land-cover change patterns detected in this case make a strong case to look into possible results of expanding human actions in the form of land-cover modification activities—the main focus of this study. The changes in forest, agricultural land and shrublands have occurred during the same period when the district was going through transformations in smallholding, shifting agricultural preferences among smallholders and initiation of forest conservation efforts like community forestry. In other words, explanations of such complex patterns of land-cover change arguably are not in the land-cover conversion process, but in the modification activities that give rise to a highly dispersed pattern of land-cover change. The forthcoming chapters, hence, focus

on providing detailed discussions on why and how the modifications in agricultural land-use strategies occurred within historical context of this mountainous landscape. In addition, the proximate causes and the driving forces of LUCC detected in Lamjung are subsequently explained

In terms of explaining the human dimensions of these land-cover changes, I will explore how and under what conditions smallholders land-use strategies are changing in the village in Chapter 5 and 6. However, it is also important to get insights into how these land-cover changes contribute to the debate surrounding the human dimensions of environmental change in the whole Nepal Himalaya range.

As Hrabovszky and Miyan (1987) propose, a study of the relationships between population growth and land-use is clearly essential for the middle hills of Nepal. Although most analyses identify population growth as a determinant of deforestation or deterioration of forest resources, considerable disagreement exists on the magnitude and the direction of the causal link. Population pressure typically is perceived as a macro-level carrying-capacity problem that establishes an absolute relationship between natural resource production capabilities of an area and the resource needs of a resident population. Nevertheless, as Shrestha (1990) suggests, the population pressure problem requires a clear understanding of resource scarcity in socioeconomic, institutional and physiographic contexts. In any case, one way or another, population growth is one of the underlying driving forces.

I believe the primacy of population, affluence and technology (PAT) variables—three major components of a macro-level framework of analysis, is not clear-cut in this region. Each is somehow related to the change, however. They interact with each other and with other variables, such as, poverty, political and economic forces and cultural strategies of the local people. These

interactions trigger a combined effect or 'synergism.' The level of affluence itself is not a significant contributing factor; rather poverty is being recognized as one of the primary forces of changes (Metz 1991; Turner et al. 1995).

Jodha (1995) presents the overall problem of environmental change as a combined effect or synergistic effect of population, political economy and poverty. In his view, these middle hills have a long history of consumption based cultivation practices and pastoralism. Population and poverty have grown at the same time that the country has sought to develop markets. These forces have combined to influence a government policy of market-oriented development aided by subsidized infrastructure and technical inputs. Perhaps the most important in this policy has been the change in resource allocation rules, which leads to a dramatic shift from traditional rules of allocation (common property) to private ownership (cropland) and state control (e.g., protected forests) and the behavioral changes associated with the increasing commodity production. At the same time, different forms of technology (e.g., innovation and intensification in agriculture, expanding market-based economy as roads were constructed, frontier expansion of settlement/migration and demand for more external inputs), indeed, have indeed influenced the patterns of change.

As population pressure increased and government's policies took a shift innovation in mountain agriculture encouraged expansion of cultivated land. Regmi (1978), for example, suggests that the introduction of maize and potato in Nepal in the early 18th century increased the productivity of rainfed fields sufficiently to encourage the population to grow them (1978: 8). After the 1950s, agricultural innovations in terms of external inputs (e.g., seeds, fertilizer, extensions and locally unavailable food supplies) and the introduction of cash crops intensified the subsistence (consumption-based) production system experienced significant influences of

wider cash economy. Allan (1995) maintains that the penetration of motor roads has integrated Western Himalayan subsistence communities into the market economy of the lowlands and changed their basic production pattern to conform to the wage-earning opportunities present in the lowlands. There are, however, some other skeptics, (e.g., Blaikie 1988; Blaikie and Brookfield 1987) who state that either smallholder cannot afford inputs necessary for agricultural intensification or these are not available to them. It is still hard to deny that the current trends of agriculture intensification are pushing farmers toward intensification while there is lack of adequate inputs.

The PAT variables and their interactions with other socioeconomic factors complicate the nature and severity of environmental change. On the production side, despite the introduction of new types of food (e.g., potato, wheat, maize, etc.) and high-yielding varieties, little improvement is to be found in most parts of the hill region. Food shortages, especially in the middle hills, occur with increasing frequency. Ives and Messerli (1989) believe that the improvements did not keep pace with population growth. In addition, on the adaptive strategy side, just as in many other highland regions of the world, one of the adaptive responses to growing population pressure is to migrate to surrounding Tarai, both in the form of rural-to-rural and rural-to-urban migration. Schroeder (1985: 33) notes that the consequent pressure for land in the hills led either to the commencement of migration of peasants to the Tarai or in the direction of intensifying existing crops and techniques while maintaining farmers' subsistence orientation. In such cases, increase in resource extractive measures is quite possible but not inevitable.

Some researchers think that the relationship between environmental degradation and size of human population is not linear but is structured by social institutions that express the power relations of various groups within society (Blaikie 1988; Metz 1991; Zurick 1988). Unequal

access to land and the resulting poverty and vulnerability of families, for example, are factors that drive population growth. Both environmental degradation and rapid population growth are fostered by poverty. At the same time, they cannot deny that rising population is a component of increased vulnerability, but they argue that demographic processes themselves are largely a reflection of people's individual responses to the opportunities and uncertainties presented to them by broader socioeconomic processes. To alleviate these serious problems, therefore, we must begin with an analysis of how social institutions influence individual and group use of resources and micro-economic factors which favor large families. As Metz (1991) observes, the inclusion of political-economic as well as environmental factors not only provides a more accurate explanation, but also allows for effective policy initiatives.

## CHAPTER 4

### SMALLHOLDERS AND MOUNTAIN AGRICULTURE

“चरी बास्यो चिरीविरी कण्ठ फुकाएर,  
कति बसौं भुजुङ्गेले दुःखै लुकाएर।  
घनपोखरा उक्लौं भने बाटो छेक्ने भीर छ  
लेकै काटी जाँउ त भने अन्नपूर्ण शीर छ।  
भुजुङ्गेको कर्ममा नौलो भाग्य रेख होला कि नहोला  
मिदिम खोला, खरानी चोला मनको मैलो धोला कि  
नधोला।...”

“The bird started chirping melodiously,  
how long should we, the *Bhujunge*, hide our misery  
Should we ascend to *Ghanapokhara*, a steep slope blocks the way,  
if we decide to go across the *lekh*, *Mt. Annapurna* stands ahead.  
No body knows if a new destiny awaits the *Bhujunge*,  
whether the *Midim Khola*, this mortal life can cleanse dirt from the  
soul.”

(Rough translations of a folk song of Bhujung village<sup>16</sup>)

Life is tough in the mountains. Hardly anyone would disagree that to live in the mountains smallholders have to adapt to the extremes imposed by the mountain environments (i.e., marginality, rugged terrain, cold climate, short growing seasons, etc.), and they need to do so in such a way that enables the crop growing potential to be harnessed properly and adequately. Mountain smallholders often complement their agricultural harvests with off-farm income sources (Rhoades and Thomposon 1975; Brush 1976; Guillet 1983; Orlove and Guillet 1985; Steven 1993). The research sites of this study and many other villages located in the mountains of Lamjung share many features of subsistence economy with mountain peoples in other parts of the Himalaya and the world. Their way of life reflects adaptation to the environmental conditions of their mountain homeland. Similarly, their land-use strategies and agricultural practices exhibit the nature and characteristics of their way of life.

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<sup>16</sup> Bhujung is a VDC located north of Maling VDC and the inhabitants of the village are called Bhujunge. The Midim Khola is a tributary that flows through Bhujung, Maling and then merges into the Madi River in Ishaneshwor and Borletar VDC. Ghanapokhara is also a VDC located east of Maling. The south-eastern side of Mt. Annapurna II (7,925m) lies north of Bhujung VDC in Manang district.

This chapter first introduces the cultural ecology of smallholding, mountain agriculture and land-use practices in mountain regions. Starting with the concepts of verticality and the context of agricultural change in the mountains, the historical altitudinal land-use strategies and agricultural production zones are examined. This in turn, sets the background for a closer look at the characteristics of smallholding and its transformation process in Lamjung. Specifically, the chapter addresses the question of how the different components of smallholding and the patterns of altitudinal land-use are changing in recent decades and what is the impact of these on land-cover. In the process, it situates smallholder agriculture within the larger context of human adaptation to the mountain environment of Lamjung.

### **1. The verticality concept and land-use strategies in the mountains**

Does the verticality concept<sup>17</sup> have any relevance to the LUCC studies of the mountains? How and under what circumstances does the concept help highlight the changing cultural-ecological contexts of smallholding and agricultural land-use strategies? Answers to these questions provide the background for the reasons why LUCC as well as agricultural transformation processes in the mountain area are so distinct from the plains.

As one of the key features of the mountain areas, ‘verticality’ is vital to a mountainous landscape like that of Lamjung. A significant rise in altitudes (i.e., from about 596masl to 7,893masl) within short distances of the latitude (i.e., approximately 30-50km) gives rise to different ecological zones, microclimates, and hence, cultural groups adapting to different elevation zones. To understand the relevance of the verticality concept, however, it is very

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<sup>17</sup> The ‘verticality’ concept has long been used interchangeably with ‘altitudinal gradients,’ ‘altitudinal zonation,’ ‘tiered zonation’ or ‘elevation zonation’; however, it is noteworthy that each term has the contextual meaning in their respective fields and simplification/generalization may obscure such contextual meanings.

important to trace its origin and uses in other mountain areas of the world. This would allow relating how the concept is relevant in this study and understand the critiques of the concept so that new insights can be gained for further consideration.

The verticality concept is one of the highly contested issues among social scientists studying mountain communities and environments. While the concept has not been as widely accepted in social sciences as in natural sciences, John Murra (1988) was the first to introduce the concept of ‘verticality’ back in the 1970s. He used it to explain the Inca Empire’s success in the effective control of different ‘production zones’ (or ‘ecological floors’) and ‘archipelagos’ located in far far remote areas. He claimed that the impressive expansion of the Inca Empire was made possible by the effective use of *vertical control*, which was done through mutual concessions, conquest and subordination or through colonists sent from the center. The main idea was to control the largest possible number of ecological zones at different elevations in an effort to achieve their ideal self-sufficiency.

Many mountain anthropologists have reiterated the relevance of the verticality concept to the mountain regions of the world; in fact it was considered as a key variable in the mountain ‘cultural-adaptation model’ that emerged in the 1970s and early 1980s (Rhoades and Thompson 1975; Brush 1976; Guillet 1983; Orlove and Guillet 1985). The verticality, as expressed in the homogenous layer of topography, climate and vegetation, is a distinct feature of the mountains. Its basis is on the same elevation or vertical dimension (3-D) features that make the mountain so distinct.

As shown in Figure 4.1, the elevation layers in this model imply similar topography, vegetation and climate (i.e., temperature, atmosphere and precipitation). However, I believe the verticality concept was so oversimplified over the years that the focus was only on ‘tiered

zonations' leading to familiar, simplified representation of the stacked 'layer-cake-like' units of mountain, as shown in Figure 4.1

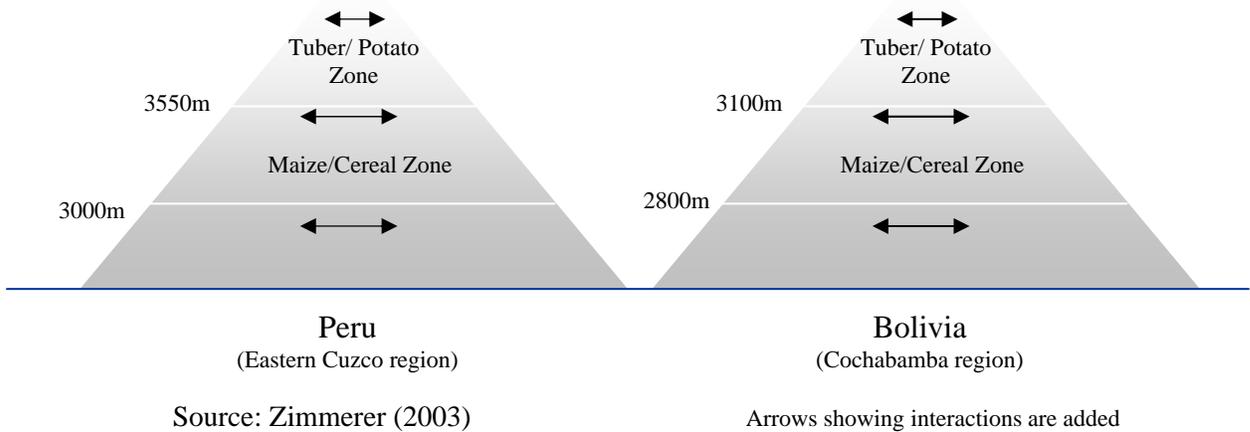
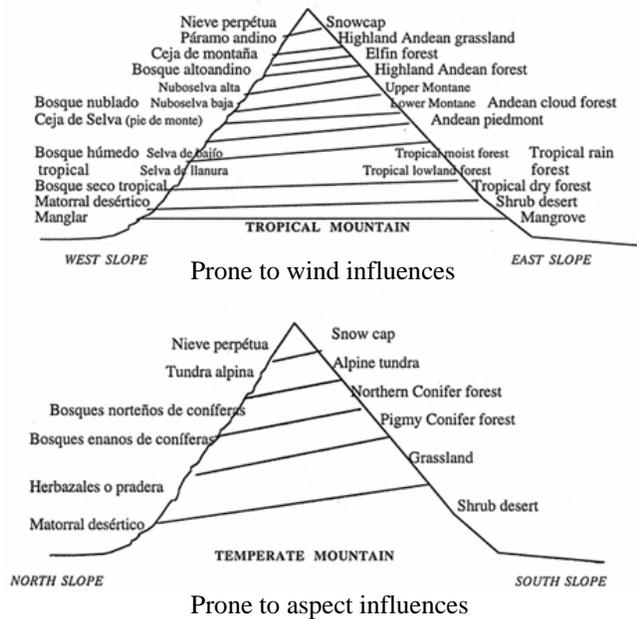


Figure 4.1 Zones of land-use as represented in a simplified version of verticality



Source: Sarmiento (2000)

Figure 4.2 Verticality model with ecological/ecotonal focus

One of the main critiques of this model is that it “presupposes the determining influence of decision-making among mountain farmers that optimizes productivity and risk aversion based on elevation-controlled factors of the mountain environment” (Zimmerer 2003). The most active interaction is limited within the specialized altitudinal zone, not between the zones. Because of oversimplification, it evokes an image of a rigid model of spatio-environmental organization in the mountains, as though these discrete layers in reality are organized in the same way everywhere. The policy implications of transmitting such images can be powerful and seductive that it somehow injects an idea of universality, which often ignores the diversity and contextual contingency within.

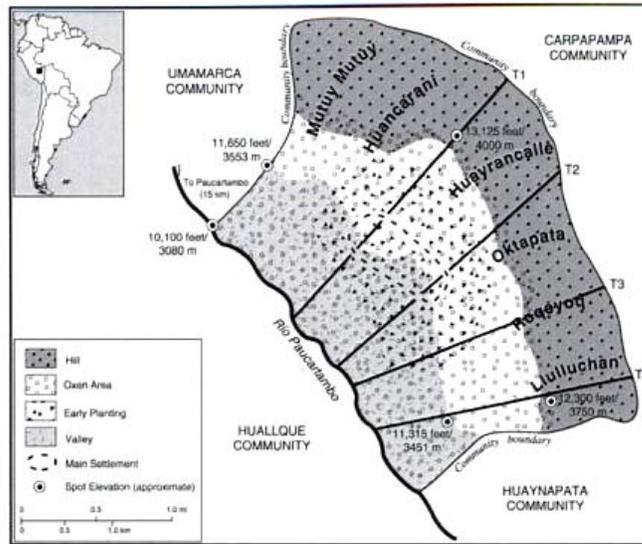
There have been several attempts to represent the diversity within the mountains in variants of verticality models. In one such attempt, Sarmiento (2000) develops a landscape model that uses Eugene Odum’s ecotonal properties of different ecosystems (Figure 4.2). His model considers the aspect and wind-driven influences with a set of more complexes, varied layers, and hence, proposes two different models for temperate and tropical mountains.

These verticality models are however, have several critiques, just like many other concepts that highlight ‘biogeography’ or ‘environmental determinism.’ Goldstein and Messerschmidt (1980) argue that the verticality concept should also consider latitudinality, since a larger category of non-vertical or horizontal factors is often utilized in human adaptation to mountain environments. Allan (1986) criticizes both the ‘altitudinal zonation model,’ specifically of Carl Troll (1968) and the ‘verticality’ model. He argues that these are very similar in the sense that both are influenced by biogeographic and landscape ecology models that tend to emphasize the environmental determinism. His main argument is that the mountain communities, especially the Alps and the Western Himalaya, have been swept by what he calls ‘increasing accessibility,’

because of expanding road networks, growing tourism industry and increasing penetration of wider market economy, eventually leading to socioeconomic transformation of rural hinterlands. As an alternative, he suggests his own ‘accessibility’ model and the idea of ‘highland-lowland’ linkages (Allan 1986), in which he attempts to show how mountain communities are being integrated into the global market through expanding road network, market and infrastructure developed in the near-by gateway towns and how these towns have an impact on resource extraction in the mountain areas.

While Allan (1986) is harsh and controversial in his critique of altitudinal zonation models, he is right about the growing influences of the ‘globalization’ on the mountain communities. There is no denying the fact that expanding accessibility brings enormous changes in mountain landscapes. It integrates mountains with the plains and beyond, often opening the hinterlands mainly for resource extractions by the plains and creating unequal economic relations. This idea was resonated by Jodha (1995 and 2003) that the highland and lowlands are linked through resource flows (i.e., maintains being the water towers, river, forest products, etc), services (i.e., labor supply) and products (i.e., commodities from plains to highlands).

Some of the recent critiques, however, have slightly different perspectives. One of the very recent rejoinders in this debate is from Zimmerer’s (2003) model of ‘overlapping patchwork’. His main contention with the ‘altitudinal zonation’ model is very similar to Allan’s (1986); however, he provides empirical evidences to claim that the mountain populations do not differentiate ‘biogeographic,’ or ‘zonation’ boundaries for their production use. Their uses reflect the ‘overlapped patches’ that are expanded in different microclimates located in different altitudinal zones (Figure 4.3). Overlapped patchworks of mountain agriculture are shaped through political-ecological interaction of farm livelihoods and mountain environmental factors.



Source: Zimmerer (2003)

Figure 4.3 Overlapped patchworks in an Andean landscape

As shown in Figure 4.3, Zimmerer (2003) argues that the overlapped patchworks are essentially the results of the interactions between different altitudinal belts and such interactions are a lot more dynamic and vibrant than assumed in the traditional verticality model. They are dynamic and vibrant in the sense that mountain communities typify these production zones based on their cognition of topography, political influence and spatial distance. Interestingly, in naming different production zones, they use the topographic basis to consider their local political, cultural, ecological and economical ideals or goals. Rather than discrete layers, all elevations showed the patchiness of different crop choices and their farm unit spanned across elevations, showing more dynamic and flexible organization of mountain resources.

In recent year, there is a growing realization that mountain populations do not live according to ‘biogeographic boundaries’ or ‘watershed boundaries’. In particular, most historic mountain agricultural groups opt for one of the three main farming strategies: (1) direct exploitation of

various zones, (2) specialization of a single zone and procurement of the products it needs through barter or exchange with other groups occupying complementary zones, or (3) a combination of zonal specialization and multi-zonal exploitations (Rhoades 1997:59-60).

It is clear from the above discussion that appropriate representation of verticality is very a complex task, although no one can deny that verticality is paramount to the mountain landscape models. It is also true that the verticality concept is widely used in landscape ecology and other natural sciences in Europe, starting from Carl Troll to the recent leaders in the European expeditions to mountain studies. Obviously, given the disciplinary focus, it is not surprising to me that the focus has mostly been on environmental parameters.

Some exceptions are the cultural ecologists like Netting (1981) and Cole and Wolf (1974), who are pioneers among anthropologists to study mountain communities. They highlighted how complex are the human-environmental relationships in the Alps, specifically, how cultural-ecological adaptations of these mountain communities helped their livelihoods in such harsh alpine environments. Although they do not mention the word 'verticality,' but their works clearly show human maneuverings to manage natural resources of different ecological zones toward their self-sufficiency.

As mentioned earlier, landscape models can be seductive, but the verticality models are yet to incorporate the complexity of human components (i.e., socio-cultural, economical and political factors) connecting different altitudinal belts. It is mainly because the complexity has increased with mountain communities integrating into the global economy. Mountains as we know of are no longer isolated; not just globalization has pervasive impact, but also processes like global change have enormously influenced the way we think of mountain environments and their status.

Table 4.1 Verticality: The conventional vs. new paradigm

The Conventional	The New
Simple, uniform, rigid and predictable	Complex, uneven, flexible and varied
Discrete layers	Spatially overlapped layers
Specialist and segregated	Holistic and scale-dependent dynamic interactions
Homogenous unit	Heterogeneous mosaic
Mostly nature	Nature and humans
Homeostatic system	Dynamic equilibrium
Stable, self-sufficient and closed system (interactions within a belt or layer)	Interaction through resources, services and products (between two or more belts)

To summarize the verticality concept, a summary of recent developments on the concept is presented in Table 4.1. The intention herein is not to dichotomize the two paradigms, but to present a set of new issues and developments for further consideration. Its main objective is to propose that a verticality model should be able to encompass and recognize the context-specific spatial and temporal variability. It means a uniform model like the one presented in Figure 4.1 cannot properly present the rising complexity of livelihoods in the mountain areas. Rather than isolating the uniqueness of each production zone located at different altitudes, the verticality concept should consider how mountain communities perceive their landscape as unbounded and relational; for them, everything in space is connected through a combination of cultural-ecological, economic, political and spatial factors. While in each zone there may be striking spatial and latitudinal similarities—as suggested in most of verticality models, there may also be significant variability—as in Zimmerer’s concept of overlapped patchworks.

This brings us to the question of the applicability of the verticality concept in this study. It is true that Lamjung and other hills and mountain districts of Nepal have also experienced drastic changes in infrastructure development (e.g., road network, education, health) in the last six decades, bringing the once inaccessible, remote mountain areas in contact with the outside world. In spite of the rise of the concept of ‘highland-lowland linkages,’ verticality is a reality for

Nepal, just as for any other mountainous area. The persistence of altitudinal zonation in the face of accessibility or modernization has started to emerge in the mountain geographical literature (Uhlig 1995 as quoted in Rhoades 1997:60). In fact, the majority of the mountainous areas in Nepal are still unconnected road. Nevertheless, the road and market extension do not completely negate the role of verticality in shaping the responses of a mountain farming community, although there is little doubt that agriculture and cropping patterns may have been altered significantly in those accessible mountain areas (Kreutzmann 1993).

This suggests that we certainly need to be careful with the use of verticality to imply that mountains are 'closed systems' or 'self-sufficient' systems (for example Cole and Wolf 1974; Netting 1981), as mountain ecosystems are also dynamic and non-equilibrium, constantly changing through time and historical experiences (Price and Thompson 1997). It is one of the key characteristics of the mountain farming system that farmers also have expansionistic open systems, not rigid closed system (i.e., other features are intensification, diversification, rules/cooperation and scheduling) (Netting 1993; Rhoades 1997). An integral part of the Nepali mountain farming system is that farmers employ various mechanisms of multi-zonal exploitation across a vertical gradient. However, the context of verticality is different for Nepal: instead of a single ethnic group exploiting multiple production zones like in the Andes (Murra 1988), there are many cultures that use institutional innovations to adapt to different microclimates. Without understanding the cultural-ecological adaptation of Nepali mountain communities, we cannot fully comprehend the complexities of the verticality model in the case of Nepal.

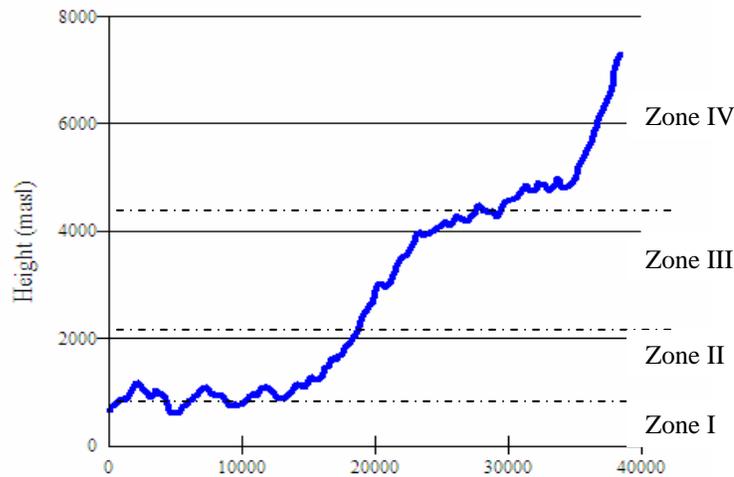


Figure 4.4 Lamjung landscape profile showing historical altitudinal land-use zones. The landscape profile is based on the interpolated line drawn between Sundarbazar VDC (approximately 600m) in south and the Mt. Himchuli (7,893m), located in the upper side of Faleni VDC in the north.

Table 4.2 Description of Lamjung altitudinal land-use and crop production system

Zones	Land-use and crop production
I	<i>Besi</i> (Valley): irrigated and non-irrigated year-round crop production (up to 3 harvests a year) <ul style="list-style-type: none"> <li>• Summer: Irrigated rice, Upland rice, Maize, Millet</li> <li>• Winter: Wheat, Potato, Vegetables, Ginger, Soybean</li> </ul>
II	<i>Pahad</i> (Hills and Mountains): Non-irrigated year-round crop production (up to two harvests a year) <ul style="list-style-type: none"> <li>• Summer: Millet, Maize, Upland rice, Buckwheat, Soybean</li> <li>• Winter: Barley, Potato, Ginger</li> </ul>
III	<i>Lekh</i> (High Mountains): Summer only crop production (1 harvest a year) <ul style="list-style-type: none"> <li>• Summer: Potato, Barley, Sheep Herding, Hay</li> </ul>
IV	<i>Himal</i> (The Himalaya): Pasture only <ul style="list-style-type: none"> <li>• Summer: Sheep and goats are brought to graze in meadows and temporary <i>bhendi goth</i> (Shepherds huts) are built in summer</li> </ul>

Lamjung smallholders utilize a span of different altitudinal zones, which range from 596masl to 4,600masl. It is, however, difficult to represent the complexity of land-use patterns of the village scale in visual form here. Nevertheless, the range of adaptive strategies, agricultural land-

use strategies and the associated cultural-ecological diversity found in Lamjung are represented at the district scale for a general overview here (Figure 4.4 and Table 4.2).

In Zone I, which covers most of the *Besi* (valley) area of the district, is historically inhabited by the *Parbatiya* or *Khas* migrants who have long used their knowledge of irrigation and terracing to cultivate arable lands for paddy, wheat and maize cultivation in arable land. Where irrigation is accessible, mainly along the major rivers and tributaries, it is possible to take two to three harvests a year. Even in the rainfed area in the *Besi*, agricultural intensification is pursued by combining major staples with horticulture (i.e., citrus, banana and other fruits) and cash crops like soybean, ginger and oilseeds.

In Zone II covering the *Pahad* (hills and mountains), rainfed agriculture produces one to two harvests, often in the form of mixed-crop cultivation of millets, maize, rice, buckwheat and potato. This zone has traditionally been inhabited by Gurungs and Tamangs, even though such demarcations have diffused in recent decades—one can find Parbatiyas living in many remote highlands and Gurungs and other ethnic nationalities settled in the *Besi*. Traditionally, smallholders in this zone practiced mixed agropastoralism emphasizing a variant of transhumant (migratory) sheep herding and multilatitude crop production. Potatoes and buckwheat are grown as high as the settlement of 4,100masl, covering both the Zones II and III.

In Zone III, which covers the *Lekh* (High Mountains), the main livelihood is agropastoralism, followed by off-farm incomes. Due to the rugged terrain, cold climate and short-growing season, crop cultivation is limited to potato, buckwheat and barley and only one harvest per year is possible; that too comes with very low productivity. Traditionally, Gurungs used this zone for their pastoral way of life. They specialized in raising herds of *Chauri* (a female hybrid of yak and

hill cow), sheep, goats and cattle. Specially, Gurungs highly value sheep raising; even to this date, sheep are highly preferred in Gurung rituals and feasts.

Except for occasional visits of migratory sheep and goats for grazing during the peak period in summer season, there is no major agricultural activity in the Zone IV. Pasture and forest coverage of this zone, however, indirectly contribute to the maintenance of subsistence agriculture in the Zone II and III. This Zone is also the ‘water tower’ for all other zones, providing sources of rivers and streams for downstream.



Figure 4.5 Agricultural landscape of the Marsyandi valley. The photograph was taken from the ridge top of Baglungpani VDC (approximately 1800masl), facing southeast and it clearly shows the overlapped patchworks agriculture and forest at different altitudes.

To relate Lamjung with the Verticality Model, the direct and dynamic interactions (i.e., overlapped patchworks) between different altitudinal production/land-use zones are evident in various forms but not limited to the following, even though each altitudinal zone has some unique characteristics:

1. Agropastoralism, mainly the transhumant or migratory sheep herding practices, utilize selective resources of the Zone II, III and IV in a rotating, seasonal basis, and hence, relieves pasture and forest of lowlands from the constant pressure and over-extractions.
2. All three major land-cover categories--forest, agricultural lands and shrublands--are scattered and often overlapped in each zone. Although production and climatic constraints put limits to crops (i.e., rice cultivated only in the valley, barley only in the mountains) and each zone may have cropping patterns variability, the case of potato is interesting. It is cultivated widely in *Pahad*, but the seeds for potato always come from the *Lekh*.
3. Some VDCs located in the northern side (e.g., Bhulbhule, Faleni, Bahundanda, Khudi, Ghanpokhara) stretch from the valley to the Himal region and share forests and pastures that are overlapped not only in different altitudinal zones, but also in different political (VDC) boundaries. The significance of political boundaries is important when it comes to controlling those resources; VDCs' jurisdiction and power over forest and pasture resources matter more than the question of which altitudinal zones those resources are located in.
4. Trade and exchange of goods, especially salt for wool and grains have historically connected different ecological zones, exchanging the commodities needed by other zones. Although the forms of trade and exchange have changed in recent decades, trade remains a key domain for interaction between different zones. In recent decades, the trade in terms of the flow of resources, services and commodities is skewed in favor of plains and valleys.
5. Gurungs moving their settlements from the temperate regions to the subtropical areas in the process of adopting sedentary agriculture also indicates that the complex relationships existed between different altitudinal zones for long. These historical evidences (e.g., settlement move, trade, etc.) suggest that spatial integration and interactions between

different altitudinal belts have always been there; while there are indeed evidences of specialized zones of productions (e.g., rice, barley), the cultural-ecological practices also change to accommodate and utilize the multiple zones of production.

6. Cultivated lands are often fragmented into small parcels located at different altitudes and locations (VDCs). Land fragmentation here means not only of division of land parcels into small units, but also spatial distributions of land parcels in different locations. Aside from the division of family inheritance (i.e., land and other fixed properties) equally among sons, fragmentation of lands is as an adaptation strategy to ensure effective labor mobilization and reduce the risk and vulnerability of crop failures. Table 4.3 also corroborates the fact that land fragmentation is higher in *Pahaad* (Maling VDC) than in the *Besi* (Banjhakhet VDC)

Table 4.3 Number of land parcels owned by the sample households in research sites

No. of parcels	VDCs		Total
	Maling	Banjhakhet	
1	2 5.7%	0 .0%	2 3.0%
2	4 11.4%	6 19.4%	10 15.2%
3	5 14.3%	12 38.7%	17 25.8%
4	6 17.1%	6 19.4%	12 18.2%
5	6 17.1%	4 12.9%	10 15.2%
6	5 14.3%	2 6.5%	7 10.6%
7	3 8.6%	0 .0%	3 4.5%
8	4 11.4%	1 3.2%	5 7.6%
Total	35 100.0%	31 100.0%	66 100.0%

These evidences show that the decision to choose certain land-use over others is a complex process; it depends on topographic, climatic and vegetational factors, but there is a growing recognition that the perceptions and knowledge of how the available resources could be best used under different socio-cultural and political circumstances also matter. In such cases, existing shared cultural knowledge of the mountain communities shape their adaptation strategies. The transhumant or migratory sheep herding (*bhendi goth*), for instance, is a perfect example of how complex the concept of altitudinal land-use is. To avoid overgrazing and degradation, they decide on managing or rotating herds; their ecological knowledge helps them to decide where to go, when to go, how to rotate the fields and their ecological basis, how to maximize their return from the herds and so forth (for detailed discussions, see Chapter 5). They do all these with the specialized knowledge of availability of resources in each altitudinal belts. Without the knowledge of verticality (or in the sense multiple zones of productions), it is hard to understand their decisions to untie particular land-use or resources over others. Similarly, without knowing the factors that influence the land-use decisions, it is hard to contextualize their land-use decision only from characteristics/specifities of the altitudinal belts.

Agropastoralism is disappearing fast, however. Gurungs, who historically practiced it as their livelihood have shifted their preference to sedentary agriculture in the lower valley. The agropastoral system that developed different land-use strategies to exploit production potentials of different altitudinal zones is being replaced by the rice-based agricultural intensification in the lower valleys, which emphasizes the specialization of certain land-use and crop types (i.e., rice-based agricultural intensification). Nevertheless, the significance of such historical processes and events in agricultural change (e.g., the diffusion of terracing techniques, the introduction of new crop varieties and changing trade patterns) is that the interactions between different altitudinal

production or land-use zones remain dynamic and they continue to change, as mountain communities are increasingly being influenced by the wider market economy and globalization processes.

## **2. Explaining changes in mountain agriculture**

Lamjung's shifting agricultural system from agropastoralism to agricultural intensification bears striking resemblances to how mountain communities across Nepal have been transformed in recent decades. To explain the kind of agricultural change these mountain communities have experienced, some discussions of different agricultural change theories is imperative.

Agricultural growth generally takes place either through expansion—the extension of land under cultivation—or intensification—the increased utilization or productivity of land currently under production. The expansion strategy is more common than the intensification strategy under the low population density and greater availability of lands. In contrast, in the areas with limited cultivated land, agricultural growth comes often from the intensive use of agricultural lands.

Theories and themes that seek to explain agricultural intensification are generally divided into two broad categories: those that relate production to household needs and wants (consumption production) under conditions of 'subsistence' and those that relate production to demand from the 'market.' These theories and themes are potentially complementary, even though they seem mutually exclusive in their characteristics and features.

(Neo)-Malthusians are pessimistic in their premise that population growth has the ability to outstrip agricultural growth. This means a downward spiral of land degradation and impoverishment is inevitable when the society faced with rising population will reach the limits of its capability of producing more food (Erlich and Erlich 1990). This means the physical

production capabilities of the system (an individual farm, a village, a region, or a nation) may not be able to keep pace with actual growth in demand. In contrast, Boserupians have positive expectations—they assert that population growth is, in fact, the major cause of positive change in production system or the stimulus to expansion of food-producing potential (Boserup 1965, 1981; Netting 1993). This view blends into the larger context of markets and external relations of the neo-liberal economist who posit outcomes dependent on an appropriate economic structure that provides rewards to the individual farmer for intensifying production, encourages specialization and facilitates entry into ‘free markets’ (Schultz 1964). Finally, the market context also gives rise to the pessimistic view among the neo-Marxists (Peet and Watt 1993), who argue that the colonial legacy, the current international reach of capitalism and class-based national politics have created political and economic conditions that inhibit the development spin-offs of intensification, even if they were to occur.

		Population growth under agricultural Conditions of	
		Subsistence	Market
Expectation of outcome	Optimistic	Boserupian	Neo-Liberal economics
	Pessimistic	Neo-Malthusian	Neo-Marxist Neo-Malthusian

Figure 4.6 Four major theories to explain agricultural change (Source: Kates et al. 1993)

Although it does not quite fit into the grid (Figure 4.6), political ecology has had a major impact on how we look at conditions in different agricultural societies (Blaikie and Brookfield 1987; Robbins 2004). The core of political ecology is that relations between different economic

sectors, economies and political systems are fundamental to determining local dynamics. This theme helps to understand the unequal relations, which allow one sector to extract surplus or some other benefits from another sector. This relations between different economic sectors and classes focus political economy analysis on a what is opposed to the technology and demand themes influenced by the (neo)-Malthusian views.

As for explaining agricultural change in subsistence economies, the Boserupian Theory has been widely used. Some critiques, however, believe that the theory being so simplified has its limitations and exceptions (Grigg 1979; Stone 2003). Brookfield criticizes Boserup for focusing on population as the only major cause of intensification (Brookfield 1972: 39). He emphasizes 'innovation' (Brookfield 1984) as an alternative explanation of agricultural change. Innovation is new practices or new combination of practices that change the productivity or quality of a unit of labor input. Anything that introduces qualitative changes to production systems is an innovation (e.g., a change in land tenure, change in pattern of settlement). Other critiques urge to consider the broader socioeconomic, political and ecological conditions (Padoch 1986; Stone and Downum 1999). Similarly, exogenous factors, such as market incentives (Brush and Turner 1988), class, or impoverishment (Turner and Ali 1996) can also have considerable impact on the agricultural mode of production.

Much of the contemporary 'consumption-based' theory has its origins in Chayanov's theory of peasant economies (1966). He asserts that peasant labor investment depends on the ratio between consumers and producers in the household, which changes in relation to the normal domestic cycle. The amount of work done by a household is determined not only by its need but also by the 'drudgery' of work, and once a family has produced enough food to meet its needs or if drudgery is too great, there is little incentive to produce a surplus (Brush and Turner 1987).

The agricultural involution concept of Clifford Geertz (1963) also takes the similar notion in the sense that the intensification process involves putting even more labor into paddy field cultivation, increasing per hectare output while maintaining per capita output—every addition would be for labor employment rather than for output increase. The major factors for intensification include exogenous economic demands and internal pressure from rapidly increasing population.

The market or commodity theory applied to Third World farmers has its modern origins in the pioneering works of Tax (1953), Schultz (1964) and other agricultural economists and economic anthropologists. It asserts that once farmers accept commodity production, they respond to market demand within the constraints placed upon them, maximizing production to the level of maximum reward.

How do these theories apply in the context of the mountains? Commercialization of agriculture has been a central part of regional integration in mountain in recent decades, which has put pressure on peasant households to produce goods with high cash value and demand. N. S. Jodha, an economist and mountain scholar, provides the most elaborate discussion available to date on the impact of globalization on mountain agriculture (Jodha 2001). He believes the following improved accessibility of technological and institutional interventions and a rise in people's expectation level, even extremely subsistence-oriented communities have slowly moved toward cash transactions. A rising proportion of external inputs, in both consumption and production activities, has accelerated the process. The need for cash reduces the importance of other considerations (e.g., resource conservation, regeneration, interdependence of multiple activities) in farm decisions (Jodha 1995:163). This type of change, combined with changes in rules of resource allocation, exacerbates pressure on cultivated land, forest and shrublands. They

may also bring changes in LUCC dynamics and result in land stress and adverse impact on the fragility of mountain areas.

Jodha (2001) believes that the commercialization of agriculture, in terms of internal inequities and changed human attitude, has led to rapid erosion of social sanctions and informal collective arrangements for production and sustainable use of resources. Furthermore, the commercialized orientation has introduced imbalance in land-use patterns. Relatively good land is put under profitable cash crops, especially vegetables and staple food crops (e.g., maize) are pushed to sub-marginal land with low productivity, compelling the extension of crops to still more sub-marginal lands. An increasing emphasis on cash crops, vegetables, fruit crops and high-yielding food crops in some areas has led to reduced diversity of mountain agriculture and a decline in interdependence of different land-based activities.

This is certainly a way of looking at the changes in mountain agriculture; not many mountain scholars believe that every mountain community experiences the commercialization trend the same way (Rhoades and Thomposon 1975; Brush 1976; Mayer 2001; Ives 2005). Some communities are more integrated to the wider market economy than others are; their experiences are differentiated by history, institutional arrangements or rules of resource allocation, economy, demography and most importantly, socio-cultural compositions (Rhoades 1997).

Furthermore, the trend toward commercialization is one example of a historic pressure resulting in different foci of exploitation in the mountains (Brush 1976:130), which essentially means that the verticality makes a difference in the mountains. While many perceive land fragmentation as a constraint on agricultural growth, it is a key feature of the mountain agriculture (Netting 1976) and helps diversify agricultural strategies in different altitudinal zones

while effectively mobilizing labor forces to minimize risks (e.g., crop failure, environmental stresses).

Similarly, the commercialization causing agricultural intensification, for instance, is part of an overall diversification of livelihoods and crop resources, rather than specialization of a single enterprise, as is commonly assumed (Brush 1992). Similarly, their agricultural strategies cover diversification of crop resources through innovation and incorporation to risk reduction and efficient use of land and labor resources (i.e., economic reasons) and adaptation to diversity, resilience and stability (i.e., ecological reasons) (Rhoades and Bebbington 1990). In other words, agricultural intensification in the mountains is not as linear as is generally assumed in the Boserupian Theory; both intensification and disintensification can occur as the result of the changes in agricultural livelihood strategies (Guillet 1987), caused by both exogenous and internal factors mentioned in theories.

Based on these insights of mountain scholars, the case of intensification in the mountains can be considered as an ecological exception discussed in the Boserupian Theory (Grigg 1979; Stone and Downum 1999; Stone 2003). It is certainly different from the plains in the sense that the key characteristics of the mountains (i.e., verticality, land fragmentation) have enormous impact on the ways agricultural strategies are adopted in the mountains. To explain the changes in mountain agriculture, therefore, we must look beyond the key surrogate measure: the ratio of cultivated land and fallow land (Turner and Dolittle 1978) and situate the agricultural change in to the contextual historical perspectives of how smallholding and associated adaptation processes developed in a particular place. In particular, we have to consider how the mountain communities have developed complex rules of resource allocation and integrated the network (interdependence) of agriculture, forest and livestock in their food system.

### **3. Smallholding and land-use strategies in Lamjung**

Going by the definition of ‘smallholders’ (Netting 1993), most of the mountain farmers fall into this category: they practice intensive, diverse range of agriculture in relatively small or fragmented parcels of land. Verticality and land fragmentation in the mountains give rise to different altitudinal production/land-use zones and smallholders have no other choice but to rely on different production zones to diversify their livelihood portfolios. In doing so, they spread out the risks involved with specialized production in smallholding (e.g., crop failure, seasonality) to ensure stable harvests. Their small possession of assets *per se* is a risk, but their risk increases even more in a single enterprise-based smallholding.

These characteristics of smallholding apply in the case of Lamjung and other mountain areas as well. Like many other mountain regions of the world, Lamjung smallholders have historically relied on the interdependence of agriculture, livestock and forest resources. This strategy is a complex adaptation process to the mountain environments Besides pastoralism; smallholders in this case, in contrast to pastoralism, are adapted to such environments where a single enterprise specialization is a risky option, since the return rate is relatively low without high-energy inputs. This explains why mountain smallholders have a number of adaptation strategies, which make the case of smallholding in the mountains unique. Whether in the Alps (Netting 1976 and 1981) or the Himalaya (Rhoades 1997), smallholders’ adaptation strategies include intensification, diversification, expansion, cooperation or regulations and scheduling.

The kind of agropastoralism once widely adapted by Gurungs and even the mixed-mountain agricultural system that has emphasized rice-based agricultural intensification in recent decades, share the majority of characteristics discussed by Netting (1976 and 1981) and Rhoades (1997).

Much of the 19<sup>th</sup> century and the first half of the 20<sup>th</sup> century saw the expansion of agricultural land. With the introduction of rice, maize and potato in the area in the early 19<sup>th</sup> century and the *Khas* migrants utilizing their knowledge and skill in irrigation and agricultural terracing, agricultural lands were expanded extensively in the *Besi* area (lower valleys). This was the trend elsewhere in the Central Nepal for the period as well, which caused increasing population growth and deforestation (Regmi 1968).

Although agropastoralism among Gurungs evidently started to decline as early as the early 19<sup>th</sup> century when they began to move to lower ridges and valleys (Hamilton 1810), Gurungs were found to have taken immense pride in their agropastoral tradition as late as the 1970s (Messerschmidt 1974; Macfarlane 1976; Pignede 1993). Even to this date, a few Gurung villages in Lamjung, such as Pasgaun, Bhujung, Ghanpokhara, Tanghring, Faleni and Khudi still practice sheep and cattle herding practices (for discussion on their operating system, see Chapter 5). Herding and animal husbandry, as a unit, is well complemented by farming, trade and soldiery, for which Gurungs are renowned (Messerschmidt 1976b; Pignede 1993).

Historically in Gurung agropastoralism, sheep, goat and cattle (mainly *chauri*) hold special place in the economy. They rely on buckwheat, barley, maize and millet on for their food supplement. Gurungs also used to practice the *Khoria* (slash-and-burn) cultivation to grow beans, yams and other colocasia species. When practiced under the lower population pressure with sufficient fallow period, the *Khoria* system helps maintain the ecological system (Boserup 1965; Dove 1983). However, with the *Khas* migrants dominating in the lower valley and the introduction of new crops (i.e., rice, maize and potato) pushing the pace of agricultural expansion, the *Khoriya* system also came under extreme pressure to limit its production area in

the remote higher elevations. The system disappeared eventually around the 1980s once the state policies termed this system as a ‘deforestation activity’ and banned it all together.

As shown in the Historical Altitudinal Land-use (Figure 4.4), Gurungs adapted to the *Lekh* area (higher mountains) environments with their reliance on sheep, goat and *chauri* for meat, fiber and draft power and the successful incorporation of high-altitude crops like buckwheat, barley and millet into their food system for centuries. Even in the existing mixed mountain agricultural system, the inputs from both livestock and forest including shrubland and grassland have been crucial to maintain yield stability in agriculture. This system perhaps would not survive long without the substantial contributions of these inputs, usually coming in the form of manure, traction/draft power, mulches and so forth, mainly because access to ‘modern’ agricultural inputs (e.g., chemical fertilizer, seeds, pesticides) are not adequate and affordable.



Figure 4.7 Main agricultural land-use: (a) *Paakho* and *Baari* (Rainfed upland, sloping terraces); (b) *Khet* (Irrigated lowland)

In terms of land-use strategies, there is a variation between the villages located in *Pahad* and the ones in the *Besi*, which suggests that verticality makes a difference in climate, vegetation patterns and resource availability and use. Villages in the *Besi* often have dispersed settlement

patterns and have more irrigated agricultural terraces (*khet*) where they grow wet rice (paddy). They keep fewer livestock close to the house and those are mostly stall-feed. Villages in the Pahad have clustered settlements and have few irrigated and more rainfed fields (*baari* and *paakho*). They keep larger numbers of livestock and are often moved in different pastures.

Land-use variations within a landscape or between landscapes are often attributed to land types in use, which are characterized by water availability (moisture content), soil type, climatic conditions, economy needs and so forth. To this end, the impact of verticality or altitudinal zones on those attributes is also well recognized; however, Gurungs moving their agricultural base from agropastoralism to the rice-based agricultural intensification indicates something more than those attributes. Gurungs decision to pursuit sedentary agriculture in the lower slopes of the valley and subsequent changes in their land-use strategies were also the results of their attraction toward rice and rice-based agricultural intensification under the growing influence of Hindu ideology (see Gurungs' concept of soft and hard foods and their crop preferences in Chapter 5).

Similarly, the state's 'rent-seeking' policies encouraged sedentary, intensive agriculture mainly with the aim of generating higher revenue from the area (Regmi 1976). Agropastoralism, in contrast, was not only discouraged, but eventually was severely restricted with the abolitions of customary rights over pastures and forests (Steven 1993). These resulted in less incentives in agropastoralism, which was further aggravated by a number of changes in the Nepali national and regional economies (e.g., closure of the Tibetan border to salt trade and concomitant shift toward increased trade at the lower hill markets and decreasing market for Gurung homespun woolen products) (Messerschmidt 1974). Because of the reduced flexibility level in their livelihood with all these changes, Gurungs started moving their settlements downward and some went even further and out migrated to other places in the second half of the 20<sup>th</sup> century. These

shifting choices and preferences their food system did have considerable impact on which crop and land-use strategies they value and where they would intensify their resources.

#### **4. Labor management, cooperation and scheduling**

The impact of changes that the Gurung economy faced (i.e., increasing influence of the Hindu ideology, abolition of customary rights, the closure of Tibetan border, increasing outside contact) apparently was not limited to its agricultural system. Profound changes affected social organizations, institutions and scheduling strategies of the Gurung economy—all these are the main social drivers of how they use their land, agriculture, pasture, forest and other natural resource base. To understand the institutional aspects of how Gurungs traditionally managed and scheduled their labor and agricultural resources, I elicit two key examples that characterize the Gurung social organizations: (1) customary pasture management system, and (2) labor network.

Historically, Gurungs have been well known for self-organizing into co-operative groups where the individual depends heavily on the community. Although some critiques have highlighted the emergence of ‘independent character’ within Gurung culture (McHugh 1989), they hardly negate the fact that their cosmology or concept of interdependence or interconnectedness (see Chapter 5) has held Gurungs together in their adaptation process. Their sheep herding and pasture management system manifest the culture of collectivity deeply embedded in their social organization.

Sheep herding and pasture management systems—key components of the agropastoral Gurung culture—is much dependent on their social institutions with the salient features of collective efforts, mutual trust, cooperation and shared cultural knowledge. Each village traditionally has 150 to 600 sheep and goats in their herd. When each village had customary

rights over several *kharka* or *bugani* (summer pasture) in the *lekh*, each herd was taken to a different *bhendi goth* (shepherd's or herder's camps) located in these *kharka*. There was then a regular cycle of movement of herds. In the winter months, shepherds and herds stayed in the lowest camps, not far from the village, and after all the crops had been harvested, the sheep fed on the stubble remain on the fields. In April, they were taken to higher hills and from then on the herds moved upward until June they reached the highest camps at altitudes above 4,000-5,000m. There they stayed throughout the monsoon months and in October, they began to come down to lower camps, until in December when they again reached again the vicinity of the village.

The owners of the sheep collectively provide the food and clothing for shepherds and some give annually one sheep to the shepherds. Sheep milk is also a benefit for the shepherds, which they can use in whatever way they chose, for the owners had no claim on it. The sheep were shorn in March and in October and the wool belonged to the owners. Sheep were slaughtered for meat, usually one ram for each household and in October and November some villagers also sold sheep to people in the lowlands.

The key point is to understand the complex institutional arrangements that organized this system effectively for centuries. A group of village leader, elders and *tiyanle* (chief shepherd) meet every early spring, mostly around the *Khe Ku Tyeh* (*Phagu Purnima, N*), which falls around March 1. After consulting *poju* (priest) to set the suitable date of departure, they decide on the particular *kharka* for the year, days to be spent in each pasture, and the migratory route they take. In case when members of other villages (e.g., *Khas* people) wish to send their sheep and use the particular *kharka*, this group decides on the fees and levies.

They also resolve or mediate any conflict related to herds and *kharka*. Most importantly, they define clear boundaries (the *kharka* belonging to them), set up shares for members, implement

rules for use, monitor appropriation and sanction free-riders and thieves: it resembles several characteristic of a successful model of common property regime as discussed in Ostrom (1991). At the member level, each participating household had to participate in the group activities (e.g., rituals for departure and arrival), abide by the rules established in the group, provide food and cloth support to the shepherds as compensation and so forth. The main benefit for member households, in return, is that their sheep and goats are the shepherds' responsibilities and they can spend their labor and resources in other economic activities. In addition, they get their turn to manure their fields when the herds are kept near the village in winter season. This shows effective and institutionalized labor and resource management within the Gurung culture.

The second example indicates the social cohesiveness and highlights the value of social network within the Gurung culture. Among various forms of cooperative, agricultural labor gangs or informal labor networks, *Nogar* and *Thigur* were once widely practiced in Gurung villages in Lamjung. *Nogar* is organized to perform most agricultural tasks. Generally 10 to 20 boys and girls, occasionally joined by some slightly older people, organize themselves for practically every type of agricultural activity, with the exception of plowing rice-field (at least in Maling VDC). On rotation basis, they extend their help to the member households. Each member household is obliged to return *Nogar* to other members through participation in *Nogar*; otherwise, they would have to compensate the group financially—the money goes to the group fund to be used during festivals and other social activities. Typically, in January-February the members assemble for a *Nogar* to carry firewood. From March through May, they *Nogar* (assemble) for carrying manure and preparing fields for next planting. In June, their activity is focused on planting rice, in August and September, for weeding paddy. In this way, they accomplish the same task quickly; a single household would spend weeks on the task otherwise.

The basis for *Nogar* formation has a much larger context in the Gurung tradition called *Rodhi*, which is “a nightly social gathering place, a semi-private dormitory where young girls and boys of the village congregate to sing, talk and joke” (Andors 1974:10). They decide in *Rodhi* about the activities they want to pursue. Although there are various versions—some of outsiders’ views are even derogatory about its’ origin and purpose, *Rodhi* is the institution of Gurung culture that provided opportunity to members to “socialize, perform communal tasks and find marriage partners” (Andors 1974:11). ‘*Ro*’ literally means weaving and making of baskets and ‘*dhi*’ mean home. Members usually gather in the house of one of the members and the parents of the house would regulate members’ behavior and monitor their activities. As the name applies, this is also the place for the young people to learn the concept of interdependence (i.e., how to work in a group, learn spinning wools and weaving blankets, plan activities for Gurung festivals and agricultural tasks).

The *Rodhi* group is responsible for volunteering in several social and religious activities. Along with performing communal work like *Nogar*, their role in the *Ghaantu*<sup>18</sup>, which is perhaps the biggest narrative folk music tradition in the Gurung culture, is so critical that they are invited by village leaders well in advance to plan for the performance and feasts. *Rhodhi* groups also sponsor and assist long pilgrimage to shrines, fairs and festivals (e.g., trek to one of the sacred ‘Dudhpokhari’ in the high mountains). The *Rodhi* tradition, like many other Gurung traditions, is

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<sup>18</sup> *Ghaantu* (or *Ghaanto*) dance, which is a hallmark of Gurung culture, is performed between the *Shri Panchami* (around March 15) and the *Baisakhi Purnima* (around May 1). A *Rodhi* group is responsible for three consecutive years to arrange the performance (i.e., two dancers, costumes, ornaments and props) and foods. The main performance lasts up to five days, in which prepubescent female dancers (*ghaantu sarees*) go into trance induced by the singing of the *ghaantu gurume* (main singers are village elders). The song verses are sacred to Gurung; they are memorized and passed on to the next generation in oral tradition (Moisala 1989, Macfarlane 1990). Considering the fact that Gurungs have no written scripts yet, the feat of memorizing the lengthy verses all the more remarkable. Gurungs believe that the *gurumes*’ accuracy in reciting the verses is critical for *sarees* to enter and safely return from the trance-state.

slowly disappearing, especially where the influences of Hindu ideologies are dominant. The outsiders often tend to focus only on the 'socialization' and 'entertainment' parts of the institutions with negative connotations attached it, implying that unrestricted mobility and socialization of girls in such environments run counter to the 'moral values of high caste Hindu society.'

These two examples signify the complex cooperation system that once characterized the Gurung culture. These institutions did not only effectively manage labor pools, but also bonded the community in legislating rules and scheduling their agricultural tasks. The fact, nonetheless, remains that such labor and cooperative networks are fast disappearing from the mainstream Gurung culture. I was able to record some facets of these institutions in Maling and the adjacent VDCs. I would not be surprised if these networks functioning more effectively in remote villages like Pasgaun, Bhujung, Faleni, Uttarkanya and Ghanpokhara.

While the growing influence of the Hindu ideology is to be blamed for the disappearance of such traditions and institutions, several other socio-cultural and economic factors also played important roles in the declining interest in certain traditions among some Gurungs. First and the foremost is the way state policies patronized Hindu elements and practices (e.g., sedentary agriculture, Hindu religion, *Khas* or Nepali language) over native culture. These did not only give preferential treatment to one over the other, but also valorized the Hindu elements and practices over others, changing the native's perceptions and preferences.

Secondly, the impact of the cash economy is now considerable, as all exchanges of goods and services are increasingly monetized. These days, *Parma* (exchanging labor during the rice plantation season and in some cases they are paid NRs.150 to 200 per day for their labor) is the most dominant form of labor network in Lamjung and other parts of Nepal. As much as 92% of

the respondents in my household survey mentioned that they rely on *Parmaa* for the rice-planting season, whereas only 40% reported to have gotten help from Nogar.

Thirdly, increasing number of young boys and girls now attend schools, which limits their participation. Similarly, young people who have passed high schools tend to go to cities and abroad to find jobs, which is perceived to be superior to farming in the village. This trend has increased tremendously in recent years, mainly after the Maoists insurgency. Forced recruitment of the insurgents and constant intimidation and harassments of the soldiers have prompted young people to flee the village.

Lastly, the traditional Gurung economy did not readjust and respond well to the changing economic and institutional arrangements. Only in recent years, Gurungs have organized themselves nationally to preserve their cultural identity and the traditions that made them a distinct nationality (Macfarlane 1989, 2002). Furthermore, it would be naïve to consider that there was no inequality and internal conflicts within Gurung communities (see Messerschmidt 1976b for examples). As Netting (1981) notes, labor exchange network, for instance, may benefit the rich disproportionately and collective obligations temporarily suspend the disparities between the rich and poor households in the interest of getting big tasks done. To be able to retain such social traditions and institutions, Gurungs would have to recognize both the merits and shortcomings of those institutions and readjust them to fit into new economic context.

## **5. Recent changes in mountain agriculture and livelihoods**

As discussed in previous chapters, the increasing penetration of wider market economy and road networks, especially after the 1990s have transformed Lamjung's cultural and ecological landscape. This 'modernization process' did not just develop market towns in the valley, it

changed the consumption-production based (subsistence agriculture) system to more market-integrated agricultural system, transforming every economic aspect of villages. The demand for cash income increased tremendously to have access to basic services like education, hospital, extension services and so forth, which in turn have put monetary value on every goods/products, services (i.e., labor, cooperation) and resources exchanged in villages. Changes are also visible in the way houses are built, natural resources are used and food system is sustained.

The changes occurring in recent years can be broadly categorized into three types: (1) trade and tourism, (2) agriculture and forest, and (3) seasonal migration and labor shortage. The proximate causes for these changes are the penetration of wider market economy and road networks, changes in rules of resource allocation (i.e., abolition of customary rights, the emergence of community forestry in the 1990s), the Maoist Insurgency and attraction toward jobs in the cities and overseas countries.



Figure 4.8 Roads in Lamjung: (a) a portion of the Dumre-Besishahar road in Dhamilikuwa VDC, and (b) a portion of the ‘green road’ near Baglungpani VDC—this ‘environment friendly road’ (no use of heavy equipments and blasting to reduce the environmental impact) is being built to promote agricultural markets and when complete it will make VDCs in western Lamjung ‘market accessible.’

Strategically located in the middle of the ‘Tibet-India Trade Route,’ Lamjung came under the purview of the Shah kings as early as the 1749. Controlling of the trade route, along with forest and land resources, was so important to collect taxes in the economy where other revenue generating sources were meager. The traders from the north would exchange salt and woolen blanket with food grains from south; however, the closure of Tibet and the opening of the Tarai and Indian markets in the 1960s changed the trade dynamic. After the opening of the Dumre-Besishahar roads and other road network, the trade started mainly with southern neighboring districts like Tanahun, Kaski and Chitwan. It also attracted the tourism industry, since around 1995 when it became the entry point for the Annapurna Circle Trekking, one of the most popular trekking destinations in the world. Until the tourism industry took a nosedive from 2001 due to the swelling Maoist insurgency, the district received around 4,000 tourists every year and the number of tourists was increasing. Nevertheless, in terms of its impact on the economy and environments, it is safe to claim that since the Annapurna Circle is a new route, it is nowhere near other popular tourist destinations, such as the Everest region (Steven 1993). There also some changes in infrastructure developments, such as the construction of the 70MW Middle Marsyandi Hydro-power Project in Udipur and a number of micro hydropower projects (e.g., Khudi Hydro-power, Nyadi Hydro-power, Syange Hydro-power).

Another important landscape change occurred with the Community Forestry Program (CFP), which has its roots in the state-controlled ‘Panchayat Forest’ implemented since 1984, even though the program officially started in 1993 (for detailed discussion of forestry, see Chapter 6). The CFP has both conservation and livelihood implications, as it came as a negotiated-response to check ‘deforestation’ and to reverse the ‘past failures in state policies in meeting basic needs

of forest resources' (Fisher 1989). While the CFP has sporadic success in forest conservation, its equity and efficiency in addressing the livelihood goals remain questionable (Granner 1999).

In terms of the direct impact in Lamjung, CFP has helped reclaim the forest coverage in both research sites. There are, however, two key issues that have pervasive impact, for good or bad, on smallholders' agriculture:

- CFP's restrictions and severe sanctions against livestock roaming and grazing reduced the incentives of keeping livestock.
- CFP's membership based rights, in contrast to customary rights in which everyone in the village, differentiated access to forest resources among smallholders—only those who are the present members are allowed.

Similarly, permanent or seasonal migration and off-farm employment have constituted a major part of coping strategies adopted by the smallholders. Since remittance plays a crucial role during the slack agricultural seasons and reduce dependence on the stock or on fragile lands, off-farm employment, hence, is taken both as a coping strategy to meet immediate needs (e.g., food demand and pressing cash needs) and as an alternative income sources to spread risk. An increasing number of youth are leaving to work as unskilled workers in the cities and foreign countries and the trend has exacerbated with the Maoist Insurgency.

The consequences of these socioeconomic and structural factors (e.g., wider market economy, roads and community forestry) on agricultural system are clearly experienced differently on two different fronts:

- *Pahad* and *Lekh*: roles of forest and livestock decreased in food system, declining productivity, labor shortage, disintensification and lower incentives
- *Besi*: increasing access, competition, intensification and higher incentives

In other words, while a few low-altitude communities with access to prime lands and irrigation are facing land-stress, most other villages have seen increased household engagement with the market economy, primarily in the form of outmigration for employment. Out-migration has created acute labor shortages for mobilizing collective labor for agriculture and livestock, which in turn, decreased the adaptive capacity to maintain land-use and productivity.

This trend has differentiated villagers' interest in and dependence on agriculture. Once intensively cultivated land parcels that are far away from home are now being abandoned in favor of *baari* (home-gardens). The transhumance system (migratory sheep and cattle herding), which used to provide significant protein sources and manure among other things, have disappeared. Remittances are no longer being reinvested in agriculture; these are now evidently concentrated in buying estates in cities and towns (Seddon et al. 1998).

Even in the *Besi* area, where the intensification process is dominant in recent decades, there are many challenges. Intensification requires adequate technological capacities and higher energy inputs (i.e., chemical fertilizer, improved seed variety, weeding, labor and agricultural mechanization) at different levels of cultivation which smallholders lack. It would be certainly interesting to see how the productivity of cultivated land in the *Besi* will be increased or maintained in the future. To this date, the *Besi* area relies heavily on mixing forest and livestock components. Although it is not necessarily so, in most cases land stress leads toward resource extraction measures, when there is little, if any, alternative around. In the case of Lamjung, the competition for *Besi* land is so high that almost all the arable land have already been brought into cultivation and the forest area have already been clearly demarcated through the CFP and other forestry programs.

To understand how land stress in the *Besi* and the disintensification in the uplands would change in the future, I believe we should start with capturing how smallholders perceive, manage and change agricultural and forest resources. How do smallholders perceive these changes? Do they share cultural knowledge that resulted in shifting crop and land-use preferences? What are their strategies to respond to the changes? How have they managed their resources? Is there any discontinuity or difference in the understanding of changing context of smallholding? In Chapter 5, I have attempted to answer these and some other questions relevant to the changing context of smallholding in Lamjung.

**CHAPTER 5**  
**ETHNOECOLOGY OF AGRICULTURE,**  
**FOREST AND THE LANDSCAPE**

Anthropologists have long been using ethnoecological approach to study how native folks perceive, manage and change agricultural and forest resources (Conklin 1967, 1967; Brush 1992; Posey 1992; Nazarea-Sandoval 1995; Nazarea 1999; Atran et al. 2002). In this study, I apply the ethnoecological approach to analyze the underlying subsistence behavior of smallholders in Lamjung and explore the processes involved in agricultural land-use change decisions. Thus, the main purpose of this chapter is to explore how smallholders' decision-making processes in agricultural land-use are related to their shared cultural knowledge and rules.

Ethnoecology is mainly known for its proven usefulness in understanding the cultural value of the natural world, human cognition of their organization and utilization of their entities (e.g., natural resources). Application of ethnoecological methods has increased over the years in studying human perceptions of agricultural resources, as there has been a growing emphasis on the conservation of agricultural genetic resources (Nazarea 2006). The use of ethnoecology, particularly the way Conklin (1980) approached ethnoecological methods in combination with cartographical analysis, can tell us so much about the role of cognition in framing human behaviors (e.g., human choices of land-use and the impact on land-cover categories). It can reveal useful information to understand how human cognitions are influenced by the schemas, prototypes, models, action plans and scripts, while linking the thoughts with human behavior. It also provides clues to the "situated nature of knowledge that are shaped by history, power and

stake” (Nazarea 1999). Most importantly, the developments of ethnoecological methods has contributed enormously to what we have come to know as ‘indigenous knowledge’ (Sillitoe 1998; Ellen et al. 2000; Dove 2006).

In a slightly different approach, Ingold (2000) integrates ecological psychology and phenomenology to assess the environmental perceptions. One of the premises of ecological psychology is that an organism perceives its environment not simply in its mind, but rather through its entire body, as it moves about or interacts with its environment. This ‘knowledge’ accrued through perceptual interactions with the environment is considered to be ‘practical,’ mainly because “it is knowledge about what an environment offers for the pursuance of action in which the perceiver is currently engaged” (Ingold 2000:166). His concept of ‘agent-in-environment’ elucidates ecological feedbacks between farmers and their farming environments, while simultaneously providing a critique of cognitive science and its dedication to the nature and culture dichotomy.

In the specific case of LUCC, the role of ethnoecological principles and methods can be powerful to understand the circumstances and the ways farmers modify their land surface, specifically, on the cultural interpretations of those modifications of land-use and their relevance to particular agricultural or ecological system. Apart from helping list the plants or landforms that the farmers are aware of and actually use, ethnoecology can also explain also how farmers differentiate in their daily use—something that are crucial but lacking from sheer ‘land-cover’ analysis purely based on aerial photographs, satellite imageries and other spatial data. Conklin (1980) in fact clearly cautions against total dependence on such aerial photo interpretations because there are many significant cultural features that might be hidden under vegetation or not

apparent in the photographs (e.g., swidden, irrigation ditches). Nevertheless, when used as a ‘means of matching’ other field methods, it can be very useful.

### **1. Perceptions of smallholding: interdependence and interconnectedness**

Smallholding by its nature is dependent on the crop and livelihood diversity to maintain its stability and productivity. Similarly, in many folk cultures the “abiotic components, plants, animals, and humans within a certain ecological/geographical unit are considered to be interlinked” (Berkes et al. 1998). The case of Lamjung is not so different from smallholding mountain communities elsewhere, as the smallholding or its subsistence mode of production is also largely based on the concept of interdependence and interconnectedness. Every community has the similar concept in one form or another the meaning of interdependence is central to how smallholding functions in Lamjung and the larger Himalayan region.

Among Gurungs, the concept of interdependence and interconnectedness has profound meanings. Not only does this concept apply to diversify their household resource pools, but it also covers the norms of trusts and reciprocity among the households within a certain geographic unit (e.g., cluster, neighborhood, village and watershed). For them, even the life and death are intrinsically connected (McHugh 2001) and they emphasize the interrelationships of the living and the dead during their mortuary rituals *pae* and *arghau*: *Poju* recites sacred texts in which the names of their ancestral places are mentioned in the reverse order. In doing so, they believe they truly celebrate the life of the deceased and they can guide the spirit to their ancestral place. The chain of these connections is what, they believe, bonds their heritage and community.

Just as in the analogy the interconnection between life and death, they see the significance of how agriculture, livestock and forest (including grassland and pasture) are interdependent and as

mentioned in Chapter 4, they coordinate and schedule their resources and tasks accordingly to maintain stable harvests. Here, coordination implies interdependence and it makes sense, given the fact that the output of a single enterprise is inadequate to meet the household needs.

Even from an outsiders' perspective it is clear that 'prime' lands—arable land with higher productivity—is limited in the mountains and their agricultural production is severely constrained by the short growing season. In such conditions, even a small level of natural hazards (e.g., frosts, hailstorm, landslides) and risks (e.g., drought) can have relatively higher impact in the sense that they can put households at risk.

One of the adaptive strategies developed to respond to these environmental limits and socioeconomic constraints is to create: (1) a network of households, and (2) a network of enterprises or livelihood options. In both cases, the idea is to seek the interdependence. Since, in Chapter 4, I have already discussed how smallholders in Lamjung manage their household network of labor and livestock, I now turn to the second type of network.

Just as in the network of households, in which the network provides, besides the norms of trust and reciprocity, the much needed redundancy of resources—often alternative, short-term, but crucial pulses of resources (e.g., labor, cash, grain, expertise)—to individual households in the need, the network of household enterprises also provides a buffer against the natural hazards and risks. While the outcome of one enterprise may affect the performance of the others, it certainly spreads the risk and offers the much needed redundancy of resources.

In the case of Lamjung, when agropastoralism was swiftly replaced by the mixed-mountain agricultural system, smallholders' livelihood priority also shifted from livestock to diverse resources and activities focused on sedentary farming and collection of forest resources (e.g. firewood, bedding material, wild fruits and fodder). They now have to strike a balance between

agriculture, livestock and forest to adapt to the lower valley environments. This is an adaptation strategy to compensate for financial and natural resource scarcity in the lower valley where the impact of cash economy and government policies is increasingly pervasive.

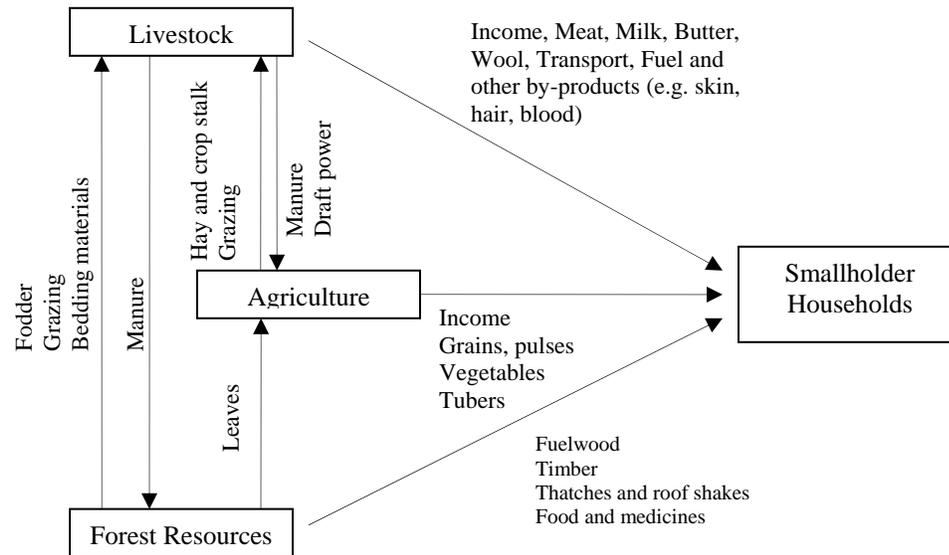


Figure 5.1 Smallholding based on the agriculture-livestock-forest interrelationships (Adapted from Steven 1993)

As shown in Figure 5.1, all three enterprises—agriculture, livestock and forest resources (including grassland and pasture)—rely on each other’s outputs. Although forest resources take the heavier burden from agriculture and livestock than the other way round, it is clear that the whole smallholding system here is based on the concept of interdependence. Livestock (cattle, water buffalo, sheep and goats) play an important role in maintaining soil fertility, particularly in the *Pahad*, where the use of chemical fertilizers may be prevented by either unavailability or cost, or may still be unknown to the farmers. Farmers consider goat and sheep manure to be superior to that of other ruminants, so when the herds of sheep and goats are kept close to

settlements during the winter season, they are allowed to graze in the just harvested paddy fields. They can graze on the crop stalks, while providing the much-needed manure before the farmer plough and prepares the land for paddy in summer. Thus, the farm-productivity is basically maintained by recycling plant nutrients through livestock grazing to yield field manure.

In this dynamics the household relies on agriculture, livestock and forest for different purposes, but the amount and quality they get from each of them is also conditioned by the structure (or composition) and functions of the other two which make them interdependent as well as interconnected. Here, agriculture may get disproportionate amount of investments (i.e., land, inputs and cash) from the households, but the herding and collection of fuel wood and fodder demand considerable labor and time; the sample households in Maling had spent approximately 4 hours/day for 2-4 times a week in collecting fodder and fuel wood.

Table 5.1 Main forest products utilized by sample households

Forest products	VDCs		Total
	Maling (n=35)	Banjhaket (n=31)	
Fuel wood	34	25	59
(% of column total)	97.1%	80.6%	
Fodder	31	21	52
(%)	88.6%	67.7%	
Timber	28	28	56
(%)	80.0%	90.3%	
Other materials	1	0	1
(%)	2.9%	.0%	
<b>Total</b>	<b>35</b>	<b>31</b>	<b>66</b>

Fuel wood is the most sought after forest product in both research sites, even though timber outweighs fuel wood in Banjhaket VDC (Table 5.1). An interesting point in the table is that in Banjhaket, the reliance on forests for fodder is relatively low (67.7%) and no one among the

sample population uses forests for roofing and cattle bedding. In recent years, the use of corrugated tin as roofing materials has increased considerably and having a house with corrugated tin means higher prestige. In addition, with the emergence and the expanding control of the CFP, the restrictions on forest products in Banjhakhet are more severe than in Maling.

There are other non-timber forest products, which are not used so frequently but have deep cultural significance, and they are considered important for their multiple uses. For instance, *Amriso* (*Thysanolaena maxima*) is considered sacred in many Gurung rituals and is widely used to make brooms and also as a preferred fodder. They believe every part of *Amriso* has some uses, so nothing is lost. Similarly, Gurungs' *arghau* ritual is considered incomplete without *simtaa* (*sim* means dead and *taa* means flower) or *chhiyuntaa* plant, which are found only in the dense forests of the *Lekh* and higher elevations. Gurungs believe that *simtaa* plant's roots saved their ancestors during the times of crisis (e.g., droughts, illness). Another plant called *jhaankri kaantaa* (meaning shaman's plant) is used by *Ghyaabri* in their rituals and is preferred as cattle fodder—the mother cow and newly born calves are fed the leaves of this plant.

The examples presented above are just a few among many to show that various forest products are utilized in the household; some are used directly (i.e., fuel wood, food, medicine, ritual materials, etc.) and some are extracted through direct means of livestock (i.e., grazing, fodder) or agriculture (i.e., leaves for manure, mulch). Thus, when the demand increase for biomass needed to support the subsistence agricultural system, which involves husbandry as a vital component, it invariably puts pressure on the non-cultivated land, mostly forests (Mahat et al. 1987a). This resembles the complex relationships between forest, livestock and agricultural land–use.

The impact of the recent changes (e.g., disintegration of traditional network and customary rights, non-farm employment drawing labor out of villages and land stress caused by agricultural intensification in lower valley) that I discussed in Chapter 4 is also evident in the farmers perceptions of interdependence and interconnectedness. With the pressure on agricultural intensification to maximize agricultural production, that too in the condition of insufficient agricultural inputs (i.e., fertilizer, high yielding crop varieties, irrigation), the emphasis of smallholding may not be on interdependence, but on the specialization of rice cultivation while using a set of diverse crops and livelihood options as a secondary option. Intensification also means the decreasing fallow periods and growing land stress. This has been the agricultural trend in the lower valley areas.

When this trend is compared with other parts of Nepal, certainly many challenges lie ahead in Lamjung's agriculture. Although it is not always the case, land stress may lead toward resource extractive measures, when there is little, if any, alternative around (Bishop 1990; Jodha 1995). The pressure on these resources also points to the existing pressure on cultivated lands, since such land is still heavily dependent on the interrelation of the forest, shrubland, grazing land and livestock. The important characteristic of this inter-relationship is that the forest to agriculture ratio is also decreasing (Mahat et al. 1987; Metz 1991; WECS 1985; Wyatt-Smith 1982). The subsistence farming population is facing a reduced ratio of forest to arable land upon which the various systems of mixed subsistence farming systems are dependent.

The recommended average ratios of agricultural land to forest land (the A:F ratio) for most efficient nutrient transfer in the Nepali farming system range widely: the LRMP recommendation of 1:5 is the most conservative, followed by Wyatt-Smith's (1982) standard of 1:3.5, and Mahat et al. (1987) value of 1:3.3. The ratio will vary from place to place since it

depends on local farming practices and forest conditions. Often villagers are aware of deteriorating communal grazing land and forests, but their limited resources force them to focus attention and energies on their most valuable lands and their private properties to secure food (Johnson et al. 1982). This compels farmers to focus only on a few, preferred crops and plant resources rather than on interdependence or networks of enterprises.

## **2. Agricultural land-use strategies**

Apart from verticality, climatic conditions and other biophysical factors aside, smallholders' shared cultural knowledge and experience are important socio-cultural factors that shape agricultural land-use strategies at different elevations of Lamjung. Particularly, the knowledge of micro-environmental condition of every kind of agricultural site and land-use type is either transmitted through generations or newly acquired by experimenting with innovations. This observation reiterates the findings of the Rhoades and Bebbington (1990) in the sense that farmers do experiment with new crops and it is based on their considerable knowledge of and experience with the characteristics, requirements and capabilities of crops.

The key question, which requires further discussions, rather is the continuity of such knowledge and practices across many generations through 'cultural memory' (Nazarea 1998, 2006), especially how and under what circumstances some communities have been able to preserve their shared cultural knowledge than others. Linking the question with the recent socioeconomic and institutional changes that occurred in Lamjung and other mountain communities would be very interesting; however, it is beyond the scope of this dissertation. What I would like to highlight here is that crop cultivation practices and the local knowledge that underlies it remain strongly based on cultural patterns developed earlier. Particularly in the case

of Lamjung, the factors that affect agricultural-use decisions and for which shared cultural knowledge and rules are known, can be categorized into two major domains: soil types and land-use types.<sup>19</sup>

They discriminate between several soil types on the basis of color and texture and use this categorization in assessing land value and choosing appropriate crop selection and manuring for fields. Smallholders I worked with do have a few general ‘rules’ of differentiating good quality soil from others, but these do not necessarily follow the systematic and scientific classification system. It was hard to fit them, mainly because of my own inability to collect and fit them into the standard Nepali soil classification or the USDA classification scheme (see Appendix G, No. 3 Training Sample Form). The black soil (*kaalo maato*), which is neither sandy nor clay, is the most preferred, followed by the red soil (*raato maato*) which is either loam or sandy loam and yellowish sandy soil (*pahelo maato*). The black clay (*kaalo chimte maato*) is considered to be of poor quality and is used only for pottery. The red color soil and white clay (*kamero*) are traditionally used to paint the house during the festivals and special occasions.

In terms of major agricultural land-use types, the respondents identified six major categories: *ban/jungle* (jungle), *khet* (irrigated land), *paakho* and *baari* (non-irrigated upland and home gardens), *gaaun* (settlements), *butyan* (shrubland) and *charan* (grazingland). When asked them about the types without probing and showing them aerial photographs, they listed only three: *jungle*, *khet* and *baari*, but they added others afterwards. The most interesting part of the exercise was that they identified more details than I expected, which I present in Figure 5.2.

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<sup>19</sup> There are some other examples of shared cultural concepts. For example, Gurungs at least those of Maling VDC, have a concept called ‘*Aayo waa Gayo*,’ which literally means ‘came or gone’ (‘gain or loss,’ to be precise). For this reason, the odd numbers are always considered the ‘gain’ (fortunate) and the even numbers as ‘loss’ (misfortunate). They prefer odd numbers in their festivities and rituals (e.g., 3 or 5 rams as sacrifice, 7 or 9 grains for worshipping, etc) and in any gift or other exchange items they receive from kins and neighbors.

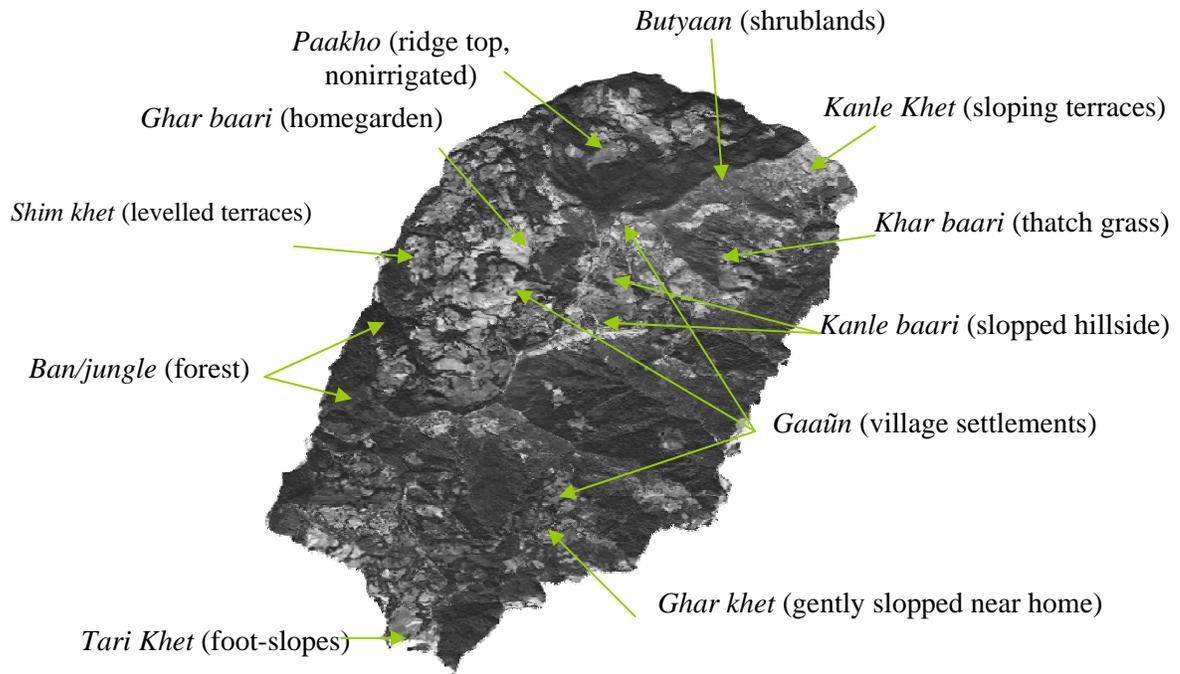


Figure 5.2 Local interpretations of land-use in an aerial photo (1996) of Maling VDC

Within each agricultural land-use type (i.e., *khet* and *baari/paakho*), there are considerable variations within, which are mainly based on slope, moisture content, soil type and utilization (crops are usually grown). These variations are the basis for characterizing agricultural land-use types at the farm level. These sub-classes can be incorporated in the LUCC classification scheme, but will require very high resolution images or aerial photographs.

Table 5.2 *Baari* Classification

<i>Baari</i> Types	Characteristics
<i>Taar Baari</i>	River terraces, fan mostly used for maize and upland rice cultivation
<i>Pataa Baari</i>	Moderately sloping, middle size hillside used for maize, millets, beans
<i>Ghar Baari</i>	Gently sloping hillside, mostly home gardens
<i>Kanle Baari</i>	Moderately to steeply sloping hillside used for fodder trees and beans
<i>Khoriyaa Baari</i>	Strongly sloping hillside and often recently cleared land
<i>Khar Baari</i>	Strongly sloping hillside for thatch grass production
<i>Paakho</i>	Non-irrigated ridge tops, fans

The concepts of *paakho* and *baari* are often confusing to many, even to those Nepali who are not familiar with the nuances used in farming communities. The main difference between the two is that *baari* is derived from *baar* (fence) to refer to an enclosed area in the home for growing fruits and vegetables, while *paakho* is strictly non-irrigated upland, ridges or terraces. *Baari* is mostly classified on the basis of the slope and utilization (Table 5.2). *Taar* and *paate baari* are the most valued types.

Although *paakho* is included within the *baari* classification, the respondents divided it into three sub-categories, which are based on the size and amount of labor required for tilling: large fields (*hal* means yoke or pair of bullocks used for plowing), medium fields (*pate*) and small fields (*kodaale* means hoes, which are used to till the land). These categories are even used in legal codifications and documents, as shown in the following excerpt from a historical document:

Prime Minister Juddha Shumshere sanctioned the following arrangements for a fresh revenue settlement in Kaski and Lamjung on Wednesday, Chaitra 28, 1991 (April 19, 1935): “The local landholders have demanded that the existing system of classifying homesteads as *Hale*, *Pate*, and *Kodale* be retained for the purpose of taxation. Two categories of homesteads have now been recognized: *Hale-paakho* if an ox-team can be used for plowing, and *Kodaale-paakho* if only the hoe can be used...”

(Regmi Research 1984:56)

Table 5.3 *Khet* Classification

Types	Characteristics
<i>Bagar Khet</i>	Valley bottom, floodplain
<i>Khola Khet</i>	Stream banks, stream terraces
<i>Shim Khet</i>	Head hollows, footslopes of colluvial slopes, spring areas
<i>Ghol Khet</i>	Valley floor depression
<i>Daldale Khet</i>	Swamp in valley floor
<i>Gairi Khet</i>	Valley floor, intermediate terraces, footslopes, most fertile
<i>Tari Khet</i>	Old river terraces, fans, tars
<i>Ghar Khet</i>	Moderately/gently sloping hillside, colluvial slopes
<i>Kanle Khet</i>	Steeply sloping hillside

The local classification of *khet* follows the basis of irrigation (water availability), elevation, slopes and utilization. Among these, *gairi khet* and *khola khet* rank the highest for their value. These types can provide up to three crops a year. This local classification does not match with the standard, legal terms used in the existing land taxation system, which classifies lands into four distinct types: *awal*, *doyam*, *sim* and *chaar*<sup>20</sup>. In Lamjung in general, only *sim* and *chaar* lands are common, at least that is what farmers would tell you, because claiming their lands as *awal* or *doyam* would mean the higher taxes, so they prefer to keep the same way.

Both *khet* and *paakho* usually have terraces of different kinds. These terraces are carved out to retain the water, soil and soil nutrient by matching micro-environmental conditions, climates, and slopes of the topography. In steeply sloping areas, where irrigation is poor or nil, farmers construct outward-sloping terraces (*paakho*), which is the most common type and covers almost the two-thirds area of all the cultivated lands in Maling VDC. This type does not get much labor for the maintenance, as only the minimum cutting and filling of earth are required. Wet rice (paddy), which requires intensive labor and inputs, is cultivated in leveled terraces (*khet*) located in lower slopes, valley area. Reverse-sloped terraces are mostly concentrated in the higher slope area. Another important aspect that influences terracing is whether there can be any slope stability, which is judged by the presence (or absence) of *paharaa* (massive bedrock) at the slope base. In some exceptional cases, wherever irrigation is available for paddy cultivation terraces are constructed, irrespective of slope stability. In sum, a number of reasons and their

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<sup>20</sup> Literal meanings of *awal*, *doyam*, *sim* and *chaar* are the first, second, third and fourth grade lands respectively. The classification, which is based on fertility, productivity and taxes, is done accordingly: *awal* land has no soil limitation and is taxed the highest amount, whereas *chaar* land is almost uncultivable and has lowest taxes.

combinations are associated with the changes between *khet* and *baari*, which include irrigation, slope, labor availability and micro-environmental conditions.

Table 5.4 Changes in the area of irrigated land (*khet*), as perceived by the sample respondents, comparing 2004 to 1994 and 1994 to 1984

Trend	VDCs (1994)		Total	VDCs (1984)		Total
	Maling	Banjhakhet		Maling	Banjhakhet	
Larger	9 26.5%	8 26.7%	17 26.6%	3 18.8%	3 30.0%	6 23.1%
Smaller	8 23.5%	4 13.3%	12 18.8%	1 6.3%	0 .0%	1 3.8%
Same	17 50.0%	18 60.0%	35 54.7%	12 75.0%	6 60.0%	18 69.2%
Total	34 100.0%	30 100.0%	64 100.0%	16 100.0%	10 100.0%	26 100.0%

Table 5.5 Changes in the area of non-irrigated (*baari* and *paakho*) as perceived by the sample respondents, comparing 2004 to 1994 and 1994 to 1984

Trend	VDCs (1994)		Total	VDCs (1984)		Total
	Maling	Banjhakhet		Maling	Banjhakhet	
Larger	1 2.9%	2 6.5%	3 4.5%	0 .0%	1 9.1%	1 3.6%
Smaller	0 .0%	6 19.4%	6 9.1%	4 23.5%	7 63.6%	11 39.3%
Same	34 97.1%	22 71.0%	56 84.8%	13 76.5%	3 27.3%	16 57.1%
Total	35 100.0%	31 100.0%	66 100.0%	16 100.0%	17 100.0%	28 100.0%

In terms of the changes in the total area of *khet* and *baari/paakho* (Tables 5.4 and 5.5), the majority of the respondents mentioned that there were no big change in their *khet* and *bar/paakho* areas, even though the percentage change for *khet* is higher than for *baari/paakho* and the changes that occurred between 1994 and 2004 are higher between 1984 and 1994. This trend is not surprising because cultivated land expansion had already stopped by this period and

some changes mentioned in *khet*, mainly in Maling, came from the purchase of land by a few households from fellow villagers.

Bunds and risers are commonly placed in the edges of these terraces, mainly to separate the parcel ownership while checking the water and soil run-off. These terrace risers throughout Nepal are stone-lined, vegetated or purposely cut to bare soil surface (Carson 1985). Farmers plant legume crops like soybean, pulses and some grasses in the risers. The farmers who are under extreme land stress tend to scrap off a portion of the riser surface every year before mostly paddy cultivation. Jodha (1995) notes this strategy as a sign of growing unsustainability in mountain agriculture; however, these strategies are very much limited to places with land stress, mostly in the *Besi*. Building bunds in the *Besi* is dependent on the limited availability of adequate lands. Although vegetation in bunds provides green manure for the field, paddy fields (*khet*) in general tend to have lower number of bunds than in *paakho*.

In *paakho*, what locally known as *kaanlaa* and *kaanlo* provide wild vegetation buffer areas between sloping terrace fields. The *kaanlo* checks soil erosion during heavy monsoon rains, while providing the space for growing some fodder and small fuel wood trees. Fodder trees are not planted around the paddy fields because of their shading effect, which might hinder crop growth. As pressure on cultivated lands availability increases, especially in the valley, the farmers periodically do face the dilemma of having to cut into these *kaanlo* areas for cropland expansion, thus threatening this important land-use strategy.

So, what is the significance of detailed discussions and classification of these agricultural land-use categories and their classifications to overall LUCC in Lamjung? The objective here, as mentioned in Chapter 1, is to document the major pattern of changes in agricultural-land use strategies or the so called ‘modification activities’ with explanations of the household and

community conditions under which these changes occur. To explain the changes in agricultural land-use strategies, I have to start first with the conversion of land-cover from forest to agriculture land and then examine the modification activities within agricultural lands.

The conversion of land-cover from forest and agricultural lands in Lamjung usually takes place through two different processes:

- Deforested area, caused by both agricultural expansion and non-agricultural causes (i.e., fuel wood, timber, settlement expansion), with the transition from mature forest to shrublands to grassland (the so called ‘rollback’ process) and then these shrublands eventually brought into cultivation with the expansion of *paakho* and *baari*
- Once *khoriya* system (slash-and-burn) was outlawed, the areas that once utilized on a rotation basis were individually claimed and converted into sedentary *paakho*. It is hard to corroborate from the field, but according to some respondents there are many land parcels that are now under either *baari* or *paakho* were once *khoriya* land 50-60 years ago.

As noted in Chapter 3, the conversion process here, however, is not as linear or as irreversible as widely assumed in many LUCC studies. In recent years, there have been considerable gains in forest area, mainly through the reclamation of shrubland and pastureland. Even in the *Besi*, there is a trend toward forest consolidation. Because of various reasons (i.e., restrictions on animal husbandry, in non-farm employment drawing labor out of the villages and differentiated interest in agriculture in *Pahad*, insurgency creating security fears) increasing numbers of remote parcels are being abandoned, which are now considered shrubland. In many villages where the community forestry programs are operated, there are significant areas with forest re-growth or ‘transitional forest,’ mainly by reclaiming the shrubland.

The changes in land-use strategies also vary in the *Pahad* and *Besi* areas. In the *Pahad*, it is mostly through the expansion into claimed forest, increase in the agricultural area at the expense of less productive or buffer areas (e.g. *kaanlaa*, *khar baari*) and ‘false expansion’<sup>21</sup> (borrowing or renting someone else’s land and stabilizing fallow cycles on the borrower’s own land). In contrast, land-use changes in the *Besi* mainly come through excessive cropping frequency, intensification and diversification (introduction of new crops), even though the last one is a very recent phenomenon and the impact is not well-studied.

In incorporating and intensifying new crops, there are roles of innovation and dissemination, but farmers’ knowledge of and experiences with the characteristics, requirements and capabilities of the crops also contribute to their decision-making process. Again, their land-use strategies are strongly related to their shared cultural knowledge and experience with individual crops.

### **3. Crop choices and agro-diversity**

In order to understand Lamjung Gurungs’ shared cultural knowledge of crop choices and the factors that influence the shifting preferences in food, it is necessary to elucidate their food concept, which classified every edible grains and tubers into two categories: *naram* (soft) or *kadaa* (hard). Their definition of soft and hard is based on the foods’ hardness: whether it is easy to process (i.e., grind, mill and prepare) and digest. Soft foods, such as rice, maize and potato are valued more, in terms of social prestige and monetary value. Ideally, women, elders, children and someone the sick are supposed to get the soft foods for their meals; however, the intra-

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<sup>21</sup> The idea of ‘false expansion’ and other land-use modification strategies is based on Laney (2004), in which she uses the ‘induced-intensification theory’ (Turner and Ali 1996) to differentiate the ‘agricultural processes’ involved in land-use modification. Based on the past land-use strategies and the declared land-use strategies for future farming, she proposes a ‘process-led’ LUCC model to predict the future LUCC patterns.

household dynamics of food serving may or may not conform to this ideal. Hard foods, such as buckwheat, millet, barley, wheat and pulses are considered inferior to rice and are served to persons doing a lot of manual labor—they often eat *dhindo* (porridge of buckwheat, millet or maize), which make them feel full for longer hours than rice or maize meals do. As one of my key respondents put it succinctly: “*dhan bhanyaa Raajaako khaanaa ani deuta ko aksheta bho, tara kodo ta prithivipalaknai bho*” (“rice may be the king’s meal and the grain to worship the god, but millet is what feeds the Earth”).

Table 5.6 Main Crops Cultivated in 2004-05

	Maling		Banjhakhet		Total	
	(n=35)	%	(n=31)	%	(n=66)	%
Maize	35	100	31	100	66	100
Rice	34	97	30	77	64	97
Millet	35	100	18	58	53	80
Potato	25	71	17	55	42	64
Lentils	7	20	27	87	34	52
Soybean	12	34	21	68	33	50
Ginger	13	37	15	48	28	42
Oilseeds	7	20	9	29	16	24
Greens	3	9	6	19	9	14
Others	21	60	15	43	36	55

The household survey data show that maize, rice, millet and potato are the main crops cultivated in the research sites (Table 5.6). While crops like buckwheat, potato and barley have historical and cultural meanings, the food preference also changed as they started to move downward to the lower valleys, where new crops like rice and maize were widely used by the *Khas*-speaking groups. Buckwheat and barley are ranked lower and many even do not even list them in the freelisting of their crop choices (Tables 5.6 and 5.7). The symbolic and cultural value of barley and buckwheat, however, should not be measured only in the terms of their utilization

frequencies, because these ‘archaic’ crops (see Dove 1999) persist precisely because of their ritual value. Millet and maize are more common, because they can thrive in upland with no irrigation: seasonal rain is enough for adequate production and they are less susceptible to pests and droughts.

Table 5.7 Freelisting of most important crops, sorted by frequencies (n=19)

	ITEM	FREQUENCY	RESP %	AVG RANK	Smith's S
1	RICE	19	100	1.737	0.914
2	MAIZE	19	100	2.053	0.886
3	MILLET	18	95	2.722	0.758
4	POTATO	18	95	3.944	0.648
5	GINGER	12	63	7.417	0.237
6	MUSTARD	9	47	8.778	0.153
7	ONION	9	47	8.222	0.165
8	GOURDS	8	42	8.000	0.160
9	PULSES	8	42	6.500	0.192
10	BEAN	7	37	10.143	0.117
11	GREENS	7	37	8.000	0.124
12	TURMERIC	5	26	11.200	0.040
13	COWPEA	5	26	10.200	0.046
14	YAM	5	26	6.800	0.120
15	SOYBEAN	4	21	5.750	0.129
16	ORANGE	4	21	10.250	0.077
17	CRUCIFERS	4	21	8.000	0.070
18	RADISH	4	21	10.750	0.056
19	WHEAT	3	16	6.000	0.100
20	BUCKWHEAT	3	16	4.000	0.127
21	TOMATO	3	16	7.333	0.071
22	GARLIC	2	11	13.500	0.023
23	LENTIL	2	11	7.500	0.059
24	SESAME	2	11	13.500	0.024
25	CUCURBITS	2	11	13.500	0.026
26	OKRA	2	11	7.000	0.053
27	PEA	2	11	9.000	0.053
28	CHILLIES	2	11	6.500	0.047
29	LEMON	1	5	6.000	0.031
30	GHAIYA	1	5	4.000	0.030
31	BANANA	1	5	12.000	0.008
32	OILSEEDS	1	5	9.000	0.011
Total/Average:		192	10.105		

Another very interesting aspect of the food system is that millet—the most widely grown crop virtually by every household—has more uses in their food system than any other crops (Appendix C), but it is ranked only after maize and rice. They make *jaand* (local beer) and *raksi* (alcohol) and a variety of dishes from millet. Millet alcohol is preferred over rice and maize

alcohol for its superior quality: it tastes better and does not cause headache. Even between maize and rice, maize is more widely cultivated and their uses outweigh rice, but rice is ranked higher than maize in pile-sorts (Table 5.8).

As shown in Table 5.7, among the 19 respondents for the freelisting of main crops, the saliency of rice is higher than that of any other crop and it was ranked more frequently than any other crop. Millet and maize are more common because they can thrive in upland with no irrigation: seasonal rain is enough for adequate production of maize in addition to relatively less susceptibility to pests and drought. The case of potato is interesting. Although it was introduced here only in the last two centuries ago, it has become the staple crop for many mountain villages, where cereals are hard to grow. The potato seeds are mostly brought from the *Lekh* area and they are preferred over those from the lower valley markets; they exchange potato seeds and every three years renewal from higher altitude takes place, which is also the case for other parts of Nepal (Rhoades 1985).

Table 5.8 Pile sorting of preferred crops and reasons

Crop Choices	Decision	Reason(s)
Maize – Wheat	Maize	Easy to eat
Maize – Millet	Maize	Provides more variety of food
Maize – Rice	Rice	Delicious
Maize – Buckwheat	Maize	Higher productivity and easy to digest
Rice – Wheat	Rice	Easy processing and easy to eat
Rice – Millet	Rice	Easy processing and delicious
Rice – Buckwheat	Rice	Easy to eat, delicious
Wheat – Millet	Millet	Less labor required
Wheat – Buckwheat	Buckwheat	Nutritious and less processing time
Millet – Buckwheat	Buckwheat	More nutritious

The preference for rice is closely tied with socio-cultural reasons, status and religious values. When Gurungs started to settle in the lower valley, they also came under the influence of the Hindu ideology and the food system of the *Khas*-speaking groups, who had the knowledge of

and experience in irrigation and wet rice cultivation and for whom rice was the most preferred staple. Thus, Gurungs also embraced the rice culture and the rice has become so much part of their culture that feasts without rice items, such as *bhaat* (rice meal) and *selroti* (rice doughnut) are perceived incomplete. They always try to serve rice meals with rich flavor and softness to guests and in feasts. It is a very common knowledge that only wealthy and higher caste people can afford rice; thus, there is social prestige and status attached with the house that grow and consume rice.

Table 5.9 Rice varieties and landraces for different level of water availability

Sufficient water	Moderate water	Limited or no water	Riverbed	Cold weather
<i>Thulo Saali</i>	<i>Bhangere Saali</i>	<i>Aango</i>	<i>Ekle</i>	<i>Chhumrung</i>
<i>Ramainaa</i>	<i>Darmaali</i>	<i>Ghaiyaa</i>		
<i>Jhinuwaa</i>	<i>Naule</i>			
<i>Anadi</i>	<i>Mansaraa</i>			
<i>Mansaraa</i>				

Table 5.10 Freelisting of rice varieties and landraces sorted by frequencies

	VARIETIES	FREQUENCY	RESP %	AVG RANK	Smith's S
1	THULO SAALI	7	100	2.143	0.823
2	RAMAINA	7	100	3.143	0.679
3	JHINUWA	7	100	3.000	0.737
4	MANSARA	6	86	5.500	0.270
5	BHANGERE SAALI	4	57	4.250	0.297
6	NAULE	4	57	4.750	0.267
7	ANADI	4	57	6.000	0.215
8	DARMAALI	3	43	4.000	0.257
9	AANGO	1	14	9.000	0.039
10	EKLE	1	14	10.000	0.026
11	CHHUMRUNG	1	14	11.000	0.013
12	GHAIYA	1	14	7.000	0.020
13	JETHO BUDHO	1	14	1.000	0.143
Total/Average:		47		6.714	

Improved rice varieties: Khumaltar, Vijay, Radha 1, Radha 2, Dalle

Farmers also differentiate the quality of rice by two different factors: (1) different varieties and landraces are cultivated according to water availability, (2) quality (i.e., taste, flavor, texture and color) and usefulness (multiple uses like hay as fodder, matt, etc). *Thulo Saali*, *Ramainaa* and *Jhinuwaa* are the most preferred varieties. *Ramaina* and *Jhinuwa* are the most preferred for their aroma, whereas *Thulo saali* has taste better and provide high productivity; its ‘by-products,’ such as hay and husk are more palatable to cattle and buffalo. This is why in the freelisting exercise, the salience of *Thulo saali* outweighed others. I believe only *Aango*, *Ekle* and *Chhumrung* can be considered landraces, even though other have been around for decades. Some ‘improved varieties,’ such as *Khumaltar*, *Vijay* and *Radha* were introduced in the *Besi* area and they were introduced only in the last 10 years or so; however, these varieties require adequate flooded water and chemical fertilizer to yield the desired productivity (Table 5.9). Farmers’ incorporation of and experimentation with new crops in this area are, hence, influenced by a host of factors. For them, the productivity of a new crop really matters, but they also consider several other crop uses that are not so important from the perspective of agricultural extension agent or other outsiders. As one farmer mentioned:

I was once told that the *Bikaase dhaan* (improved paddy variety) were like gold. I don’t know about that, though...Many years ago, they brought some species of maize from Lumle (Agricultural Research Station). Those were big ones that grew in abundance. But it was less tasty, so we gave it up growing. And paddy too was introduced not so long ago—only four or five years ago. This *Bikaase dhaan* is being tested now; we’ll know its results only a few years. In some areas, the effect is significant; paddy has grown at least four folds. This is why people are using *Bikaase*. However, we have stopped weaving *gundri* (rectangular shaped, long mats made up of hay), which we used to weave in the past. *Paraal* (hay) is very little for *dingaa* (cattle). Hay has disappeared altogether. Cultivation of that short paddy has yielded good harvest, but there is very little hay.... *Bikaase dhaan le phal paayechha, maal paaye chhaina* (improved paddy varieties have produced good harvests, but have not given manures)...

While the farmers have incorporated many new crops, such as wheat, soybean, tomato and crucifers in their food system within the last two decades, the numbers of varieties and landraces for existing crops, for instance rice, found in this area have significantly declined in the recent

years. In Maling, the respondents could list as many as 12 different varieties, but their rice cultivation has limited to only two or three varieties (i.e., *Ramaina*, *Thulo Saali* and *Mansara*) over the last five years (Table 5.10). If the current trend continues, it will not be surprising if all these ‘local’ varieties are replaced by the ‘improved varieties’ within the next 10 years or so, shrinking rice genetic pools and the agro-biodiversity of their food system.

While further assessments is required to shed more lights on the issues, such as valorization of rice over widely used maize and millet and agro-biodiversity, the significance of the shifting preferences in crop and crop variety choices is that it indicates how smallholder households make changes in their food systems and how it can influence their land-use strategies.

#### **4. Livestock and pasture management**

Cattle, water buffalo, sheep and goats are the main livestock in the research sites. Gurungs usually do not raise pigs, mainly because they are considered ‘impure’ in the Hindu religion and Gurungs also hold this taboo. For Gurungs, sheep and goats have traditionally been important. The wool of Gurung sheep is coarse and can be used only for weaving blankets and heavy men’s coat. In recent years, however, the importance of the sheep has lingered only in rituals, especially in the *arghau* (the final mortuary ritual and memorial services) when three sheep are required to accompany the dead person’s soul to the villages of the dead.

There are two different kinds of animal husbandry in Lamjung: (1) the mix of cattle, water buffalo, goat and sheep; (2) traditional migratory sheep (including goats) herding. In the case of cattle, water buffaloes mix with sheep herding, which is more dominant in the lower elevations and is replacing the traditional sheep herding practices in many *Pahad* villages as well, animals are kept in unused fields near the village during the dry winter months and young boys look after

them. Cattle and water buffaloes are often stall-fed and are primarily kept for the milk. During the wet summer months, however, when herds are taken to higher forest pastures, the strength of teenage youth and young adult men is needed.

When livestock are kept within the village or close to the village, each morning the cattle and goats are released from their sheds and pens and gathered together by small herd boys who take them to nearby grazing areas the sight of the village. By dusk, they are returned to their stalls adjacent to the household to which they belong. These cattle, goats, and sheep are the major sources of manure, *mal*, for field fertilizer and goats are also used as sacrificial animals, the *seba*, on certain ritual.



Figure 5.3 Herds of sheep and goats in Ghermu VDC

In the traditional migratory sheep herding practices, households in a village organize themselves within the communal rules and send animals to one of the village herds. A *Tiyanle* or *chiba* (chief shepherd), who is accompanied by 3-5 *Bhendi-Gothaala* (shepherds) and 3-4 Tibetan

mastiff dogs, looks after the herds. These shepherds are mostly compensated in kind with gifts (e.g., grains, *selroti*), cloths and blankets based on the number of sheep and goats sent in herds. In addition, the shepherds may receive one or two animals from the owners in kind for a year's shepherding. In some areas, shepherds may also receive a nominal sum as commission from the owner for any animals sold. These rules vary by villages and herd size.

In Lamjung, there are three breeds of sheep namely *kage*, *baruwal*, *bhyanglung* and two breeds of highland goats namely *khari* and *chyangra*. These shepherds construct *Bhendi goth* (shepherds' camp) in their summer pastures (*kharka* in Nepali or *bugani* in Gurung) to shelter from the frequent summer rains and cold nights. The very young kids and lambs are kept inside. The shepherds carry their provisions with them. Large quantities of milk, clarified butter and cheese are stored and periodically transported back to the village by young *bhendi gothaalaa*, who then return with new supplies. The shepherds mainly eat *kheer*, rice pudding. They also carve woods or make *doko* and other bamboo items.

In this transhumance system, herds of sheep and goats graze fallow fields, shrubland and forest under-cover around lower villages (1000masl) during winter (January-February) and then **ascend** through higher villages (1600-2000masl) and dense forests (2000-3700masl) to the alpine pastures (3700-4500masl), where they graze during summer (June-August). At this height, there are no trees, but a thick grass grown on the top of the ridges and in the hollows, which have been free from snow for several months. They start to **descent** during late September and return to the higher village in November, spending about six months away from the village.

As shown in a typical transhumance calendar of Lamjung and Kaski district (Figure 5.4), herds leave the villages for the alpine pastures between April and May, depending on the cropping pattern and climatic conditions of the area. During this period, the sheep herds move

steadily upward through the forests. They stay for one to three nights in one of the en-route *kharka*, which is simply an open grass area in the forest.

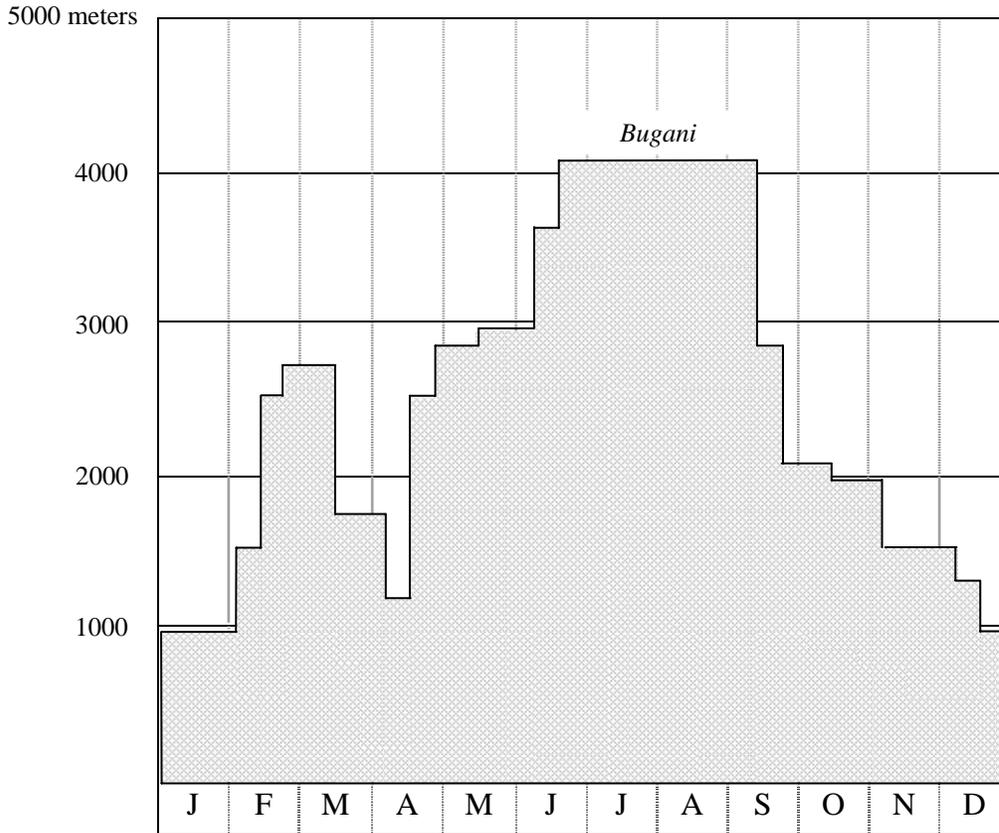


Figure 5.4 A typical transhumance calendar among Gurungs in Lamjung and Kaski

For the ascend, the route selection is based on the location of the *Kharka* or *Bugani*. By the late May, the condition of the summer pasture begins to improve, so the shepherds schedule their migration calendar accordingly. Mostly around the early June, herds reach *kharka* located between 3,600masl and the permanent snowline at 4,500masl. Sheds (Goth) are often constructed to protect new born and other weak sheep and goats from the harsh weather. From late July to early September, herds are kept in one of the *Bugani*, which provides the most

nutritious feed of the year, allowing them to gain significant body weight. After about two-three months of grazing, herds start the descent, depending on the climatic condition (e.g., sign of snowfall, chilly climate, vegetation). In the descent period, the herds may pass through the forest and small *kharka* in a similar manner to their ascent. In these small *kharka*, the herds might be left to graze at one place for as long as 25 days. When they return toward the village around the first November the herds are first taken in groups onto the recently harvested millet field and fed the millet stubble. These fields are usually located at the height of 2,000-2,500masl. After a few days, herds reach the villages (1500–2000masl). As the farmers harvest maize, millet and other crops, the herds are brought around the village ‘*baari*,’ where in return for grazing herds are kept in these recently harvested land during the night for manuring. In some cases, they are also grazed in local forests. Following a rotation system, these herds are constantly moved; they spend on an average one terrace for one or two nights. Once the herds leave, these fields are plowed immediately to mix manure into soil.

Around the mid November, they further descend toward the valley bottom to be fed on the rice stubble about 1,200-1,700masl. Thus, the herds remain near the village during the winter. During early the late winter, they are also moved in the recently harvested maize and the millet fields to manure them before the spring plowing. They remain at lower elevations (800masl to 1,700masl) until the date of their new ascent to *kharka*, which is around the mid-April.

From December to the late February, the herds are moved to the *Besi* area (800–1000masl), moving from one field to another after spending one or two nights at each site. Farmers in the *Besi* often request the herds to graze and manure their fields; they compensate with free food and clothes to the shepherds. The winter forage thus consists of crop stubble, shrubs and forest undergrowth adjacent to the villages. While competition for these scarce resources also comes

from sedentary herds (e.g., cow and water buffalo), sheep and goats' manure are considered higher quality. One key exception is that these herds are not generally flocked on *khet*, as these fields are usually wet, which makes it unsuitable for sheep and goats' grazing.

This transhumance system is a complex system. It entirely depends on the rich ecological knowledge of *tiyaanle* (chief shepherds) and other *bhendi gothaalaa* (shepherds) for many operational aspects of the system, such as selecting the migratory routes, deciding on the days to be spent on each en-route *kharka* and the final *goth* (sheds or camp) and rotating between different *kharka*. The shepherds have to walk long distances carrying their own food and shelter with them. This system follows the clear boundaries and strict communal (customary) rules—each member household strictly follows the rules or has to face the sanctions. The transhumance system utilizes the fodder and grasses, which would otherwise be wasted. All these make the system one of the most challenging animal husbandry practiced in the world.

This system is fast disappearing from almost all but a few villages in Lamjung. When Donald Messerschmidt (1973, 1976a and 1976b) conducted his fieldwork in the early 1970s in Lamjung, this system was already in the decline, and much less practiced in the original agropastoralism form. The pursuits of sheep herding by Gurungs have suffered from a loss of labor pools to other pursuits, primarily to sedentary agriculture, mercenary soldiering, and other non-farm employment options. The effects of animal illnesses, changing patterns of trade (i.e., the closure of the Tibet border and the opening of the trade in Tarai) and decreasing forest reserves worked as catalysts.

The most important change that influenced the transhumance system is the changes in institutional arrangements, mainly the abolition of Gurungs' customary rights over the forest and pastures through the Forest National Act of 1957 and the Pasture National Act of 1973. Once

communal and customary rules were abolished, no rules and institutions were in place to regulate the pasture management for a while. After almost three decades of devastating effects of the 'open access' regime then came the CFP, which has achieved sporadic success in forest conservation, but has even put more strict restrictions on the migratory sheep herding, effectively putting the pressure of 'enclosing' all livestock to keep them away from forest and grazing land. Obviously, there are no incentives to keep bigger herd of livestock anymore. Thus, in recent years, there are more and more preferences for stall-feeding of animals. Those who cannot afford cattle and buffaloes have smaller livestock, mostly goats and chicken, which they can sell to meet household needs and contingencies.

## **5. Agricultural priorities and constraints**

The focus, priorities and constraints in the livelihood of Lamjung smallholders have also changed when the main agricultural system of Lamjung transformed from agropastoralism to the rice-based intensification of mixed mountain agricultural system. Thus, the majority of the energies (e.g., capital, labor, land, time) are now expended in maximizing the productivity of rice in *khet* and maize, millet, vegetables and other crops in *baari/paakho*; livestock is no longer a priority and is kept only for milk and draft power. Each of these two systems has its own merits and demerits and it is certainly interesting to compare how the smallholders themselves compare these systems. In Table 5.11, I present a comparison of the merits and demerits of two different agricultural systems; that is agropastoralism and rice-based intensification of mixed mountain agricultural system, as perceived by the key respondents.

The main contrast between the two systems is not only limited to the higher energy inputs in the rice-based intensification, but also in the way farmers perceive the latter to be superior to the

former. There is clear evidence that the lower incentives in livestock eroded the long-held concept of interdependence (the interrelationship of agriculture, forest and livestock) in the face of changing rules of resource allocation and the growing influence of the wider market economy. Because of this, the legitimacy of customary rules and authority structures was declining and the terms of goods and services were increasingly defined by their cash value.

Table 5.11 Respondents' comparison of two different types of agricultural systems

Agropastoralism	Intensive Agriculture/Mixed Mountain
<ul style="list-style-type: none"> <li>• Meat as protein source, dairy</li> <li>• Community oriented</li> <li>• Reliance on livestock and forest</li> <li>• Less cash, better for contingencies</li> <li>• Labor management</li> <li>• Purity (cultural and symbolic value of cow and sheep)</li> <li>• Draft power for plowing</li> <li>• Wools</li> <li>• Recycling of waste</li> <li>• Low but steady productivity</li> <li>• Ancestral profession</li> <li>• Manure for agriculture</li> <li>• Lower incentives (discouraged with a lot of restrictions)</li> </ul>	<ul style="list-style-type: none"> <li>• Higher cash, market value</li> <li>• Higher social status</li> <li>• Less communal obligations</li> <li>• Reliance on livestock decreased</li> <li>• 12 months work is better than leaving fallow</li> <li>• Abandonment increases animal encroachment</li> <li>• Higher productivity</li> <li>• Requires higher labor, problems when labor force decreases</li> <li>• Seasonal variations and risk</li> <li>• Variety of crops and vegetables</li> <li>• Higher incentives (extension services, subsidies, credits, etc)</li> </ul>

There are, however, some positive gains (e.g., higher productivity of rice and maize, incorporation of vegetables in the diet system, break-down of traditional 'patron-client' relationships, diffusion of ethnicity-specific land-use) as well as risks (e.g., decrease protein intake, increased work burden for women, monoculture, narrow genetic pools in rice farming) associated with the change. One of the key demerits of the change is that the decreasing numbers of cattle and buffalo also means less availability of organic nutrients available for agriculture, as they have been the main source of manure, at least where chemical fertilizers are not common

yet. The majority of the respondents considered the decline in organic manure availability as the main reason for declining productivity of their cultivated lands (further discussion provided in Chapter 6). Organic manure, which once used to be so abundant, has become a so crucial commodity in the recent years so that it even plays an important role in defining the relationships between the land owner-tenant relationships (see Table 5.12). Apart from the type and quantity of land, the return obligations and amounts depend on whether the tenant receives organic manure from the landowner to support cultivation.

Table 5.12 Work relations among the landowner and the tenant

Land tenure category	Obligations and rights
Owner ( <i>jagga dhani</i> )	Either cultivate own land or rent them out to others for fixed returns
Renter ( <i>bhaandaama line</i> )	Fixed lease and contract agreements. This form is more liberal than sharecropping agreements. Higher the risk, higher the gain principle applies here, since the return amount is fixed regardless of the harvest quantity, even in the case of natural calamities, seasonality and so forth. No manure is provided
Sharecropper ( <i>adhiyaa</i> )	Literally means half and half. There is an equal division of produce between the landowner and the tenant. When manure is provided, the owner gets a half of the total harvest of all crops. In the case of <i>paakho</i> , a half of the millet harvest has to be returned, when the manure is provided; otherwise there is no obligation on the maize harvest
Servants and workers (called <i>hali, ropali</i> or <i>baneli</i> )	This practice has disappeared. Historically, they were hired mainly for three months of the rice plantation season (May-July) by compensating their labor for up to 3 muri of rice.

The impact of the wider market economy is now considerable in every form of livelihood. As all exchanges of goods and services are increasingly monetized, it is often hard to rely exclusively on *Parmaa*, the most dominant informal labor exchange network, or on other forms of labor exchange network. Even the nature of *Parmaa* is often monetized, especially during the

peak rice planting seasons, when there is labor shortage; many households end up paying NRs.150 to 200/person/day for their labor. The effect of commercialization is expanding so fast in the *Besi* area that those who can afford hire wage laborers to cultivate their land, as it frees them from social and economic obligations to their neighbors and fellow villagers. Besides, performing such menial and strenuous job is considered a matter of losing prestige among the higher castes and classes.

The growing influence of the cash economy, together with increasing interest in non-farm employment opportunities, is the main reason behind the labor shortage. In the area where agricultural intensification is actively pursued, the existence of market infrastructure, extension services and the farmers' capacity to maintain the required level of inputs (i.e., irrigation, fertilizers, seeds, intensive labor for weeding and other cultivation practices) are the necessary conditions. This is, however, not the case of Lamjung, where access to irrigation water tops the list of farmers' priorities and concerns (see Table 5.13) and where market is still precarious and extension services are inept in delivering services outside the limited 'pocket area' and 'demonstration plots.'

For smallholders, the existence of markets is almost like a 'one-way traffic,' their reliance on the market for consumer commodities is growing every day, while the constant price variability--mainly because of availability of cheaper alternatives coming from southern markets, is making it unpredictable for farmers to produce exclusively for the market. In Banjhakhet VDC, which is more integrated into the market economy, for instance, tomato and potato are the most profitable, because they are demand in Besishahar market. However, farmers are hesitant to produce primarily for the market, given the rudimentary infrastructure and high variability in prices. Despite some reportedly selling more crops, many smallholders are still unable to capitalize on

market opportunities: only wealthier farmers can engage in input intensive cash cropping. No link exists between the extension services and the market support system, which could facilitate and regulate fair trade and exchange of goods. Without the support system, even rich farmers cannot afford a season of crop failure.

Table 5.13 Freelisting of major constraints and issues as perceived by the sample households (sorted by frequencies n=66)

ITEM	FREQUENCY	RESP %	AVG RANK	Smith's S
1 IRRIGATION	42	64	1.429	0.535
2 TRANSPORTATIO	28	42	1.857	0.285
3 AGR EXTENSION	21	32	1.762	0.232
4 MARKET	17	26	2.353	0.136
5 ELECTRICITY	8	12	1.875	0.083
6 POTABLE WATER	6	9	2.000	0.058
7 LAND DEGRADAT	5	8	1.600	0.053
8 SEED SCARCITY	4	6	1.750	0.043
9 BRIDGE	3	5	2.667	0.020
10 ROADS	2	3	2.500	0.015
11 NO MILLS	2	3	1.000	0.030
12 DEFORESTION	2	3	1.500	0.025
13 BOARDING SCHO	1	2	2.000	0.010
14 FODDERS	1	2	2.000	0.010
15 UNEMPLOYMENT	1	2	2.000	0.010
16 LIVESTOCK ROAMING	1	2	1.000	0.015
17 MONKEY	1	2	2.000	0.008
18 AWARENESS	1	2	3.000	0.005
19 HOSPITAL	1	2	1.000	0.015
20 DISEASE	1	2	1.000	0.015
21 CHEMICAL OVERUSE	1	2	1.000	0.015
22 SKILLS	1	2	1.000	0.015
Total/Average:	150	2.2		

The need for irrigation water aside, the major issues for the farmers in Lamjung are the lack of transportation and roads, agricultural extension services and market. These also indicate the growing influence of the market economy, but the infrastructure and inputs required for agricultural intensification have not been adequate to meet the farmers' aspirations.

## 6. Landscape level change

Apart from the development of road and towns along the Marsyandi river, almost all of the key respondents of interviews and the household survey cited the increase in forest coverage over the last 20 years as the most significant landscape level change. They gave various reasons for the expanding forest coverage, as listed below in Table 5.14. The impact of the CFP and other forest conservation programs has contributed to this. The top three reasons (i.e., forest conservation, restrictive rules on forests and community forestry) and a few others (i.e., six forest assigned to each ward, nine restricted membership, 10 forest guards and 14 controlled animal roaming and grazing) are essentially the same. These are the components and the impact of the CFP. The fourth reason that is the decline in livestock population, is apparently the adverse impact of the CFP and the fifth reason—migration, is more prominent in Maling than in Banjhakhet.

Table 5.14 Major factors for increasing forest coverage from 1984 to 2003 as perceived by the sample household (sorted by frequencies n=66)

ITEM	FREQUENCY	RESP PCT	AVG RANK	Smith's S
1 FOREST CONSERVAT.	35	53	1.686	0.384
2 FOREST RESTRICTI.	26	39	1.692	0.285
3 COMMUNITY FORE.	24	36	1.333	0.311
4 DECLINE LIVESTOC.	24	36	1.667	0.263
5 MIGRATION	12	18	1.833	0.121
6 FOREST ASSIGNMEN.	7	11	2.000	0.063
7 ABANDONED LAND	5	8	1.200	0.071
8 INSECURITY INSUR.	4	6	2.750	0.023
9 RESTRICTED MEMB.	2	3	2.000	0.015
10 FOREST GUARDS	2	3	3.000	0.010
11 AFFORESTIONS	2	3	1.500	0.025
12 LOWER POPOPULATI.	1	2	3.000	0.005
13 IMPROVED COOKSTO.	1	2	1.000	0.015
14 CONTROL ANIMAL R.	1	2	1.000	0.015
Total/Average:	146	2.212		

The labor shortage issue, which I believe is one of the most pressing agricultural issues in Lamjung, was apparently not even listed. The losing interest in agriculture mainly among young

populations is drawing labor out of the village to non-farm employment in the cities and abroad, which in turn, is putting pressure on smallholder household to abandon the land parcels that are far from home and are less fertile. The major impact of these on agricultural production is already discussed, but the need for recording what Nazarea (1998) calls the ‘cultural memory’ associated with the food system is also growing, as there is already some evidence of the erosion of genetic pools of rice and a few other crops. Furthermore, in order for past actions to affect present agricultural land-use and the present land-use to affect the possibility of future coordination, a long-term, collective memory of the past is necessary.

To summarize the chapter, the ethnoecological investigation of smallholders’ agricultural land-use strategies in Lamjung reveals that:

- They still used the shared cultural knowledge and rules to differentiate agricultural land-use strategies, which are based on the ecological knowledge of topography, climates, micro-environmental conditions, individual crop’s capability and their cultivation practices. In addition, they classify land-use strategies in finer details than what can be incorporated into the existing LUCC framework designed for the study.
- Their agricultural priorities also shifted from livestock and cold climate crops (i.e., barley and buckwheat) to rice-based agricultural intensification within the mixed-mountain agricultural system, after they moved their settlements toward the lower valley in the past several decades.
- Forest coverage has increased because of the CFP and other forestry conservation initiatives, but since these programs severely restrict the traditional animal husbandry and ‘enclose’ livestock, other alternative strategies are being adopted (e.g., decrease in

livestock number, keeping stall-feed animals and small ruminants, practicing agro-forestry in *baari/paakho*).

- Decrease in livestock herd size of cattle, sheep and water buffalo and more reliance on small animals (e.g., chicken, goats). The decreasing livestock number in a household also means less manure and the less draft power available for cultivation, which effectively breaks the long held concept of ‘interdependence’ of farming, livestock and forest and prompts the household to rely on the market for fertilizer and pay cash money to hire bullocks to plow.
- Maximize the productivity of rice-based intensification in the *khet*, as rice is more preferred for meal and its cultivation and consumption symbolize a higher social status among all ethnic and caste groups in Nepal. The quality of rice or many other food are measured with fineness (texture), color and flavor.
- Withdraw labor from less fertile *paakho* parcels that are far away from home and from the crops (e.g., wheat, barley) that require longer processing and milling time and harder labor.
- Diversify crop and vegetable choices in *baari/paakho* through the incorporation of new crops (e.g., soybean, radish, citrus) to meet the household demand and a small cash needs.
- Rely on the market for provisional items (e.g., replace thatch roofs with corrugated tins, local seeds with improved seeds, fuel wood with kerosene and cooking gas) when the cash is available in their household
- Seek non-farm employment, preferably wage earning in the cities and abroad to meet the increasing cash need to purchase these commodities, to acquire services (e.g., labor for

rice plantation, livestock care) or to be able to access basic services (e.g., education, health services and other contingencies).

- The impact of the cash economy is felt in every aspect of life and this plays an important role to monetize every good and service, mainly because there is declining legitimacy of customary rules and authority structures. However, the lack of adequate infrastructure and market support system has constrained the agricultural system, even in the *Besi* area, where the competition for 'prime land' is high, causing land-stress. They cannot afford to produce only for the market; they have to diversify their livelihood options.

**CHAPTER 6**  
**THE HOUSEHOLD CONDITIONS AND COMMUNITY**  
**CONTEXT OF THE CHANGES IN LAND-USE STRATEGIES**

In this chapter, I use the integrated land history of the district and region as a baseline to discuss the long-term changes in the community context and household economy and their impact on the current land-use strategies. In doing so, I also present the results of household and community-level surveys and link the results with the theories on the institutions and land-change science, mainly to identify the proximate causes and social drivers.

As Klepeis and Turner (2001) suggests, LUCC studies are based on the integration of socio-cultural, natural and geographical information. Apparently, each of these has different means and interest in treating human-environmental interactions, spatial variables and scales. Without the consideration of longer histories of human-environmental interactions, LUCC studies may fall into different ‘traps,’ they may be spotty, may have mismatched scales, or may suffer from issues like ‘ecological fallacy,’ or the modifiable areal unit problem.

**1. Integrated land history**

Integrated land history is a fast-emerging research theme within land change science and addresses the temporal significance of land-cover change study by carefully analyzing the impact of historical events and episodes on agriculture, forest and other land-use types. Integrated land history serves as a baseline for land-use/cover change study and identifies path-dependent

qualities of the overall system (Klepeis and Turner 2001). Besides adding the value of spatial analysis and visualization techniques to make narratives and descriptive analysis ‘visible,’ integrated land history serves as a baseline for LUCC studies and identifies path-dependent qualities of the overall system. It integrates the methodological advantages of both remote sensing applications and social research processes. In integrated land history, the georeferencing of key land features is important, but it is more than just getting spatial information of the location by portable GPS or a few maps. It is about integrating theoretical perspectives with spatial and visualization methods to have spatially and temporally explicit account of land-cover change trajectories.

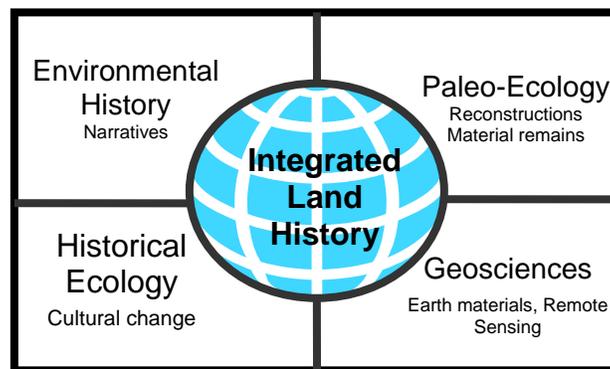


Figure 6.1 Integrated land history approach in relation to other alternatives

The reason for integrating historical analysis is that it is difficult to understand the dynamics of LUCC at a point of time if these are not analyzed within the context of longer histories of human-environmental interactions (Batterbury and Bebbington 1999). I believe that the importance of such integrative studies is especially important for places like Nepal where the issue of environmental degradation has long been debated. Such studies help debunk what Ian Scoones calls ‘environmental orthodoxies,’ which essentially valorize certain ideas over others.

The kind of environmental orthodoxies that was valorized in the HED case until the early 1990s was representative of the dominant worldview on environmental degradation. It placed the cause of massive deforestation on the increasing population of the poor who had no other alternative other than carving out steep land for agricultural activities, which in turn, led to landslides, mass wasting and further environmental degradation. Over the years, however, the key assumptions of HED faded away in the light of data uncertainty and overgeneralization or oversimplification of 'deforestation' claims. One of the key findings was that the environmental change taking place in contemporary Nepal was in fact not a recent phenomenon. Historical facts were not carefully analyzed in the making the case of the environmental degradation.

The main issue concerning LUCC in Nepal is the changes in forest structure and composition. As discussed earlier, historically forest resources in Nepal have been extracted to maintain the state apparatus, address food shortage and fuel wood consumption and meet fodder and grazing demands (Mahat et al. 1996; Bajracharya 1983). In particular, forests and land grants (e.g., *birtaa*, *jaagir*) have been the key resource for the successive nation-states to maintain the military and state apparatuses. Conversion of forests into cropped lands to extract maximum land rents from peasants became a common practice (Regmi 1976; Mahat et al. 1986). In other words, the government's heavy tax burden on farming household also promoted the conversion of forests to agricultural land to maximize agricultural surplus and pay taxes. The government had taken forest and forest resources as resources rather than renewable resources, and then conversion process persisted for a long time. Such a 'rent seeking behavior' on the government's part led to 'land dualism' (e.g., absentee landowner) and skewed land ownerships (Regmi 1976).

In this process, most conversion of forests to arable land had occurred by the early 1900s. This process had resulted in the conversion of all the good quality forests to arable land and had

extended onto marginal slopes with poor soil. The change in the forest cover in the *Pahad* and *Himal* regions over the past half a century has been largely deteriorated forest resources and reduced their spontaneous and natural, regrowth and reforestation (Mahat et al. 1987). After the 1970s, marginal deforestation occurred in the *Pahad* and *Himal* regions, although some areas of forest under excessive utilization have degenerated to shrublands. At the same time, following the malaria control initiatives in the *Tarai*, the clearing of forests for the resettlement encouraged the migration of people from these regions and from India (Shrestha 1990). In other words, most of the rapid deforestation has occurred in the southern *Tarai*, exactly resembling the scenarios presented in the HED.

In 1964, the government introduced a land reform program to bring about changes in the agrarian structure in favor of the poorest sections of the rural society. Although initiated with great acclaim and fervor, the land reform program met with only limited success as the government's resolve to push through with reforms weakened in a year or two. Similarly, the legislation of 1957 for the nationalization of forests and commons (e.g. grasslands and pastures) in fact accelerated deforestation (Mahat et al. 1986; Bajracharya 1983; Kumar and Hotchkiss 1988; Kanel et al. 2000). It also led to the weakened many traditional forest control systems (Bajracharya 1983; Macfarlane 1976; Mahat et al. 1986b; Messerschmidt 1987). This act hastened deforestation by prompting individuals to convert as much private forest to agricultural land as possible before it was nationalized. The reason is simple: where there had previously been clear incentives to preserve private forest for local benefit, it encouraged them to overexploit forests when faced with the risk of losing forest to nationalization. In some cases, the mere fact of government ownership caused many communities to adopt an attitude of dependence and short-term gain toward resource management issues.

The government policies aside, the food demand for growing population led to changes in land-use (Bajracharya 1992a). Historically, the expansion of area cultivated through the conversion of forests and shrublands and construction of new terraces has been a key factor to sustain a growing population (Macfarlane 1976). Furthermore, the initial fertility of virgin lands and the heavy tax burden on farmers induced steady expansion of agricultural lands. This expansion was accelerated by the introduction of maize and later potato, which allowed productive farming on steep slopes (Metz 1991).

Table 6.1 Major historical and institutional factors of land-use in Lamjung

Historical period	Events/episodes	The impact on land-use
Pre 1548	Ghale Raja ruled	<ul style="list-style-type: none"> <li>• Hunting</li> <li>• Exclusive use of <i>Lekh</i> and <i>Pahad</i> for Agropastoralism</li> </ul>
1500	Arrival of <i>Khas</i> groups and Hindu ideology	Introduction of <ul style="list-style-type: none"> <li>• irrigation techniques</li> <li>• agricultural terracing system</li> <li>• rice, corn</li> </ul>
1548 to 1950	The <i>Khas</i> group as the Shah King's allies	Land tenure and landownership <ul style="list-style-type: none"> <li>• land grants and preferential treatment</li> </ul>
1800-1970	Gurungs moving toward the valley	<ul style="list-style-type: none"> <li>• Toward sedentary agriculture</li> <li>• competition for 'prime lands'</li> </ul>
1957-73	Abolition of customary rights over forest and pastures	Abolition of customary rights and the state failed to implement the Acts <ul style="list-style-type: none"> <li>• 'Open access'</li> <li>• Deforestation</li> <li>• <i>Khoria</i> outlawed, intensification</li> </ul>
1993	Community forestry program (CFP)	<ul style="list-style-type: none"> <li>• Restrictions on roaming/grazing</li> <li>• Low incentives in agropastoralism</li> <li>• Forest are gain</li> </ul>
2000 -	The Maoist insurgency and political turmoil	<ul style="list-style-type: none"> <li>• Labor shortage</li> <li>• land abandonment</li> </ul>

Although I have already discussed the historical events and episodes important to Lamjung's LUCC in Chapters 2 and 4, I recapitulate and synthesize them in this chapter to trace the

integrated land history of Lamjung. It helps understand the historical context of agricultural land-use and broader land-cover change. In doing so, I highlight the benefits of making ‘thick narratives’ of environmental history spatially explicit and enabling them to be more consistent and directly applicable to LUCC research.

As shown in Table 6.1, by the time Gurungs were already beginning to move to lower ridges and valleys below the high forest in the early 1800s (Hamilton 1810), the *Khas* migrants were already using their knowledge and skills in irrigation and agricultural terracing to cultivate rice and corn in the *Besi* area. Since these *Khas* speaking groups were also Hindu and had helped the Hindu (Shah) King to conquer over the Ghale Raja, they became allies of the King and received land grants from the Kings in return. At the same time, those Gurungs who came into contact with these *Khas* groups, were also influenced by the Hindu ideology and they swiftly embraced and incorporated many elements of the ideology and language into their own culture.

The most significant impact is the shifting of their preferences from agropastoralist life to rice-based intensive agriculture, which immensely changed their social organization, their food and diet system and agricultural land-use strategies. Agropastoralism undoubtedly is a very challenging livelihood, as it involves continuous toiling in cold climates and rugged terrains. The system seemed to have worked well until it faced three key challenges from within and outside: (1) water scarcity in settlements once located in higher altitudes; (2) increasing influence of Hindu ideology among Gurungs; (3) attractions toward ‘modernization’ and ‘comforting means’ of life, as the influence of cash economy, expanding accessibility and changing institutional arrangements dislocated the customary rules and traditional authority structure.

These challenges and changes had profound impact on other historical altitudinal land-use that were the key features of Gurung culture, such as the transhumance or migratory sheep

herding practices, *khoriya* (slash-and-burn) system and the concept of agriculture-forest-livestock interdependence. All the new rules of resource allocation brought about by the governments (e.g., abolition of *khoriya* system and the customary rights, initiation of the CFP and other forest conservation programs) directly targeted those traditional practices, as the traditional practices were viewed as ‘backward’ and ‘destructive.’ In the changing context of smallholding, the new focus or priority was to stop migratory herding practice, ‘enclose’ the livestock and encourage sedentary agriculture so that they could be ‘governed’ (or tax levied).

In terms of spatial dimension of these changes, we have to note that Gurungs historically settled in the north-western part of Lamjung, mainly in the upper ridges of Ghanpokhara, Pasgaun, Bhujung, Ghalegaun (Uttarkanya) and Khudi, then when they moved toward the lower valleys their settlements are spread across the district and beyond. There are still many villages where the entire populations is that of Gurungs or they are most dominant ethnic group within (see Appendix F: Map 12).

Outside of agricultural land-use practices, the most important land-cover change occurred was in forest areas, which requires a separate section for a discussion of the significant impact the changes in rules of resource allocation had in it.

## **2. Forest and other institutional arrangements**

The historical analysis of Nepal’s forest governance and management elucidates that there have been constant shifts in property rights from communal or customary control and management to state and individual control and management. However, in recent years, there are some small but notable reversals in these processes toward re-establishment of greater community control over forests and village commons, which formally came in the form of the

CFP in Nepal in 1993, even though it has its roots in the state-controlled ‘Panchayat Forestry Program’ initiated in 1984.

Developed and promoted as the main strategy of the national forestry policy, the CFP in Nepal has both conservation and livelihood implications. Laws and regulations are in place to achieve two ‘intertwined’ goals: (1) conserve ecosystem and genetic resources by protecting forest resources from degradation, and (2) regulate the forest users’ groups to meet the basic need for forest products on a sustainable basis. While the program has long been cited as ‘a successful model of forest conservation,’ its efficiency and effectiveness in meeting the livelihood goal have come under scrutiny in recent years. Some critiques have even questioned the rhetoric of ‘community participation,’ incentive structures and property rights, heterogeneity and equity issues (Agarwal 2001; Granner 1999; Varughese and Ostrom 2001). These critiques are also contentious and hence, are open to debate. Nevertheless, within Lamjung and beyond, the CFP has been successful, albeit sporadically, to protect the remaining forest area and even reclaim the degraded forest and abandoned agriculture land where the vegetation has improved.

In order to understand the reasons for the implementation of the CFP, an examination of its historical background is required. Although forests technically ‘belonged’ to the state, forests were officially placed under government protection and control only in 1957, when the Private Forest Nationalization Act was enacted. While some believe the real purpose of the nationalization was to reduce the area of land controlled by the allies of the Rana regimes (Gilmour and Fisher 1991), the usurpation of forest area by the government is considered as the biggest source of Nepal's severe deforestation problem (Mahat et al. 1986; Bajracharya 1983). Arguably, the national government was not strong enough to securely enforce its own property

rights<sup>22</sup>, therefore since 1957 local populations treated many forests as ‘open access resources’ (Kanel et al. 2000). It is believed that the conversion and modification rate of structure and species composition of forests have been dramatic during the last five decades, drawing worldwide attention (Eckholm 1976; Ives and Messerli 1989).

One of the major adverse impacts of the nationalization was the abolition of customary management of forests common among ethnic minorities in the remote areas (Fisher 1989; Gilmore and Nurse 1991). In these systems, landholdings were collectively owned according to traditional, customary property rights. Such systems loosely considered the issues of fairness and equity by balancing family needs and communal responsibilities. Customary forest management operated *de facto* either in conflict or in parallel to government policies. Because government intervention capacity remained limited due to inaccessibility, different forms of customary practices continued (Fisher 1989; Messerschmidt 1976). Jodha (1992), on the other hand, holds the view that while the custom or convention justified common resource use by some well-defined local population in the past, as development continues, the pressures of changing preferences, expanding nation-state and increasing population levels rendered some customs and conventions no longer effective in maintaining these common rights of resource use. It is widely held that denied access to local resource management eroded the feeling of common responsibility on common properties, especially when there was an ‘open access forests’ regime. In such circumstances, the CFP emerged as a response to address the both sides of the ‘conservation and development dilemma.’ Although detailed discussions of the CFP, its implementation and the changes it brought about can be a separate topic of investigation, I want

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<sup>22</sup> Inaccessibility due to rugged terrain and relatively inadequate structure of the forest bureaucracy are held as the major factor in the government's inability to manage forests, which led to open-access regime (Kanel et al. 2000).

to analyze the institutional dimensions, mainly the so-called ‘usufruct rights’ of the CFP, which in turn, reveals some clues about the new rules of forest resource allocation that replaced the traditional, communal customary rights and the impact of the CFP on smallholders agricultural strategies and overall landscape-level change.

The usufruct rights are the key parts of the CFP, which allow the group of participating members to manage local forests under the fixed management plan without the governance power. The debate emerging among the CFP stakeholders in recent years is that whether the usufruct rights can guarantee the community-controlled management as described in the CFP goals and whether the existing incentive structures and management are adequate and inclusive enough to compensate for the loss of customary rights.

In one of the classics of ‘common property regimes’ theories, Schlager and Ostrom (1992:250-54) suggests that the incentives for improving certain resource systems (in this case, community forests) depend on the ‘bundles of rights’ extended to individuals or groups which can have two different rights: ‘operational-level property rights’ and ‘collective-choice level property rights.’ When individuals have the authority or right of access to particular resources in a particular area as set by the governing rules, they obtain the products or benefits of the resources. This provides the incentives for the individuals to make long-term investments to improve the state of resources and sustain the benefits for the future. However, collective-choice level property rights are more common in common property regimes and hence, powerful since these define how the future rights will be governed. They argue that the clear specifications of rights: management, exclusion and alienation characterize the collective-choice property rights with stronger incentives. Apart from the right to regulate internal use patterns and improve the resources, such specifications provide the exclusive access rights only to those individuals who

obey the shared rules and ensure the rights to transfer the rights. In other words, alienation rights, combined with the rights of exclusion, produce incentives for owners to undertake long-term investments in a resource (Schlager and Ostrom 1992:256). This means, not just ‘owner’ and ‘proprietor,’ but also ‘claimant’ and ‘authorized users’ face "incentives that are frequently substantial enough to encourage similar long-term investments" given the bundles of rights (i.e., access/withdrawal, management, exclusion and alienation).

The governance structure and organization of the CFP are as such that the members, not necessarily the whole community which depend on the particular forest, are the ‘authorized users’ within the property regime. They must discount the values associated with forest products of the particular forest from the immediate use with the hope of better returns in the future. In this sense, their investment of time and participation to actively protect the forest is entirely based on the incentive structure that is limited to occasional, time-limited and defined access to non-timber forest products and their rights to ‘exclude’ non-members.

There are three key issues with implications for agricultural land-use strategies: (1) excluded members of the community now have to find alternatives to the same forest they had access under the customary rules; (2) the existing incentive structures have been attractive enough (e.g., access to some forest products better than in open access to degraded forest, management rights) to draw active participation in the short run, but it may have more challenges in the future; (3) it actively discourages livestock and subsistence agricultural practices that tend to depend on forest resources and label any change from forest to agriculture or shrubland as destructive, as if land-cover change is always a linear and irreversible process, regardless of the fact that many shrubland and abandoned agricultural lands are now reclaimed by forests.

The main point is that the forestry programs may have been successful in expanding the forest coverage with strict rules and regulations, but they should also respond to their socioeconomic issues, as mentioned above, and livelihood goal as well. When those socioeconomic issues are addressed, the CFP can become more effective conservation drive.

### 3. Changes in household conditions

Households are the unit of analysis of this study, so the flows of resources in and out of these households and the associated conditions under which household change their land-use practices are crucial to the objectives of this study. For this study, 66 households (35 in Maling and 31 in Banjhakhet) were selected through stratified random sampling. The descriptive statistics of are the sample household are presented in Table 6.2.

Table 6.2 Descriptive statistics from the research sites

	(n)	Minimum	Maximum	Mean	Std. Deviation
Respondents gender (35 male, 31 female)					
Respondent's age	66	23	83	49.74	13.717
Household/family size	66	2	20	5.86	3.098
No. of males in households	66	1	15	3.08	2.085
No. of females in households	66	1	8	2.67	1.592
No. of children in households	66	0	7	2.17	1.869
No. of people currently living	66	1	13	4.85	2.355
No. of labor hired in 2004	66	20	300	122.45	60.119
No. of parcels of land owned	66	1	8	4.15	1.833
<i>Baari</i> owned (in ha)	62	0.05	0.5	.15	0.9
<i>Khet</i> owned (in ha)	65	0.05	1.25	.35	0.24
Fallow period (in month)	66	0	6	3.29	1.6
No. of chickens	65	0	100	5.31	13.072
No. of ducks	64	0	5	.08	.625
No. of bullocks	66	0	4	1.14	1.094
No. of cows	66	0	5	.56	1.204
No. of he-water buffalo	66	0	2	.17	.414
No. of she-water buffalo	66	0	5	1.83	1.235
No. of sheep and goats	66	0	14	3.33	3.816
No. of pigs	66	0	4	.11	.611
No. of other animals and birds	66	0	1	.17	.376
Time taken to collect fodders (in hours)	66	0	6	3.91	.907

The descriptive statistics clearly indicate the smallholding nature of these sample households, as their average landholding is below 1ha and their livestock holding patterns reveal their preferences for small ruminants and chickens. Obviously, agriculture is the main income and employment source, followed by the pensions from the British Gorkha Regiments and remittances (Table 6.3).

Table 6.3 Primary occupation/income source in sample households (in frequencies)

Primary occupation	VDCs		Total
	Maling	Banjhakhet	
Agriculture	24	22	46
(%)	68.6%	71.0%	69.7%
Remittances (off-farm)	4	6	10
(%)	11.4%	19.4%	15.2%
Craftsmanship	1	1	2
(%)	2.9%	3.2%	3.0%
Office and factory	1	1	2
(%)	2.9%	3.2%	3.0%
Pensions	5	1	6
(%)	14.3%	3.2%	9.1%
Total	35	31	66
	100.0%	100.0%	100.0%

Economically active family members, both men and women, are responsible for cultivating social and economic relationships, which open up opportunities for them, close relatives and neighbors. Households also cultivate complex social exchange networks to open up economic opportunities for members. The actual mix and the scale of activities each household undertakes are shaped by family members' access to the socioeconomic resources. The key factors shaping household strategies are landownership, cash income, family structure and social exchange network. The role of social ties and social exchange network is also the key to finding jobs and gain access to resources outside of the villages. This practice also avoids exhausting any one resource and reduces risks.

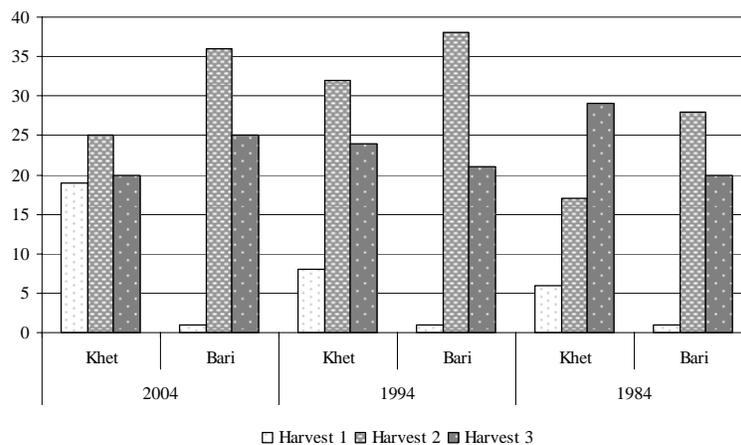


Figure 6.2 Crop rotation (expressed in number of harvest per year) in *khet* and *baari/paakho* lands, between 1984 and 2004 (in frequencies)

Table 6.4 Number of harvests per year in *baari/paakho* by villages

No. of harvest per year	VDCs		Total
	Maling	Banjhakhet	
One harvest more	1 2.9%	13 44.8%	14 21.9%
One harvest less	19 54.3%	5 17.2%	24 37.5%
Same number	15 42.9%	11 37.9%	26 40.6%
Total	35 100.0%	29 100.0%	64 100.0%

Table 6.5 Number of harvests per year in *khet* by villages

No. of harvest per year	VDCs		Total
	Maling	Banjhakhet	
One harvest more	7 20.0%	5 17.9%	12 19.0%
One harvest less	2 5.7%	6 21.4%	8 12.7%
Same number	26 74.3%	17 60.7%	43 68.3%
Total	35 100.0%	28 100.0%	63 100.0%

In terms of the number of harvests per year (Table 6.5), a decade ago (around 1994) 38 households had two harvests per year in *baari/paakho* and 32 households had two harvests per year in *khet*, which outweighs the harvests per year in the same categories in both 2004 and 1984. The other two major points to note is that in 1984 *khet* were more intensively worked to get three harvests per year, but in 2004 the number of households significantly decreased in the three harvests per year, while the three harvests in the *Baari* category for the same year increased considerably. When the number of harvests per year category is disaggregated by the villages (Tables 6.4 and 6.5), more households in Banjhakhet were able to produce ‘one more harvest’ in *baari/paakho* in 2004, compared to 1984.

Table 6.6 Fallow months by villages (in frequencies, n=66)

Months	VDCs		Total
	Maling	Banjhakhet	
0	0 .0%	5 16.1%	5 7.6%
2	0 .0%	24 77.4%	24 36.4%
3	4 11.4%	2 6.5%	6 9.1%
4	10 28.6%	0 .0%	10 15.2%
5	15 42.9%	0 .0%	15 22.7%
6	6 17.1%	0 .0%	6 9.1%
Total	35 100.0%	31 100.0%	66 100.0%

Intensive crop rotation also means decrease in fallow period. The number of months of fallow period ranges from none to six months. When disaggregated by villages, the average fallow period is higher in Maling (3.29 months/year) than in Banjhakhet (2.1 months). The fallow period has increased significantly over the last twenty years in Maling, whereas in

Banjhakhet the pattern has not changed much. Almost the half of the respondents (29 out of 31 respondents) in Banjhakhet keep the fallow period to two months or less, which clearly shows the intensification emphasis in the village.

Table 6.7 Fallow period trend (1984-2004)

Trend	VDCs		Total
	Maling	Banjhakhet	
Mean	3.29	2.1	
Increased	33	7	40
	94.3%	22.6%	60.6%
Decreased	1	5	6
	2.9%	16.1%	9.1%
Same	1	16	17
	2.9%	51.6%	25.8%
Don't know	0	3	3
	.0%	9.7%	4.5%
Total	35	31	66
	100.0%	100.0%	100.0%

Table 6.8 Patterns of agricultural productivity by villages (in frequencies)

Trend	VDCs		Total
	Maling	Banjhakhet	
Increased	10	6	16
	28.6%	19.4%	24.2%
Decreased	15	15	30
	42.9%	48.4%	45.5%
Same	9	10	19
	25.7%	32.3%	28.8%
Not applicable	1	0	1
	2.9%	.0%	1.5%
Total	35	31	66
	100.0%	100.0%	100.0%

In both villages, agricultural production has declined; almost a half of the respondents (45.5%) believe that their production has decreased between 1984 and 2004 (Table 6.8). About the 75% of the respondents, however, call the decline 'a little' (Table 6.9). The two main reasons cited for the declining production were inadequate manure and poor management (Table 6.10).

In fact, in broader terms both are related to the declining numbers of livestock and labor shortage during the peak planting period. When they said poor management in farming, they often mean inefficiency in labor and resource management. Once the labor shortage started in these villages and the CFP was aggressively implemented, these restricted the number of livestock and their rotation in different fields, which had a major impact on manure availability.

Table 6.9 Trends in decreasing agricultural productivity

	VDCs		Total
	Maling	Banjhakhet	
A little	12	10	22
	85.7%	66.7%	75.9%
Somewhat	2	5	7
	14.3%	33.3%	24.1%
Total	14	15	29
	100.0%	100.0%	100.0%

Table 6.10 Reasons cited for the decreasing agricultural productivity

Reasons(a)	VDC		Total
	Maling	Banjhakhet	
No irrigation	7	4	11
	46.7%	26.7%	
Excessive water	3	0	3
	20.0%	.0%	
Unfavorable weather	6	3	9
	40.0%	20.0%	
Disease and pests	4	3	7
	26.7%	20.0%	
Not enough manure	12	9	21
	80.0%	60.0%	
Excessive chemical fertilizer	1	6	7
	6.7%	40.0%	
Poor quality manure	2	1	3
	13.3%	6.7%	
Deteriorating soil quality	4	4	8
	26.7%	26.7%	
Poor management	11	10	21
	73.3%	66.7%	
Others	6	11	17
	40.0%	73.3%	
Total	15	15	30

From the farmers perspectives', availability of manure and water is the key to maintaining the fertility of cultivated land. One of the respondents elucidates the significance of the water and manure in their farming:

There is nothing more important to agriculture than hard labor, but now we have more things to worry about...In the past, there was manure, there was water. There was plenty of manure for crops that we had a saying '*gobar haale dobbar*' (apply cowdung/manure, harvest double). All we knew was that if you applied more cowdung and worked hard, the production would be more. We did just that. Now the land has turned into *sukkha* (dry, porous land) because of *bikase mal* (chemical fertilizer)...I tell you, one day there wouldn't be any farming because manure is not enough. Nothing is enough, *bikase mal* (chemical fertilizer) is inadequate. Even the land near *Besi* has started drying. The old people put in more hard work and increased their land. Now what has been destroyed is already destroyed, there is no question of increasing the farmland by any means.

In these villages, nevertheless, agriculture remains the major source of food, income and employment. Production of crops for household consumption still is the dominant strategy. While most of the farmers in both villages (about 71% of the respondents) produce for their household consumption, about 25% of the respondents in Banjhakhet produce to sell their crops and vegetables (Table 6.11). As expected, the impact of cash economy is higher in Banjhakhet than in Maling.

Table 6.11 Patterns in subsistence (in frequencies)

	VDCs		Total
	Maling	Banjhakhet	
Kept all	26 74.3%	21 67.7%	47 71.2%
Kept most	8 22.9%	1 3.2%	9 13.6%
Sold half	1 2.9%	1 3.2%	2 3.0%
Sold most	0 .0%	8 25.8%	8 12.1%
Total	35 100.0%	31 100.0%	66 100.0%

#### 4. Demographic factors and other broader socioeconomic issues

If you ask me whether the population has increased, I have contradictory answers. If I say yes, then I realize more people are abandoning their lands, you see.. If I say no, then I see the same number of *khaane mukh* (literally meaning mouths to be fed) as before. This is tricky, you see... the difference I think is the problem caused by the young people leaving the village for jobs in Arab (the Gulf countries). When a son (mature labor) leaves the village for a job elsewhere, it affects not just his family but also affects his neighbors who are dependent on his labor during cultivation seasons... Nowadays, all other family members don't do much...they just look up to him to send money for food, medicines and expenses... This is what is making the difference...

(a 67 years old male respondent from Maling VDC)

The local demographic characteristics in both villages exhibit the persistent influence of cultural factors. Gurungs in general tend to have the extended family and this is evident in bigger family sizes in Maling than Banjhakhet. Because the size of Maling is also smaller than Banjhakhet, the population density is higher in Maling (see Appendix F: Map 11 for the population density map covering all VDCs of Lamjung); however, these two villages have also responded similarly to their biophysical conditions.

While much of Maling still maintains the remnants of agropastoral way of life, agricultural intensification based on paddy cultivation has been the main basis of farming and livelihood for years. Banjhakhet also experienced an increasing interest in agricultural intensification in the early period (around 1970s and 1980s) and the farmers adopted 'modern' agricultural practices, mainly the paddy cultivation, vegetable production and citrus-based horticulture. One very commonality both villages share is the permanent outmigration in the 1970s and 1980s and the recent trend of the young people leaving their home to seek job non-agricultural jobs elsewhere.

At the district level, Lamjung had one of the highest population pressure indexes around 1971 and it was one of the overpopulated districts in Nepal (Gurung 2004). However, with the

eradication of malaria and opening of *Tarai* for resettlement, migration from Lamjung significantly increased between the 1960s and the late 1980s. Although it is hard to give exact numbers, the low population growth trend of the district clearly reflects the consequences of sizable out-migration (Table 6.12). During this period, the extent of out migration was higher for Lamjung than the national level.

Table 6.12 Population trend

Census Year	Population	Decennial Change	Change Percent	Remarks
1941	107,543	-	-	Unreliable census data
1954	133,627	+ 26,084	+ 24.3	Heavy monsoon (1954, 1955)
1961	130,935	-2,692	-2.0	Chitwan resettlement continues
1971	140,226	+9,291	+7.0	Malaria eradication program
1981	152,720	+12,494	+8.9	
1991	153,697	+977	+0.6	
2001	177,149	+23,452	+15.3	Road to Besishahar
1961-1991		(+46,214)	+35.3	+ 107.9% national average

(Source: Gurung 2004 based on various census data)

Table 6.13 Population density and absentee population comparison with country

Aspects	Lamjung		Nepal	
	Person km <sup>2</sup>	% of total Population	Person km <sup>2</sup>	% of total Population
Population density 1961	77.4		64.0	
Population density 1991	90.8		125.6	
Absentee population in 1961	10,927	8.3	386,824	4.1
Absentee population in 1991	9,083	6.6	658,290	3.6

(Source: Gurung 2004 based on various census data)

Out-migration not only implies a lower level of population increase, but also the availability of less labor forces. In addition, in the recent decades, a sizeable portion of the population was

drawn from the labor pool due to both out migration and the increasing enrolling of children into school. The net effect is a shortage of labor to attend farm activities. On the other hand, the rate of population growth itself has been very slow, comparing to the national average. The total population of the district in 1971, 1981, 1991 and 2001 were 7.0%, 8.9%, 0.6%, and 15.3% respectively (Table 6.13). In 1961, the population density of the district (77.4%) was much higher than the national average (64.0%); however, the population density for the whole country more than doubled in 1991 (125.6%), whereas the district had a slight increase by 1991 (90.8%). In terms of the absentee population, Lamjung has higher percentage than the national average. Interestingly, the number of absentee population was much higher in 1961 than in 1991. This is mainly because those who were working as soldiers and wage earners in 1961, they would still return to their home and invest there, but this pattern changed dramatically after the roads were built and people started to buy estates in the cities or Tarai.

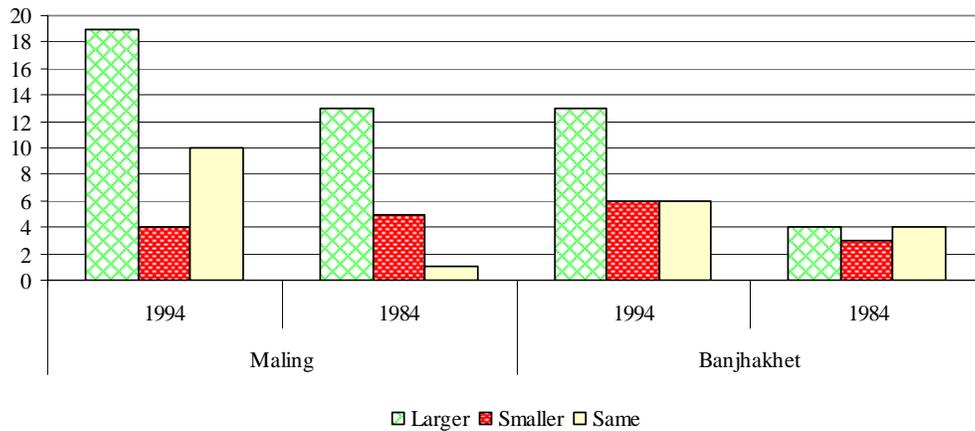


Figure 6.3 Number of family members living in the household, comparisons of 2004 to 1994 and 1994 to 1984 (in frequencies of respondents)

Within the research sites, the highest number of respondent mentioned that the number of family members living in the household was higher in 1994 than in 2004, especially in Maling (Figure 6.4). In Banjhakhet as well, the number of family members living in the household was relatively higher in 1994. This trend matches the fact that the number of family members leaving for non-farm income increased significantly between 1994 and 2004. The main source of the non-farm income is the wage earning abroad (Table 6.14). The two main reasons for seeking outside employment are ‘good income’ and ‘increasing cash needs (Table 6.15)

Table 6.14 Outside (non-farm) employment sources

Outside employment	VDCs		Total
	Maling	Banjhakhet	
Foreign remittances	11 50.0%	15 68.2%	26 59.1%
Trade	1 4.5%	0 .0%	1 2.3%
Office and Factory	3 13.6%	3 13.6%	6 13.6%
Wages	0 .0%	1 4.5%	1 2.3%
Pensions	7 31.8%	3 13.6%	10 22.7%
Total	22 100.0%	22 100.0%	44 100.0%

Table 6.15 Reasons for seeking outside (non-farm) employment

Main reasons	VDCs		Total
	Maling	Banjhakhet	
Farming cannot support	1 4.8%	2 9.1%	3 7.0%
Good income	13 61.9%	8 36.4%	21 48.8%
Insecurity here	0 .0%	2 9.1%	2 4.7%
Cash need	7 33.3%	10 45.5%	17 39.5%
Total	21 100.0%	22 100.0%	43 100.0%

An excerpt from one of the in-depth interviews sheds more light on the changing household conditions and community contexts and sums up the way household consumption-production system has transformed in recent years in the district.

*Q029: You mentioned that agricultural intensification has decreased. When do you think all of these started? Which year, if you remember exactly?*

B04: The year? There is something else I have to tell you first. After democracy (the restoration of multiparty democracy in 1989), people became more awareness, they started to diverge and disperse. People became free to move about anywhere and soon it became the trend. Once they saw others' places and come into contact with others, they became attracted to new places and lifestyles. It's always good to expand your contact, but I know it came with the price. Young people now live free with the thinking that life is too short... they want to make fast money and then spend everything at their disposal to enjoy... For me, seeking job abroad is like "*karkalako paani*" (like a dew or water drop on a yam leaf; it may drop anytime)... Come to think of all these, agriculture altogether has decreased. Now the passion for agriculture has definitely diminished.

I tell you why... When one family member starts working in one of those Gulf countries, he starts telling his family to stop worrying about the drudgery of agriculture and other hardships. The family members often start buying foods on credit from the local provisional stores, but we have often seen so many cases when they could not repay because no money came from the Gulf... not everyone is lucky to make money there..

*Q030: What about the Maoist insurgency? Does it have any difference on agriculture?*

Insecurity has a major impact. There used to be freedom to roam around; we could go to jungles, our farm.. we used to walk two hours, three hours to farm our lands and we could return easily home by the dusk, but we cannot continue to do the same anymore.... If we go alone, there is always a fear of getting abducted... who knows what happens? So, we just leave the land as it is.. but we still live here. It would be great if it (the land) remains there, otherwise whatever happens to it, we just have to accept it... many leave to their fate.. Some say "one son works in the Gulf anyway, so why worry about how to be fed." This is the reason farming is fast diminishing.... Farming that requires group labor hasn't decreased, only the ones there were once done individually...

*Q031: So, this means the trend of abandoning farmlands has increased for sure?*

Yes, it has increased in recent years. We used to have a labor network called *Thigur* (*Thugur*), which is more complex and demanding than *Nogar*, since it is done by the laborious workforce of mature individuals. Just like we have the safe vault for valuables and money, *Thigur* used to be our labor vault. Having adequate labor force at our disposal, we seldom left a piece of land to be remained fallow, even the marginal lands. Now all of those are gone, much of those lands have turned into bushes. ... I haven't seen any farmland expansion lately. Now fallow lands have expanded and they look alike *paakho* and it will not be so long before we see those turning into jungles. That has been the trend.

## 5. Accounting for land-use dynamics

The impact of non-farm employment drawing the labor force from village has the a multi-fold impact. The first and the foremost is that it has differentiated villagers' interest in and dependence on farming. By fragmenting common dependence on agriculture, outmigration has created stresses within the smallholding; which is manifest in declining participation, increased conflict and declining legitimacy of customary rules and authority structures.

Once intensively cultivated land parcels that are far away from home are abandoned in favor of *baari* (home gardens) these days. The decreasing reliance on livestock, mainly because of the labor shortage and the CFP, has resulted in low availability of draft power, protein sources and manure. Most importantly, the incentives for farming, specifically in the uplands are so low that the remittances are no longer being reinvested in agriculture like the way it used to be; these are now evidently concentrated in buying estates in cities and towns and are paving the way for out migration. Although the exodus of people took place between the mid-1960s to the end of 1980s, the outmigration process has not ceased.

Besides the way agricultural land-use strategies have changed after the 1960s, it significantly altered traditionally practiced agricultural land-use patterns, and this in turn, has entailed more complexity and spatial variability in agricultural systems. In the *Pahad* and *Lekh* areas, agricultural disintensification is occurring in *khet* and *paakho* while the pressure on *baari* has increased considerably. In the *Besi* area, in contrast, the value of riverine terraces (e.g., valley floors, level terraces), has grown tremendously and access to irrigation has become extremely important, and often being a highly contested issue.

In some extreme cases of agricultural intensification, as Jodha (1995) notes, it is possible that the intensity of resource use, even without significant technological and institutional innovations

can increase. Sub-marginal lands hitherto kept under natural vegetation (forest and pasture) have gone over to annual crops and fallow periods have decreased. Cropping has extended to steeper and more fragile lands. Above all, agricultural options have narrowed and farmers are pushed to accept inferior quality of options and more resource extractive strategies to secure food at reduced levels of flexibility. There is much evidence that reveals how change in land-use sometimes may bring adverse impacts on mountain agriculture fragility as well as vulnerability to smallholders.

In terms of spatial differences in the agricultural land-use system, road access by proxy still is the key factor. Households in Maling, for instance, still have larger landholdings and greater total production and are more reliant on subsistence agriculture than those of Banjhakhet households, which use more agrochemicals, have smaller landholdings and are more reliant on off-farm employment to meet their families' needs.

By accounting land-use dynamics of Lamjung in recent years, it is clear that land-use changes are not only the causes of land-cover, but also the decreasing capacity of fragile mountain agriculture and the increasing impoverishment of smallholders and herders who are using less productive and more fragile land for their livelihoods (cf., Blaikie 1988; Jodha 1995; Metz 1991; Seddon 1987; Zurick 1988). The fragility of the mountain agriculture brings a backlash in livelihoods of smallholders when human interventions lead to mismanagement and exact higher societal costs for management or for substitution. In this sense, fragility is both, the sensitivity of the mountain ecosystem to human-induced perturbations and its resilience to such perturbations (Turner and Benjamin 1994: 10).

In these circumstances of poverty, food security is the most important priority for the smallholder. In the earlier period of the competition for resources, their adaptive processes were

in fact leading toward more resource extractive measures and many forests have been degraded and thinned, but there have been reversal processes in recent years with the emergence of the CFP and the increasing reliance on the non-farm employment.

Nevertheless, it is safe to claim that the recent trend in agricultural system in much of the district is disintensification. This is further aggravated by the recently swelled Maoist insurgency. Although it has not been long since the insurgency started in the district, it was clear in the field that it has profound impact on how people choose to abandon remote farms that they used to cultivate and the way they manage different agricultural and forest resources. Only one of the positive changes that occurred in recent years is the emergence of the CFP, which has helped gain forest coverage in many villages. It has brought about substantive alternation in the structure and species composition of forests.

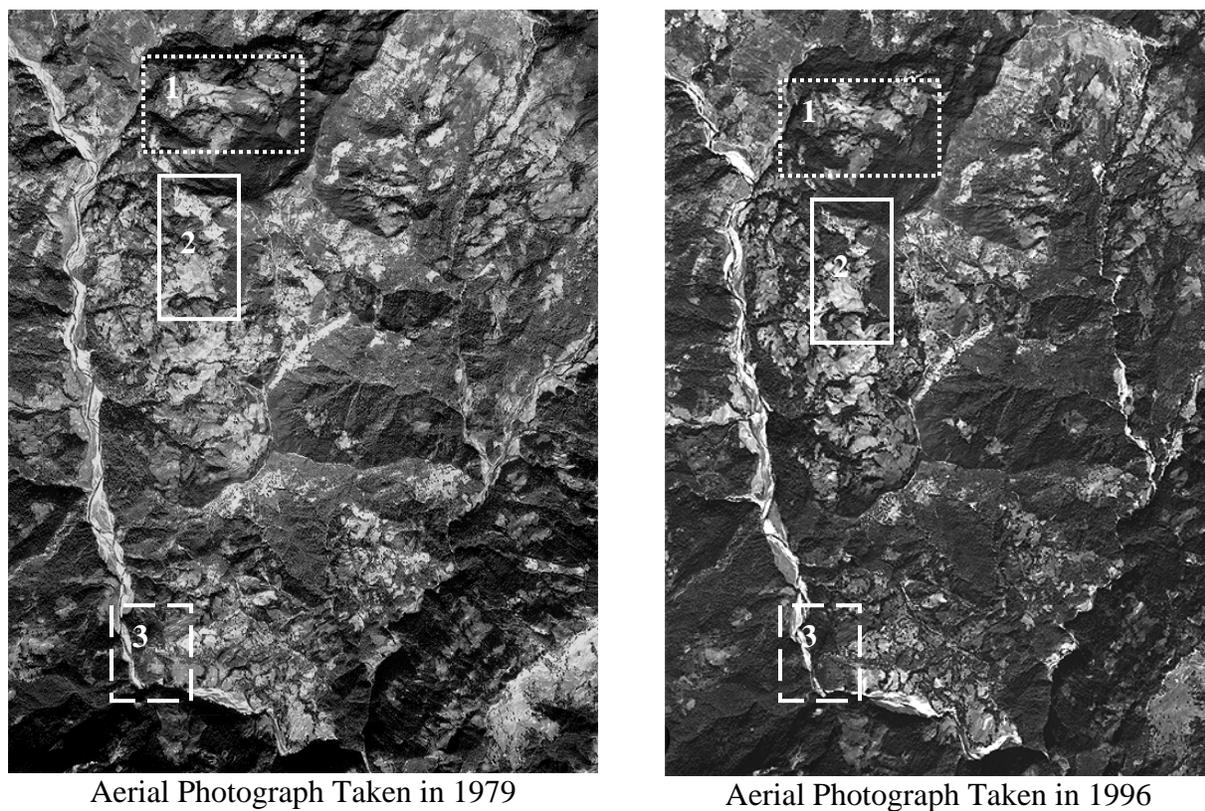
## **6. The scale issue in linking land-use and land-cover**

The integration of household and community level data with broader scale spatial data in this study was operationally quite challenging. Some of the recently devised techniques that are similar include: (1) a method for overlaying a farm property grid over a multi-temporal set of remotely-sensed images for linking household behaviors to deforestation rates (McCracken et al. 1999) and (2) linking household demographic data with land-use and land-cover categories (Fox et al. 1994; Moran et al 2003). Unlike the first case, the integration of the community level data with broader level spatial data has been widely applied for many years, as many social scientists tend to aggregate their unit of analysis to a community level (Gibson et al. 2000). However, the issue of modifiable area unit problem (MAUP) can have equal impact on the way one aggregates the scale of unit of analysis while combining such entirely different scales.

Conventionally, in a spatial modeling the unit of analysis for the study is defined by partitioning the study area into zones. Since there are no fixed rules about defining these zonal boundaries, the selection of the scale of study and the aggregation of data are often done arbitrarily. Numerous processes are not visible at high levels of aggregation. As Openshaw (1977) argues, "the aggregation problem arises because of uncertainty about how the data is to be aggregated to form a given number of zones. These problems always occur in the design of zones for the study of spatial data; and the two together represent one of the greatest unsolved problems facing spatial study today." This, nonetheless, does not mean that it is impossible to come up with an appropriate aggregation measure for defining the scale of the study while integrating household level and/or community data with others, as long as there are high-resolution remotely sensed data and the social data of the same period and the area. To exploit fully the potential of integrating social science and remote sensing, one should also examine finer-grained relationships.

In this study, the main challenge of linking the household and community data with the remote sensing data was the lack of land parcel data. Unlike in the cases of the Amazon (McCracken et al. 1999, Moran et al. 2003), where there are records for new settlements, it is very hard to get land parcel data in Nepal, that too in mountainous landscape. Only plausible option, which I followed, is to take samples using GPS and record land-use history of select area. Nevertheless, I was able to collect and document farmers' detailed knowledge of land-use strategies, classification and how their land-use strategies have changed between 1984 and 2004 (see Chapter 5, especially 5.2). The challenge here too is to incorporate those detailed land-use classifications—in most cases, half a dozen sub-classes within a common agricultural land-use—and agricultural land-use strategies into satellite data-based remote sensing for the whole district.

In principle, it is possible to do so by automating land-use classifications in the highest resolution satellite imagery (e.g., Quickbird, IKONOS) and close range digital images. In this case, access to such imageries was not possible due to resource and time constraints. The best possible option left for me was to use, interpret and compare a set of multi-temporal aerial photographs, and extrapolate the changes in local land-use strategies to link with the observed land-cover change patterns observed at the district level (Chapter 3). This is exactly where the linking of agricultural land-use strategies to the land-cover patterns is conceivable.



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Figure 6.4 Land-use change in Maling VDC (1979 to 1996)

In Figure 6.4, the interpretations of two aerial photographs covering Maling VDC (taken in 1979 and 1996 at the scale of 1:25,000) show that there were no dramatic changes in land-use

categories. Most importantly, there was no sign of the “massive deforestation,” as assumed in the HED; in fact, forest coverage consolidated in 1996. As shown in Number 1 and 3, expanding forest in the area previously covered by agricultural land and shrubland is clearly visible. The villagers attribute this land-use change to two proximate causes: (1) the newly implemented rules in forest protections, and (2) abandonment of marginal agricultural land due to decreasing labor availability. Number 2 shows the shrinking area of cultivated land. Nevertheless, unlike in the case of 1979, agricultural lands and forests are more clearly demarcated and the overall vegetation coverage seems more consolidated in 1996. The same patterns of changes were detected for land-cover changes at the district Nepal.

The changes observed in agricultural land-use strategies at the village level are indicative of much broader district-level land-cover change patterns. However, because of the fact that I use two different data sources for two different scales (i.e., aerial photograph for the village level and satellite data for the district level), I have to consider the issue related to the scale, particularly the modifiable aerial unit problem. While it is safe to claim that the same land-cover change trajectories exist at both village and district scale, it was not possible to successfully demonstrate the ‘cause-to-cover relationship,’ mainly because there was no simple ‘one-to-one’ relationship in smallholders’ decision to change their land-use and their links to broader land-cover patterns.

At a superficial level, the environmental change in Lamjung was seemingly the effect of population (i.e., pressure on early period leading to deforestation and subsequent outmigration trend resulting in natural reforestation). A closer examination of historical and the recent changes, however, showed that the issue is much more complicated. It was unfortunate in the past that smallholders were blamed as being responsible for the deforestation, overgrazing and the similar other problems. In effect, they are alienated from access to and control of forest and

grazing land resources they are dependent on for their survival. These are obviously the result of several 'biases' of the rules, policies, programs and professionals toward the poor and ethnic groups that have traditionally relied on forest resources (Acharya 1989). This case shows that a new set of relevant and close insights are needed to examine the relationships of subsistence farmers' production system and the land they are using, both cultivated area and forest.

In conclusion, it is clear that the patterns of LUCC in Lamjung are complicated and there is no 'one-to-one' type relation exists between the causal factors and the LUCC trajectories. Rather, the evidence suggests that the human driving forces of land-use and land-cover change are systematically interacting clusters of variables and that their operation is strongly influenced by social variables and environmental context (Meyer and Turner 1994). In this Lamjung case, for example, while a few low-altitude communities with access to prime lands and irrigation are facing land-stress, most others (*Paahad* and *Lekh* areas) have seen increased household engagement with the market economy, primarily in the form of outmigration for employment. Out-migration has created acute labor shortages for mobilizing collective labor for agriculture and livestock, which in turn, ceased the maintenance of land-use and adaptive capacity. Increasing reliance on non-farm employment has also differentiated people's interest in and dependence on agriculture among smallholders.

## CHAPTER 7

### CONCLUSION AND SIGNIFICANCE

In Lamjung, the cultural-ecological context of smallholding has changed over the last forty years. The most notable changes were in the resource allocation rules, local economy, labor management and agricultural system. These were more pressing and visible (the proximate causes) at the household and village scales. Combined, these have mediated the effects of population pressure and poverty, influencing smallholders' land-use decisions.

At the district level, the growing influence of the cash economy was the most dominant driving force, even though outmigration, under the population pressure and poverty, has had the enormous impact on LUCC trajectories. With the development of Dumre-Besishahar roads and other secondary roads inside the district, accessibility increased so fast that the effect of the cash economy is felt virtually in every aspect of smallholder households. Their synergistic effect resulted in the dynamic transitions or trade-off between forest, agricultural land and shrubland. The most notable LUCC pattern was the loss of shrubland coverage to agriculture and forest, decreasing from 37,825ha (22.33% of the total area) in 1976 to 16,717ha (9.86%) in 2003.

#### **1. Findings and conclusions**

In this study, the community context and the household conditions under which Lamjung's smallholders change their land-use strategies were analyzed with the solid understanding of the coupled human-ecological system. Gurung smallholders had historically developed a complex

adaptation process, mainly relying on strong social organizations, agropastoralism and the ecological interdependence. They effectively combined different altitudinal zones into their production system through the transhumance or migratory sheep herding, farming, trade and soldiery. Specifically, their agricultural land-use strategies were not specialized, but included a typical adaptation strategy of mountain smallholders: a mix of intensification, expansion, diversification, rules/cooperation and scheduling (Netting 1981; Rhoades 1997). They had their traditional institutions in place to organize the community, fulfill labor needs and complete agricultural tasks; besides, these institutions also provided safety cushions against vulnerability. However, these institutions faced the influence of complicated processes over the years, as they encountered unfavorable government policies, cultural beliefs and the wider market economy.

The first major change affecting Gurung smallholders' land-use strategies was their steady downward movement of settlements to lower altitudinal zones (*Paahad*), primarily from cool temperate and subalpine zones (Trans-Himalaya and *Lekh*). This trend eventually resettled many Gurungs into subtropical, the lower valley bottom zone (*Besi*). This trend accelerated after the southern part of the district became accessible by motor vehicles, which in turn, paved the way for the penetration of the wider market economy into hitherto isolated villages based on subsistence economy. This movement brought about the shift in agricultural preferences, mainly the switch from agropastoralism to agricultural intensification as their mainstay, which resulted in significant changes in the techniques and the types of land employed in their new agricultural practices. Similarly, settling in a new ecological zone also required them to choose different crops and domestic animals, and the scale at which they cultivate crops and raise animals.

What is important to stress here is that these changes are relatively complex to be addressed by remote sensing applications and ecological modeling or even classical cultural-ecological

studies that focused on a simple ‘closed-corporate’ community, where the relationships between population and the environment are direct and endogamous that those can easily be measured in a few variables. These changes in Lamjung are, in contrast, connected to the exogenous factors located outside of the district; the ‘self-sufficiency’ or ‘closed-corporate’ concept can no longer be applied to understand the changing context of smallholding. It is only through the notion of ‘dynamic equilibrium,’ agricultural land-use strategies of these smallholders could be understood. The specific community context and the household conditions under which land-use strategies are changed are discussed below, while explaining their processes and social drivers.

### *1.1 Institutional arrangements*

Whether it is at the household, community or district levels, institutional factors have played key roles in the changes of smallholders’ land-use strategies. Starting with the dislocation of customary rights and informal labor network, these institutional arrangements had profound impact on other historical altitudinal land-use that were key features of the Gurung culture, such as the transhumance or migratory sheep herding practices, *khoriya* (slash-and-burn) system and the concept of agriculture-forest-livestock interdependence. These institutions provided social organization as well as managed the much needed labor allocation for farming.

All the new rules of resource allocations brought about by the governments (e.g., abolition of *khoriya* system and the customary rights, the CFP and other forest conservation programs) directly targeted those ‘traditional practices’ and abolished them, as those were viewed as ‘backward’ and ‘destructive’ to the environment. In the changing context of smallholding, the new focus and priority was to cease migratory herding practice, ‘enclose’ the livestock and encourage sedentary agriculture, so that they could be ‘governed’ (or levied taxes) properly. The

downside of the change in institutional arrangements was that these dislocated and replaced traditional networks completely, while the new rules of resource allocation were still inadequate to provide the safety cushion provided by the 'traditional institutions' for years during the time of stresses and the needs.

Just as in agricultural intensification cases elsewhere, popular literature on Nepal often tend to attribute such sifts toward intensification and its subsequent impact on the environment to growing population, subsistence needs and the influence of wider market economy. In this study, I have highlighted how institutional arrangements and state policies driven changes in the community context historically led to reduced flexibility and options for mountain smallholders and why this case of mountain agriculture is more complex than prevalent intensification theories suggest.

### *1.2 Household conditions and community contexts as the social drivers*

It is well-recognized in LUCC literature that the demographic and household processes shape the nature of human adaptation to the environment. In Lamjung, the impact of demographic factors has been pervasive; whether it was the population growth resulting into pressure on forest resources in the pre-1970 period or the beginning of the outmigration to *Tarai* or cities in the post-1970 period. It was the growing population pressure that brought agricultural intensification processes in the earlier period (the 1950s through the 1970s); however, the recent trend has been the disintensification of agriculture, mainly because of the lack of interest in agriculture among the young population and a growing attraction toward non-farm jobs in the cities and over-seas. Once increasing non-farm employment started to draw labor away from agriculture, it created labor shortage, which in turn, led to a drastic decline in transhumance and started the chain effect

of declining manure availability, decreasing crop productivity and increasing abandonment of distant cultivated land.

The shortage of labor caused by permanent outmigration and the young people seeking non-agricultural employment outside of the district has conversely resulted into a positive feedback to the environment. Under the condition of the lower population pressure, there have been lower level of extraction and less imposition on forests, in some cases even natural reforestation. The trend toward abandoning of cultivated land has been exacerbated by the Maoist insurgency, which despite being a new phenomenon has had a devastating impact on agriculture land-use and the farmers' livelihood in general.

At the household level, the smallholders' agricultural priorities have found to be shifted from livestock and cold climate crops (i.e., barley and buckwheat) to income diversification and rice-based agricultural intensification. The most common household strategies have been to decrease livestock herd size of cattle, sheep and water buffalo and rely more on small animals (e.g., chickens, goats), while focusing mainly on the paddy field and home-gardens to meet the household demands. The decreasing livestock number in a household, however, has meant the less manure and the less draft power available for cultivation, which effectively broke the long held concept of 'interdependence' in farming, livestock and forest ,and it prompted the household to rely on the market for fertilizer and pay cash for labor and bullocks during planting and harvesting seasons.

The impact of the cash economy is felt in every aspect of Gurung life and it has played an important role in monetarizing goods and services, which in turn, exacerbated the declining legitimacy of customary rules and authority structures. Ironically, the state of the lack of adequate infrastructure and market support system has constrained the agricultural system, even

in the *Besi* area, where the competitions for ‘prime lands’ are higher, causing land-stress. Since farmers here cannot afford to produce only for the market, they have to diversify livelihoods. Those with access to and can afford the labor and inputs have maximized the productivity of rice-based intensification in the *khet*. Rice is more preferred as a food and its cultivation or consumption symbolizes a higher social status.

In addition, many sample households were found to have relied on the market for provisional items (e.g., replace thatch roofs with corrugated tins, local seeds with improved seeds, fuel wood with kerosene and cooking gas) when cash is available. The transportation costs for consumer and construction materials have significantly reduced, making them readily available in local markets. Cheaper transport of goods such as, food grains, salt and kerosene and their instant availability in local markets made them attractive alternatives.

The impact of the changing economic and social relations is that smallholders are now faced with increasing demand for cash incomes in the recent years and that their economic activities now center mainly around markets and gateway towns. This is another reason for seeking non-farm employment, preferably wage earning in the cities and abroad to meet the increasing cash needs to purchase these commodities, to acquire services (e.g., labor for rice plantation, livestock care) or to be able to access basic services (e.g., education, health service and other contingencies). Also, besides the break down or slow erosion of customary rules and traditional support networks, the recent changes have pervasive influence on the choices and preferences of crops and land-use types. For instance, while the millet, potato and corn still constitute the major diet source, virtually anyone would tell rice is their most preferred staple. Similarly, the increasing accessibility has also influenced the mobility of people: places and route of travel they choose for paying social visits to their kin and friends, interaction with markets, use of different

elevation zones and so forth. These changes have influenced the meaning of the way we understand how people choose certain land-use over others and why they do the way they do.

There is no doubt that forest coverage has increased because of the outmigration, CFP and other forestry conservation initiatives, but since these program severely restricts the traditional animal husbandry and ‘enclose’ livestock, other alternative strategies are adopted (e.g., decrease livestock number, keep stall-feed animals, small ruminants, agro-forestry in *baari/paakho* )

### *1.3 Trajectories of land-cover change*

The trajectories of land-cover change—analyzed from multi-temporal Landsat data of 1976, 1984, 1990, 1994, 1999 and 2003—illustrate the dynamic transitions or trade-off between forest, agricultural land and shrubland in the last four decades. This analysis also suggests that there is no linearity of land-cover change as is generally assumed (i.e., irreversible conversions of forest and shrublands to agricultural land). These land-cover changes are in fact non-continuous in space, leading to complex landscape mosaics and overlapped patchworks in the district. These results also support the basic premise of this study that we must look beyond the popular notion that conceives land-cover change as simple and irreversible conversions from one cover type to another. The land-cover change patterns identified in Lamjung can be explained in terms of the expanding human modification activities (i.e., agricultural land-use strategies), which are mainly characterized by the shifting crop and food preferences, the changes in labor allocation, and the growing pressure of the cash economy. In other words, such complex, dynamic patterns of land-cover change cannot be fully addressed by remote sensing applications and ecological modeling alone; narrative details of historical facts and farmers’ ecological knowledge of land-use are

needed to fully understand the modification activities that give rise to a highly dispersed pattern of land-cover change.

#### *1.4 Linking land-use strategies with land-cover change*

In Lamjung, smallholders' land-use decisions were influenced by four notable changes, which can be categorized as the proximate causes of LUCC, both at the village as well as the district levels. These changes are: (1) the growing influence of the cash economy following road building and market development; (2) outmigration and labor shortage resulting in changes in agriculture and forest resource use; (3) changing institutional arrangements with the significant impact on landscapes as well as on Gurung culture in general and their labor network and social ties in particular; and (4) shifting crop and food preferences as the result of the downward movement of settlements and the adoption of new agricultural systems. To make the dynamics even more complicated, relatively recent Maoist Insurgency has also brought about changes in social relations and in the use of agricultural and forest resources—the most noteworthy being the growing sense of insecurity that is pushing the farmers to abandon distant farm land.

The impact of these proximate causes is already discussed earlier; however, to link them to the observed patterns of land-cover change was challenging. While the claims about the proximate causes were still valid across scales (i.e., village and district levels), there were the technical problems or the constraints associated with operationalizing the research. In terms of linking land-use strategies with land-cover change, this study faced two major challenges. First, the investigation of land-use strategies, for example, ideally requires georeferenced land parcel data or GPS-aided parcel maps to be used with remote sensing data and techniques. Since it was improbable to get the georeferenced land parcel data for the whole sample village with past and

the future (forecasted) land-use strategies, a set of training samples were recorded. Those sample points and plots (polygons) were identified in aerial photographs as well to elicit the farmers' perspectives on land-use changes, land classification, and the causes of those changes. However, the use of aerial photograph for the whole district, which is the best available solution, was a daunting task and would have been the well beyond the scope (time and resource-wise) of this dissertation. The use of highest resolution satellite imagery (e.g., Quickbird, IKONOS) or even airborne digital images is a good possibility in the future, provided the sufficient resources are available and the constraints, such as remote sensing limitations in mountainous terrain, land ownership records and outmigration data, are properly addressed.

Secondly, this study recorded farmers' detailed knowledge on land-use classification and their land-use strategies; however, the existing GIS and remote sensing applications are not capable of capturing farmers' cognitive knowledge. So, my alternative was to first identify the patterns of land-cover change at the district level and then extrapolate their proximate causes from the processes of land-use modification observed and recorded at the village level. By doing so, it at least provided detailed explanations of the social drivers associated with those land-cover patterns and their relations with the local land-use.

In this study, hence, the linking of land-use strategies with land-cover change could not be established on the 'one-to-one' basis or the 'cause-to-cover' relationship, which is the most common approach in land change science. It, nevertheless, provides a case study of how effective an integrative multiscale study can be to: (1) elicit detailed documentation of land-use strategies at the household and village level, (2) analyze the processes and social drivers of LUCC consistently across scales.

## **2. Significance for ecological anthropology**

Investigating the household and community contexts of the changes in agricultural land-use strategies, this study contributes to three key areas of anthropology: (1) ecological anthropology, particularly ethnoecology and agricultural anthropology, (2) the anthropology of mountains, and (3) the integration of ethnographic and survey methods with GIS and remote sensing. The results of this study help establish general relationships underlying the subsistence behaviors of mountain smallholders, their dependence on agricultural and forest resources and the extent to which their behaviors are influenced by the changing local demography, expanding market economy, shared cultural knowledge and institutional arrangements in use.

This study also puts forward a counterpoint to the dominant tendency that often blames subsistence agriculture for deforestation, as though the relationships between forest and agriculture are always linear—the same tendency that presents land-cover changes from forest to agriculture as an irreversible phenomena. For smallholders in Lamjung, the meaning of forest conservation or community forestry is connected to their concept of forest-agriculture-livestock interdependence, in which the outcomes of one component constantly affect the other two.

Finally, this study also captured how an important cross-section of actors perceive, manage and change agriculture and forest resources in the Nepal Himalaya—one of the environmentally critical regions in the world. In spite of all the changes occurring around them, smallholders' knowledge of agricultural land-use knowledge has persisted. They still use the shared cultural knowledge and rules to differentiate agricultural land-use strategies, which are based on the ecological knowledge of topography, climates, micro-environmental conditions and individual crops' capability and their cultivation practices. This means future LUCC studies should develop the ways to incorporate their knowledge and classification system within the LUCC framework.

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## APPENDICES

### APPENDIX A

#### Glossary

<i>adhiyan</i>	Form of rent, amounting to half of the summer rice crop
<i>angsa</i>	Inheritance, patrilineal
<i>arghau</i>	Ritual performed after certain period of time in the memory of deceased family and clan members
<i>asaami</i>	Borrower or mortgagor
<i>baahun</i>	Brahmin or Jaisi Brahmin
<i>baari</i>	This term is derived from <i>baar</i> (fence) to refer to the enclosed area of homestead for fruit and vegetable production. It literally means in-field, there, it is wrong to equate it with <i>paakho</i> (unirrigated field) (Gurung 2004)
<i>bajaar</i>	Settlement or town with commercial services
<i>beshi</i>	Valley bottom
<i>bhaagya</i>	Good fortune, luck
<i>bhaat</i>	Cooked rice meal (in some cases maize or millet as well)
<i>bhangra</i>	It is a small hand-woven piece of cloth put across the chest (for Gurung men)
<i>bhendaa</i>	Sheep
<i>bhendi gothaalo</i>	Sheep herders, who are known as <i>prachhe</i> (G). Headmen are called <i>chhibaa</i> (G)
<i>bhumi</i>	land
<i>birtaa</i>	A form of land grant rewarded by the state to remunerate a noble and local functionaries for carrying out particular service
<i>chauri</i>	A female hybrid of Yak and Hill cattle
<i>cholo</i>	Also known as <i>choli</i> , is a sleeved, velvet blouse
<i>chhorten</i> (G)	A small shrine in a hill in the memory of deceased family members
<i>daanda</i>	Hill range or ridge
<i>dasaa</i>	Misfortune, inauspiciousness
<i>daun</i>	Village or rural settlement
<i>dhindo</i>	porridge made of millet or maize flour; considered low quality, only for those who cannot afford rice, or live in areas where there is no rice
<i>doko</i>	Load basket
<i>dukha</i>	Hardship
<i>deurali</i>	Convergence of two hills or ridges
<i>gaaun</i>	Village or settlement
<i>ghaiyaa</i>	Upland rice landrace, which is directly-seeded, broadcast in landslopes and hillside terraces and requires no irrigation
<i>ghaantu</i> (G)	Also known as <i>Ghaanto</i> , is a traditional Gurung dance
<i>ghar</i>	Home, household

<i>Ghyaabri (G)</i>	Gurung shaman, also known as <i>Klehpre</i> or <i>Klebri</i> , are influenced and/or trained in Bön religion rituals
<i>goth</i>	Shepherd's (herder's) hut and cattle sheds
<i>gothaalo</i>	Herdsman. Also known as <i>praachhe (G)</i> .
<i>hal</i>	Amount of land ploughed by yoke or a pair of bullocks, oxen in one morning
Himalaya	A Sanskrit term, also used as a geological term for structural formation overriding the Main Central Thrust
Himal	The high mountain range with permanent snow
<i>jaand</i>	Millet beer brewed locally
<i>janai purnima</i>	The sacred thread festival for Hindus, celebrated on the full moon day around July
<i>janjaati</i>	Indigenous and ethnic groups
<i>jaat</i>	Caste
<i>jaati</i>	Hindu social division according to the ritual status of a person by birth
<i>jutho</i>	Ritually impure
<i>kharbaari</i>	Marginal land allocated to produce thatch, fodder, and other useful grasses
<i>kharka</i>	Alpine pasture for summer grazing. Also called <i>bugyani (G)</i>
<i>khoriya</i>	A form of slash and burn cultivation with or without fallow periods
<i>khas</i>	Also known as Parbatiya, are the Hindu migrants who speak <i>khas bhasa</i> (present day Nepali language, which is of the Indo-Aryan linguistic families). <i>Khas</i> mainly include caste groups like <i>Brahmin</i> , <i>Chhetri</i> , and <i>Dalits</i>
<i>khet</i>	Irrigated land with horizontal terraces
<i>khola</i>	Stream, tributary
<i>lekh</i>	High mountain area with snow in winter
<i>lungi</i>	Wrapper worn by women
<i>mal</i>	Manure
<i>maanaa</i>	Unit of measurement equal to approximately 1lb
<i>muri</i>	Measurement for grain, equivalent to approximately 50 kg, also 1,369 sq. ft.
<i>nadi</i>	River
<i>nogar (G)</i>	Informal or seasonal labor exchange networks of young boys and girls
<i>paathi</i>	Volumetric measurement; one <i>paathi</i> is approximately 3.6 kg.
<i>Pahad</i>	Often known as the 'midland' or the 'middle mountain,' this refers to the hill area with no snowfall and often lies between the Himalaya and <i>Mahabharat Lekh</i> .
<i>pae (G)</i>	Mortuary rite and it symbolizes Gurung culture's faith in ancestors and spirits
<i>paakho</i>	known locally as <i>swaanraa</i> . Non-irrigated land with outward sloping terraces
<i>parmaa</i>	Informal labor exchange network
<i>patuka</i>	Cloth wrapped around the waist
<i>Pochyu (G)</i>	Also called <i>poju</i> are Gurung priest or ritualist
<i>pret</i>	Ghost
<i>Purnimaa</i>	Also called <i>Purne</i> . Full moon day in Nepali Calendar
<i>raajaa</i>	King
<i>rakam</i>	Land grants given by the state to remunerate agents of specific governmental administrative tasks
<i>raksi</i>	Liquor
<i>raikar</i>	A form of land tenure in which lands are state property under which the rights to an individual are limited to utilization and transfer as long as taxes are paid
<i>rin</i>	Loan bearing interest

<i>riti-thiti</i>	Customs, traditions
<i>rodhi</i>	Also pronounced as <i>rodi</i> and in its' literal meaning, <i>ro</i> means wool spinning and weaning and <i>dhi</i> means house. It is a nightly gathering place for youth of both gender to socialize, entertain, plan for communal tasks and the likes
<i>ropani</i>	Area measurement equivalent to 5,476 square feet and 1 hectare = 19.7 ropani
<i>Sakraanti</i>	The first day of a month
<i>saapat</i>	Short-term lending, mostly without interest
<i>sel roti</i>	A kind of bread or doughnut made on special ritual occasions
<i>sildo saji (G)</i>	Land deities
<i>taar</i>	Old river terraces, fans
<i>tarkari</i>	Vegetable
<i>tihun</i>	Vegetable or curry for meal
<i>tiyanle (G)</i>	Head of shepherds. Also known some places as <i>Chiba</i>
<i>thar</i>	Clan or descent group
<i>thigur(G)</i>	Informal labor network formed by adults to perform laborious tasks

## Pronunciation Guide

aa	as in	car
e	as in	neck
i	as in	feet
ō	as in	dove
ṅ	as in	land
ñ	as in	strong
ṭ	as in	tin
ṭh	as in	thug
u	as in	gaun

## Conversion Factors

1 <i>Khet</i>	=	1.3 hactares (ha)
1 <i>bigha</i>	=	0.67 ha (Tarai)
1 <i>matomuri</i>	=	0.13 ha = 0.25 <i>ropani</i>
1 <i>ropani</i>	=	0.05 ha (Hills) = 4 <i>muris</i>
1 <i>muri</i>	=	0.013 ha
1 <i>seer</i>	=	0.80 kg (Hills)
1 seer	=	0.93 kg (Tarai)
1 <i>mana</i>	=	0.3 kg rough rice
1 <i>mana</i>	=	0.454 kg rice
1 <i>maund</i>	=	37.32 kg rough rice (Tarai)

## APPENDIX B: INVENTORY OF COMMONLY FOUND TREE SPECIES

(based on the training sample collection in Maling VDC)

### Jungle Trees

S.N.	Local name	Botanical name
1	<i>Chaanp</i>	<i>Michelia champak</i>
2	<i>Chilaaune</i>	<i>Schima wallichii</i>
3	<i>Daar</i>	<i>Debregeasia salicifolia (D. Don) Rendle</i>
4	<i>Guraans</i>	<i>Rhododendron arboretum</i>
5	<i>Katus</i>	<i>Castanopsis arboretum</i>
6	<i>Laankuri</i>	<i>Fraxinus floribunda</i>
7	<i>Okhar</i>	<i>Juglans regia</i>
8	<i>Phalaant</i>	<i>Quercus lamellose</i>
9	<i>Saal</i>	<i>Shorea robusta</i>
10	<i>Sishau or sishoo</i>	<i>Delbergia sissoo</i>
11	<i>Uttis</i>	<i>Alnus nepalensis</i>

Mathillo Bheg (*Pahad and Himal*): *Chilaaune, Katus, and Uttis*

Tallo bheg (*Besi*): *Saal, shishau*

### Agroforestry (fodder trees)

Local name	Botanical name
<i>Baabiyo</i>	<i>Eulalopsis binata</i>
<i>Baans</i>	<i>Bambusa sps.</i>
<i>Badahar</i>	<i>Artocarpus lakoocha</i>
<i>Bakaina</i>	<i>Melia azaderach</i>
<i>Chutraa</i>	<i>Berberis nepalensis</i>
<i>Dudhilo</i>	<i>Ficus nemoralis</i>
<i>Ghangaaru</i>	<i>Berberis crenulata</i>
<i>Khanayu</i>	<i>Ficus semicordata</i>
<i>Koiraalo</i>	<i>Bauhinia variegata</i>
<i>Nimaro or nibharo</i>	<i>Ficus roxburghii</i>
<i>Siru</i>	<i>Imperata cylindrical</i>
<i>Taanki</i>	<i>Bauhinia purpureu</i>

**APPENDIX C: COMMON FARM TOOLS, CULTURAL ATTRIBUTES OF CROPS  
AND SEASONAL CALENDAR**

Name	Nepali (Gurung)	Functions
Plough	<i>Halo (halo)</i>	Plow
Spade/Hoe	<i>Kodaalo (toh)</i>	Dig
Wooden tool	<i>Ledko (ledko)</i>	Break big lumps and level the surface
Wooden tool	<i>Mungro (thaungne)</i>	Compacting surface
Harrow	<i>Daante (daante)</i>	Pulverize
Big basket	<i>Doko (phe)</i>	Conical basket for carrying loads on the back with a <i>naamlo</i> (strap) round the head Carry big loads of fodder, manure, etc
Small Basket	<i>Daalo (daalo)</i>	Carry small loads of grains
Rainsack	<i>Syaakhu (syakhu)</i>	Keep dry from rain during planting
Sickle	<i>Hansiya (koro)</i>	Cut stalk and grass
Plough yoke	<i>Juwa (juwa)</i>	Keeps bullocks together in tracks
Bamboo bag	<i>Korko (korko)</i>	Used in carrying/swinging babies,
Flat tray	<i>Naanglo (Naanglo)</i>	Dusting grains
Stone grinder	<i>Jaanto (redo)</i>	Grinding maize, millet, pulses
Foot operated pestle	<i>Dhiki (kune)</i>	dehusking and milling grains
Strap	<i>Naamlo (naamlo)</i>	Carry load

### Common Crops Cultivated in Maling

Local Name	English Name	Botanical Name	Main Use	Location	Occurrence
<i>Dhaan (mlah)</i>	Paddy		Bhat, roti, puja, paral, gundri, dori,		1 harvest
<i>Makai (makai)</i>	Maize		Bhat, khaja, prashad ( <i>phool</i> ), gaibastu, jand ( <i>khoipa</i> ) khoi = chhanne pa = jand,		
<i>Kodo (nare)</i>	Millet				
<i>Phapar</i>	Buckwheat		Roti, dhido	<i>paakho</i>	9, 7, 5 Dhosh bhetinchha
<i>Tori</i>	Mustard				
<i>Ghaiya</i>	Upland rice				
<i>Ganhun</i>	Wheat				
<i>Jau</i>	Barley				
<i>Til</i>	Sesame				
<i>Bhatmas</i>	Soybean				
<i>Gahat</i>					
<i>Bodi</i>	Field peas				
<i>Raayo</i>	Mustard greens				
<i>Sarsyoon</i>					
<i>Cauli</i>	Cauli flower				
<i>Banda</i>	Cabbage				
<i>Daal (Maas)</i>	Lentils				
<i>Aalu</i>	Potato				
<i>Mula</i>	Radish				
<i>Boda</i>	Beans				
<i>Ghieu Simi</i>	Long beans				
<i>Chaite Simi</i>	Flat beans				
<i>Aduwa</i>	Ginger				
<i>Besaar</i>	Tumeric				

m = main starch staple, v = vegetable for side dish, k = snack food, b = beverage, f = feed (for livestock), t = technology, s = social interactions, r = ritual B = *baari*, K = *khet*, J = *jungle*, P = *pakho*, R = *khoriya*, H = *kharka*,





## Cultural Attributes of Crops

### 1. Principal **Maize** Uses and Preferred Landraces/varieties

Type	Preparation, Rationale	Local name	Landraces/Verities
Roasted/fried			
Corn on the cob			
Milky raw grains			
Boiled cob or grains			
Fine gruel			
Vegetable mix/daal		<i>purano chalan</i>	
Beer-making			
Coarse gruel		<i>bhaat</i>	
Kundo or Khole			
Dried			
Beaten rice		<i>chiura</i>	
Pudding	<i>kosheli for prochhe and gothaalaa</i>	<i>kurauni jasto</i>	
Finely grinned mush		<i>dhindo</i>	
Flour or snack flour	<i>Roti</i>		
Silage (green)			

## 2. Principal **Rice** Uses and Preferred Landraces/varieties

<b>Types and uses</b>	<b>Local name</b>	<b>Notes, preparation or rationale</b>	<b>Preferred landraces or varieties</b>
Boiled rice	<i>Kai</i>		<i>Ramaina, jhinuwa, thulo saali, bhangere</i>
Rice doughnut (deep fried ring bread)	<i>Selroti (Sur khe)</i>	Prepared for festivals and special occasions (wedding, arghaun). Sur means making a ring and khe means bread	<i>Jhinuwa, thulo saali, mansara</i>
Bread/flour	<i>Roti</i>		<i>Ramaina, jhinuwa</i>
Flat bread	<i>Roti (pla khe)</i>		<i>Thulo saali</i>
Rituals	<i>Tika</i>		
Beaten rice	<i>Chiura</i>		<i>Taichung, mansara, gaiya</i>
Puffed rice	<i>Bhuja, khatte</i>		
Beer Making	<i>Jaand (mlah paa)</i>	Rice or corn brewed <i>jaand</i> are considered inferior to millet <i>jaand</i> .	<i>Darmaali</i>
Pudding porridge	<i>Khir</i>	Special occasions	<i>jhinuwa, thulo saali, ramaina</i>
Husk	<i>Dhuto</i>	Fed to cattles	
Anadi	<i>Latte</i>	Special occasions	<i>Anadi</i>
Hay	<i>Paral</i>	Paral is also used in making <i>puriyo</i> , small finely weaved baskets, to save seeds and grains. Those <i>puriyo</i> are kept in well-ventilated place	<i>ramaina, thulo saali, jetho budho</i>
Long, rectangular matt	<i>Gundri</i>		<i>thulo saali</i>
Round, small matt	<i>Chakati</i>		<i>thulo saali</i>

### 3. Principal **Millet** Uses and Preferred Landraces/varieties

<b>Types</b>	<b>Preparation</b>	<b>Local name</b>	<b>Preferred Landraces/Varieties</b>
Gruel		<i>Dhindo</i>	Lumle and local (black)
Local beer		<i>Jaand</i>	Local (black), lumle, seto
Liquor		<i>Raksi</i>	Local (black)
Pan cake		<i>Roti</i>	Local (black) and lumle
Hay		<i>Nal (Paral, Ghans)</i>	Lumle

### Seasonal Calendar

Task (Crops)	Months											
	Jan-F	Feb-M	Mar-A	Apr-M	May-J	Jun-J	Jul-A	Aug-S	Sep-O	Oct-N	Nov-D	Dec-J
Rice												
Millet												
Wheat												
Maize												
Pulses												
Oil												
Veg.												
Kharka												
Fodder												
Fuelw												
Labor												











## APPENDIX D: IMAGE RESAMPING AND PROJECTION SYSTEM

All maps produced in this project have a Transverse Mercator projection\* with the projection parameters defined below:

Projection type	:	Transverse Mercator
Spheroid Name	:	Everest 1830
Datum Name	:	Everest 1830
False_Easting	:	500000.000000
False_Northing	:	0.000000
Central_Meridian	:	84.000000
Scale_Factor	:	0.999900
Latitude_of_Origin	:	0.000000

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\* The same project parameters are used as the “Modified UTM Projection” in topographic maps produced by the Department of Survey, the Government of Nepal

## APPENDIX E: INDICES FOR LAMJUNG GIS DATASET

The GIS database acquired from ICIMOD followed the Land Management Resource Project's land-use/cover classification system (LRMP 1986).

<b>Aggregation of LRMP Land-use/cover Classes</b>	<b>Note</b>
Class 1. Sloping terraces	Level II (agriculture/cultivated land)
Class 2. Valley floors	Level II (agriculture/cultivated land)
Class 3. Grazing land	Level I (Grazing land, Shrubland)
Class 4. Rocks, sand & boulders	Level I
Class 5. Snow & ice	Level I
Class 6. Foothills & tars	Level II (agriculture/cultivated land)
Class 7. Forest	Level I
Class 8. Landslides	Level I
Class 9. Level terraces	Level II (agriculture/cultivated land)
Class 10. Shrubland	Level I (Grazing land, Shrubland)

### *Agricultural sub-classes*

Middle mountain

C1: low intense cultivated

C2: medium intense cultivated

C3: intense cultivated level terraces

High mountain

T1: low intense cultivated

T2: medium intense cultivated

T3: intense cultivated

V: valley floors

F: Foothills and tars

### **Land capability map**

Class I. Nearly level < 1 degree

Class II. Gently sloping (slope 1 - 5 degree)

Class III. Moderately to strongly sloping (slopes 5 - 30 degree)

Class IV. Too Steep to be terraced (> 30 degree)

Class V. Alpine with more than 20cm deep soils and > 30 degree slopes

Class VI. Areas with slopes 40 to 50 degree slopes

Class VII. Rock and ice

Class VIII. Area cover by rivers and streams

### **Land system map**

9. MM alluvial plains and fans

9a river channel

9b alluvial plains

9c alluvial fans

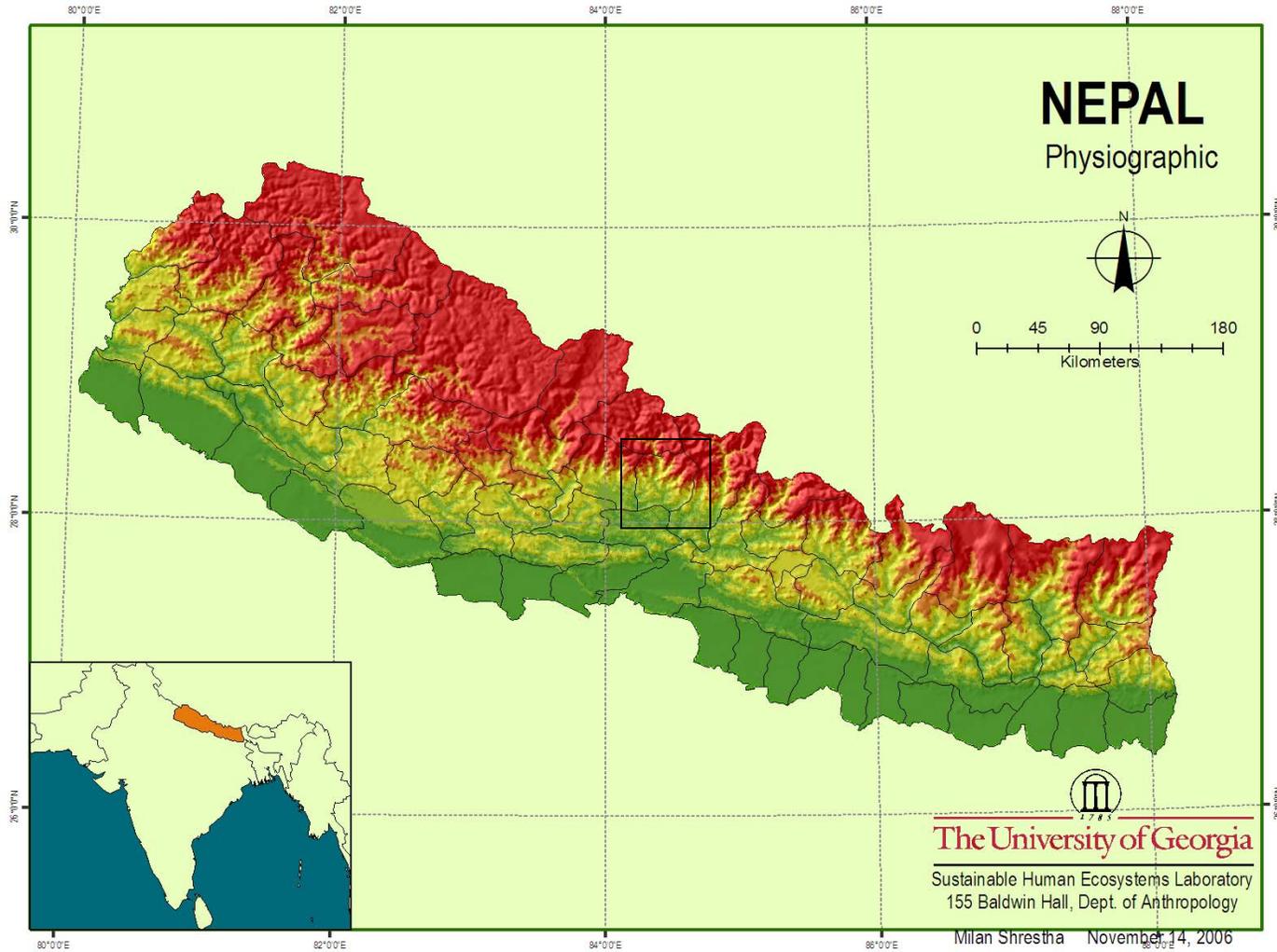
10. MM ancient lake and river terraces (Tars)

11. MM Moderately to steeply sloping mountainous terrain

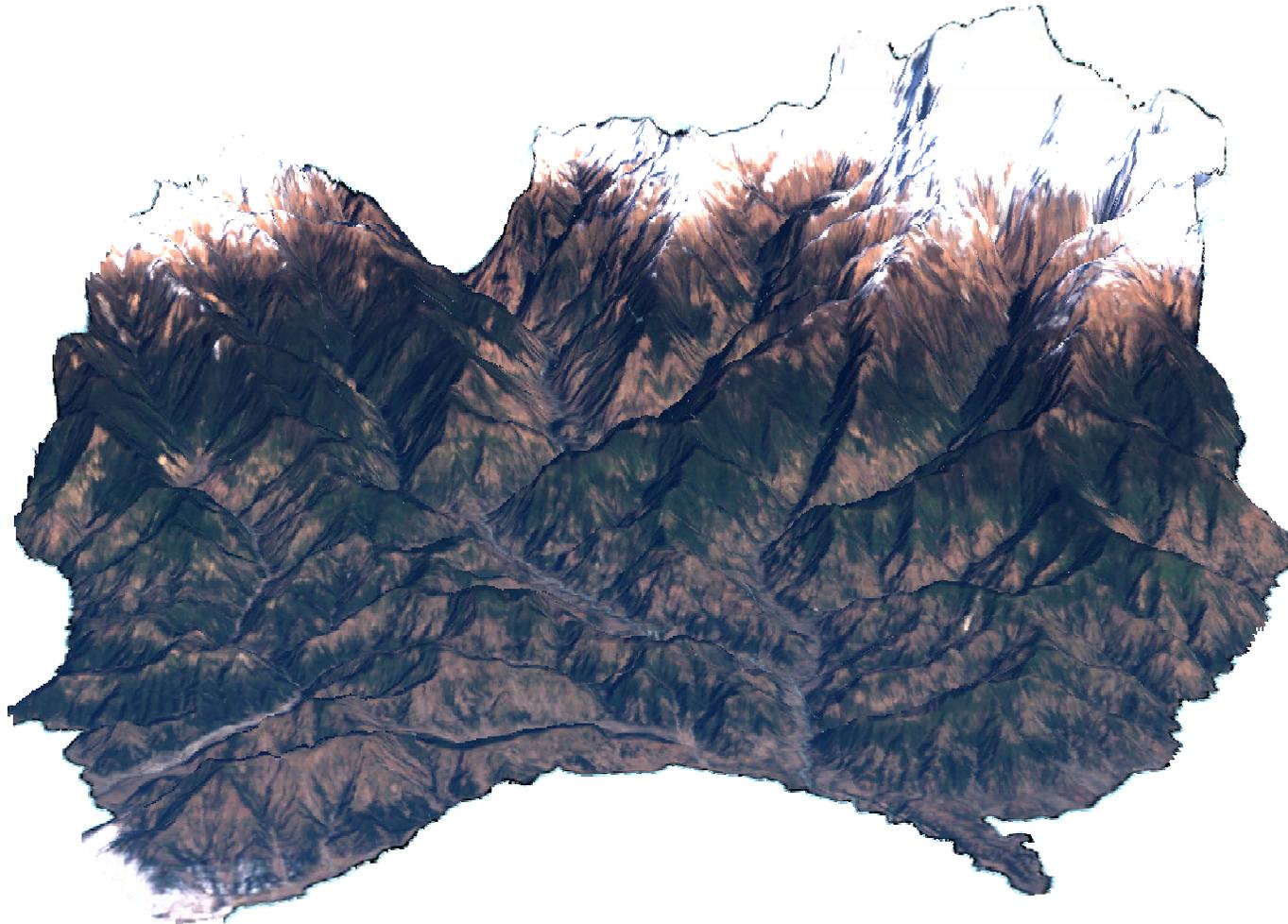
12. MM Steeply to very steeply sloping mountainous terrain
13. HM alluvial plains fans
14. HM past glaciated mountainous terrain below upper altitudinal limit of arable agriculture
15. HM past glaciated mountainous terrain above upper altitudinal limit of arable agriculture
16. HH alluvial, colluvial and morainal depositional surfaces
17. HH steeply to very steeply sloping mountainous terrain

**APPENDIX F: MAPS PRODUCED FOR THE STUDY**

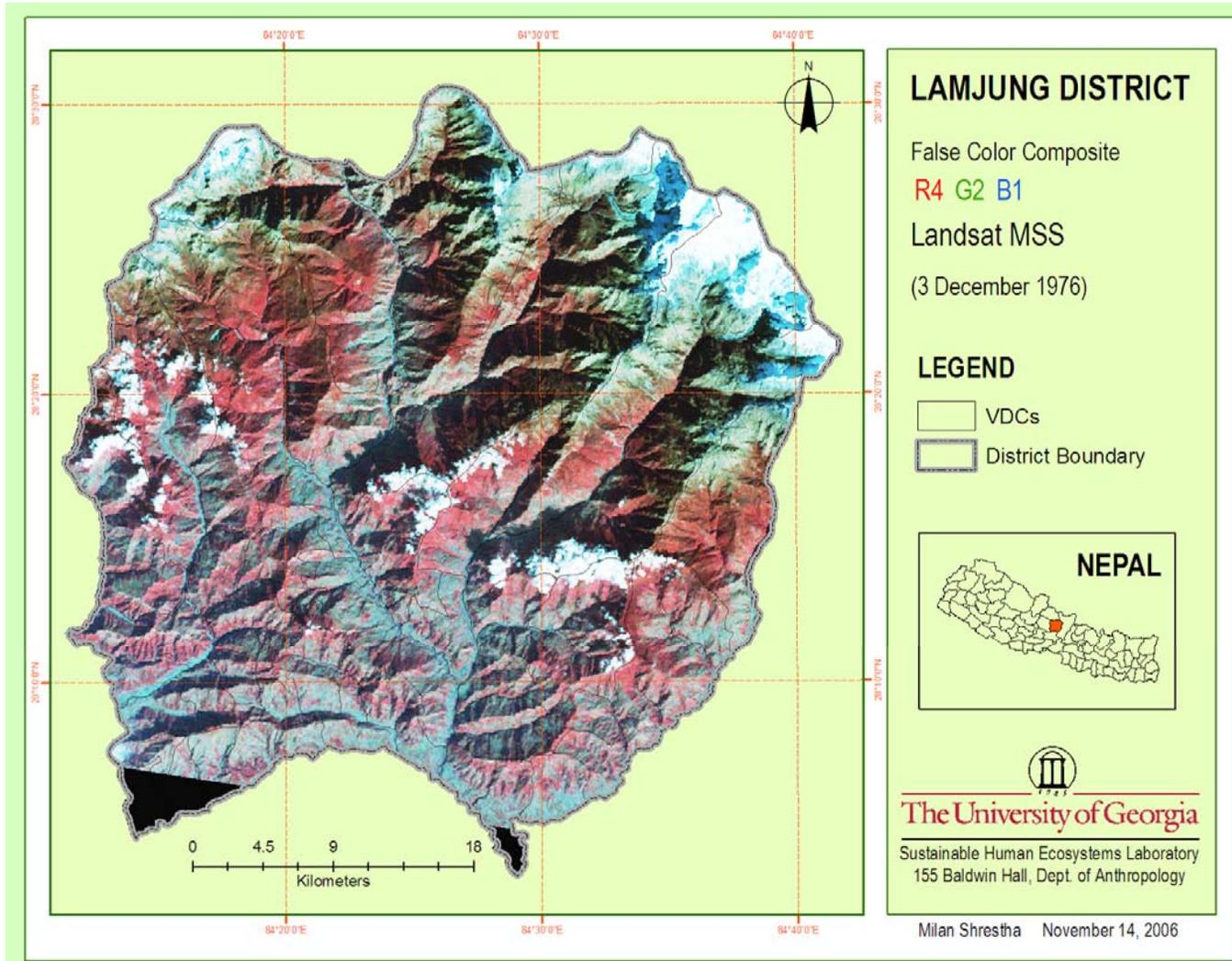
Map 1: Lamjung District in Nepal



Map 2 Virtual Lamjung Landscape (Landsat ETM+ 1999 image draped over the digital elevation model)

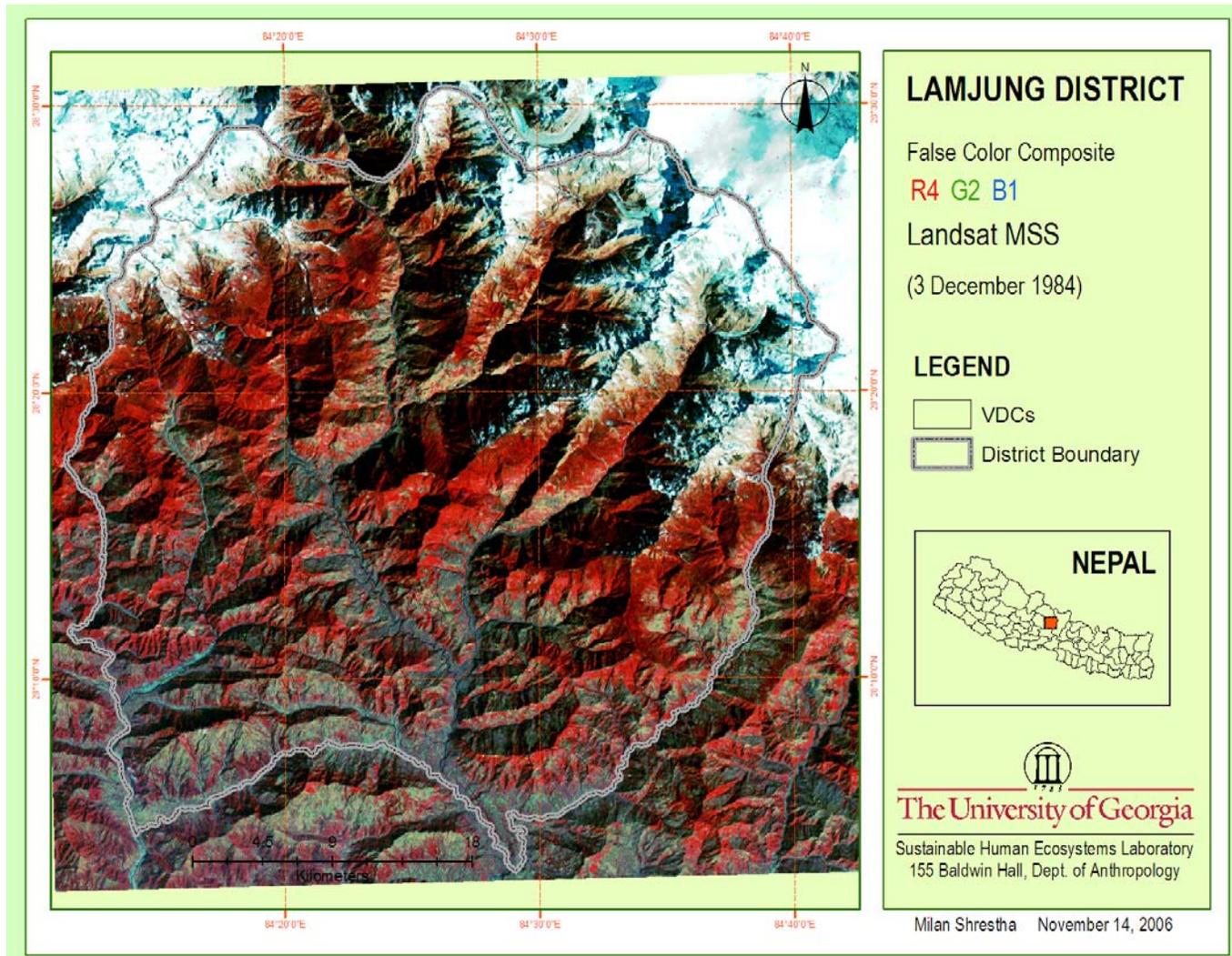


Map 3 Landsat MSS Image (1976)

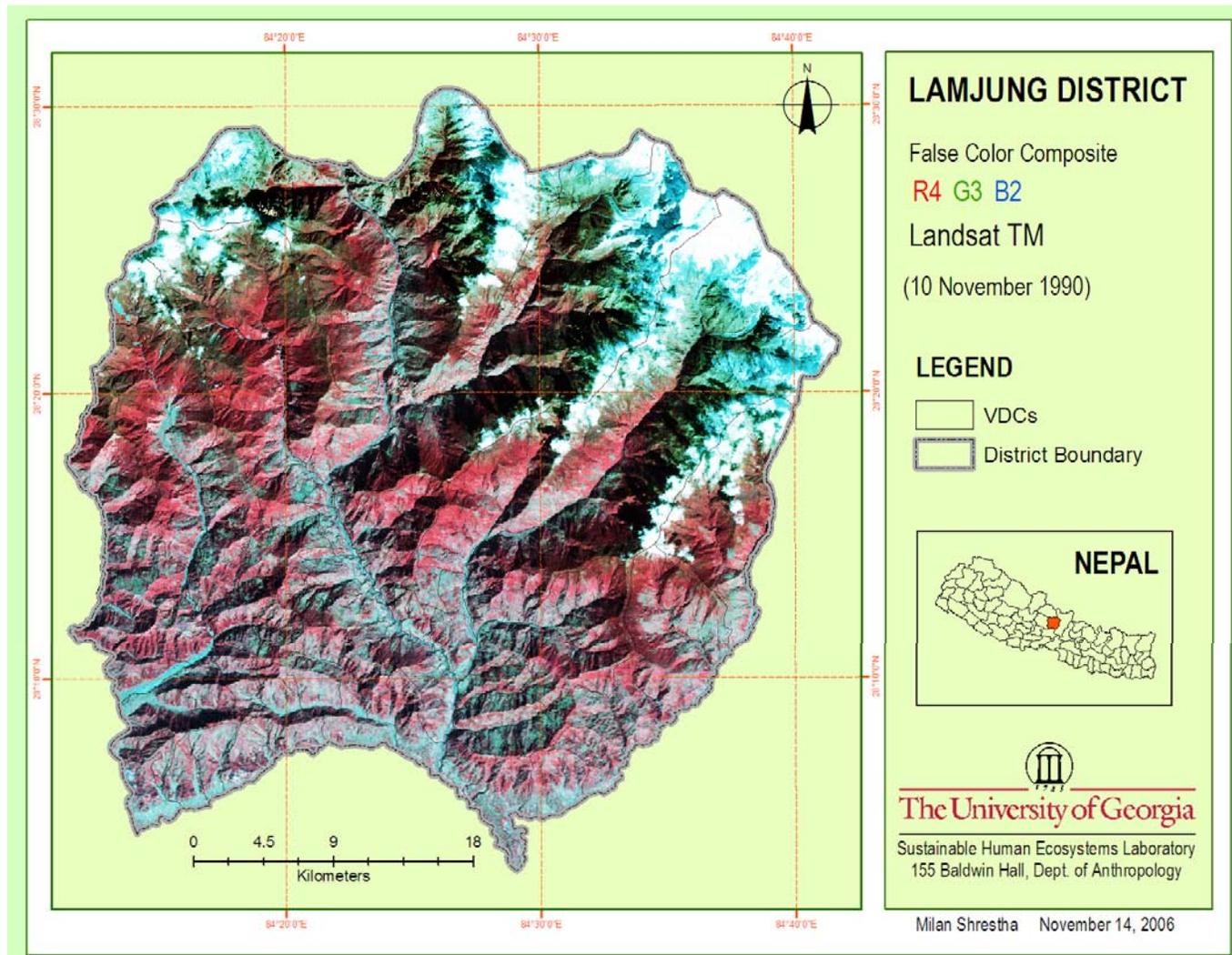


Map 4 Landsat MSS Image (1984)

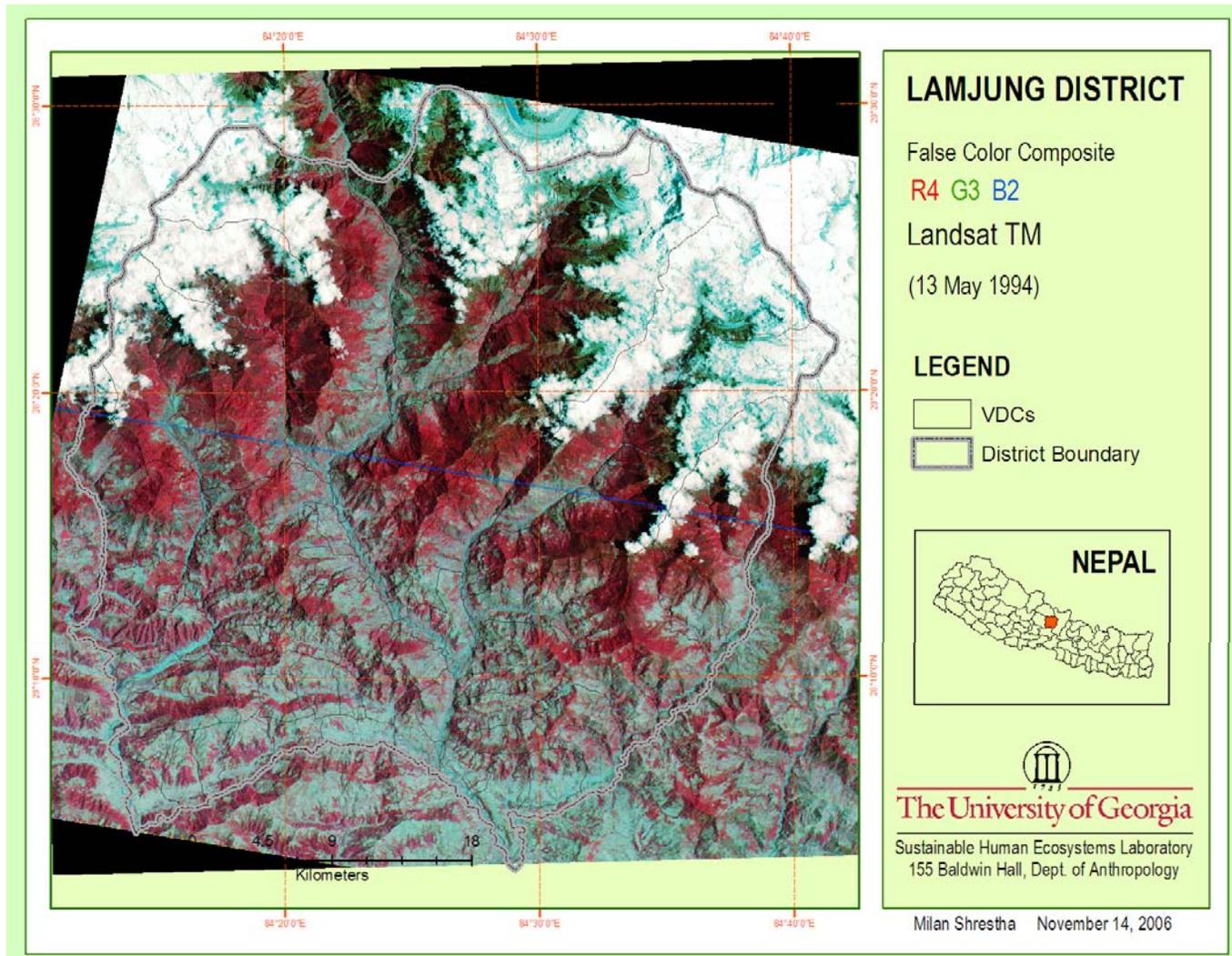
267



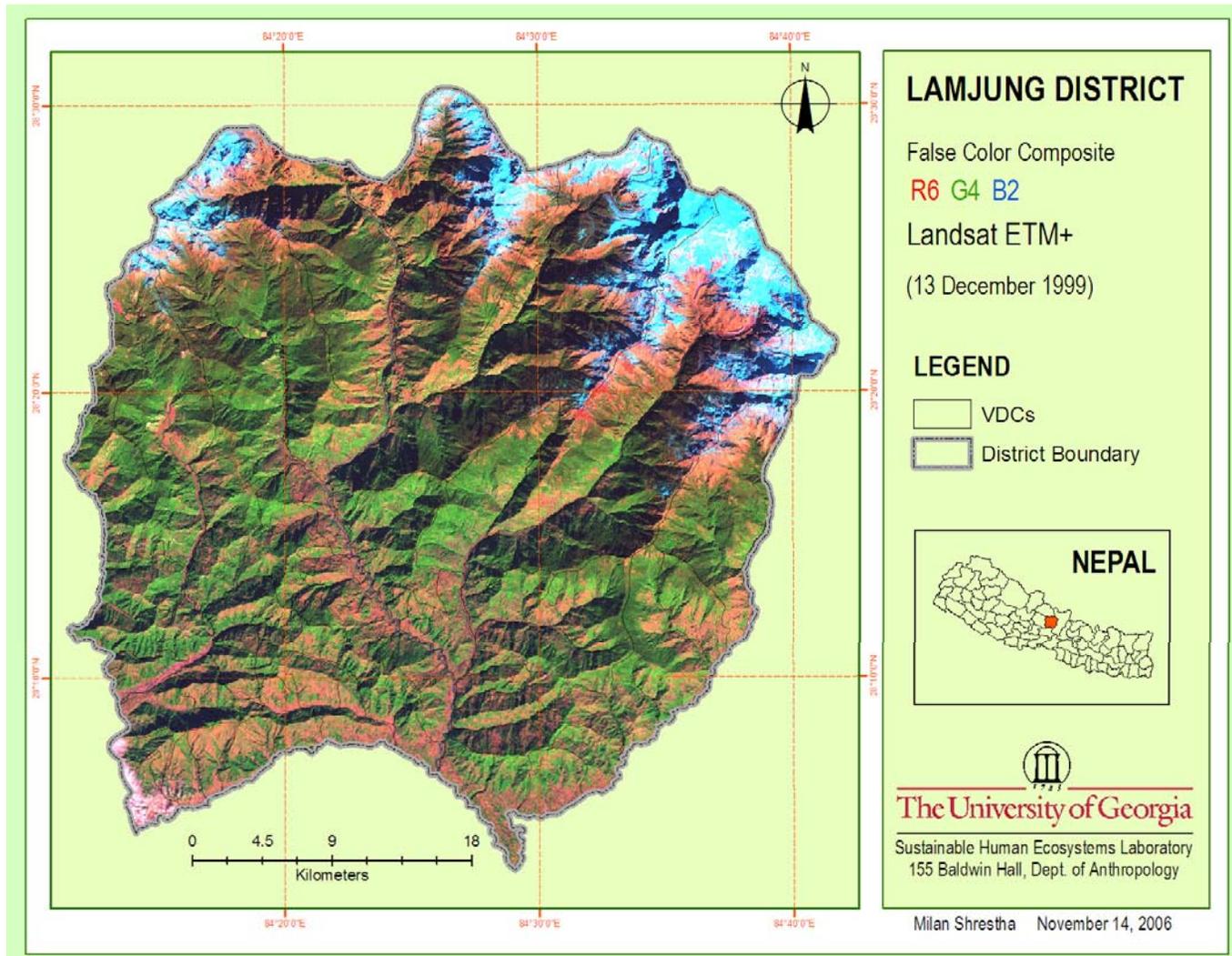
Map 5 Landsat TM Image (1990)



Map 6 Landsat TM Image (1994)

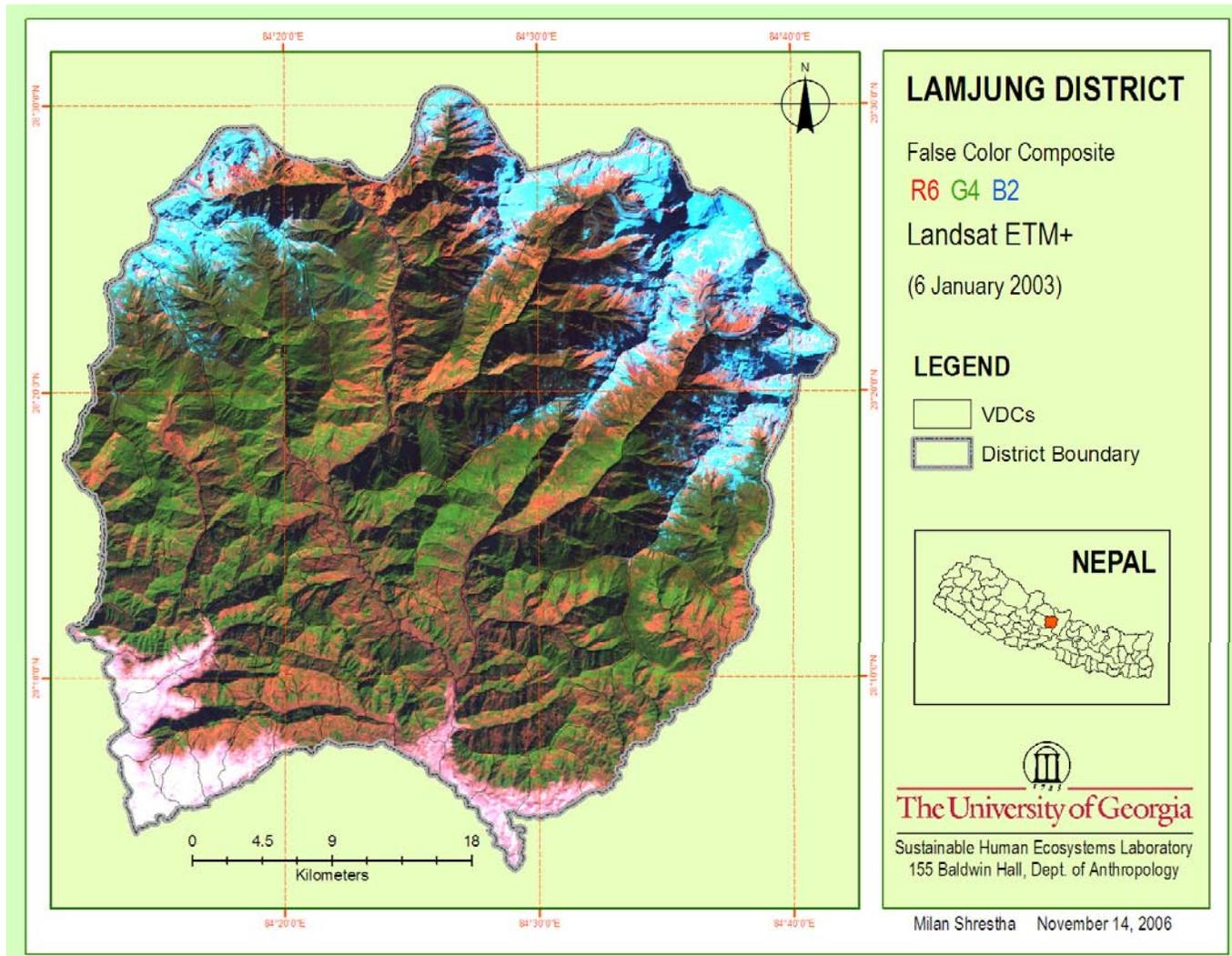


Map 7 Landsat ETM+ (1999)



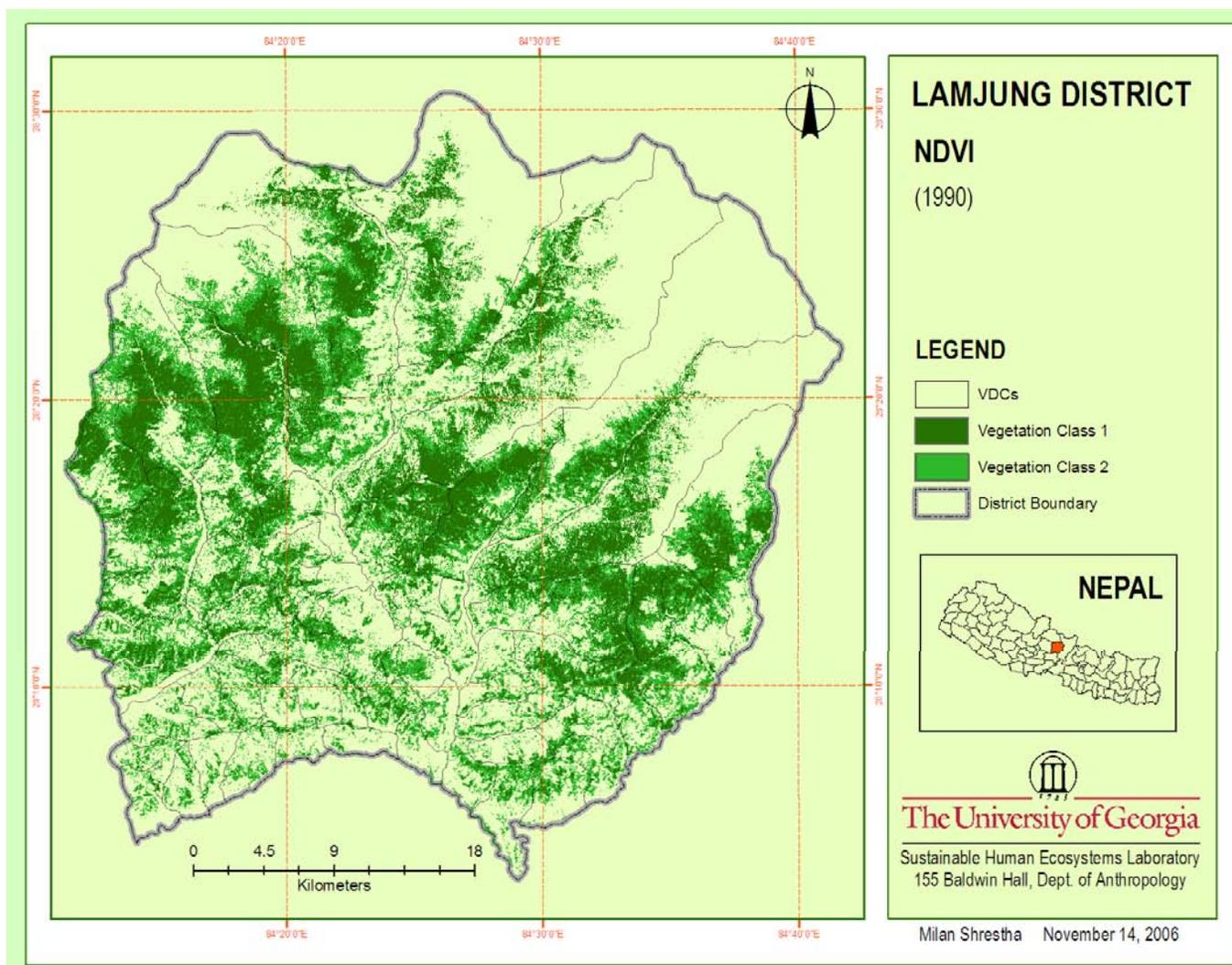
Map 8 Landsat ETM+ Image (2003)

271

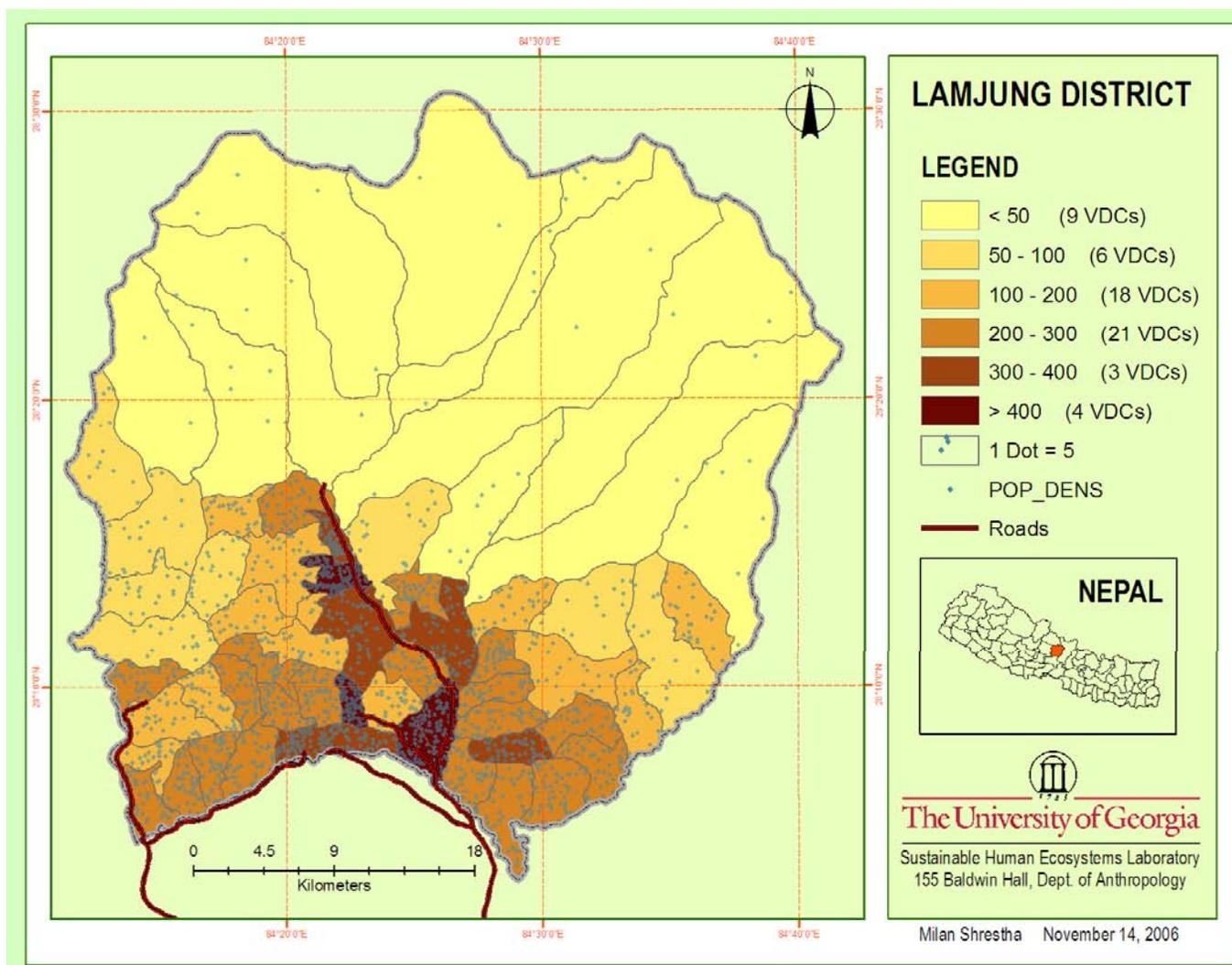


Map 10 NDVI (1990)

272



Map 11: Population Density in VDCs



## APPENDIX G: INTERVIEWS, TRAINING SAMPLE AND SURVEY FORMS

1. Structured participant observations
2. Questions for Semi-structured Interviews,
3. Training Sample Forms, and
4. The Household Survey Questionnaire

### 1. Structured Participant Observation:

#### Farm Level Information

Total landholding and type (*khet/Baari*)

Livestock number, type, and changes in the last ten years

Number of fields/parcels and sizes, location, crop, and nutrients management practices in each fields

Estimated total organic compost/manure available in a year

Estimated constituents make-up of organic compost (dung, leaf litter, bedding materials, crop residues, and green grass)

Perception of compost quality and possible improvements

Livestock management practices: location and frequency of grazing, or stall feeding

Fodder collection: type, location, frequency, and gender

Bedding material: type, location of supply and frequency of collection

#### Field Level Information

Site characteristics: size, location, soil type, and irrigation practices

*Farming Practices (Output)*

Crop rotation:

Number of crops and production per annum

Any change in the last five to ten years? Why?

Crop residues: removed from the field to stall feed, compost, etc.

Any practice to bring cattle in the field for manure?

*Input*

Inorganic fertilizer: quantity, type, change in the last five years, deficit strategy

Organic compost: quantity, type, composition, and change in the last five, deficit

#### Community Level

Factors affecting application of fertilizers/composts used

Spatial differences in application rates across farms

Composting practices: constituents, storage, and application

Constrained in improved crop yields

Importance of forest resources to farming and changes in forestry practices

## 2. Semi-structured Interview Questions with probings and prompts

- What was the landscape like when you were young in terms of societies, culture, forest, agriculture, and so forth?
- What are some of the most important changes you have seen in your life time, your village?
- Do you know from where your ancestors migrated?
- Do you think forest coverage has decreased over the decades? Why do you think it increased (decreased)?
- Is there any reason to modify land type?
- What are the crops you grow in *Baari*, *paakho*, *khet*?
- Which crop do you prefer? Why? (probes, prompts, etc.)
- What about the productivity of particular crop over the year? Increased or decreased? How much?

### Probing and prompts:

*Family compositions, labor allocation, livelihood sources*

1. Which ethnic group does the respondent belong to?
2. Cultural identity: what are the key things about your ethnicity
3. How many family members?
4. Sources of income?
5. Their labor allocation and acquisition? Labor exchange networks

*Agricultural Systems:*

1. Tell me about the *Bhendi Goth* or *Kharka Jaane* tradition
2. How did it work? What are the important aspects of it?
3. Why did it decline or disappear? Local interpretations
4. Key features of different agricultural systems? Their ecological, cultural, economic, and social contexts? Advantages and disadvantages of each agricultural systems

*Crops*

1. What types of lands (land-use) you have?
2. What are the crops you grow in *Baari*, *paakho*, *kanla*, *khet*, *tandi/tari*?
3. Why did you choose certain crops over others? Which one do you prefer? Economic, cultural, and ecological rationale for choosing certain crops
4. Which is the highly valued crop? And, why? Which is the most useful? Is there any crop that has multiple use? Their rankings
5. Document the whole rice, corn, and potato cultivation practices (so called cultural practices). List all the local varieties
6. Seed network and exchange system. How things have changed over the years.
7. Agricultural inputs?
8. Spatial and topographical significance in location of land parcels
9. compost manure making practices and its declining uses

*Land and Soil*

1. Local interpretation of each land-use types? Which ones are preferred and highly valued?
2. how choosing a particular crop results in changes in land-use types

3. Freelist all the modification activities
4. Local soil classification? What are the basis (e.g., color, texture, etc.): soil characteristics, crop performance, agricultural management, environmental factors, and biology. The term 'field fitness' suits more than 'soil fertility' alone.

*Forest:*

1. The cultural meaning of forests. Folklores associated with the forest.
2. Which tree species you prefer and why? Is there any relation with crops? Their rankings
3. How crops are dependent on the forests?
4. Dependence on the forests resources. Spatial significance of forest location
5. Types of forest. Types of timber and non-timber forest products. Multiple use
6. Past rules and present rules/institution

*Memories, values, hopes, and concerns*

1. What was it like when you grew up in terms of societies, culture, forest, agriculture, and so forth?
2. What are the some of most important changes you have seen in your life time, your village?
3. What has stroked you so intensely in terms of the changes you have witnessed
4. Labor exchange network
5. Youth moving to the cities
6. Remittances (British Gorkha, Arabian countries)
7. Declining interest in agriculture
8. Where the first settlements they could remember? Where are their ancestors from?

*Rituals and Cultural Contexts of key festivals: Pae, Arghau, Ghaantu, Ekadashi, etc.*

**3. Training Sample Form 2005** (adapted from the CIPEC Training Sample Protocol)

Registration Number:      (village/ward/ land-use type/ patch no.)

Today's date (mm/dd/yr): \_\_\_/\_\_\_/\_\_\_ Local Time: \_\_\_:\_\_\_

Training Sample (TS) Area Name/Owner Name: \_\_\_\_\_ TS Class: \_\_\_\_\_

Image Products Used: Image ID/date \_\_\_\_\_ Color Composite Used: R= \_\_\_ G = \_\_\_ B = \_\_\_

Map only: Y/N \_\_\_\_\_ Unsupervised classification: Y/N \_\_\_\_\_ TS ref. : \_\_\_\_\_

**DIAGRAMS OF GENERAL OBSERVATIONS:** Locations of GPS points & training sample area in relation to major features.

**Arial View**

**Profile Diagram** (parallel to maximum slope)

(include land marks and north arrow)

(overall draw of vegetation and slope, include vertical scale)

**GEOGRAPHIC COORDINATES:**

UTM Northing (X) \_\_\_\_\_ [m] UTM Easting (Y): \_\_\_\_\_ [m] UTM Zone: \_\_45N\_\_ Datum: \_WGS84\_\_

Latitude (N/S) \_\_\_ ° \_\_\_ ' \_\_\_ " Longitude (E/W) \_\_\_ ° \_\_\_ ' \_\_\_ " Decimal Degree (N/S) \_\_\_\_,\_\_ (E/W) \_\_\_\_,\_\_

**GPS INFO:** File Name: \_\_\_\_\_ PDOP: \_\_\_\_\_

**LOCATION OF PLOT TOPOGRAPHICALLY:** Ridge \_\_\_\_\_ Slope \_\_\_\_\_ Flat \_\_\_\_\_ Steepness of slope \_\_\_ ° (0-90°)

**LAND-COVER TYPE** (put a check mark next to land-cover type or write in others):

EXISTING VEGETATION TYPE:	AGRICULTURE/PLANTATION:	DISTURBED:
Semi-deciduous broadleaf forest	Broadleaf crop	SS 1 (initial succession)
Mixed semi-dec. forest (needle/broad)	Annual grass crop	SS 2 (intermediate succession)
Semi-deciduous floodplain forest	Wood perennial fruit crop	SS 3 (advanced succession)
Mountain needle leaf forest	Plantation (eg., Eucalyptus)	Disturbed forest (logging)
Grassland	Agroforestry/crops	Burned field
Woodland savanna	Agroforestry/pasture	Quarry
Marsh Wetland	Pasture	Forest with cleared understory
Seasonal wetland	Pasture wi shrubs/woody regrowth	(others-use space below):
Tall grass and shrubs	Bare soil	
Gallery forest	Stubble field	<b>INFRASTRUCTURE:</b>
Dry woody shrubs	Plowed field	Residential
Cactus / succulents	(other-use space below):	Commercial
Palm forest		Industrial
Bamboo		Lawn
Temperate deciduous forest		Blacktop
Other		Gravel
		Other

If existing vegetation is secondary, give original vegetation if known: \_\_\_\_\_

**VEGETATION STRUCTURE ESTIMATES:** [N/A: \_\_\_\_\_ No vegetation in sample]

Use ground cover estimate sheet to nearest 5%: % herbaceous \_\_\_\_; % litter, \_\_\_\_; % soil \_\_\_\_; % rock \_\_\_\_

Dominant Canopy Tree Species: 1<sup>st</sup> \_\_\_\_\_ 2<sup>nd</sup> \_\_\_\_\_ 3<sup>rd</sup> \_\_\_\_\_

Comments: \_\_\_\_\_

Presence of Others: \_\_\_\_\_ Average number: \_\_\_\_\_

Canopy closure: \_\_\_\_\_ % cover Average canopy height: \_\_\_\_\_ m, height of emergent trees: \_\_\_\_\_ m

Average DBH of canopy trees: 2-10 cm\_; 10-20 cm\_; 20-30 cm\_; 30-50 cm\_; 50-70 cm\_; 70cm-1m\_; >1 m\_

Av. DBH of emergent trees: 2-10 cm\_; 10-20 cm\_; 20-30 cm\_; 30-50 cm\_; 50-70 cm\_; 70cm-1m\_; >1 m\_

Presence of Saplings: Absent \_\_\_\_\_, Few \_\_\_\_\_, Moderate \_\_\_\_\_, Abundant \_\_\_\_\_

Presence of Seedlings: Absent \_\_\_\_\_, Few \_\_\_\_\_, Moderate \_\_\_\_\_, Abundant \_\_\_\_\_

Presence of Lianas: Absent \_\_\_\_\_, Few \_\_\_\_\_, Moderate \_\_\_\_\_, Abundant \_\_\_\_\_

Presence of Epiphytes: Absent \_\_\_\_\_, Few \_\_\_\_\_, Moderate \_\_\_\_\_, Abundant \_\_\_\_\_

Presence of Palms: Absent \_\_\_\_\_, Few \_\_\_\_\_, Moderate \_\_\_\_\_, Abundant \_\_\_\_\_

Presence of Succulents: Absent \_\_\_\_\_, Few \_\_\_\_\_, Moderate \_\_\_\_\_, Abundant \_\_\_\_\_

Presence of Others: \_\_\_\_\_ Absent \_\_\_\_\_, Few \_\_\_\_\_, Moderate \_\_\_\_\_, Abundant \_\_\_\_\_

**PRESENCE OF MANAGED SPECIES** (agriculture, agroforestry, plantation): Number of managed species (inc. planted)

Sci. Name (Family/Genus/Species): \_\_\_\_\_ Common Name: \_\_\_\_\_

Density: Absent \_\_\_\_\_, Few \_\_\_\_\_, Moderate \_\_\_\_\_, Abundant \_\_\_\_\_

Sci. Name (Family/Genus/Species): \_\_\_\_\_ Common Name: \_\_\_\_\_

Density: Absent \_\_\_\_\_, Few \_\_\_\_\_, Moderate \_\_\_\_\_, Abundant \_\_\_\_\_

Other Observations: \_\_\_\_\_

**LAND-USE HISTORY** (Fill out as far back in time as possible, recording dates of change to forest, pasture, crop, orchard, etc.):

Time period (mm/yr) Land-cover /Land-use Informant: \_\_\_\_\_

\_\_\_\_ / \_\_\_\_ - present \_\_\_\_\_

\_\_\_\_ / \_\_\_\_ - \_\_\_\_ / \_\_\_\_\_

\_\_\_\_ / \_\_\_\_ - \_\_\_\_ / \_\_\_\_\_

**GENERAL OBSERVATIONS:** Elevation (Altimeter reading in meters above sea level): \_\_\_\_\_

**SOIL PROPERTIES:** Color: \_\_\_\_\_ Type: \_\_\_\_\_ Nepali name : \_\_\_\_\_

**WATER DRAINAGE AND AVAILABILITY:** \_\_\_\_\_

**CROP-ROTATION** (if applicable): \_\_\_\_\_

**MIXED CROPS** (Dominant ones): 1<sup>st</sup> \_\_\_\_\_ 2<sup>nd</sup> \_\_\_\_\_ 3<sup>rd</sup> \_\_\_\_\_

Comments on agriculture/cultivated land: \_\_\_\_\_

**SEASONAL CHANGE AFFECTS LAND-USE OR LAND-COVER:** No \_\_\_\_\_ Yes \_\_\_\_\_ If yes, explain: \_\_\_\_\_

**TRAINING SAMPLE MARKED ON IMAGE PRODUCTS:** No \_\_\_\_\_ Yes \_\_\_\_\_ If no, explain: \_\_\_\_\_

**SLIDES:** CF card name \_\_\_\_\_ File name/no. \_\_\_\_\_ Exposures # / direction (N, S, E, W, sky, ground): \_\_\_\_\_

### Soil Classification (Local vs. Scientific) Reference Guide

Local Name	USDA Texture
Pango	Silty loam/silt
Balaute	Sand
Domat	Loam
Balaute domat	Sandy loam
Balaute chimte	Sandy clay loam
Domat chimte	Clay loam
Chimte	Very fine clay
Masino	Fine
Gagren	Gravelly
KhasroPango	

**MILAN SHRESTHA - HOUSEHOLD SURVEY FORM (2004-2005)**

Registration Number:      (village/ward/household/gender)

Interview Date: \_\_\_/\_\_\_ (mm/dd) Follow up: \_\_\_\_\_ (Y/N) Record Start Time: \_\_:\_\_\_ (hh:mm)

Name of Respondent: \_\_\_\_\_ Age: \_\_\_\_\_ Household Head: \_\_\_\_\_

Location: Coordinates ( \_\_\_\_\_ , \_\_\_\_\_ ) (records from GPS)

**Section A. Household Composition, Labor Force, and Livelihood**

A1. Household size (no.): \_\_\_\_\_ A2. How many? Male: \_\_\_\_\_ Female: \_\_\_\_\_ A3. No. of children: \_\_\_\_\_

(Code Occupation: 1. agriculture 2. Gorkha/Arab 3. craftsman 4. trade 5. Factory/office employee 6. wage labor 7. Other: \_\_\_\_\_)

A4. Primary occupation of the household head: \_\_\_/\_\_\_ A5. Secondary occupation: \_\_\_/\_\_\_

A6. Is anyone employed (*Jaagir, Gorkha Sainik, India, or Arab*) outside of the village? 1. Yes 0. No

A7. What kind of job is it? \_\_\_\_\_ / (use the above occupation code)

↓  
Go to A8

A8. Labor force and variation over the years

Labor force for agriculture, livestock, fuelwood, and home building/repair (No. of individuals)	A. Actual no. of individuals in 2004	B. 1994 (10 years ago) was 1. Larger 2. Smaller 3. The same to 2004 97. I don't know/remember 98. Not applicable	C. 1984 (20 years ago) 1. Larger 2. Smaller 3. The same to 2004 97. I don't know/remember 98. Not applicable
8.1 No. of people living in the household			
8.2 No. of paid wage labor used in the household			
8.3 No. of village help used			
8.4 No. of people employed outside of the village			

8.5 Where do the paid labors (wage labor) come from?

1. From the village and/or neighboring villages  
2. From elsewhere, inside the district mostly  
97. Don't know  
3. From elsewhere, from other districts  
98. Not applicable (N/A)

8.6 The type of help you get within village

1. Relatives 2. *Nogar* 3. *Parma* 4. *Aama Samuha* 5. Others \_\_\_\_\_

8.7 If anyone of your family member is employed outside, where is that?

1. Lamjung 2. Pokhara/Kathmandu 4. India 5. Arab 6. Others \_\_\_\_\_

A9. What is the main reason for seeking employment outside?

1. Farming alone cannot support 2. Very good income 3. Insecurity in village  
4. Increased cash needs for family 5. Attractive lifestyle 6. others \_\_\_\_\_ 98. Not applicable \_\_\_\_\_

## Section B. Farming, Land-use Portfolio, and Land Holding

Now, let's talk about your farming activities.

B1. Does your household do any farming?  1. Yes  0. No →

B2. On how many sites (*Thaun*) or parcels (*Tukra*) of farmland does your household farm?

1	2	3	4	5	6	7	8 and more
---	---	---	---	---	---	---	------------

B3. *Baari*

3.1 Do you have any *Baari* (rainfed land)?

<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No	→	<input type="button" value="Go to B4"/>
---------------------------------	--------------------------------	---	---

3.2 How much *Baari* do you farm?

*Ropani* \_\_\_\_\_ *Hal* \_\_\_\_\_ (Convert to hectare: \_\_\_\_\_)

3.3 How much *Baari* do you own?

*Ropani* \_\_\_\_\_ *Hal* \_\_\_\_\_ (Convert to hectare: \_\_\_\_\_)

3.4 Does your household own the land, is it sharecropped, is it mortgaged, is it on contract to you, are you the tenant of the land, or are there some other arrangements? (**mark all that apply**)

1. Own    2. Share crop (*Adhiya*)    3. Mortgage (*Dhito*)    4. Contract    5. Tenant farm  
6. *Ailani*    7. *Khoria*    97. Others (specify) \_\_\_\_\_

3.5 What are the **most preferred** crops, fruits, or vegetables that you grow in *Baari*?

1. \_\_\_\_\_    2. \_\_\_\_\_    3. \_\_\_\_\_  
4. \_\_\_\_\_    5. \_\_\_\_\_

B4. *Khet*

4.1 Do you farm any *Khet* (irrigated land)?

<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No	→	<input type="button" value="Go to B7"/>
---------------------------------	--------------------------------	---	---

4.2 How much *Khet* do you farm?

*Ropani* \_\_\_\_\_ *Hal* \_\_\_\_\_ (Convert to hectare: \_\_\_\_\_)

4.3 How much *Khet* do you own?

*Ropani* \_\_\_\_\_ *Hal* \_\_\_\_\_ (Convert to hectare: \_\_\_\_\_)

4.4 Does your household own the land, is it sharecropped, is it mortgaged, is it on contract to you, are you the tenant of the land, or are there some other arrangements? (mark all that apply)

1. Own    2. Share cropping    3. Mortgage (*Dhito*)    4. Contract    5. Tenant farm  
6. *Ailani*    7. *Khoria*    97. Others (specify) \_\_\_\_\_

4.5 Can any of the parcels of *khet* be irrigated (*sinchai garna milne khet*)?

<input type="checkbox"/> 1. Yes	<input type="checkbox"/> 0. No	→	<input type="button" value="Go to B5"/>
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4.6 How much *khet* can be irrigated?

*Ropani* \_\_\_\_\_ *Hal* \_\_\_\_\_ (convert to hectare: \_\_\_\_\_)



B15. For how many months do you usually keep the land fallow (*Banjho*)?

1	2	3	4	5	6 and more
---	---	---	---	---	------------

B16. Has the fallow period increased in the last 20 years or so?

1. Increased    2. Decreased    3. Same    97. Don't know    98. Not applicable

B17. Are you using the land that you are currently not farming for any other activities?

1. Yes	0. No	→	Go to B19
--------	-------	---	-----------

B18. For what other activities are you using this land?

1. \_\_\_\_\_    2. \_\_\_\_\_    3. \_\_\_\_\_    4. \_\_\_\_\_

B19. Compared to 20 years ago, do you think **crop production** has increased, decreased, or stayed same?

1. Increased	2. Decreased	3. Same	98. Don't know
	↓	↓	↓
	Go to B22	Go to B24	Go to B24

B20. Do you think that production has increased a little, **increased** somewhat, or increased a lot?

1. A little    2. Increased somewhat    3. Increased a lot

B21. What, in your opinion, are the reasons for this increase in production? (Check all that apply)

1. Use of a new variety of crops	2. Better irrigation facilities
3. More favorable weather	4. Less insects and diseases
5. Improved agricultural tools	6. Application of more manure ( <i>Prangaric Mal</i> )
7. Applied more chemical fertilizer	97. Others (specify) _____

↓

Go to B24
-----------

B22. Do you think that production has **decreased** a little, somewhat, or a lot?

1. A Little    2. Somewhat    3. A lot

B23. In your opinion, what are the reasons for this **decrease** in production? (Check all that apply)

1. No irrigation facility	2. Excess water
3. Unfavorable weather	4. Insects and diseases
5. Not enough manure	6. Application of excess chemical fertilizer
7. Poor quality manure	8. Deterioration of soil quality
9. Poor management	97. Others (specify) _____

B24. Interviewer's checkpoint:

## Section C. Livestock

Now I'd like to ask you some questions about livestock, poultry and pastureland.

C1. Does your household raise chickens (*Kukhura*) or ducks (*Haans*)?

1. Yes	0. No	→	Go to C4
--------	-------	---	----------

C2. How many chickens does your household have?

0. None      Number \_\_\_\_\_

C3. How many ducks does your household have?

0. None      Number \_\_\_\_\_

C4. Does your household raise other livestock (*Pashu*)?

1. Yes	0. No	→	Go to D1
--------	-------	---	----------

C5. How many bullocks (*Goru*) does your household have?

0. None      Number \_\_\_\_\_

C6. How many cows (*Gai*) does your household have?

0. None      Number \_\_\_\_\_

C7. How many male buffaloes (*Raangaa*) does your household have?

0. None      Number \_\_\_\_\_

C8. How many female buffaloes (*Bhainshi*) does your household have?

0. None      Number \_\_\_\_\_

C9. How many sheep (*Bhenda*) and goats (*Bakhra*) does your household have?

0. None      Number \_\_\_\_\_

C10. How many pigs (*Sungur* or *Bangur*) does your household have?

0. None      Number \_\_\_\_\_

C11. Does your household have any other farm animals other than mentioned above?

1. Yes	0. No	→	Go to C13
--------	-------	---	-----------

C12. What other farm animals have you raised?

Type \_\_\_\_\_      Number \_\_\_\_\_

Type \_\_\_\_\_      Number \_\_\_\_\_

Type \_\_\_\_\_      Number \_\_\_\_\_

Type \_\_\_\_\_      Number \_\_\_\_\_

C13. How do you store manure (*Gobar Mal*)?

1. Pit (*Khaadal*) 2. Pile (*Thupro*) 3. Both (*Dubai*) 97. Other (Specify) \_\_\_\_\_

C14. Do you stall feed or graze your livestock?

1. Stall feed ( <i>Badhuwa</i> )	2. Graze ( <i>Charuwa</i> )	3. Both
----------------------------------	-----------------------------	---------

↓

Go to C18

C15. Where do you usually graze (*charauane*) your livestock?

1. Farm land    2. Common land    3. Forest    4. *Kharka*    97. Other (Specify)\_\_\_

C16. How do you obtain the fodder (*paraal, ghans* and *dale ghans*) needed to feed your livestock? Do you buy all of it, more than half of it, half of it, less than half of it, or none of it?

1. All of it    2. More than half of it    3. Half of it  
4. Less than half of it    5. None of it

C17. Where do you usually go to collect fodder? Do you go to farm land, common land, forest, or some other place?

1. Farm land    2. Common land    3. Forest    97. Other (Specify) \_\_\_\_\_

C18. Now, let's talk about the household members who collect fodder. Do children from your household who are younger than 15 years old collect fodder?

1. Yes	0. No	→	Go to C20
--------	-------	---	-----------

C19. How many **children** from your household under the age of 15 collect fodder?

Number \_\_\_\_\_

C20. Do women from your household collect fodder?

1. Yes	0. No	→	Go to C22
--------	-------	---	-----------

C21. How many **women** from your household collect fodder?

Number \_\_\_\_\_

C22. Do men from your household collect fodder ?

1. Yes	0. No	→	Go to C24
--------	-------	---	-----------

C23. How many **men** from your household collect fodder?

Number \_\_\_\_\_

C24. How long does it take to travel to the place where the fodder is, collect it, and then bring it home?

Time \_\_\_\_\_ (approximate hours and minutes)

C25. Did you ever send your cattle or sheep to *Kharka* or *Bhendi Goth*?

1. Yes	0. No	→	Go to D1
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C26. How many months did you send your cattle or sheep to *Kharka* or *Bhendi Goth*?

Months (specify) \_\_\_\_\_ (From \_\_\_\_\_ to \_\_\_\_\_ )

## Section D. Land-use Change, Agricultural Intensification, and Forests

D1. Can you tell us for each type of field you cultivated in the following years: the area (in *ropani/hal*) and the distance from your house (in minutes).

Field	Distance	A. 2004	B. 1994	C. 1984
1.1 <i>Khet</i>	1.1.1 Area			
	1.1.2 Distance			
	1.1.3 Area			
	1.1.4 Distace			
	1.2.2 Distance			
1.2 <i>Baari</i>	1.3.1 Area			
	1.3.2 Distance			
1.3 <i>Bagaincha</i>	1.4.1 Area			
	1.4.2 Distance			

D2. What is the difference in the size of the areas that you have used for the following crops between 1994 and 2004 (10 years ago)? And also between 1984 and 1994 (20 years ago)?

D2. Crop	A. 2004 area is (compared to 1994)	B. 1994 area is (to 1984)
	1. Larger 2. Smaller 3. Same 4. Crop not cultivated in these two years 97. I don't know 98. Not applicable	1. Larger 2. Smaller 3. Same compared to 1994 4. Crop not cultivated in these two years 97. I don't know 98. Not applicable
2.1. Irrigated rice and wheat		
2.2. Upland rice ( <i>Ghaiya</i> )		
2.3. Fruits and tree crops		
2.4. <i>Baari</i> crops (maize, bean, lentil, cowpea, ginger, bean, soybean, buckwheat, barley, potato, ginger, etc)		
2.5. <i>Khoria</i> and <i>khar Baari</i>		
2.6. Abandoned ( <i>Banjho jagga</i> )		

D3. Is there a change in the number of harvests you can get in one year? (Comparing now to 1984)

D3. Crop	Change in frequency
3.1 Irrigated field ( <i>Khet</i> )	
3.2 Non-irrigated upland ( <i>paakho</i> )	
3.3 <i>Baari</i>	
3.4 Orchard (fruit and tree plantation)	

Code for answer: 1. One harvest more    2. One harvest less    3. same number

D4. Since February (*Maagh mahina*) last year, did you buy any seeds?

1. Yes	0. No	→	Go to D7
--------	-------	---	----------

D5. For which crops did you buy seeds? (Please use Appendix I for crop codes)

1. \_\_\_\_\_ 2. \_\_\_\_\_  
3. \_\_\_\_\_ 4. \_\_\_\_\_

D6. Where did you acquire the seeds?

1. Town centers (Markets) 2. Extension (NGO, JTA, etc.) 3. Neighbors  
4. Relatives 5. Other neighboring villages 6. Others (specify) \_\_\_\_\_

D7. Did you save seeds (*Biu jogaune*)?

1. Yes  0. No  → Go to D10

D8. For which crops did you save seeds? (Please use Appendix I for crop codes)

1. \_\_\_\_\_ 2. \_\_\_\_\_  
3. \_\_\_\_\_ 4. \_\_\_\_\_  
5. \_\_\_\_\_ 6. \_\_\_\_\_

D9. How did you borrow the seeds from?

1. Borrowed from relatives 2. Natal home (*Maiti*) 3. Neighbors  
4. Other neighboring villages 5. Extension agents 6. Others (specify) \_\_\_\_\_

D10. Could you tell us whether you used the following inputs for cultivation (i.e., *Bishadi*) in the years mentioned? To answer yes, you must use it at least for all your production of one crop.

Use of Inputs	A. 2004	B. 1994	C. 1984
10.1 Fertilizer			
10.2 Herbicides ( <i>ghans</i> )			
10.3 Insecticides ( <i>kira</i> )			
10.4 Fungicides ( <i>rog</i> )			

Code of answer = 1. Yes 0. No 97. Don't know/remember 98. Not applicable

D11. Crop Rotations (*Baali Chakra*): How many types of crops you grow in the following fields? Please mention what are the crops you grow for those years. (Please use Appendix I for crop codes)

Field	A. How many harvest per year (1, 2, or 3 <i>baali</i> )?	B . 2004 (crops-crops)	C. 1994 (crops-crops,)	D. 1984 (crops-crops)
11.1 <i>Khet</i>				
11.3 <i>Baari</i>				
11.4 <i>Bagaincha</i>				

D12. Which of the following markets do you usually go to? Name one.

1. Besishahar 2. Bhote Wodhar 3. Dumre  
4. Kathmandu 5. Pokahra 6. other (specify) \_\_\_\_\_

D13. Forest dependence: Which is the main use of forest for your household?

1. Bedding material 2. Fuelwood 3. Fodder 4. Timber  
5. Medicinal plants 6. Roofing material 7. Others (specify) \_\_\_\_\_

D14. Are you a member of local community forest management committee?

1. Yes 0. No

D15. In your opinion, has the forest cover increased over the last 10 years in the village?

1. Yes	0. No	→	Go to D17
--------	-------	---	-----------

D16. What is the main reason do you think contributed to increased coverage?

1. \_\_\_\_\_ 2. \_\_\_\_\_

D17. What is the main reason do you think contributed to decreased coverage?

1. \_\_\_\_\_ 2. \_\_\_\_\_

D18 Which kinds of diseases, insects, birds or rats attacked your paddy, maize, wheat, or mustard fields?

- 0 None      1. Disease      2. Insects      3. Birds  
4. Rodents      5. Wild Animals      97. others \_\_\_\_\_

So far we have talked about different aspects of your household. Thinking now about everything we talked about, what would you say are the **three main problems** facing your community?

1. \_\_\_\_\_ 2. \_\_\_\_\_ 3. \_\_\_\_\_

**Thank you very much for your time and cooperation! The information that you provided is very useful, valuable, and important. We hope to come again and obtain more information from you at a later date. Namaste !**

**Exact time now:** \_\_\_\_:\_\_\_\_ (HH:MM)

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### Section E: To Be Filled by the Interviewer

For the interviewer: Answer the following questions based on your own observations.

H1 In what kind of house does the respondent live?

1. Single-family house      2. Multi-family house

H2 How many stories are there in the house in which the respondent lives?

1. One story      2. Two stories      3. Three stories or more

H3 Of what materials are the **walls** of the respondent's house made?

1. Brick      2. Cement/concrete      3. Cane w/ mud  
4. Stone      5. Wood shakes      6. Mud  
97. Other(Specify) \_\_\_\_\_

H4 Of what materials is the roof of the respondent's house made?

1. Tin      2. Thatch (*Phoos*)      3. Thatch stick (*khapptiyeko*)  
4. Stone/slate      5. Wooden plank      6. Plastic  
7. Concrete      97. Other(Specify) \_\_\_\_\_

H5 Of what materials is the **floor** of the respondent's house made?

1. Mud      2. Wood      3. Concrete/cement  
4. Brick      97. Other(Specify)

## Index I: List of Crops and Their Codes to be Used in the Questionnaire

Crops	Code	Crops	Code	Crops	Code
<b>Cereals</b>		<b>Vegetables</b>		<b>Fruit and Cash Crops</b>	
Rice	11	Crucifere ( <i>Gobhi</i> )	31	Banana	51
Maize	12	Gourd ( <i>Lahare phal</i> )	32	Fiber crops ( <i>Jute</i> )	52
Wheat	13	Cucurbits ( <i>Kakro</i> )	33	Citrus ( <i>Suntala, Kagati</i> )	53
Finger Millet ( <i>Kodo</i> )	14	Solanácea ( <i>Gaano</i> )	34	Tobacco ( <i>Surti</i> )	54
Buckwheat ( <i>Jau</i> )	15	Radish ( <i>Mula</i> )	35	Other fruits/cash	55
Barley ( <i>Phapar</i> )	16	Greens ( <i>raayo, tori, etc.</i> )	36	<b>Bulb Crops</b>	
<i>Ghaiya Dhan</i>	17	Okra ( <i>Bhindi</i> )	37	Potato ( <i>Aaloo</i> )	61
Grass Crop ( <i>Bikashé</i> )	18	Unspecified vegetables	38	Onion ( <i>Pyaj</i> )	62
<b>Pulses</b>		<b>Oil Crops</b>		Garlic ( <i>Lasun</i> )	63
Soybean ( <i>Bhatmas</i> )	21	Mustard/Rape ( <i>Tori</i> )	41	Ginger ( <i>Aduwa</i> )	64
Cowpea ( <i>Bodi</i> )	22	Sesame ( <i>Teel</i> )	42	Turmeric ( <i>Besar</i> )	65
Bean ( <i>Simi</i> )	23	Linseed ( <i>Aalas</i> )	43	Colacasia/Yam ( <i>Tarul</i> )	66
Pea ( <i>Kerau</i> )	24	Other oil crop	44	Other Bulb Crops	67
Lentil/Lathyrus ( <i>Maas</i> )	25			Other crops than above	68
<i>Boda</i>	26				
<i>Kamuno</i>	19				

**Mixed crops (more then one crop planting together at the same time),**

Crops	Code	Crops	Code	Crops	Code
<b>Usual cereal-based mixed crops</b>		<b>Usual Vegetal-based mixed crops</b>		<b>Usual Fruit/Cash crop based mixed crops</b>	
Maize + cowpea	71	Maize + cucurbits	81	Ginger + Banana	91
Maize + soybean	72	Maize + vegetables	82	Ginger + Citrus	92
Maize + lentil	73	potato + radish	83	Citrus + Banana	93
Wheat + lentil	74			<i>Sisoo</i>	94
Wheat + pea	75			<i>Chilaune, katus, uttis</i>	95
Rice + Soybean	76				
Rice + Lentil	77				
Finger Millet + Soybean	78				
Finger Millet + Lentil	79				
Others	80				

## APPENDIX H: FREELISTING RESULTS

Width of field: MIN  
 # of decimals: MIN  
 Rows to display: ALL  
 Columns to display: ALL  
 Row partition:  
 Column partition:  
 Input dataset: C:\APAC\CROPRESP

Order in which each item (column) appears in each person's (row) freelist.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32			
	RIC	MAI	MIL	BUC	POT	SOY	GIN	ORAL	ENBE	AP	EA	MUS	ONIG	ART	TUR	SESC	UCW	HEC	COW	GOUL	ENCR	UYAM	RAD	BANG	HAG	RELE	MOT	OKR	CHIO	IL					
1	1-2-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
2	2-2-2	2	3	1	0	4	7	0	0	6	11	0	10	9	0	0	0	0	5	8	12	0	0	0	0	0	0	0	0	0	0	0	0		
3	3-2-1	4	2	1	0	3	0	6	0	0	0	0	5	0	0	0	0	0	0	0	7	8	0	0	0	0	0	0	0	0	0	0	0		
4	4-1-1	1	3	5	0	2	4	7	0	0	0	0	0	0	0	0	0	0	8	0	0	0	6	0	0	0	0	0	0	0	0	0	0		
5	5-1-2	1	2	3	4	5	6	8	13	0	9	0	10	0	0	0	0	0	0	0	0	0	7	11	12	0	0	0	0	0	0	0	0		
6	6-1-1	2	3	0	0	1	0	5	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7	0	0	0	0	0		
7	7-2-2	1	2	3	0	4	0	9	5	0	11	0	0	7	0	0	0	0	12	0	0	0	10	0	0	0	0	6	8	0	0	0	0		
8	8-2-1	1	4	3	0	2	0	10	0	0	11	0	9	0	0	0	0	5	12	13	0	0	0	8	0	0	6	0	7	0	0	0	0		
9	9-1-1	2	1	3	0	4	0	5	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	10-1-2	3	1	2	0	5	0	0	0	0	0	0	7	4	0	0	0	0	0	0	8	0	0	6	0	0	0	0	0	0	0	0	0	0	
11	11-2-2	2	1	3	0	0	0	0	0	0	0	7	15	12	13	14	11	0	8	0	4	9	10	0	0	0	0	6	0	0	5	0	0	0	
12	12-2-1	1	2	3	0	4	0	8	0	0	0	0	0	0	10	0	0	0	0	0	5	0	6	0	0	0	0	0	0	0	0	0	7	9	
13	13-1-2	1	2	4	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	14-1-1	1	2	4	0	3	0	0	0	0	0	0	0	0	10	0	0	0	0	5	9	8	0	0	0	0	0	0	7	0	6	0	0	0	
15	15-1-2	1	3	2	0	5	0	7	0	0	0	0	8	0	0	0	0	0	0	6	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	16-1-2	2	3	1	0	4	0	0	0	0	6	0	5	0	0	0	0	0	11	0	8	0	0	10	0	0	7	0	0	9	0	0	0	0	0
17	17-1-2	2	1	3	4	7	0	12	15	0	13	0	0	8	0	0	0	10	0	0	11	6	0	5	14	0	0	16	0	0	0	0	0	0	0
18	18-1-1	2	1	3	0	4	0	0	0	0	0	0	7	0	0	0	0	0	0	0	5	0	0	0	0	0	6	0	0	0	0	0	0	0	0
19	19-1-2	3	1	2	0	6	0	5	0	0	0	0	0	0	7	0	0	0	0	0	4	0	0	0	0	0	8	0	0	0	0	0	0	0	0

- |              |             |               |               |               |
|--------------|-------------|---------------|---------------|---------------|
| 1. Rice      | 8. Orange   | 15. Turmeric  | 22. Crucifers | 29. Tomato    |
| 2. Maize     | 9. Pulses   | 16. Sesame    | 23. Yam       | 30. Okra      |
| 3. Millet    | 10. Bean    | 17. Cucumbers | 24. Radish    | 31. Chillies  |
| 4. Buckwheat | 11. Peas    | 18. Wheat     | 25. Banana    | 32. Oildseeds |
| 5. Potato    | 12. Mustard | 19. Cowpea    | 26. Ghaiya    |               |
| 6. Soybean   | 13. Onion   | 20. Gourds    | 27. Greens    |               |
| 7. Ginger    | 14. Garlic  | 21. Lentils   | 28. Lemons    |               |