

THESIS

CONNECTIVITY AND DISTANT DRIVERS OF LAND  
CHANGE: A CASE STUDY OF LAND USE, LAND COVER,  
AND LIVELIHOOD CHANGES IN QUANG TRI, VIETNAM

Submitted by

Eric Rounds

Department of Anthropology

In partial fulfillment of the requirements

For the Degree of Master of Arts

Colorado State University

For Collins, Colorado

Spring 2016

Master's Committee:

Advisor: Stephen Leisz

Melinda Laituri  
Kathleen Galvin

Copyright by Eric Rounds 2016

All Rights Reserved

## ABSTRACT

### CONNECTIVITY AND DISTANT DRIVERS OF LAND CHANGE: A CASE STUDY OF LAND USE, LAND COVER, AND LIVELIHOOD CHANGES IN QUANG TRI, VIETNAM

The urban lowland areas of Vietnam have been at the forefront of economic liberalization over the last 30 years, while the more remote mountainous areas of the country have lagged behind. Upland areas in the Northern and Central portions of Vietnam in particular remain largely impoverished and disconnected from broader national and regional markets. To address this economic inequality in the uplands, recent economic development efforts such as the East-West Economic Corridor (EWEC) have aimed at expanding road infrastructure to remote areas in Central Vietnam. This study examines the impact of road expansion in the EWEC on a single village in Quang Tri, Vietnam. It draws from social economic data gathered during fieldwork and a historical land cover analysis to address how land use, land cover, and livelihoods have changed in recent decades. Moreover, the paper discusses the distal and proximate drivers of these changes. Findings show that the improved road connectivity provided by new roads has facilitated the transmission of distant market-related drivers into the study area, and that these drivers have fostered significant changes in land use, land cover, and livelihoods.

## ACKNOWLEDGEMENTS

I would first like to thank my parents and my partner who have supported me in numerous ways over the last couple years. An immense amount of gratitude goes to my advisor Dr. Stephen Leisz of the Anthropology Department at Colorado State University, without whom this paper and the research it is based on would not be possible. Special thanks to the villagers we worked with in Quang Tri to conduct this research and my colleagues from the Hanoi University of Agriculture. I would also like to acknowledge the grant that funded my field work: Grant# NNX13AC51G; Funder/Program: NASA Land Use Land Cover Change Program; Title: Increased accessibility, landscape changes, rural transformations, and urbanization: Impacts of the east-west economic corridor from Da Nang, Vietnam, to Khon Kaen, Thailand-Progress Report.

## TABLE OF CONTENTS

Abstract.....	ii
Acknowledgements.....	iii
1. Introduction.....	1
1.1 Land Change Science.....	2
2. Background.....	7
2.1 Major Policy Changes.....	7
2.2 Ethnic Minorities in Vietnam.....	9
2.3 Economic Development in Quang Tri, Vietnam.....	12
3. Theoretical Frameworks.....	16
3.1 Von Thunen Land Use Model.....	16
3.2 Proximate and Underlying Drivers.....	17
3.3 Teleconnections & Telecouplings.....	19
4. Literature Review of LULCC in Southeast Asia and Vietnam.....	22
4.1 Swidden in Southeast Asia.....	22
4.2 Land Use and Land Cover Change in Vietnam.....	23
5. Methods.....	27
5.1 Structured Interviews: Household Surveys.....	27
5.2 Semi-structured Interviews.....	27
5.3 Historical Interviews.....	28
5.4 Ground Truth Points.....	29
5.5 Remote Sensing Land Cover Analysis.....	29
6. Results.....	32
6.1 Village History.....	32
6.2 Agricultural Land Use.....	35
6.3 Local Economy.....	39
6.4 Infrastructure, Mobility, and Interactions with Outside World.....	41
6.5 Land Cover Analysis.....	43
7. Discussion.....	50
7.1 Livelihood Changes and Drivers.....	50
7.2 Land Use/Cover Changes and Drivers.....	54
8. Conclusion.....	61
9. References.....	64
10. Appendix A.....	72
Appendix B.....	88
Appendix C.....	89

## **1. Introduction**

Vietnam has undergone drastic social and economic changes over the last 40 years. During the 1980s, the Vietnamese economy began transitioning from a state-based to a market-based economy in which property rights came closer to resembling a privatized system. While this quickly transformed Vietnam into a competitive exporter of agricultural products, the urban lowlands experienced the transition much differently than the rural areas in the lowlands and uplands. On the one hand, urban areas have been at the forefront of economic liberalization and growth. On the other hand, rural areas continue to be characterized by poverty, despite making significant contributions to agricultural production. Numerous legislative efforts aimed at reducing poverty within rural farming communities have produced mixed results, and many areas in the uplands of Vietnam, particularly those inhabited by ethnic minorities, remained disconnected to wider markets into the 2000s.

Recent efforts to reduce poverty in the uplands of Central Vietnam focus on integrating rural agrarian communities into national and international markets by expanding transportation infrastructure. To assess the impact of this strategy on Central Vietnamese villages, this paper presents a case study of one rural village in Quang Tri, Vietnam. The goal of the paper is to investigate the role that road connectivity plays in village livelihood system changes and land-use/cover changes. The hypothesis at the base of this study is that the construction of roads in the study area and the resulting connectivity afforded to villagers has facilitated significant changes in livelihoods, land use, and land cover within the last ten years. Key questions that are addressed by this investigation are: (1) how have livelihoods changed in recent decades?; (2) have there been significant shifts in land use and land cover?; and (3) what are the main drivers, distal and proximate, of change in the study area? The study integrates social-economic data and

land cover data derived from remotely sensed imagery to identify these changes and the variety of factors impacting these changes. The results and conclusions of this paper will contribute to the growing literature on land use and land cover change (LULCC) in Southeast Asia and to the broader study of the drivers of land-use/cover changes and livelihood system changes in the region.

## **1.1 Land Change Science**

Researchers in the early 1990s called for an interdisciplinary framework that would bring together diverse disciplines interested in the impact of land use on human and ecological systems. The new theoretical and methodological framework would integrate the interactions of populations, technologies, poverty, economic systems, and political structures in order to facilitate a global study that could compare land use and land cover changes (LULCC) at local to regional scales (Turner et al. 1994). The interest in LULCC studies intensified in large part due to the thorough documentation of the impacts of human land use on ecosystems and climate (Millennium Ecosystem Assessment 2005, Ramankutty & Foley 1999, and Ellis et al. 2010).

Recognizing the importance of human land use on broader environmental changes, NASA began funding the land cover and land use change program in the mid-90s to investigate the complex interactions of biophysical and socioeconomic factors that shape land use dynamics (Gutman et al. 2004). The interdisciplinary research group that was formed combined the expertise of natural scientists, social scientists, including geographers specializing in remote sensing interpretation and spatial analysis. The core objectives of this research program are (1) to gain a comprehensive understanding of land use and land cover processes; (2) to develop innovative ways to assess global land use and land cover patterns using satellite technologies; and (3) to improve modelling and forecasting capabilities that can account for human induced

land cover change as well as the impacts of those changes on broader human and ecological systems (Gutman et al. 2004). A rich literature has since developed that addresses the major trajectories of land use and land cover change as well as the drivers of these changes

Despite these efforts to unify LULCC research, land change scientists have written at great length about the challenges facing any sort of standardization of LULCC methods (Rindfuss et al. 2004, Geist & Lambin 2002). Many of these challenges revolve around the inherent difficulties involved in combining disparate data collection, methodological, and analytical approaches of the social, natural, and geographic information sciences (Rindfuss et al. 2004, Magliocca et al. 2015, and Van Vliet et al. 2016). Other issues relate to the appropriate selection of methods on a case by case basis and the minimization of uncertainty in results (Verburg et al. 2010). Accordingly, NASA's LULCC programs divide up research by region, meaning the methods and analytical frameworks are formulated to fit the specific geographic, social, political, and economic context of that region.

Methods, like the researchers employing them, are necessarily diverse in LULCC studies. One common thread is that studies require a contextual understanding of the social, political, and economic history of the study population(s). However, many studies integrate methods from both the social and natural sciences to study the local-scale interactions between local populations and changes in land use and land cover. Researchers frequently use social science techniques to conduct interviews with land owners or local government officials who are best aware of the local forces at play. Interviews are intended to build a greater understanding of why a particular type of land use change occurred and what political, economic, or social factors could have influenced the outcome. Conversely, the natural sciences provide avenues to investigate changes in climate, biodiversity, the water cycle, the ecological system, and CO<sub>2</sub> emissions.



Researchers are also interested in taking local land use dynamics and extrapolating the results to a regional scale, where broader conclusions can be made about global impacts and processes of LULCC. To do this, computationally intensive remote sensing as well as spatial and non-spatial modelling methods have been advanced to identify past land cover changes and to predict future alterations of the Earth's surface. The USGS Landsat program offers a time-series of global Landsat imagery that dates back to the 1970s, providing 60 m (Multispectral Scanner data) and 30 m (Thematic Mapper [TM]) resolution data, making it possible to quantify historical changes in land cover using spatial analysis and remote sensing methods. Many studies have combined analyses of this historical land cover data with land use studies carried out in the field that provide information on the causes of land use changes (Walsh et al. 2004, Leisz 2005, Ostrom 2006, Fox 2009). Land use modelling, which is increasingly aimed at modelling the drivers of land use change, has proven very useful for understanding how linked human and ecological systems can be impacted by various perturbations (Veldkamp & Lambin 2001 and Verburg et al. 2004). As these model, geographic information systems (GIS), and remote sensing technologies continue to develop and become more readily available, researchers of LULCC will continue to find innovative ways to incorporate them into interdisciplinary research.

Analytical frameworks presented by LULCC researchers largely center on issues related to identifying the drivers, or causes, of land use and land cover change. The frameworks used to analyze these drivers have become increasingly complex in an attempt to account for economic globalization and technological advancements in transportation that have made it possible for places of production and consumption to be located further apart (Lambin & Meyfroidt 2011). A studies' scale can therefore be of the utmost importance. Looking at forest loss from a local scale might suggest a transition towards forest protection. However, investigating it from a regional or

international scale might lead to a different understanding of the issues, such as revealing that forest gain in one area is counter balanced by comparative forest loss in another area dislocated from the place of regrowth (Meyfroidt et al. 2013 & Walker 2012). Furthermore, primary trajectories of land use change (e.g. tropical deforestation, agricultural intensification, urbanization, etc.) cannot be explained in simple universal terms; location dependent factors such as local and regional economies, institutions, constraints on land use, individual and societal responses to markets, and government policies must all be considered as potentially playing a role in land use changes (Friis & Nielsen 2014, Lambin et al. 2001, Seto et al. 2012).

To account for the complexity of drivers influencing the study area this paper will utilize several theoretical frameworks prevalent in land change literature. Von Thunen (1966) provides one of the earliest means of analyzing agricultural land use with his idea of land rent and the importance of the relative distance to market. Geist & Lambin (2002) apply another framework that utilizes the concepts of proximate and underlying drivers of change to differentiate between direct drivers and the more opaque drivers that influence land use indirectly. Finally, the concepts of teleconnections and telecoupling are employed to account for drivers affecting land use and land cover change from a great geographic distance (Seto et al. 2011, Eakin et al. 2014, Liu et al. 2014).

To examine land use and livelihood changes within the context of the Central Vietnamese village studied, this paper provides historical background information on recent shifts in Vietnamese land laws and economic systems. The role of ethnic minorities in historical land management and broader politics is also addressed, as the study population is one of numerous ethnic minority groups in Vietnam. Finally, recent development efforts within Quang Tri

Province will be presented in an effort to shed light on some of the economic development forces influencing the study area.

## **2. Background**

### **2.1 Major Policy Changes**

Following the second Indochina war, known in the United States as the “Vietnam War”, all modes of farming and production within Vietnam were enveloped by collectivization policies that gave the state total control over the production and distribution of goods. Collectivization had a detrimental effect on food supplies and ultimately had devastating social and economic consequences (Castella et al. 2002).

To address related economic and livelihood issues, the Vietnamese government implemented a series of laws starting in the 1980s that incrementally shifted land rights to individual households. The 1988 Land Law permitted the contracting of lands to individuals for long-term management, and allowed those entrusted with the land to sell the fruits of their labor. The 1993 Land Law further privatized land use rights by granting five rights to the individual land holder: the rights to lease land, mortgage land, repurpose land, transfer land to others, and transfer land as an inheritance (Liljestrom et al. 1998). These national policies that were applied to the lowlands, delta areas, and the uplands (Table 1) put Vietnam on the path to economic liberalization and facilitated the transition towards a market economy.

A number of laws directly addressed land use rights in relation to forests, some of which are listed in Table 1. The objectives of these policies center on several key themes: forest protection, reforestation, and the devolution of management rights. Another primary objective of these policies was to sedentarize shifting cultivators who the State saw as degrading forests throughout the uplands (Castella et al. 2006).

*Table 1. Government policies and programs in the uplands and their objectives since 1983 (Leisz et al. 2007)*

Year	Government policies/programs	Objectives and implementing body
1983	Directives 29/7CP	Allocation of forest land not only to forest enterprises and cooperatives, but also to farm households
1986	Decision no. 1171/QD	Management regimes of production, protection, and special use forest
1988	Land reform [(Doi Moi)]	Allocation of agricultural land directly to land users
1990	Decision 72—HDNT	Socio-economic development program in the uplands
1991	Forest Law	Law on forest protection and management
1992	327 program	Regreening barren hills and making use of wasteland
1992	1586/QDUB	The province policy on forest management renovation in state owned farms and forest enterprises
1994	Resolution no. 02/CP	Forestland allocation for forestry purposes
1995	Resolution no. 01/CP	Allocation of contract land for agriculture, forestry, and aquaculture
1998	661 program	Reforestation of 5 million ha. during the period: 2000-2010
1999	Decision 245/TTg	State management of forest with recognition of the role of communes
1999	Circular letter 56/1999/TT/BNN-KL	Guidance reagreements for protecting and developing forest in native hamlet communities
2001	Direction 52/2001/CT/BNN-KL	To promote local groups and local people's participation in forest protection and development activities
2001	Determination 178/2001/QD TTg	Allow local people to collect NTFPs except for those noted on the protected species list
2004	Determination 04/2004/QD-BNN-LN	Regulating the exploitation of timber and other forest products

These changes in Vietnam's land policy led to significant increases in production nationwide, with national agricultural output increasing 6.7% annually between 1994 and 1999 and then by 4.6% from 2000 to 2003 (Macaulay et al. 2006). As of 2010, the incidence of poverty was 27.0 % in rural areas compared to 6.0% in urban areas (World Bank 2012). The regions with the highest incidence of poverty were, in descending order, the Northwest Mountains (60.1%), the Northeast Mountains (37.7%), Central Highlands (32.8%), and the North Central Coast (28.4%)—where the study area is located— (World Bank 2012). These statistics speak to some of the remaining issues confronting economic development efforts in Vietnam,

many of which revolve around integrating rural communities, especially ethnic minorities, into current market economies. The regional statistics also show that the region containing the case study presented here, the North Central Coast, is among the poorest in the country.

A new Land Law that was put into effect in July of 2014 made no significant alterations to the basic principles of Vietnamese land use rights, but did address differences between foreign and domestic enterprises in Vietnam. This 2014 Land Law expanded the rights of foreign investors, or foreign invested enterprises (FIEs), providing equal means of leasing land from the state and paying for those land use rights (Allens 2014). Such provisions are intended to facilitate a smoother and more equitable process of land leasing that would ideally encourage the expansion of domestic and foreign investment. However, at the same time, these provisions maintain the Vietnamese government's dominion over land use rights and land prices in particular, as the new Land Law permits for the case-by-case assessment of land prices (Nguyen 2014).

## **2.2 Ethnic Minorities in Vietnam**

Although the policies overviewed in the preceding section helped stimulate national economic growth, the mountainous regions of Vietnam did not experience the same benefits as the urban and delta regions in the north and south (Liljestrom et al. 1998, Minot 2002). This is true despite efforts by the Vietnamese government, international development organizations, and NGOs to specifically aim programs and projects at these upland populations in the 1980s and 1990s (Jamieson 1998).

The Socioeconomic Atlas of Vietnam (1999) offers a unique look at relative location and overlap of factors such as elevation (Epprecht & Heinemann 2004, p.41), transportation networks (p.39), population density (p.47), incidence of poverty (p.155), and accessibility to urban areas

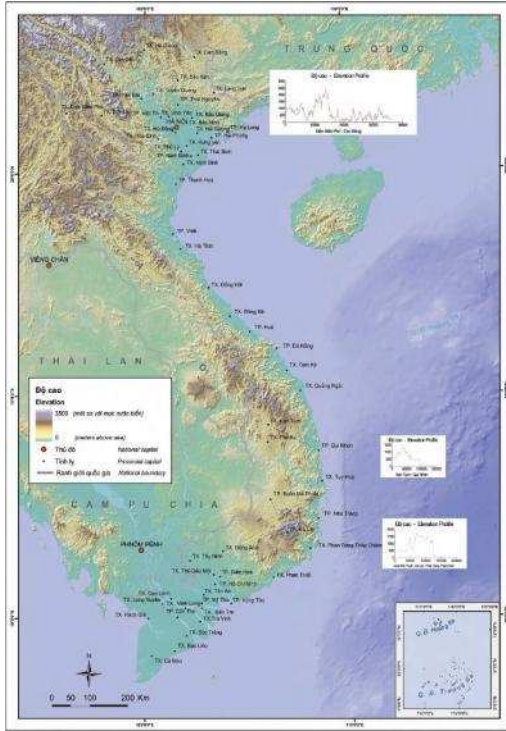


Figure 1: Elevation in Vietnam

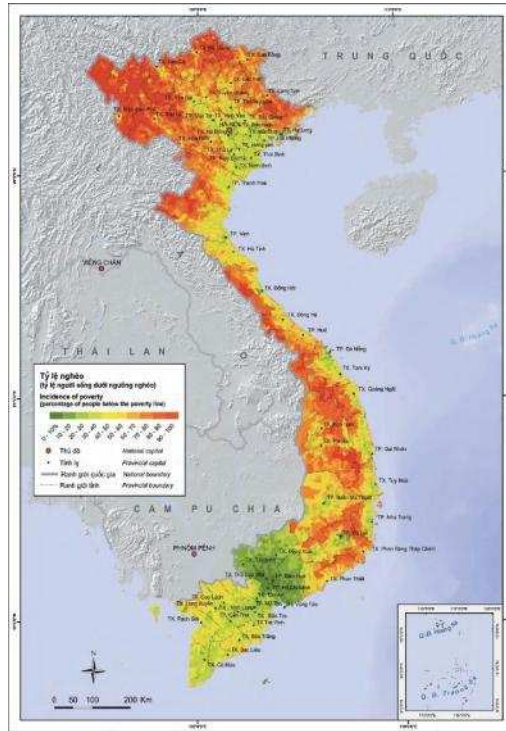


Figure 2: Incidence of Poverty in Vietnam

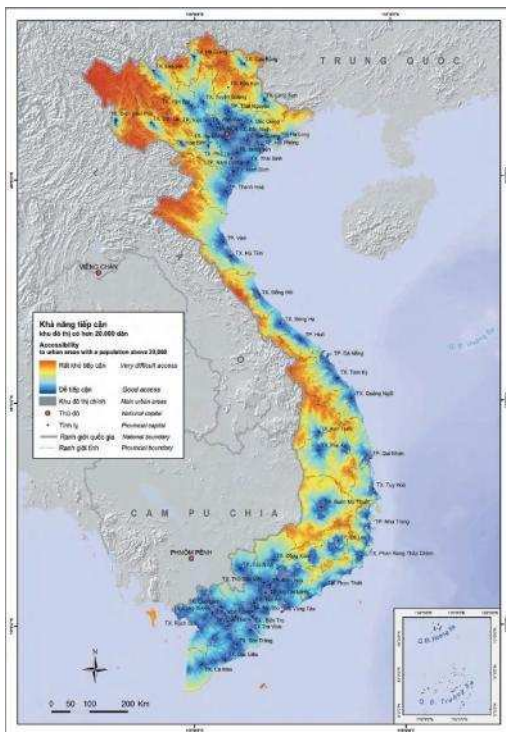


Figure 3: Accessibility to Urban Areas with Populations Above 20,000

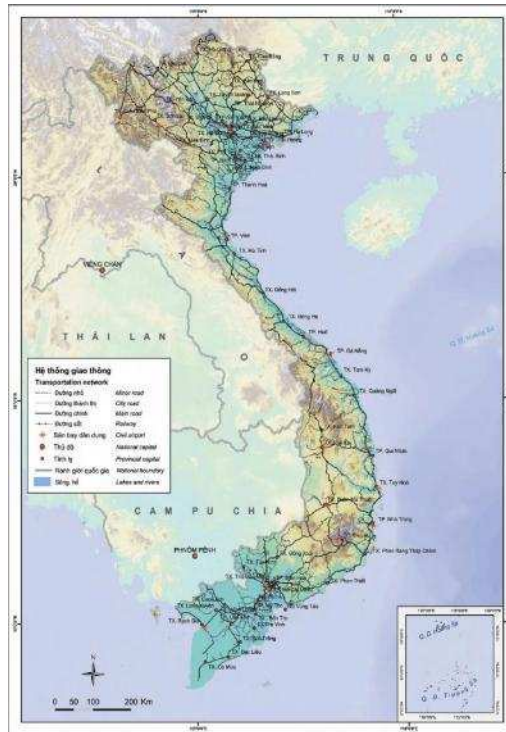


Figure 4: Transportation Networks in Vietnam

(p.159). Though these maps (Figures 1-4) are based on census data gathered in the 90s, they provide valuable information pertaining to the disadvantages experienced by upland areas of the country. They clearly show a correlation between regions of higher elevation and areas that experience higher incidence of poverty, have sparse transportation networks, and limited accessibility to urban areas.

To better understand the disparity between lowland and upland areas in Vietnam, it is important to acknowledge the interaction of ethnicity and agricultural practices in Vietnam's political and social history. The delta regions are dominated by intensive irrigated rice agriculture and urban areas that contain the majority of the nation's population, which is comprised primarily of the ethnic Kinh majority. However, the upland areas are home to many of the countries' ethnic minority groups who traditionally practice shifting or swidden agriculture on mountain and hill slopes.

Ethnic minorities in Vietnam have long been subject to negative ethnocentric beliefs regarding their agricultural practices and livelihoods. Since the colonial era, ethnographic descriptions have served to differentiate between "modern" lowlanders and "more primitive" uplanders, effectively portraying upland people as representations of early stages of societal evolution (Sowerwine 2011). This view was influenced in part by the Marxist inspired idea that swidden agriculture, the primary mode of agriculture in the uplands, was somehow emblematic of an earlier stage of human development (Jameison 1991, Rambo 1995). Cartography also played a part in establishing the lowland-upland dichotomy by linking social and land use differences with elevation, while forestry acted as a mechanism to exert state authority over upland territories that were viewed as predominantly forested and otherwise barren (Sowerwine 2011).



Jamieson (1998) argues that popular misconceptions of the uplands as “remote, empty, and exotic” (Jamieson 1998, p.2) fueled previous national development efforts that imposed lowland ideals and practices on upland communities. Resulting national efforts such as the resettlement of lowland populations in the uplands increased pressure on already growing upland populations, ultimately adding to environmental degradation, the loss of biodiversity, and the marginalization of ethnic minority groups in the uplands (Jamieson 1998). These beliefs ultimately influenced national policies (see Table 1) aimed at ‘regreening’ the uplands and sedentarizing swidden communities who have been blamed for environmental ills such as deforestation (Lang 2001, Jakobsen et al. 2007).

Now nearly 30 years removed from the *Doi Moi* land reforms, the uplands of Vietnam are still being transformed by economic, social, and political forces from both within and outside of the country. To understand the dynamics of these forces within a narrower context, it is necessary to consider these forces at the provincial-level.

### 2.3 Economic Development in Quang Tri, Vietnam

Located in Central Vietnam, Quang Tri Province is bordered by Laos to the west and the South China Sea to the East. Figure 5 displays the location of Quang Tri Province as well as Ba Nang Commune, where the fieldwork for this project was performed. The province contains three major roads: National Highway 1A, the Ho Chi Minh Highway, and National Highway 9. It is also home to some 601,377 people as of 2011, 28.45% of which lived in urban areas.

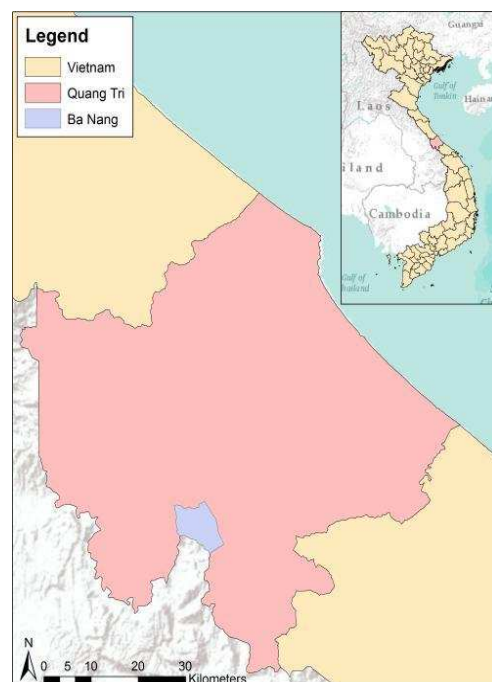


Figure 5: Location Map—Quang Tri Province, Ba Nang Commune

Between 2000 and 2011 the province experienced significant growth in several areas, including industry/construction (15.1% to 37%), exports (21.851% to 80.2%) and trained workforce (19% to 35.2%). In a much shorter period of time, income per capita grew from 13.7 million Vietnam Dong (VND) in 2009 to 21.6 million VND in 2011 (1 U.S. Dollar = 22,307 VND (3/27/2016)). By contrast, agricultural production decreased from 44.9 to 27.9%; and the service industry decreased from 40 to 35.1% (Quang Tri Provincial People's Committee 2010 & 2012). These statistics reveal substantial transitions toward wage jobs and the exporting of goods, as well as a transition away from agriculture.

Major economic development projects have played a key role in shaping these socioeconomic changes in the region, and a prime aspect of those development efforts has been the expansion of infrastructure. One such project is the East-West Economic Corridor. In 1998, representatives from Myanmar, Thailand, Laos, and Vietnam met with major regional development agencies, most notably the Asian Development Bank (ADB), to discuss plans for the East-West Economic Corridor (EWEC) (ADB 2010). Together, this group invested in creating and expanding infrastructure (road systems) that stretches from the coastal Vietnamese city of Da Nang to Myanmar (See Figure 6). One of the primary goals of this project was to “stimulate the type of economic growth that reduces poverty and raises the standards of living in the areas covered by the corridor” (ADB 2010, p. 2).

The 2001 Strategy and Action Plan (SAP) focused specifically on expanding infrastructure in the member countries in a way that would facilitate economic growth, trade, and poverty reduction in a cost-effective manner (ADB 2010). Although much of the infrastructural development was completed in large parts of the corridor by 2006, the 2009 SAP acknowledged that there was still much to be done in terms of raising incomes in poor areas along the corridor

(ADB 2010). The 2009 SAP for the EWEC further emphasized the need to focus on economic development at all levels of government, including sub-regional, national, and provincial levels. The primary goals of the 2009 plan include promoting private-sector growth, alleviating poverty, equitably distributing the benefits of growth, striving for environmental sustainability, and continuing infrastructural improvements where they best work to achieve the economic goals of the EWEC (ADB 2010).



Figure 6: Credit: Strategy and Action Plan for the GMS EWEC (2010)

Efforts to reduce poverty along the EWEC focus on creating jobs that will provide higher incomes for low-income groups, improving economic cooperation (i.e. trade and investment) among member states, and making the transportation of goods cheaper and more efficient. Poverty reduction strategies are coupled with expansions in infrastructure aimed at increasing connectivity between member states and between rural areas and transportation networks (ADB 2010). To achieve the latter objective, the SAP identifies secondary road development as a powerful tool that can connect rural hinterlands to transportation networks at the heart of the EWEC. Authors of the 2009 SAP noted that “the rural road component enhanced mobility and

enabled rural communities including ethnic groups and women to gain access to markets, jobs, and social services” (ADB 2010, p. 95).

This strategy to enhance mobility and economic growth in rural and ethnic communities via road expansion lies at the base of this paper’s hypothesis. The study area, which is in the Vietnamese portion of the EWEC and within 15 km of National Highway 9, the main road in the corridor, and the changes it has experienced will be analyzed using several theoretical frameworks that help encapsulate distal and proximate livelihood and land use/cover changes.

### 3. Theoretical Frameworks

#### 3.1 Von Thunen Land Use Model

The first edition of Johann Heinrich Von Thunen's *Der Isolierte Staat*, or *The Isolated State*, was published in 1826. In this now classic book on agricultural land use, Von Thunen laid out his idea of the "isolated state" and used it to develop a model that could predict the type and location of agricultural land uses relative to the town center.

In the theoretical "isolated state" model, a town is located in the center of a consistently fertile and flat landscape with no rivers, canals, or roads running through it (Von Thunen 1966). The model can be visualized as a traditional bulls-eye target, with concentric rings surrounding the town in the center, each representing a different type of agricultural activity. The model predicts the location of agricultural land use relative to the town based on (1) the distance of the land from the town, (2) the transportation costs associated with the agricultural product, (3) perishability of the product, and (4) the market price for that product. To encapsulate these variables, Von Thunen utilizes the concept of "land rent," which essentially represents the farm revenue following the deduction of investments in the land (Von Thunen 1966, pg 18). Therefore, the types of agricultural land use that will yield the highest economic rent in a given area will be able to pay the most to rent that land, while other land uses will be pushed further from the town center where economic rent will be viable.

Items that perish quickly such as vegetables and milk will dominate the first ring. Intensive land use is a necessary characteristic of this first ring because of the high cost of the land. In addition, since the land closest to the city is the most expensive to rent, it will never be allowed to fallow unlike some of the more distant rings. As distance from the center of the model

increases, the land use must be such that production and transportation costs do not outweigh the value of that crop at market.

The second ring from the town contains forest that is used for timber and fuel. Although this agricultural land use takes very little investment in the land, the high cost of transporting wood to the town requires the land use to be located relatively close to the town center. The third, fourth, and fifth rings outward from the town contain different types of extensive grain production. These crops do not have the same perishability factor as fruits, vegetables, or dairy products and grains are relatively cheap to transport in bulk. The sixth and final ring is reserved for raising livestock, as transporting livestock requires only the time and effort to walk the cattle to these remote fields. A modified version of this model will be applied to this study as a means of understanding why farmers have planted their crops where they do.

### **3.2 Proximate and Underlying Drivers**

One of the primary facets of land use and land cover change research is the identification of the causative factors, or drivers, of why one-type of land use is preferred over another in a given location. In the past, many scientists conceptualized land use changes in a linear fashion; the primary land use change trajectory was thought of as the conversion of forests to agricultural use with driving forces attributed to something immediate to the area, such as population growth (Lambin 2003). However, recent studies have moved past this and other over-simplifications of drivers and recognize that there are more complicated relationships between indirect and direct drivers of land change. Lambin & Meyfroidt (2011) make clear that economic globalization has muddied the waters for both those investigating the drivers of land use changes and political actors trying to influence these trends. As such, a number of frameworks have been proposed to try to account for direct and indirect influences on land use change.

Proximate and underlying drivers of change are presented as a means of understanding both the direct causes of land use change, as well as the more distant and indirect drivers of change (Geist & Lambin 2002). Proximate causes refer to the direct human actions that affect land use and land cover, while underlying causes refer to the fundamental social, political, and economic forces that underpin land use and land cover changes. The most telling differences between these two types of drivers are the temporal and distance aspects; proximate drivers occur directly and almost immediately, while underlying drivers can influence land use change from a great distance and over a long time.

Geist and Lambin (2002) identify the major proximate and underlying causes of tropical deforestation in a meta-study of 152 case studies. The most evident proximate causes include infrastructure expansion, agricultural expansion, and wood extraction. The main underlying causes include demographic factors (e.g. migration), economic factors (e.g. market growth), technological factors (e.g. agro-technical change), policy and institutional factors (e.g. formal policies), and cultural factors (e.g. public attitudes, values, and beliefs) (Geist & Lambin 2002). In all cases, there are multiple proximate and underlying drivers to land use and land cover change.

Case study examples include Miyamoto et al. (2014) who cite palm oil expansion as a proximate driver and poverty alleviation efforts as underlying drivers of forest cover change in Malaysia. A study of land use change in Pakistan identified wood extraction and accessibility to markets as major proximate causes of deforestation and agricultural expansion; underlying causes were related to weak governance and conflicts over property rights (Qasim et. al.2013). Cropper et al. (2001) assesses the impact of a number of variables on land clearings in Thailand,

and emphasizes that one of the most important factors affecting the probability of an area being cleared was the relative distance to an all-season road.

Analyses of proximate and underlying drivers of land use change continue to persist in land change science literature. However, the stark distinction between the two types of drivers has come under scrutiny by some who question the validity of a framework that sorts drivers into two categories when drivers interact across a number of spatial, temporal, and institutional scales (Friis & Nielsen 2014).

### **3.3 Teleconnections and Telecoupling**

First used in atmospheric sciences to refer to connections between climate variations in non-contiguous areas, the teleconnections framework has been used in various ways to link local land use changes to geographically distant, often urban, drivers of change. Seto defines urban-rural land teleconnections as “the distal flows and connections of people, economic goods and services, and land use change processes that drive and respond to urbanization” (Seto et al. 2011 p. 7687). In this sense, the teleconnections framework focuses on the processes that link distant and otherwise independent places together. These teleconnections can range from short to very distant linkages and can include multiple linkages between an urban area and non-urban areas (Gunalp et al. 2013).

The teleconnections framework is not only a powerful tool for linking urbanization to rural land use changes, but also for studying the consequences of that connection.

One example of a teleconnection given is the correlation between rising incomes of urban workers and the willingness of urban residents to pay for the protection or conservation of certain ecosystem services. In this example, the agglomeration of capital in urban areas and the



willingness of urban residents to pay can be linked to several near and distant environmental conservation efforts (Güneralp et al. 2013).

Teleconnections can result in drastic unintended land use and land cover changes. Such was the case when demand for building materials in urban areas like Monterrey and Mexico City influenced land use in the Perote Valley of Mexico. Farmers converted their agricultural land to mines in order to meet the demands for pumice in those urban areas. However, once the market died down, that land was depleted and no longer suitable for agriculture (Güneralp et al. 2013). In what has become a classic example of teleconnections, Nepstad et al. (2006) analyzed economic teleconnections and the environmental impacts—mostly deforestation—of beef and soy production in the Brazilian Amazon. The market for the beef and soy produced in Brazil is primarily located in Europe and China, thus creating a teleconnection between the demand for meat in these largely urban territories and land use transitions in the Amazon from forest to agriculture. By identifying these distant connections between urban drivers and rural land use change, it is possible to investigate the social, political, and economic factors that directly facilitate changes in rural land use at a local scale.

The telecoupling framework is another relatively new framework within the land change science literature that has been proposed to analyze distant drivers of land use change. While similar to teleconnections, the concept of telecoupling puts an added emphasis on the feedbacks between the land use change and the distant driver of that change. Liu et al. (2013) argue for a highly structural approach while Eakin et al. (2014) takes a much more agent-based approach.

Eakin et al. (2014) present a framework that hones in on the process of establishing a telecoupling by identifying five key aspects: the trigger, direct impact, indirect impact, feedback process, and institutional change. This approach focuses heavily on the actors involved in

telecouplings and their role in land change and feedbacks between distant systems. An example provided in the paper is that of smallholder farmers in Vietnam and Mexico and the respective impact of a fluctuating global coffee market on land use and livelihoods within those countries (Eakin et al. 2009 & Eakin et al. 2014).

In contrast, Liu et al. (2014) apply a highly structural approach that also involves five key components: systems, agents, flows, causes, and effects. The examples provided in the paper apply these components, as well as characteristics about the types of systems, to cases of invasive species and transnational land deals (Liu et al. 2014). Once each case is systematically sorted into these individual components of a telecoupling, their implications are then described broadly, often in economic terms. One primary way in which these approaches differ, as Friis and Nielsen (2014) point out, is that Liu et al.'s (2014) framework is a rather rigid list that must be applied to each telecoupling, while Eakin et al. (2014) offers a more heuristic option that seems more flexible and, perhaps, more appropriate for small-scale, local applications.

## **4. LULCC in Southeast Asia and Vietnam**

### **4.1 Swidden in Southeast Asia**

The mountainous regions of Southeast Asia are ecologically diverse and contain an array of natural resources. They are also home to a substantial amount of diverse indigenous cultures, many of which practice swidden agriculture and are experiencing pressures to modernize. Identifying some of the broader trends and drivers of LULCC within the upland areas of Southeast Asia will help illuminate and contextualize changes in Vietnam.

A number of studies have analyzed the status of swidden agriculture in Southeast Asia over the years. Fox and Vogler (2005) analyzed individual case studies, identifying two primary forces that have facilitated changes in the practice of swidden over the last 50 years: government land tenure policies and market pressures. Fox et al. (2009) goes further than this by identifying six trends that have contributed to a decline in swidden systems, including the classification of swidders as ethnic minorities, the division between forest and permanent agriculture, the rise of forestry departments and their conservation efforts, resettlement, privatization and commodification of land, and the expansion of market infrastructure and industrial agriculture (Fox et al. 2009, p. 305). More recently, Van Vliet et al. (2012) published a study on swidden in the tropics that acknowledges the pros and cons of transitioning from swidden to intensive agriculture; namely the corresponding increases in incomes and permanent deforestation. The study finds that swidden cultivation in Southeast Asia is disappearing at a particularly fast rate, something the authors attribute primarily to government policies that have prohibited swidden and promoted forest protection (Van Vliet et al. 2012).

As Van Vliet et al. (2012) acknowledge, governments in Southeast Asia, including Vietnam, have outlawed swidden agriculture and aimed various policies and programs at the

eradication of such practices. While much has been written about the impact this and other land reform policies in Vietnam have had on swidden, an increasing amount of studies focus on economic and market-based drivers (Cam 2011, Tuyen et al. 2011, Leisz et al. 2011).

#### **4.2 Land Use and Land Cover Change in Vietnam**

In her study of common property regimes in Ha Tinh Province, McElwee (2011) discusses some of the problems faced by traditional common property regimes following the *Doi Moi* reforms. McElwee attributes the erosion of traditional land management practices to national land classification programs and major reforestation programs. Arbitrary classifications of significant portions of the land as “bare hills” and the establishment of the Ke Go Nature Reserve set the foundation for reforestation projects, such as the 5 Million Hectare Reforestation Project (5MHRP), to take control of the land (McElwee 2011). McElwee argues that much of this land was actually managed under common property regimes, a fact that was ignored by the government and Department of Forestry. As a result, land classified as “bare hills” was privatized and allocated to individual landowners, with the best and most productive plots typically going to those with the most financial and political resources to draw upon (McElwee 2011). In this instance, government policies and their ill-informed land cover classification systems proved to be major drivers of land cover and land use change.

Cam (2011) provides an investigation of government policies and markets driving LULCC with his article on “forest thieves” in Muang Tac valley of Northwest Vietnam. Since the nationalization of all forests in the 1960s, livelihoods in Muang Tac valley have been challenged by government implemented restrictions to forestlands that had previously been utilized by the local people for either cultural purposes, swidden, or as a source of non-timber forest products. Cam argues that the pressure put on forest resources increased immensely

following the late 1980s transition from state dominated control to a free market model of production and distribution. This transition and the resulting development of timber markets played a large part in driving the exploitation of certain valuable species of trees in the uplands of Vietnam. Moreover, the demand in the urban lowlands of Vietnam for quality wood furniture and home décor forms a teleconnection with the exploitation of forest resources in northwest Vietnam.

Multiple other studies have explored the role of Vietnamese land tenure policies in livelihoods and agricultural land use. Jakobsen et al. (2007) explored the role of forestland allocation policies in an ethnic Thai village in Nghe An Province. This study identified government policy, specifically resolution no. 02/CP, as a prime driver restricting farmer's access to traditional swidden lands and forcing them to rely on limited flooded paddy land and swidden in permitted areas. Though the policy was successful in preserving more forested areas, available paddy land did not expand quick enough to compensate for losses of swidden land, leading to detrimental impacts on the village's food security.

Leisz et al. (2011) conducted a study of four ethnic Thai hamlets and their respective implementation of policies related to forest and land allocation, as well as agricultural extension programs. The main factors that impacted the successful implementation of these policies and programs were the geographical setting, efficiency with which extension agents could access and monitor communities, and market opportunities. Geographical settings proved important because the proximity to the district town and protected areas influenced the amount of oversight afforded to that hamlet by the authorities as well as the ability of hamlets to effectively transport goods or livestock to the market. The topography of a hamlet also related directly to the ability of

most hamlets to adopt market-oriented programs, with some being restricted by the lack of flat, irrigated land for flooded or irrigated rice.

In their analysis of pre and post Doi Moi market networks in the Northern Uplands, Tuyen et al. (2011) address the origin of markets and the impact they have on small agricultural producers. In doing so, they use the cassava market in Bao Thang District of Northern Vietnam to exemplify the expansion of market networks post Doi Moi. They show how economic liberalization policies, an increased number of options for producers, and more recent investments in infrastructure and transportation have strengthened connections between the market and rural farmers, facilitating a flow of information and goods. Moreover, the integration of rural farmers into larger markets has produced connections between farmers in the uplands of Vietnam and the markets in China, which Tuyen et al. identify as the destination of much of the cassava grown in Bao Thang (Tuyen et al. 2011).

Alther et al. (2002) investigate the impact of accessibility (i.e. access to roads) on four rural villages of Ban Kan Province of northern Vietnam. The authors argue that accessibility is the primary determinant of a village's access to the open market economy and of the relative success of government policies and development efforts. Moreover, accessibility is the primary factor driving successful efforts to create non-agricultural income activities. According to the study, there are four elements, all heavily influenced by road access, to farmers' strategies to generate non-agricultural income in Bac Kan: participation in state programs and development projects, exploiting and selling natural resources or agricultural products, non-agricultural wage employment, or migration (Alther et al, 2002).

The villages that were least accessible in this case study were perhaps in the most need of development assistance projects, but the lack of market access and the increased costs of

accessing a remote village means that government money could be applied more efficiently to a village with road access. Additionally, the more remote and inaccessible villages proved less likely to engage in market activities, producing agricultural products only for subsistence. By contrast, villages closer to the market displayed a much more diverse set of annual household production activities, generating about half their total production from subsistence and agricultural income as opposed to 92% for one remote village (Alther et al. 2002).

The district of Sa Pa in Northwestern Vietnam is an interesting case study because it provides a glimpse into an area in which local minorities have integrated into the tourist industry. Sa Pa, which was a hill station during the French colonial period, experienced a resurgence due to tourism in the 1990s and 2000s that has led to major changes in economic relations with some ethnic minority villages (Hanh 2011). Girls and women from Lao Chai village have been selling handicrafts and finding wage labor at tourist businesses at an increasing rate since the 1990s. Though the village has not abandoned traditional agricultural practices, the income brought in by these Hmong women and girls has contributed a growing amount to family incomes over recent years (Hanh 2011).

While this collection of land use and land cover change case studies represent only a fraction of the literature, they provide insight into some of the main avenues of research in recent years; a focus on government policies, markets, and connectivity to transportation networks as drivers of land use and livelihood changes.

## **5. Methods**

To evaluate changes in land use and land cover in the study area, as well as the forces driving those changes, this paper draws upon a combination of socio-economic data gathered in the field, ground truth observations, and analysis of Landsat TM, ETM+ and OLI imagery. These methods are similar to those found in a number of studies (Fox & Volger 2009, Jakobsen et al. 2007, and Leisz & Rasmussen 2012) that have contributed to the Vietnam LULCC literature.

### **5.1 Structured Interviews: Household Surveys**

Structured interviews (Bernard 2006) (See Appendix A) were conducted with 32 different households (HH) that were randomly drawn from a total of 80 households in the village. Each interview took place within the households of the respective villager(s) with one or two researchers present. Though some respondents had trouble recalling such information as crop yields (kg), cultivated area (sq. m), incomes and specific expenditures, the interviewers worked diligently to alleviate misunderstandings and assist villagers in the calculation of these statistics. The topics of the HH surveys related to the demography of the HHs, familial migrations, travel, contact with markets, agricultural practices, animal husbandry, forestry uses, sources of income, expenditures, and perception of HH wealth. The resulting statistics generated from these household surveys are used to support the discussion of changing livelihoods and land use in Ta Rec.

### **5.2 Semi-structured Interviews**

Six interviews were conducted with farmers who led the researchers to their fields and discussed topics such as crop rotations, types of crops grown now and in the past, whether the crops were grown as cash crops or for subsistence, and crop yields. These farmer interviews corresponded with transect walks and the collection of ground truth data.



Semi-structured interviews (Bernard 2006) were also conducted with three different shop owners in Ta Rec. The primary aim of these shop owner interviews was to learn about the background of the owner/shop. Questions included: When did they open? Where are the owners from? Why did they come to the village? And what spurred the opening of the shop? More specific questions related to the shop and its' products included: What products do you sell? Where do they come from? How many daily customers do you have? Do you get customers from outside of the village? Do you do more business in particular seasons? And is there a correlation between season and product sales? Other questions attempted to address changes over time and future prospects: How has the customer based changed since you opened? Do you have plans to expand your shop? Other informative discussions and interviews with villagers that took place throughout the five days spent in Ta Rec were recorded by researchers.

### **5.3 Historical Interviews**

Two targeted historical interviews were conducted with two men (70 and 85 years old) and two women (age unknown, but said to be very old by the villagers) respectively. The objective of these interviews was to gain a fundamental understanding of the village's history and how and why livelihoods, land use, and land cover had changed over time. The identified topics for discussion follow: the history of the population, roads, paddy land area, upland agriculture area, primary forest area, health, income, environment, and living standards. Following an initial broad discussion of the villages' history, five years (1963, 1972, 1986, 2005, and 2012) were chosen based on their proximity to major events that those being interviewed seemed to remember most clearly. After an initial oral history was done with both male and female groups, a historical ranking matrix was created and filled in by the men (Gueye & Schoonmaker- Freudenberg 1991). The women were interviewed in a semi-structured manner.

## **5.4 Ground Truth Points**

Accompanied by local landowners, three groups of researchers walked transects in different sections of the village's agricultural land, collecting GPS points and corresponding photos of the land cover. These points and photos are used to validate the location of landmarks and crops in the Landsat imagery. Specific ground truth points and photos will be presented to show the absolute location of crops, the location of crops relative to one another, as well as their relative location to transportation routes. Methodology similar to Leisz and Rasmussen (2012) was used to collect the ground truth points.

## **5.5 Remote Sensing Land Cover Analysis**

Landsat TM, ETM+, and OLI high level surface reflectance data was downloaded for the years 1991, 1996, 2002, 2004, 2006, 2007, 2010, and 2014. The selection of available imagery was limited by the presence of cloud cover throughout much of the year and gaps in the data due to satellite errors (LS7 ETM+ scan line error). Scenes were downloaded for the months of March-July in order to best identify swidden agriculture fields that are cleared and burned between February and April each year and show up as 'bare ground' in imagery between March and July. The Normalized Burn Ratio (NBR) was selected as one index for this analysis because it has been shown to successfully delineate swidden agriculture, especially if images are captured soon after the land is slashed and burned; this is due in large part to the characteristic way short-wave infrared wavelengths interact with bare ground and burned surfaces. (Li et al. 2014). The Normalized Difference Vegetation Index (NDVI) was used in conjunction with NBR to further assist in the discrimination between vegetated and non-vegetated land cover. A stack of 16 near cloud-free satellite images (8 dates, 1 NBR and 1 NDVI per date) corresponding with the aforementioned years were successfully identified and utilized for analysis.

Administrative boundary files acquired from the government of Vietnam are only available down to the commune level, meaning that village boundary shapefiles do not exist. Since the commune shapefile included a number of other villages that could skew the analysis, the study area had to be cut down in another fashion. To do this, 30-meter shuttle radar topography mission (SRTM) data, downloaded from USGS Earth Explorer, was used in conjunction with the villagers' descriptions of where their village boundary is located to create a map of the boundary which is used to delineate the study area. In order to better visualize roads and rivers, Google Earth was used to create an overlapping vector layer of existing roads and rivers for use in the display of the results.

A binary study area mask was then created using the study area file. Using this binary mask to limit the study area to the village, an unsupervised ISODATA classification was carried out in ENVI utilizing the 16 image NBR/NDVI stack. The input settings for the unsupervised classification were: 50 classes, 2 percent change threshold, and 25 iterations. The resulting unsupervised classification was interpreted using the temporal NBR and NDVI signatures of each output class to identify trends in land cover change. Target classes were those that displayed a clear decrease in vegetation in both indices compared with previous or later years. Interpretations were supplemented by ground truth data collected during fieldwork, Google Earth historical imagery, and true color Landsat images. Classes that included swidden agriculture (i.e. slash and burned areas) were the primary focus for this interpretation, but other land cover changes linked with infrastructural expansion were also detected in these classes.

In order to identify the changing distribution of agricultural fields in the study area, mean center and directional distribution analyses were performed in ArcMap. The directional distribution tool calculates the standard deviation of the location of agricultural fields and creates

an ellipsoid that portrays the distribution of cleared areas. Similarly, the mean center tool identifies the geographic center of areas cleared for agriculture. In addition, a 250m buffer was created around the secondary road in the village to assess changes in roadside agriculture. The area of agriculture land in the buffer area before the roads were built is included for comparison.

## **6. Results**

Ta Rec village is located approximately 10 km away from National Highway 9 with a total population of 440 people living in 80 households. Located in Da Krong District, Ta Rec is one of 10 villages in Ba Nang commune, and it is one of 5 villages that has electricity within the commune. It is one of two villages in the commune that members of the local People's Committee identified as "most developed"; this characterization was based on the villages' (i) better soil quality for agricultural production, (ii) better road access, and (iii) better house structures and electric systems (Interview with Ba Nang Commune People's Committee, Aug 7, 2014).

The boundaries of the village are all described in relation to the topography, with the top of the mountains constituting boundary lines for locals (Interview, Aug 7, 2014). Houses are mainly constructed from a combination of bamboo, wood, rattan, and metal roofs. There is water available at pumps around the village, but houses themselves do not have running water or sewage systems. Several streams intersect in Ta Rec and multiple roads and paths lead to other villages in the commune and to the larger transportation networks outside of the village.

### **6.1 Village History**

The central region of the country where Ta Rec is located has experienced very tumultuous times in the past century, largely due to the impact of the first and second Indochina Wars on the residents of Quang Tri. The spraying of Agent Orange was prevalent in and around the village during the mid to late 60s, leading to starvation and many deaths (Interview, August 8, 2014). Even during the first Indochina war (1945-54), residents of Ta Rec had to move to remote swidden fields outside of the village in order to avoid the French soldiers. However, this did not work during the American War, as soldiers searched in both the village and remote

swidden areas for residents. During that time (1940s-60s) there were no roads, no electricity, and no motorbikes (Interview, August 8, 2014). This and the following village history data is summarized in Table 2.

From the 1960s into the 70s, the population of Ta Rec barely grew until a noticeable increase in 1986 and 2005, which was then followed by a plateau between 2005 and 2014. According to the women interviewed, the population of the village is now more crowded than it has ever been. Living standards (i.e. basic human needs, clothing, shelter, and access to water, health care, and sufficient food) were reported as being far inferior in 1963 during the Vietnam War, improving significantly by 1972 and steadily again by 1986. Men reported that there was a general lack of clothing in 1963, and that better food and clothing are now available. Quality of life has also improved partially due to the availability of TV and radio. By 2005, living standards had improved twofold, and they are currently at their highest level in living memory (Interviews, August 8, 2014).

*Table 2: Men's Historical Interview Results (August 8, 2014)*

<b>Criteria\Time frame</b>	<b>1963</b>	<b>1972</b>	<b>1986</b>	<b>2005</b>	<b>2012- Present</b>
<i>Event</i>	<i>War</i>	<i>Independence</i>	<i>Roads, school, clinic</i>	<i>Opened center road</i>	<i>Current</i>
Population	3 X	4 X	7 X	10 X	10 X
Roads	2 X	3 X	5 X	10 X	10 X
Paddy	0 X	3 X	5 X	10 X	12 X
Upland rice	06 X	10 X	10 X	12 X	15 X
Cassava for sell	0 X	0 X	0 X	0 X	10 X
Cassava for eating	4 X	6 X	10 X	6 X	3 X
Maize	4 X	6 X	8 X	10 X	15 X
Primary Forest	10 X	10 X	6 X	2 X	1 X
Health	3 X	4 X	8 X	10 X	12 X
Income	0 X	0 X	5 X	10 X	12 X
Environment	1 X	3 X	5 X	10 X	12 X
Living standard	0 X	3 X	5 X	10 X	12 X

The quality of the environment and the health of the village have followed similar trajectories as living standards. In 2005, nurses and teachers became available to the village and

they emphasized cleaning the environment and living areas, resulting in a drastic increase in environmental and living quality. The women interviewed believed that despite the poorer health and environmental conditions of the past, there are now more diseases than their used to be (e.g. liver disease).

There was little to no monetary income earned from the 1960s into the 80s. The men reported a significant increase in income by 1986, while the women reported little to no income by 1992. However, all interviewees acknowledged a substantial rise in income by 2005, the year that both men and women identified as when the main road into the village was finished. The men reported another increase in income by 2012 (Interviews, August 8, 2014). This increase in incomes was attributed by one villager to the work ethic and general ability to earn money that villagers had learned from people in the lowlands (Interview, August 8, 2014).

No roads existed in the village until 1988-89. There were simply dirt paths that connected parts of the village to each other. It was not until 2005 that a bridge connecting the village to the Ho Chi Minh Highway was built and an all-season paved road was soon opened. The reported quality of roads remained steady after 2005 (Interviews, August 8, 2014).

Both the men and the women reported a large primary forest in the 1960s and 70s. However, partly due to swidden expansion, primary forests have declined steadily and consistently. The men reported very little primary forest was remaining, while the women said that the declining trend was halted in 2003 by increased restrictions on the clearing of forests (Interviews, August 8, 2014).

Villagers began cultivating irrigated or flooded paddy in the 1970s and production has steadily increased since. The women reported a sharp decline in paddy following 2005-2007, which they attributed to the impacts of road construction, floods, and the resulting erosion and

landslides. The amount of land cultivated for upland rice increased between the 1960s and the 1990s. While men reported a consistent growth in upland rice cultivation, the women noted a slight decline in upland cultivation by 2005-2007. Although upland rice was still grown on a significant area, it was cultivated in more remote, less productive fields (Interviews, August 8, 2014).

Cassava has been grown for consumption since before the 1960s. The major transition to increased cassava growing is said to have occurred around 2011 when high yield hybrid cassava started to be grown as a cash crop. Others recalled cassava being grown as a cash crop after 2005, but all agreed that it was grown to its greatest extent in 2014 (Interviews, August 8, 2014). Another crop that was grown for subsistence until relatively recently was maize, which started to be sold by villagers around 2005. There was a reported increase in maize cultivation between 2005 and 2007 that continued through recent years. Men also acknowledge a spike in maize production over recent years (Interviews, August 8, 2014).

When asked about the prospects for the future, one villager expressed the hope that all kids will go through school and his personal hope for his kids to graduate high school in the near future. In addition, he expressed a desire to adopt more technical lowland-like models of agriculture. However, the same villager suggested that overall living standards had nearly reached their peak, and that their current life might be as good as it gets for them (Interview, August 8, 2014).

## **6.2 Agricultural Land Use**

Ta Rec is primarily an agrarian village. People rely on the cultivation of agricultural products such as rice, maize, and cassava for their livelihoods. The data on agricultural practices is



outlined in Table 3 and detailed below. Irrigated rice cultivation is practiced to a somewhat limited extent on the areas of flat arable land along the river and roads that cut through the

*Table 3: Agricultural Land Use Results from Structured Interviews (August 9-11, 2014).*

Agricultural Activities	Irrigated Rice	Upland Rice	Cassava Swidden	Maize Swidden
# of Households with crop	16 of 31	27 of 31	28 of 31	13 of 31
# of Total Plots	30	38	47	15
Average area of plots (sq. m)	645.4	1994.8	1143.28	650
Average yield (kg)	585.75	334.6	7480.65	240.8
# of Households with Red Book	9 of 16	6 of 27	6 of 24	3 of 10 (only 10 respondents)
First Season Crop- Total #	24	20	20	6
First Year Crop- # of HHs	15	15	11	4
Second Year Crop- Total #	22	14	18	5
Second Year Crop- # of HHs	12	10	12	5
Third Year Crop- Total #	[2 Seasons, not years for wet rice]	4	9	1
Third Year Crop- # of HHs	[2 Seasons, not years for wet rice]	2	7	1

village. There are two growing seasons for irrigated or flooded rice: one in the spring (December –March) and one in the summer (April-September) (Farmer Interview, August 8, 2014). While one account reported irrigated rice being grown in the village in the 1970s, others interviewed believed villagers began growing irrigated rice in the 80s (Historical Interviews, August 8, 2014).

Planting upland rice in swidden fields is practiced to a larger extent, with much of the surrounding hillsides covered with this less productive form of rice. Prior to planting upland rice, plots of land are slashed around the 20<sup>th</sup> of January, burned around the 15<sup>th</sup> of February, and then the rice is planted between the 10<sup>th</sup> and 18<sup>th</sup> of March. Upland rice is harvested in mid-October of the same year. The process is repeated until the upland rice has been harvested for three straight years. Following those three years, the land is left fallow for four years (sometimes longer) (Farmer Interview, August 8, 2014). The rice grown in the village is almost entirely for

consumption, and no households surveyed reported receiving any income from rice sales.

However, many villagers do supplement their rice supply with bags of rice bought from local stores (Interviews, Aug 9, 2014). Of the 32 households interviewed, 16 of them reported growing irrigated rice, amounting to a total of 30 plots from those households. In contrast, 28 households reported growing upland rice on a total of 38 plots of land. The average size of upland rice plots was 1994.8 sq. m. compared to the 645.4 sq. meter average plot area for irrigated rice (Structured Household Interviews).

In addition to growing irrigated and upland rice, villagers plant cassava on swidden plots for three to four year cycles. 28 of 32 households reported growing cassava on a total of 47 plots averaging 1143.28 sq. meters (Structured Household Interviews 2014). The crop calendar is very similar to upland rice's, with planting taking place in March and the harvesting in early to mid-October. However, some families decide to let the cassava grow for longer than a year in order to get a greater yield from that plot (Farmer Interviews, August 8, 2014).

While cassava was cultivated in the past, it was only cultivated for home uses (Farmer Interview, August 8, 2014). Today, some farmers grow subsistence cassava for times of great hunger, but the majority is grown as a cash crop. Villagers started selling cassava on the market around 2011. The type of cassava grown as a cash crop is the k94-hybrid, which is favored due to its short growing period (harvested after 6 months) and the ease by which farmers can harvest it (Farmer Interviews, August 9, 2014). Farmers revealed that this new type of cassava was discovered in 2003 by villagers who saw farmers in other villages growing it. However, it was not until circa 2011 that a middleman came to the village and made arrangements with farmers to buy the cassava. The arrangement called for farmers to bring all their cassava to a single area of the village where the middleman could arrive with a tractor and/or truck to collect the cassava. A

later interview confirmed that 2010 was the same year that a cassava processing factory was built in Dong Ha, the capital of Quang Tri province.

The cassava that is still grown for home use is grown on the edges of the upland rice fields to allow for easier access to the more abundant k94-hybrid that will be sold. Farmers explained that cassava was not grown in the more remote areas surrounding the village because it is too difficult to carry harvested cassava back to the village (Farmer Interview, August 8, 2014). Another farmer echoed this, saying that cassava is mainly grown in fields close to the road that are not very steep, while the remote and steep fields are reserved for upland rice (Farmer Interview, August 8, 2014).

Maize is a less common crop than cassava and rice, with 13 of 32 households reporting that they grow maize on relatively small amounts of land. Three households reported that they intercropped the maize with upland rice in order to get more production out of the land (Structured Household Interviews 2014). Because intercropping is prevalent for maize, the average plot sizes are difficult to calculate and could be misleading.

Another crop that is present in Ta Rec is the acacia tree. There are a total of 9 acacia tree plantations reported, and although five of those households with acacia plantations could not recall the amount of trees on the acacia plots, those that did acknowledged an average of 2050 trees per plot (Structured Interviews 2014). This practice of planting acacia in the fallow was introduced by district forestry extension agents. Poor households have since been given acacia trees to plant for free at the rate of about 200 per household. (Interview, August 8, 2014). The acacia is typically left to grow for 5-10 years on land that is being fallowed and is then sold to middlemen who transport the trees to a paper processing factory in Dong Ha city (Interview, August 8, 2014).

In addition to the cultivation of rice, maize, cassava, and acacia trees, farmers gathered a variety of fruit from trees located on hillside fallows, the edges of agricultural plots, and in household gardens (Farmer Interview, August 8, 2014). Fruits gathered from these locations include bananas, jackfruit, papaya and pineapples. Fruit is primarily for consumption, as there were minimal reports of fruit being sold (Structured Interviews 2014).

### 6.3 Local Economy

Statistics on household income are presented in Table 4 and show the distribution of income generating sources. Cassava proved to be the most common product grown for sale. Non-timber forest products were also a very common source of income. Maize comprised a relatively small portion of incomes. Other agricultural products such as fruit and coffee comprised an insignificant portion of household incomes.

*Table 4: Sources of Income Results (August 9-11, 2014)*

Average Annual Income in Vietnam Dong (VND)= 15,570,556.25 -- 1 U.S. Dollar = 22,307 VND (3/27/2016)		
Income Generating Activity	Avg. Income For Participating Households (VND)	Number of Households
Sale of Crops	7,918,696.00	27 of 32
- Cassava	7,649,000.00	26 of 32
-Maize	846,160.00	5 of 32
-Coffee	4,850,000.00	2 of 32
-Bananas	200,000.00	1 of 32
-Jackfruit	1,000,000.00	1 of 32
Sale of Livestock	4,060,000	5 of 32
Planting Forest (Acacia)	23,000,000	2 of 32
Sale of NTFPs	687,059	17 of 32
- Broom Grass	685,333	15 of 32
-Honey	350,000	4 of 32

Wage Labor	3,682,666	15 of 32
Sale of Handicrafts	1,475,000	2 of 32
Government Salary	14,068,000	5 of 32
Government Pension	27,600,000	1 of 32
Other Government Assistance	300,000	1 of 32

Although livestock were mostly used for household and manual labor, five households reported selling livestock (chickens, cows, and pigs). No households reported selling timber or firewood. Even though acacia was only sold by two households during the past year, there were a number of households that were waiting until their acacia plantations were tall enough to harvest and sell.

*Table 5: Households Engaging in Wage Labor (August 9-11, 2014)*

Income From Wage Labor	# of HHs reporting wage labor and # of days/year (1 no response)
1-5 days per year	2
6-10 days per year	2
11-20 days per year	4
21-50 days per year	3
51- 100 days per year	2
100+ days per year	1 (120 days)

Table 5 shows that 15

households had at least one family member earn income from wage labor jobs during the past year. These jobs ranged from 1 day to 120 days out of the year and provided a significant source of income for those participating households.

There are four small shops in the village. These shops provide basic goods and services needed in the village. Store owners mainly come from outside the village; two of the three store owners interviewed are from outside the village and of Kinh (Vietnamese) descent. Only one is from Ta Rec and of Van Kieu descent.

Shop owners report and observation confirms that they stock and sell rice, vegetables, meat, fish, noodles, fish sauce, candy, cookies, soft drinks, beer, and clothing. They also provide

services such as credit to farmers. Customers vary from local farmers, staff from the commune's People's Committee, employees from the health clinic, and sometimes travelers. Their daily average income ranges from 50,000 to 300,000 VND. For two shops, sales go up during the rainy season, while the third shop gets less business due to flooding and heavy rain. Instead of travelling by foot and bus to the closest market as store owners had to do in the past, the store owners can now call and get goods delivered directly.

#### **6.4 Infrastructure, Mobility, and Interactions with Outside World**

In recent years, some more basic forms of infrastructure have been provided to the villagers. Drinking water pipes were installed in 2004 in the village, but were destroyed by a big flood in 2009 (Farmer Interview, August 8, 2014). A new primary school was also built in the late 2000s (Interviews, August 7, 2014).

In 2008, a local clinic opened up along the road leading from Ta Rec to the Ho Chi Minh highway and is within walking distance for villagers in Ta Rec. There are only 3 employees that work at the clinic and it only has basic medicine and equipment. They mostly treat ailments such as headaches, fevers, and digestive issues, while other more serious medical issues are referred to the hospital in the district town. According to the clinic worker interviewed, there has been no noticeable increase in disease or illness. People have slowly come to trust the clinic more, resulting in more people relying on it to treat some of the aforementioned ailments. The clinic worker went on to say that people typically medicate themselves with traditional medicines, but rely on the clinic to relieve headaches and fevers in particular.

The more substantial infrastructural expansion came in the form of road and bridge construction. The first secondary road and a bridge connecting the village to the Ho Chi Minh highway were completed in 2005, providing access to both the Ho Chi Minh Highway and the

National Highway 9, which is several kilometers away from the intersection of the Ho Chi Minh Highway and the first secondary road into the village. Another secondary road perpendicular to the first was finished in recent years, reportedly in 2011 (Transect Interview, August 8, 2014). This road leads up into some of the hills and mountains surrounding the village.

Villager’s access to media such as newspapers, radio, television, internet, and cell phones was also assessed and is summarized in Table 6. The distance was estimated from each household to the closest all-season road and the closest road on which a motorcycle can pass; a road that a motorcycle can pass on does not need to be paved, and can resemble more of a

walking path than a road.

*Table 6: Interactions With Media (August 9-11, 2014)*

Media contact in previous month	Newspaper	Radio	TV	Internet	Cell Phones
# of Households using medium	7	2	31	0	13
# of Households using medium >15 times	2	1	26	0	10

The results show that a vast majority of households are now within 10 meters or less of roads that motorbikes can pass on. Twenty-two households were within 50

meters of an all-season road.

Structured survey results shed more light on the mobility of villagers (Table 7). Eight households reported little to no mobility. Trips to the nearest market, though not uncommon, were somewhat minimal. Visits to the district town were somewhat less common. Visits to the provincial capital were relatively sparse with twenty households reporting they did not visit the capital. One household reported visiting Laos, whose border is not very far from Ba Nang. Two households reported going to Hue, which is a much further trip.

Survey results convey how common motorcycles have become in the village. 21 of 32 households travelled to the market by motorcycle, with two families reporting travel by foot to the nearest market. The majority of respondents could travel to the local market within an hour.

*Table 7: Mobility Patterns (August 9-11, 2014)*

Frequency of HH Member Visiting (Last 12 Months):	Village Center	Nearest Market	District Town	Provincial Capital	Lao, Hanoi, Ho Chi Minh, Hue, or Da Nang
0 Times	8	8	10	20	29
1 Time	6	2	5	6	2 (Hue),
2 Times	7	4	6	4	1 (Laos)
3 Times	4	6	7	2	0
4 Times	0	0	1	0	0
5 Times	2	1	0	0	0
10-19 Times	2	7	0	0	0
20-29 Times	1	1	1	0	0
30-39 Times	0	1	0	0	0
50-99 Times	0	1	2	0	0
>100 (insert #[s])	120, 360	0	0	0	0

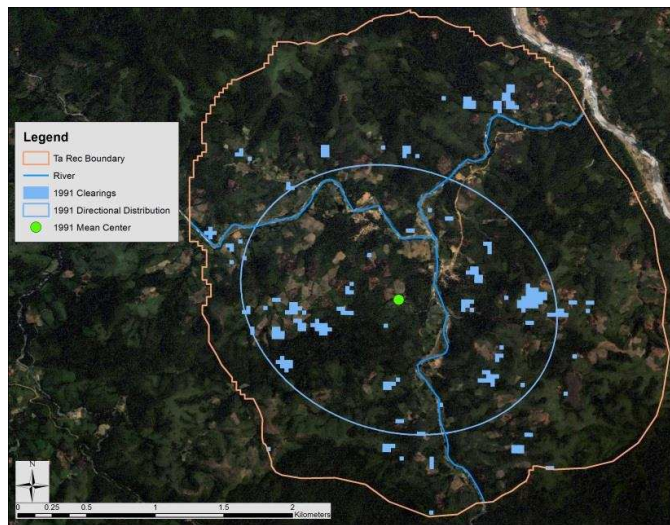
## 6.5 Land Cover & Land Use Analysis

A sample of ground truth points are provided in Appendix C. These ground truth points correspond to the main land cover types in the study area. Appendix C also shows the location of the ground truth points on a map of the study area and their proximity to transportation routes (roads and paths along rivers).

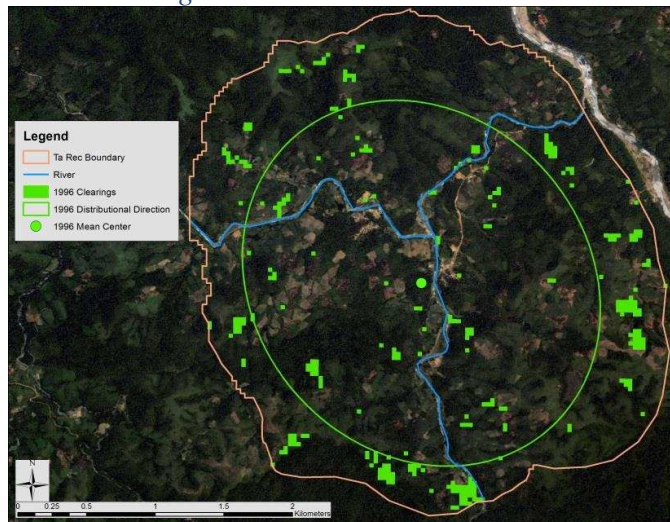


*Table 8: Cleared Vegetation by Year*

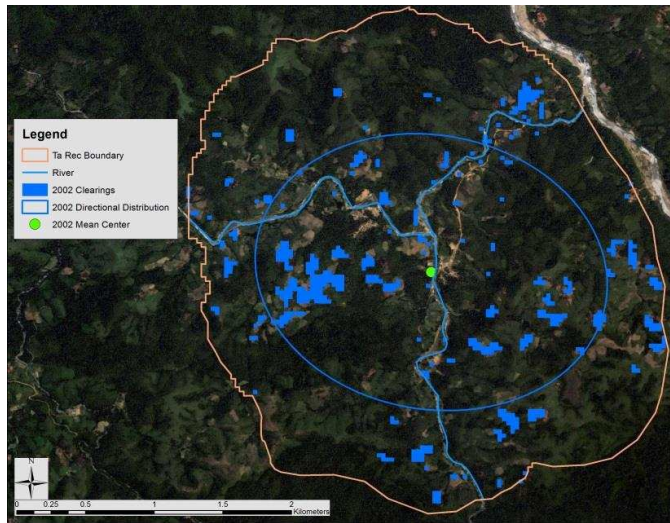
Years	Total Cleared Areas (sq. m)	Cleared Areas Within 250m Road Buffer (sq m.)
1991	212,400	51,588
1996	279,000	27,649
2002	442,800	59,379
2004	908,100	183,532
2006	878,400	74,746
2007	1,008,900	40,866
2010	1,684,800	458,814
2014	1,189,800	228,534



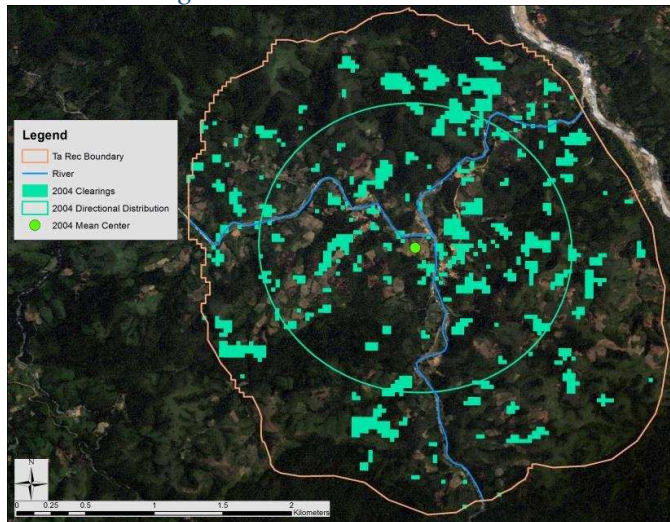
*Figure 7: 1991 Cleared Areas*



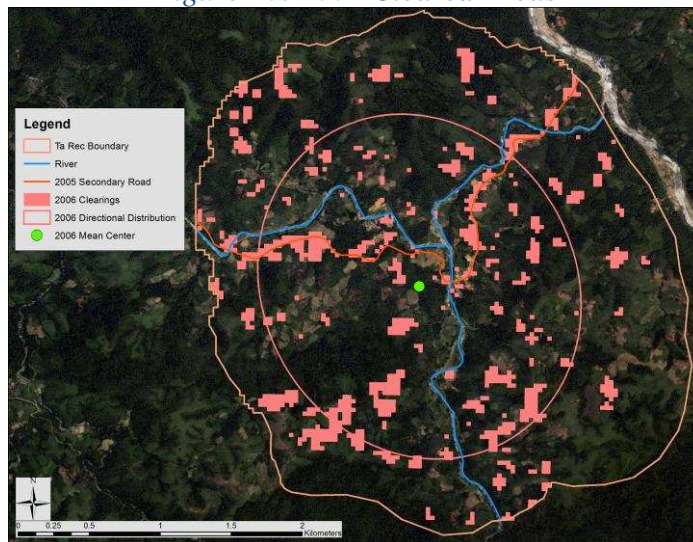
*Figure 8: 1996 Cleared Area*



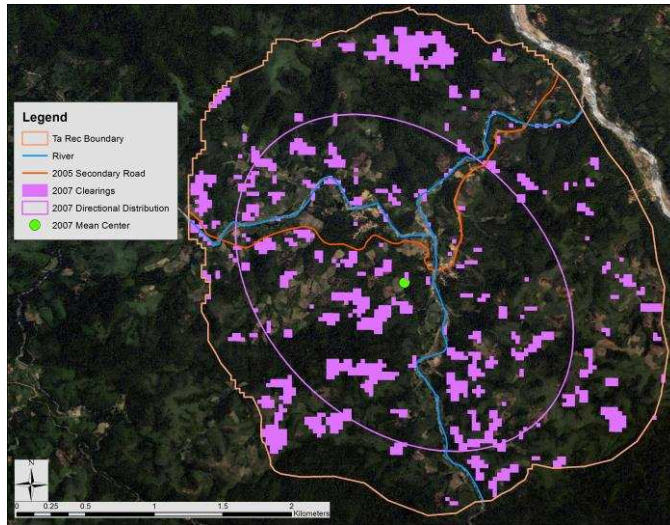
*Figure 9: 2002 Cleared Areas*



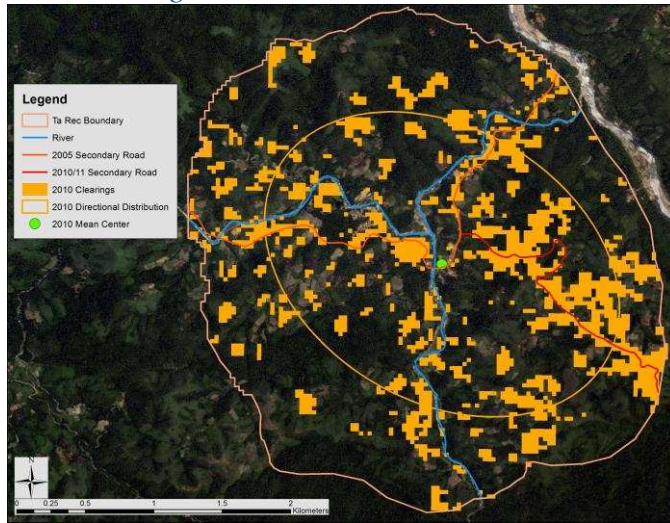
*Figure 10: 2004 Cleared Areas*



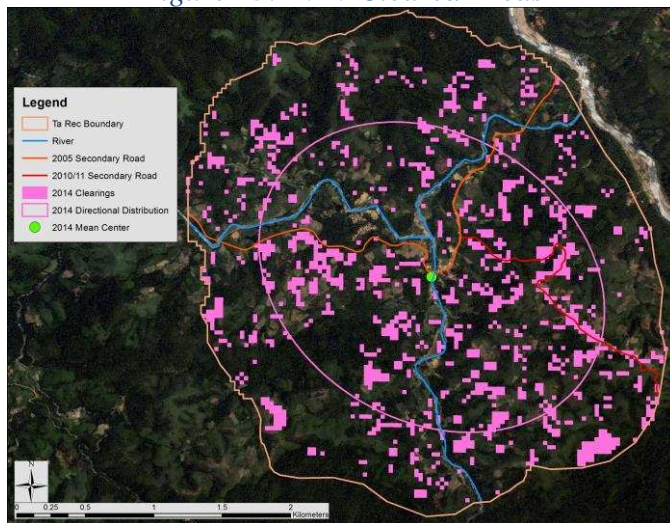
*Figure 11: 2006 Cleared Areas*



*Figure 12: 2007 Cleared Areas*



*Figure 13: 2010 Cleared Areas*



*Figure 14: 2014 Cleared Areas*

Table 8 summarizes changes in vegetation clearings detected in the historical Landsat time series analysis. Figures 7-14 display the results of the Landsat time series analysis and the delineated land clearings for the years 1991, 1996, 2002, 2004, 2006, 2007, 2010, and 2014.

There were relatively small areas (sq. meters) of cleared vegetation in both 1991 and 1996 (Figures 7, 8). The patches of land that were cleared seem to be scattered across the landscape with very little consistency in terms of distribution; some cleared areas are closer to the rivers in the study area, while other areas are located further from rivers on the mountainsides. The amount of land cleared of vegetation nearly doubled in 2002, with many of the clearings located on the mountainsides away from rivers in Figure 9. The large polygon adjacent to the river in the northeast portion of the study area is associated with an expansion of residential areas in Figure 9.

By 2004, the area of vegetation clearings more than doubled. Figure 10 shows that there are still many clearings on the mountainsides associated with agriculture, but some polygons appear to detect the early construction of the secondary road leading from the Ho Chi Minh highway. Although the total area of vegetation clearings remained ostensibly the same between 2004 and 2006, the first secondary road appears completed in the 2006 image (Figure 11). The 2007 imagery (Figure 12) shows a moderate increase in cleared areas, with the area of agriculture along rivers increasing as well.

2010 marked both the year of highest vegetation clearing and the year in which the distribution of clearings changed most drastically (Table 8, Figure 13). The most evident change in 2010 was the appearance of the upland road that leads from the main secondary road that runs through the village towards the southeast. Also, land clearings in 2010 clearly shifted closer to rivers and the newly constructed roads in the village. 2014 clearings in Figure 14 show a

continued concentration of vegetation clearings along village roads and rivers, while relatively few clearings were located a great distance from either of these potential transportation routes.

The majority of vegetation clearings detected between 1991 and 2002 are associated with upland rice cultivation or one of the other less common subsistence land use practices such as maize and cassava cultivation. Expansions of vegetation clearings between 2004 and 2007 correspond with increases in the cultivation of wet rice, upland rice, and maize identified in the historical interviews.

Many of the land cover changes in the 2010 map (Figure 13) are related to the expansion of roads and other basic forms of infrastructure. Figure 23 (Appendix C) displays the location of the upland road that is first detected in the 2010 imagery. Figures 21, 22, and 24-26 (Appendix C) show the presence of agriculture adjacent to this upland road, a practice that appears to have begun around 2010 when the road was new. Figure 23 (Appendix C) shows the area where the new school was built and the 2010 map shows this same area cleared in 2010 for the first time.

The extent of land use between 2010 and 2014 remained relatively consistent, as the agricultural expansion seems to have already taken place by 2010. In both years, agricultural land use along roads and rivers intensified compared to years past. Figures 15, 16, and 17 (Appendix C) show the prevalence of agricultural land use along the North-South running river (NS river) where agriculture is perhaps most dense. By 2014, agricultural crops dominated large portions of land immediately adjacent to roads and rivers (See Figures 15, 17, 25, and 29 Appendix C). Despite the increased amount of agriculture in areas along rivers and roads, more remote areas on mountainsides are still planted with upland rice, maize, and are used for grazing (See Figures 18-30 Appendix C).

An analysis of the spatial distribution of agricultural fields between 1991 and 2007 offers no consistent indications of change in the patterns of agricultural land use. The directional distribution analysis and the resulting ellipsoids show an inconsistent distribution of agricultural fields through 2007, with the orientation and size of the ellipsoid offering no clues of a new trend of land use. Likewise, the mean center analysis seems to only show that the mean center of agricultural fields has rotated, with the only outlier being 2004, which is explained by the unusually large clearings in the northern uplands of the study area. However, changes in the distribution of agricultural land use are identifiable for the years 2010 and 2014. In 2010, the mean center shifts about 100 meters further East than any previous year (Figure 13). The mean center in 2014 shifts back towards the southwest by 98 meters, but the ellipsoids calculated from the directional distribution analysis for both of these years show that agricultural fields have begun to consistently shift towards the new secondary road.

## **7. Discussion**

The results of this study support the hypothesis that the construction of roads in the study area and the resulting connectivity to external markets and agricultural processing factories provided to the villagers has driven significant changes in livelihoods, land use, and land cover within the last ten years. The results also show the significant role of emerging markets for certain agricultural products in affecting these changes. The results are used to answer key questions posed at the beginning of this work.

### **7.1 Livelihood Changes and Drivers**

One of the primary questions that this research is attempting to answer is, how have livelihoods in this village changed in recent decades? To delve deeper into the causes of these changes, this section also answers the question: what are the main drivers, distal and proximate, of these changes? The results presented above suggest several ways in which livelihoods have been altered; most notably, villagers have experienced increases in household income and significant improvements in mobility. These changes have largely been facilitated by improvements in connectivity and market forces that have made growing cash crops viable.

As has been the reality for many generations, livelihoods in Ta Rec depend primarily on agricultural production. However, unlike in the past, villagers now grow several crops that are sold for cash within the market system in addition to the subsistence crops they have grown for generations. Cassava has been a main staple of market oriented farming in Ta Rec since 2010/11 and offers both the most common and the most lucrative source of income to village farmers. Maize and acacia trees are a much less common source of income, but still generate a fair amount of income to households that plant them (Table 4). The subsistence activities, consisting

primarily of rice production, help absorb market changes that could potentially decrease crop prices.

The rise in incomes generated from commercial agriculture can be linked to distant underlying drivers such as the construction of a starch processing factory in 2010 in Dong Ha. Within a year of its completion, middleman/extension agents from this factory travelled to the study village to market their business and offer a rather simple way to generate income from crops they already grow. The connectivity provided by new road construction is also a driver of the increase in agriculture related incomes due to the easy access that middlemen now have to the village. Because middlemen can drive directly to the village and pay villagers directly per kilogram, the process of delivering the crops to the middleman and receiving payment is simplified. Both the construction of these new roads and the resulting connectivity to new markets are affected by the underlying influence of the EWEC and its policies aimed at improving secondary road access for remote areas within the corridor.

Villagers have diversified money generating activities by planting cash crops in gardens, collecting NTFPs, selling handicrafts to a very limited extent, and engaging in wage labor. A little less than half of the households interviewed earned income from the sale of NTFPs and wage labor in the past year, with wage labor providing a much higher average income. In addition, a small number of households earned income from either government salaried jobs or a government pension, providing some villagers with stable sources of income.

While NTFPs such as broom grass have been collected by villagers for some time, it is now relatively easy for them to sell it when they travel to the market or sell it directly to other villagers. The availability of wage labor jobs would have been much less common before expansions of infrastructure, as those employers seeking wage laborers are more likely to venture



into villages that are easily accessible via roads. Furthermore, improvements in connectivity influence the number of government related jobs available in the village due to the ease of access and oversight now afforded to the district government and commune people's committee.

In recent years, the health clinic and school that have been constructed in the village have provided improved access to health care and education for residents. Even though the clinic is restricted in terms of its supplies and potential care giving, it provides basic care for villagers and refers them to the district hospital for more severe ailments. The school very clearly resembles schools and government buildings in the lowland urban areas that also display communist party signs and symbols such as the large portrait of Ho Chi Minh plastered on the front of the school. Furthermore, teachers at the village school come from lowland areas and can influence students to further their education beyond primary school by pursuing an education at one of the district schools. These advancements in access to education and health care are largely related to the proximate improvements in roads and the underlying policy drivers that aim to improve livelihoods for poor ethnic minority communities.

Villager mobility was directly impacted by the construction of the first secondary road in 2005 which provided easy access to broader road networks for the first time. The majority of households now have easy access to paved roads, as most households are within approximately 50 meters of an all-season road. The increased access to outside towns and cities is demonstrated by the frequency with which family members visited nearby markets and the district town over the past year. Even though only 12 households surveyed reported going to the provincial capital of Dong Ha and three households reported going to either Hue or Laos, these numbers are expected to increase in the future, and are still significant due to the very recent access villagers have had to these areas.

Store owners have also benefitted from easy access to district markets because now they can simply travel to nearby markets to buy products or have them delivered directly to the store. This was not possible before the road improvements. As one shop owner pointed out, they had to walk miles to the nearest road, where they took a bus to the market and back. Whatever they could carry was what they would be able to sell. In addition, selling rice at village shops would not have been possible due to the costs and challenges associated with transporting large amounts of rice from the market back to the village without roads. Now, however, kilos of rice can be delivered directly to stores.

Another major change in village livelihoods is the increasing availability of electricity and different forms of media to residents. The vast majority of households report watching television fifteen times or more over the previous month, suggesting that they have TVs in their homes or that they have some other means of easy access (Table 6). Other forms of media and devices characteristic of modern market economies that have been introduced to the village include mobile phones, films, and newspapers. Thirteen households reported using mobile phones in the past month, with ten of those households using it fifteen times or more. Still, only one household reported using the internet over the previous month, meaning that some forms of modern media have yet to be integrated into the village.

The expansion of road systems coupled with the purchases of motorbikes by residents exemplifies the two primary trajectories of change in the village: the vast improvement in mobility that villagers have experienced in recent years due to improvements in road systems and the rapid increases in income that can be largely attributed to the adoption of commercial agriculture. Store owner interviews attest that there are more villagers relying on rice purchased from local shops than in the past. This stems from both the increase in household incomes that

gives farmers the option of buying rice and the improved mobility afforded by the new roads that make it possible for store owners to have large quantities of rice delivered to the village.

These significant changes in livelihoods are portrayed as largely beneficial by those interviewed. Historical interviews stress the substantial improvements in living standards from 1986 to 2005 and clearly identify the current time period as a high point for living standards. Other indicators such as health, income, and the environment reinforce this trend, as historical interviews show those livelihood aspects following a similar trajectory.

As household mobility has improved markedly in the last decade, so have household incomes. These changes are proximately driven by the construction of roads and the resulting connectivity provided by that road access. The main underlying drivers at play are market forces that have effectively linked villagers to middlemen that work for a provincial starch factory. Policies associated with the increased expansion of secondary roads within the EWEC have also been a primary underlying driver of change. With this increased connectivity and the potential for further increases in local incomes, the integration of this small rural village into broader markets is likely to intensify in coming years.

## **7.2 Land Use/ Cover Changes and Drivers**

Having discussed changes in livelihoods and the primary drivers of those changes, this section addresses the remaining questions motivating this research: how have land use and land cover changed in recent decades, and what are the main drivers, distal and proximate, of those changes? Some of these drivers were apparent during fieldwork, while others were much more opaque, and required further interviews and research.

Expansions of swidden fields between the 1990s and early 2000s were proximately driven by the population growth that occurred over the same time period (Historical Interviews,

August 8, 2014). This rather simple explanation suffices in this case because the crops grown in the village prior to 2005 were entirely devoted to subsistence. Underlying drivers of change during that same period related to the national economic and land use policy shifts that were implemented throughout the late 1980s and 1990s.

In 2005, the secondary road connecting the village to the Ho Chi Minh highway was completed, providing villagers with easy access to an all-season highway that connects to urban areas along National Highway 9. The construction of this road and the connection to the market acted as a proximate driver of maize cultivation within the study area. Although maize production increased only slightly between 1986 and 2005 (Historical Interviews, August 8, 2014), villagers reported selling maize for the first time in 2005, soon after the secondary road was opened. The proximate influence of extension agents and middlemen was another driver influencing the adoption of market-oriented maize production, as extension agents in Vietnam promoted hybrid varieties of corn that improved productivity throughout the late 90s and early 2000s (Thanh and Neefjes 2005).

This also coincided with the time in which maize production in Vietnam was on the rise, with total cultivated area of maize doubling between 1990 and 2003 (Thanh and Neefjes 2005). During that period, successful poverty reduction efforts at the national-level were followed by an increasing demand for meat and, thus, animal feed; the number of farm animals in Vietnam increased by about 5.1% per year ('93-'03) while the share of maize used as animal feed increased from 20% in 1990 to 70% in 1997 (Thanh and Neefjes 2005, p.7). This link between the increased demands for meat products, the majority of which emanates from urban areas, and an uptick in cultivation in the study area forms a teleconnection from lowland urban areas to upland areas that has effectively driven changes in land use. Moreover, this teleconnection was

facilitated by the underlying influence of the EWEC and associated expansions in secondary roads that gave the village road connectivity to markets.

Acacia trees are another market oriented crop that has become evident in the study area, but to a much lesser extent than cassava. Evidence of a concerted effort to convince farmers to plant acacia is provided by interviews that reveal that an extension agent/middle man went to the village and spoke about the economic benefits of planting and selling acacia. Later concerns about the length of time (5+ years) in which it took to reap financial rewards were mitigated by these extension agents/middlemen who introduced the idea of intercropping acacia with cassava (Figure 27 Appendix C). Those households that do grow acacia sell it to a middleman who ships it to a processing factory in Quang Tri that then sells the wood to markets in Vietnam and Malaysia (Interview with Foreign Affairs Official, 2015). The demand for this resource in both Vietnam and Malaysia has driven the adoption of acacia plantations and woodlots in the study area, effectively altering land use of some farmers.

In a further attempt to encourage commercial agriculture and increase household incomes, the district government supplies poor households with free acacia seedlings, a proximate driver of acacia cultivation in the study area (Interview, August 8, 2014). This specific targeting of the poorest households with assistance is influenced by underlying drivers related to broader national poverty reduction policies.

The 2010 imagery (Figure 21 Appendix C) shows further road expansions (secondary road) into portions of the uplands that were previously inaccessible to vehicles. This road expansion improved access to areas to the east and southeast of the village that were cultivated to a limited extent in the past; earlier imagery (Figures 15-20 Appendix C) speaks to the scattered nature of clearings between 1991 and 2007. Soon after this road expansion, villagers reported

growing market oriented hybrid cassava for the first time, suggesting that this upland road is a proximate driver of land use and land cover change. Figures 21, 22, and 24-27 (Appendix C) support this by showing the direct connection between the road, the easy land access it provides, and the cultivation of cassava along adjacent land.

The k-94 hybrid cassava that is currently grown as a cash crop was adopted around 2003. However, it was not until the secondary road opened that market oriented cassava cultivation accelerated. Around that time, a middleman who worked for a newly opened starch factory in Dong Ha, Quang Tri, came to the village and offered to buy cassava directly from villagers. This suggests that one underlying driver of the increase in cassava cultivation was the marketing that cassava processing factories engaged in and the expansion of processing factories relatively close to the study area. By marketing to a village that was previously remote and had only recently gained expanded road access, the factory found a village that had the land, the willingness, and the expertise to adopt and expand commercial cassava production. Moreover, a crop like cassava would be expected to thrive because of its ability to tolerate poor soils and drought-like conditions (FAO 2000).

This hybrid variety, which is more productive than the traditional variety grown for subsistence, is normally processed for use as animal feed and tapioca starch. Once harvested and dried in the village, it is reportedly shipped to one of two starch factories in Quang Tri where it is processed and then shipped to other regions of Vietnam or exported to China (Interview with Foreign Affairs Official, 2015). In this instance, the demand for cassava as a source of animal feed or processed food ingredient in Vietnam and China has created a teleconnection with land use in this small village of Central Vietnam. Farmers have responded to the increased demand,

which was relayed by factory extension agents/middlemen, by quickly adopting this market based cassava.

Like in the case of Maize, teleconnections between the village and distant markets were impacted by the underlying influence of the EWEC and its poverty reduction goals. Explicit goals related to the development of secondary roads in the corridor have clearly impacted the popular adoption of commercial agriculture in the study area and the subsequent integration of many farmers into markets for a couple agricultural products in particular.

Just as the proliferation of these market oriented crops was evident in the study area, so was a pattern and process of distributing certain crops relative to transportation routes. The use of the land is dictated by the return on the land's production and the ease/difficulty of transporting the production from the field to the road vs. the value of the product. Fields nearest the road or river are planted with cash crops, primarily cassava in this case. Farmers plant these crops in this location for two reasons: (1) to cut down on transportation costs and (2) to provide easy access to the cash crops for middle men.

Since cassava is relatively heavy and farmers cannot carry their yields over long distances, cassava is typically grown next to roads and rivers in order to provide easy access for middlemen (See Figures 21, 22, and 24-27, Appendix C). Because there is a general lack of flat land in the village, the flat land that is available next to rivers is often reserved for irrigated rice (Figures 15, 16, 28, and 34, Appendix C). In that case, cassava is then relegated to the next available land closest to the paths along the river (Figure 15 Appendix C).

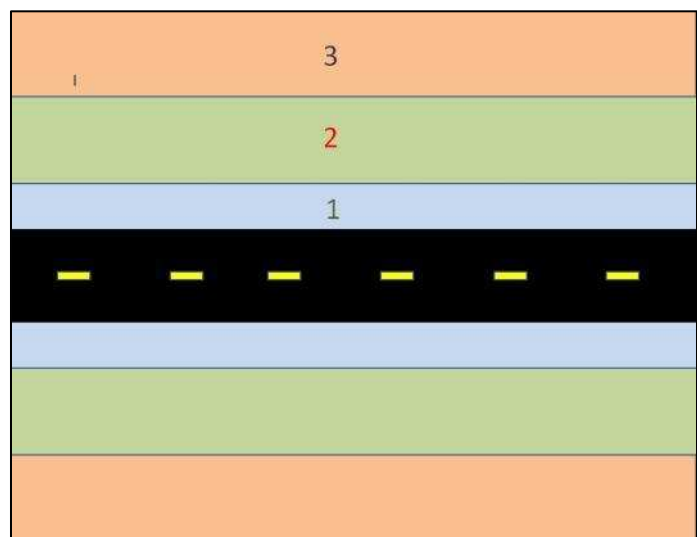
Upland rice and maize are found farther from the road (and the village center) on sloped land. Because these crops weigh less and are more easily transported, farmers can transport the yields back to the village in a basket that they wear on their back. The juxtaposition of these

areas is most apparent in Figures 16, 35, and 36 (Appendix C). Acacia trees are also planted on fallow land that is located further away from transportation networks. The transportation difficulties associated with extracting trees and getting them to the middlemen is mitigated in this case by buffalo or cows that are used to drag the trees from the forest to a road or the village.

Located even further out from this mixture of swidden crops and fallows are grazing areas and upland rice. This third and final area is separated from a transportation route by a significant distance and/or very rugged terrain. Grazing lands can be located far away from transportation routes because it costs farmers nothing (except time) to walk their livestock to this land. Figure 20 (Appendix C) shows the distant location of grazing lands for cattle and buffalo. Though somewhat less common at this distance from transportation networks, upland rice may be planted in this area in order to allow other swidden land closer to transportation networks to fallow.

This agricultural land use in the study village can be explained by applying a modified Von Thunen Model, seen in Figure 7. In this model, several bands of land use extend parallel to transportation routes, like rivers or roads,

but at varying distances from that road. The different zones correspond with the descriptions of agricultural land use above that are determined by the return on the land's production and the ease/difficulty of transporting the production from the field to the road vs. the value of the product. The construction of the upland



*Figure 7: Modified Von Thunen Model*



road in particular has increased the value of roadside land that had formerly been reserved for shifting agriculture if it was used for agriculture at all. Instead of growing subsistence crops like rice on this land, villagers now grow commercial cassava on the roadside land due to the ease by which it can be transported to middlemen and the profit farmers receive from selling it.

This new model of land use that the villagers seem to have established suggests further changes in terms of the length of fallows and the amount of land devoted to swidden agriculture. Because cash crops are almost exclusively planted along transportation routes (roads/walking paths), this land is expected to be fallowed much less frequently. In addition, these crops have essentially been removed from the traditional swidden rotation, meaning that some of the mountainside areas that would typically be rotated between fallow and agriculture may revert to permanent forest. However, such a transition must be examined over a longer time period since this study can only evaluate changes within the first 10 years of road access and only 5 years of cassava market integration.

## **8. Conclusion**

The economic landscape of Vietnam has been changing rapidly since the 1980s, when economic liberalization policies were first implemented. Although much of Vietnam has experienced a drastic shift towards a more capitalist-based economy, many areas in the country have lagged behind. The many diverse ethnic minority groups in the uplands of Vietnam are perhaps the least integrated of all social groups. Many areas have only recently been connected to wider political, economic, and social processes in Vietnam via newly developed infrastructure.

This study provides an account of one village that has gained access to broader road networks and markets in the last 10-15 years. The study village, located in the central province of Quang Tri, has been an agrarian village for generations. But in past years, the village has undergone a shift away from subsistence and towards market oriented agriculture. In order to analyze and understand how this and other changes have taken place, this paper asked three key questions: how have livelihoods changed?; how have land use and land cover changed?; and what factors have driven those changes. A variety of social data gathered in the field and a remote sensing land cover analysis were combined to answer these questions. Findings show that villagers have experienced significant increases in income and mobility, which have been driven by improvements in connectivity and market forces that have made market oriented agriculture viable. Although national poverty reduction efforts, land use policies, and the EWEC act as underlying drivers of land use changes to some degree, it was not until the construction of local roads and the resulting increase in connectivity to other locations that the village began to integrate into the broader regional market economy and the underlying drivers were transmitted into the village. Villagers in the past could not viably grow market oriented crops because transportation costs would have outweighed potential profits. However, soon after the first

secondary road leading into the village was opened in 2005, villagers began selling maize to middle men who were responding to the increased demand for animal feed in urban areas of Vietnam. Within a year after construction on the secondary road was complete (2010-11) and kilometers of roadside land was made accessible to farmers, market oriented cassava production increased dramatically. This coincided with the arrival of extension agents/ middlemen to the village who promised to buy the cassava that villagers produced. Today, cassava is the most commonly grown crop in the village along with rice, and it provides the highest annual cash income.

The findings of this study add to the literature on teleconnections/telecoupling by highlighting the role that mechanisms of connectivity play in the teleconnection/telecoupling process. The underlying drivers of the changes identified have been in place in Vietnam for many years, but did not reach into the study village until connectivity was established. In the review of literature on teleconnection/telecoupling, the role that appropriate connectivity plays is not focused on, leading one to ask if connectivity is assumed. This case shows that connectivity cannot be assumed and it is only when connectivity is present that the teleconnection/coupling occurs.

Future research can evaluate these changes as they continue to impact livelihoods, land use, and land cover in the study area. A study is needed that focuses on the impact of this type of rural road development on forests in Vietnam, a subject that has long been of interest to researchers in South America in particular. Results from this study suggest that a significant amount of land next to roads has become much more valuable and that in coming years this land may be cultivated on a more permanent basis than previous land use methods had allowed. This may lead to changes in the longevity of fallows and the number of areas that are in the swidden

rotation. Another goal of future research could be to investigate how sustainable the transition from subsistence to commercial agriculture has been in the study area.

Other research must focus on the methodology for mapping land use and land cover change in the uplands of Southeast Asia. Due to the ever changing nature of shifting agriculture, this has proven difficult in the past and a standard procedure does not exist. However, with continuing advancements in land cover change modelling at different scales, there is hope that researchers will identify new and more accurate ways of capturing local-scale land cover change.

## 9. References

- Allens Law. "Vietnam Legal Update." Allens Pte Ltd, 2014. Web. 12 January, 2016.  
[http://www.vietnamlaws.com/vlu/feb\\_2014.pdf](http://www.vietnamlaws.com/vlu/feb_2014.pdf)
- Alther, Cyril, Jean-Christophe Castella, Paul Novosad, Elrick Rousseau, and Tran Trong Hieu. "Impact of accessibility on the range of livelihood options available to farm households in mountainous areas of northern Viet Nam." *Doi Moi in the Mountains: Land Use Changes and Farmers' Livelihood Strategies in Bac Kan Province, Viet Nam*. Hanoi: Agricultural Publishing House, 2002.
- Asian Development Bank. "Pre-investment Study for the Greater Mekong Sub-region East-West Economic Corridor." Manila: ADB, 2001.
- Asian Development Bank. "Strategy and Action Plan for the Greater Mekong Subregion East-West Economic Corridor." Manila: ADB, 2010.
- Bernard, Russell H. *Research Methods in Anthropology: Qualitative and Quantitative Approaches*. Oxford: AltaMira Press, 2006.
- Cam, Hoang. "Forest Thieves: State Resource Policies, Market Forces, Struggles over Livelihood and Meanings of Nature in a Northwestern Valley of Vietnam." *Upland Transformations in Vietnam*. Eds. Thomas Sikor, Nghiem Phuong Tuyen, Jennifer Sowerwine, and Jeff Romm. Singapore: National University of Singapore Press, 2011. Print.
- Castella, Jean-Christophe, Dang Dinh Quang, Tran Dinh Long, and Le Quoc Doanh. "Scaling up local diagnostic studies to understand development issues in a heterogeneous mountain environment: An introduction to the SAM Program." *Doi Moi in the Mountains: Land Use Changes and Farmers' Livelihood Strategies in Bac Kan Province, Viet Nam* Hanoi: Agricultural Publishing House, 2002.
- Castella, Jean-Christophe, Stanislas Boissau, Nguyen Hai Thanh, and Paul Novosad. "Impact of forestland allocation on land use in a mountainous province of Vietnam." *Land Use Policy*. 23 (2006): 147-160.
- Cramb, R.A., Carol J. Pierce Colfer, Wolfram Dressler, Pinkaew Laungaramsri, Quang Trang Le, Elok Mulyoutami, Nancy L. Peluso, and reed L. Wadley. "Swidden Transformations and Rural Livelihoods in Southeast Asia." *Human Ecology*. 37(2009): 323-346

- Cropper, Maureen, Jyotsna Puri, and Charles Griffiths. "Predicting the Location of Deforestation: The Role of Roads and Protected Areas in North Thailand." *Land Economics* 72.2 (2001): 172-186.
- Eakin, Hallie, Ruth DeFries, Suzi Kerr, Eric F. Lambin, Jianguo Liu, Peter J. Marcotullio, Peter Messerli, Anette Reenberg, Ximena Rueda, Simon R. Swaffield, Birka Wicke, and Karl Zimmerer. "Significance of Telecoupling for Exploration of Land-Use Change." *Rethinking Global Land Use in an Urban Era*. Eds. Karen C. Seto and Anette Reenberg. MIT Press, 2014.
- Eakin, Hallie, Alexandra Winkels, and Jan Sendzimir. "Nested vulnerability: exploring cross-scale linkages and vulnerability teleconnections in Mexican and Vietnamese coffee systems." *Environmental Science & Policy* 12.4 (2009): 398-412.
- Ellis, Eric C., Kees K Goldewijk, Stefan Siebert, Deborah Lightman, and Navin Ramankutty. Anthropogenic transformation of the biomes, 1700 – 2000. *Global Ecology and Biogeography*. 19(2010): 589 – 606.
- Epprecht, Michael, and Andreas Heinimann, eds. *Socioeconomic Atlas of Vietnam: A Depiction of the 1999 Population and Housing Census*. Bern: Swiss National Centre of Competence in Research North-South, 2004.
- Food and Agriculture Organization. *A review of cassava in Asia with country case studies on Thailand and Vietnam (Volume 3)*. Rome: FAO and IFAD (2001).
- Fox, Jefferson, Terry Rambo, Deanna Donovan, and Truong M. Dao. "Linking Household and Remotely Sensed data for Understanding Forest Fragmentation in Northern Vietnam." *People and the Environment: Approaches for Linking Household and Community Surveys to Remote Sensing and GIS*, eds. Fox, J., Rindfuss, R. R., Walsh, S. J. & Mishra, V. Boston: Kluwer Academic (2004): 201-222.
- Fox, Jefferson and John B. Vogler. "Land Use and Land Cover Change in Montane Mainland Southeast Asia." *Environmental Management* 36.3 (2005):394-403.
- Fox, Jefferson, John B. Vogler, and Mark Poffenberger. "Understanding Changes in Land and Forest Resource Management Systems: Ratanakiri, Cambodia." *Southeast Asian Studies* (2009), 47.3: 309-329.
- Fox Jefferson, Yayoi Fujita, Dimbab Ngidang, Nancy Peluso, Lesley Potter, Niken

- Sakuntaladewi, Janet Sturgeon, and David Thomas. "Policies, Political-Economy, and Swidden in Southeast Asia." *Human Ecology*. 37 (2009): 305-322.
- Friis, Cecilie and Jonas Ostergaard Nielsen (2014). "Exploring the potential of the telecoupling framework for understanding land change." Integrative Research Institute. THESys Discussion Paper No. 1.
- Geist, Helmut and Eric F. Lambin. "Proximate Causes and Underlying Driving Forces of Tropical Deforestation." *BioScience* 52. 2 (2002): 143-150.
- Geist, Helmut, William McConnell, Eric F. Lambin, Emilio Moran, Diogenes Alves, and Thomas Rudel. "Causes and Trajectories of Land-Use/Cover Change." *Land-Use and Land-Cover Change: Local process and global impacts*. Eds. Eric F Lambin and Helmut Geist. Berlin: Springer (2006): 41-70.
- Gueye, Bara and Karen Schoonmaker Freudenberg. Introduction à la Méthode Accélérée de Recherche Participative (MARP)." *Rapid Rural Appraisal. Quelques notes pour appuyer une*. International Institute for Environmental Development (1991).
- Guneralp, Burak, Karen C Seto, and Mahesh Ramachandran. "Evidence of urban land teleconnections and impacts on hinterlands." *Current Opinion in Environmental Sustainability* 5. (2013): 455-451.
- Gutman, Garik, Christopher Justice, Ed Sheffner, and Tom Loveland. "The NASA Land Cover and Land Use Change Program." *Land Change Science: Observing Monitoring and Understanding Trajectories of Change on the Earth's Surface*. Eds. Garik Gutman, Anthony C. Janetos, Christopher O. Justice, Emilio F. Moran, John F. Mustard, Ronald R. Rindfuss, David Skole, Billy Lee Turner II, and Mark A. Cochrane. Springer Science & Business Media (2004): 17-30.
- Hanh, Duong Bich. "Changing Labour Relations in a Hmong Village in Sa Pa, Northwestern Vietnam." *Upland Transformations in Vietnam*. Eds. Thomas Sikor, Nghiem Phuong Tuyen, Jennifer Sowerwine, and Jeff Romm. Singapore: National University of Singapore Press, 2011. Print.
- Jakobsen, Jens, Kjeld Rasmussen, Stephen Leisz, Rikke Folving, and Nguyen Vinh Quang. "The effects of land tenure policy on rural livelihoods and food sufficiency in the upland village of Que, North Central Vietnam." *Agricultural Systems* 94. (2007): 309-319.
- Jamieson, Neil L. "Culture and Development in Vietnam." Indochina initiative Working Paper No.1. Hawaii: East-West Center, 1991.

Jamieson, Neil L., Le Trong Cuc and A. Terry Rambo. *The Development Crisis in Vietnam's Mountains*. East-West Center Special Reports no. 6. Hawaii: East-West Center, 1998.

Eric F. Lambin, B.L. Turner, Helmut J. Geist, Samuel B. Agbola, Arild Angelsen, John W. Bruce, Oliver T. Coomes, Rodolfo Dirzo, Gunther Fischer, Carl Folke, P.S. George, Katherine Homewood, Jacques Imbernon, Rik Leemans, Xiubin Li, Emilio F. Morano, Michael Mortimore, P.S. Ramakrishnan, John F. Richards, Helle Skanes, Will Steffen, Glenn D. Stone, Uno Svedin, Tom A. Veldkamp, Coleen Vogel, and Jianchu Xu. "The causes of land-use and land-cover change: moving beyond the myths." *Global Environmental Change* 11.4 (2001): 261-269.

Lambin, Eric F., Helmut J. Geist, and Erika Lepers. "Dynamics of Land-Use and Land-Cover Change in Tropical Regions." *Annual Review of Environmental Resources*. 28 (2003): 205-241.

Lambin, Eric F., and Patrick Meyfroidt. "Global Land Use Change, Economic Globalization, and the Looming Land Scarcity". *Proceedings of the National Academy of Sciences of the United States of America* 108.9 (2011): 3465–3472

Lang, Chris. "Deforestation in Vietnam, Laos, and Cambodia." *Deforestation, Environment, and Sustainable Development: A Comparative Analysis*. Ed. Dharendra K. Vajpeyi. Greenwood Publishing, 2001.

Leisz, S.J. "Geographical Settings, Government Policies and Market Forces in the Uplands of Nghe An." *Upland Transformations in Vietnam*. Eds. Thomas Sikor, Nghiem Phuong Tuyen, Jennifer Sowerwine, and Jeff Romm. Singapore: National University of Singapore Press, 2011. Print.

Leisz, Stephen J., Nguyen thi Thu Ha, Nguyen thi Bich Yen, Nguyen Thanh Lam, and Tran Duc Vien. "Developing a methodology for identifying, mapping, and potentially monitoring the distribution of general farming system types in Vietnam's northern mountain region." *Agricultural Systems* 85. (2005): 340-363.

Leisz, Stephen J., Kjeld Rasmussen, Jorgen E. Olesen, Tran Duc Vien, Bo Elberling, and Lars Christiansen. "The impacts of local farming system development trajectories on greenhouse gas emissions in the northern mountains of Vietnam." *Regional Environmental Change* (2007) 7:187-208.

Li, Peng, Zhiming Genf, Luguang Jiang, Chenhua Liao, and Jinghua Zhang. "A review of swidden agriculture in Southeast Asia." *Remote Sensing* 6.2 (2014): 1654-1683.



- Liljestrom, Rita, Eva Lindskog, Nguyen Van Ang, and Vuong Xuan Tinh. *Profit and Poverty in Rural Vietnam: winners and losers of a dismantled revolution*. Curzon Press, 1998 Print.
- Liu, Jianguo, Vanessa Hull, Emilio Moran, Harini Nagendra, Simon R. Swaffield, and B.L. Turner II. "Applications of the Telecoupling Framework to Land-Change Science." *Rethinking Global Land Use in an Urban Era*. Eds. Karen C. Seto and Anette Reenberg. MIT Press, 2014.
- MacAulay, T. Gordon, Sally P. Marsh, and Pham Van Hung. "Agricultural development and land policy in Vietnam: an overview and theoretical perspective." *Agricultural Development and Land Policy in Vietnam*. Eds. T. Gordon MacAulay, Sally P. Marsh, and Phan Van Hung. Australian Centre for International Agricultural Research (2006): 13-40.
- Macedo, Marcia M., Ruth S. Defries, Douglas C. Morton, et al. "Decoupling of forestation and soy production in the southern Amazon during the late 200s." *Proceedings of the National Academy of Sciences* 109.4 (2012): 1341-1346
- Magliocca, Nicholas R., Thomas K. Rudel, Peter H. Verburg, William J. McConell, Ole Mertz, Katharina Gerstner, Andreas Heinemann, and Erle C. Ellis. "Synthesis in land change science: methodological patterns, challenges, and guidelines." *Regional Environmental Change*. 15 (2015): 211-226.
- McElwee, Pamela. "Who Should Manage the Land? Common Property and Community Responses in Vietnam's Shifting Uplands." *Upland Transformations in Vietnam*. Eds. Thomas Sikor, Nghiem Phuong Tuyen, Jennifer Sowerwine, and Jeff Romm. Singapore: National University of Singapore Press, 2011. Print.
- Mertz, Ole, Christine Padoch, Jefferson Fox, R.A. Cramb, Stephen J. Leisz, Nguyen Thanh Lam, and Tran Duc Vien. "Swidden Change in Southeast Asia: Understanding Causes and Consequences." *Human Ecology*. 37 (2009): 259-264.
- Meyfroidt, Patrick, Eric F. Lambin, Karl-Heinz Erb, and Thomas W. Hertel. "Globalization of land use: distant drivers of land change and geographic displacement of land use." *Current Opinion in Environmental Sustainability*. 5 (2013): 438-444.
- Millennium Ecosystem Assessment. *Ecosystems and Human Well-being- Volume 1: Current State & Trends*. Washington DC: Island Press, 2005.
- Minot, Nicholas, and Bob Baulch. *The spatial distribution of poverty in Vietnam and the*

- potential for targeting*. Vol. 2829. World Bank Publications, 2002.
- Miyamoto, Motoe, Mamat Mohd Parid, Zakaria Noor Aini, and Tetsuya Michinaka. "Proximate and underlying causes of forest cover change in Peninsular Malaysia." *Forest Policy and Economics* 44 (2014): 18-25.
- Nepstad, Daniel C., Claudia M. Stickler, and Oriana T. Almeida. "Globalization of the Amazon Soy and Beef Industries: Opportunities for Conservation." *Conservation Biology* 20.6 (2006): 1595-1603.
- Nguyen, Vinh Quoc. "Vietnam's New Land Law: The Impact on Foreign Developers." Tilleke & Gibbins, 2014. Web. 12 January, 2016.
- Ostrom, E., Nagendra, H. "Insights on linking forests, trees, and people from the air, on the ground, and in the laboratory." *Proceedings of the National Academy of Sciences*, 103.51 (2006): 19224-19231.
- Parker, Dawn C. and Vicky Meretsky. "Measuring pattern outcomes in an agent-based model of edge-effect externalities using spatial metrics. *Agriculture, Ecosystems & Environment* 101. 2-3(2004): 233-250.
- Quang Tri People's Committee. "Quang Tri Investment Potentialities and Opportunities." Ed. Thai Xuan Lam, 2010.
- Quang Tri People's Committee. "Quang Tri Potentialities & Opportunities for Development." Ed. Tan Duc Tam (2012).
- Quasim, Muhammad, Klaus Hubacek, and Mette Termansen. "Underlying and proximate driving causes of land use change in district Swat, Pakistan." *Land Use Policy* 34 (2013): 146-157.
- Ramanakutty, Navin, and Jonathan Foley. "Estimating historical changes in global land cover: Croplands from 1700 – 1992." *Global Biogeochemical Cycles* 13.4 (1999): 997-1027.
- Rindfuss, Ronald R., Stephen J. Walsh, B.L. Turner II, Jefferson Fox, Vinod Mishra. "Developing a science of land change: Challenges and methodological issues." *Proceedings of the National Academy of Sciences* 101.39(2004): 13976-13981.
- Rudel, Thomas K., Ruth DeFries, Gregory P Asner, and William F. Laurance. "Changing

Drivers of Deforestation and New Opportunities for Conservation.” *Conservation Biology* 23.6 (2009): 1396-1405.

Samek, Jay H., Do Xuan Lan, Chaowalit Silapathong, Charlie Navanagruha, Sharifah masturah Syed Abdullah, Iwan Gunawan, Bobby Crisostomo, Flaviana Hilario, Hoang Minh Hien, David L. Skole, Walter Chomentowski, William A. Salas, Hartanto Sanjaya. “Land Use and Land Cover Change in Southeast Asia.” *Land Change Science: Observing Monitoring and Understanding Trajectories of Change on the Earth’s Surface*. Ed. Gutman, G., Janetos, A., et al. Springer Science & Business Media (2004).

Seto, Karen C., Anette Reenberg, Christopher G Boone, Michail Fragkias, Dagmar Haase, Tobias Langanke, Peter Marcotullio, Darla K. Munroe, Branislav Olah, and David simon. “Urban land teleconnections and sustainability.” *Proceedings of the National Academy of Sciences*, 109.20 (2012): 7687-7692.

Skole, David L., Mark A. Cochrane, Eraldo A T. Matricard, Walter Chomentowski, Marcos Antonio Pedlowski. “Pattern to Process in the Amazon Region: Measuring Forest Conversion, Regeneration and Degradation.” *Land Change Science: Observing Monitoring and Understanding Trajectories of Change on the Earth’s Surface*. Ed. Gutman, G., Janetos, A., et al. Springer Science & Business Media (2004): 77-96.

Sowerwine, Jennifer. “The Politics of Highland Landscapes in Vietnamese Statecraft: (Re) Framing the Dominant Environmental Imaginary.” *Upland Transformations in Vietnam*. Eds. Thomas Sikor, Nghiem Phuong Tuyen, Jennifer Sowerwine, and Jeff Romm. Singapore: National University of Singapore Press, 2011. Print.

Thanh, Hoang Xuan and Koos Neefjes. “Economic integration and maize-based livelihoods of poor Vietnamese.” Discussion Paper. Hanoi: Vietnam Institute of Economics, 2005.

Turner, B.L., W. B. Meyer, and David L. Skole. “Global Land-Use/Land-Cover Change Towards and Integrated Study.” *Ambio* 23.1 (1994): 91-95.

Tuyen, Nghiem P and Yanagisawa, Masayuki. “Market Relations in the Northern Uplands of Vietnam.” *Upland Transformations in Vietnam*. Eds. Thomas Sikor, Nghiem Phuong Tuyen, Jennifer Sowerwine, and Jeff Romm. Singapore: National University of Singapore Press, 2011. Print.

Van Vliet, Jasper, Nichola Jasper van Vliet, Nicholas R. Magliocca, Bianka Bu`chner, Elizabeth Cook, Jose´ M. Rey Benayas, Erle C. Ellis, Andreas Heinimann, Eric Keys, Tien Ming Lee, Jianguo Liu, Ole Mertz, Patrick Meyfroidt, Mark Moritz, Christopher Poeplau,

- Brian E. Robinson, Ralf Seppelt, Karen C. Seto, and Peter H. Verburg. "Meta-studies in land use science: Current coverage and prospects." *Ambio* 45.1 (2016): 15-28.
- Verburg, Peter, Paul Schot, Martin Dijst, and A. Veldkamp. "Land use change modelling: current practice and research priorities." *Geojournal*, 61 no.4 (2004): 309-324.
- Veldkamp, A., Lambin, Eric.F. "Predicting land-use change." *Agriculture, Ecosystems, and Environment* 85.1 (2001): 1.
- Von Thunen, Johann H. *Von Thunen's Isolated State*. Ed. Peter Hall. Pergamon Press, Oxford, 1966.
- Walker, R. "The scale of forest transition: Amazonia and the Atlantic forests of Brazil." *Applied Geography* 32 (2012): 12-20.
- Walsh, Stephen J., Richard E. Bilborrow, Stephen J. McGregor, Brian G. Frizzelle, Joseph P. Messina, William KT Pan, Kelley A. Crews-Meyer, Gregory N. Taff, and Francis Baquero. . "Integration of Longitudinal Surveys, Remote Sensing Time Series, and Spatial Analysis: Approaches for Linking People and Place." *People and the Environment*. Springer US, 2004: 91-130.
- Winkels, Alexandra. "Stretched Livelihoods': Social and Economic Connections between the Red River Delta and the Central Highlands." *Upland Transformations in Vietnam*. Eds. Thomas Sikor, Nghiem Phuong Tuyen, Jennifer Sowerwine, and Jeff Romm. Singapore: National University of Singapore Press, 2011. Print.
- World Bank. "2012 Vietnam Poverty Assessment." World Bank: Vietnam, 2012.

## 10. Appendices

### Appendix A. Household Survey

Trung Tâm Sinh Thái Nông Nghiệp (CARES)/Học viện Nông nghiệp Việt Nam và Trường Đại học bang Colorado tại Fort Collins, Hoa Kỳ

*Dự án “Tăng tiếp cận, thay đổi cảnh quan, chuyển đổi nông thôn và đô thị hóa: tác động của Hành lang kinh tế Đông – Tây từ Đà Nẵng, Việt Nam đến Khon Kaen, Thái Lan” (Project on “Increased accessibility, landscape changes, rural transformations, and urbanization: Impacts of the east-west economic corridor from Da Nang, Vietnam, to Khon Kaen, Thailand”)*

**Quản lý tài nguyên dọc Quốc lộ 9 trên địa bàn tỉnh Quảng Trị**

**(Natural resource management along Highway 9 in Quang Tri Province)**

**BẢNG hái phóng vấn hộ**

**(HOUSEHOLD questionnaire)**

Hộ số (household number): \_\_\_\_\_ (*According to random sampling – Căn cứ theo việc lấy mẫu phỏng vấn ngẫu nhiên*)

Nơi phỏng vấn (Address):

Tỉnh (Province): Quảng Trị

Huyện (District): Đăk Rông

Xã (Commune): \_\_\_\_\_

Bản/Thôn/Xóm/Làng (Hamlet/Village): \_\_\_\_\_

Tên người phỏng vấn (Name of Interviewer): \_\_\_\_\_

Ngày phỏng vấn (Date): \_\_\_\_/ \_\_\_\_/2014

## Phần 1. Thông tin về người được phỏng vấn (General Household Information)

*(Chỉ dẫn: Chỉ phỏng vấn chủ hộ hoặc vợ/chồng chủ hộ)*

*(Note: Only household head or his wife/her husband will be interviewed.)*

1.1 Tên người được phỏng vấn (*Name of respondent only nickname or first name – not full name*): \_\_\_\_\_

1.2 Người được phỏng vấn có phải là chủ hộ không? (*Is the respondent the head of household?*)  
\_\_\_\_\_ có (*yes*) \_\_\_\_\_ không (*no*).

Nam/nữ (*Male/Female*) \_\_\_\_\_ Tuổi (*Age*): \_\_\_\_\_

1.3 Ông/bà có phải là người sinh ra ở xã này không? (*Are you originally from this community?*) \_\_\_\_\_ có (*yes*) \_\_\_\_\_ không (*no*)

Nếu không, ông/ bà từ nơi nào chuyển đến? (*If not, where did you come from?*)  
\_\_\_\_\_

1.4 Chồng (vợ) của bà/ ông có phải là người sinh ra ở xã này không? (*Is your partner (wife or husband) originally from this community?*)

\_\_\_\_\_ có (*yes*) \_\_\_\_\_ không (*no*)

Nếu không, chồng (vợ) của bà/ ông từ nơi nào chuyển đến (*If not, where did they come from*):  
\_\_\_\_\_

1.5 Gia đình ông bà có bao nhiêu khẩu? (*How many members live in your household?*) \_\_\_\_\_

1.6 Gia đình ông bà có bao nhiêu trẻ em dưới 15 tuổi ở cùng (*How many children (<15 years old) live in your household?*): \_\_\_\_\_

Nam (*Male*): \_\_\_\_\_ Nữ (*Female*): \_\_\_\_\_

1.7 Có bao nhiêu người tuổi từ 15 đến 59 hiện nay đang sống trong gia đình ông/bà? (*How many adults between 15 and 59 live in your household?*) \_\_\_\_\_

Nam (*Male*): \_\_\_\_\_ Nữ (*Female*): \_\_\_\_\_

1.8 Có bao nhiêu cụ già hơn 60 tuổi đang sống trong gia đình ông/bà? (*How many old people (>60) live in your household?*) \_\_\_\_\_

Nam (*Male*): \_\_\_\_\_ Nữ (*Female*): \_\_\_\_\_

1.9 Có thành viên nào của gia đình hiện đang tạm trú ở ngoài làng/bản không? (*Are there any household members who are temporarily residing outside of the community?*)

\_\_\_\_\_ có (*yes*) \_\_\_\_\_ không (*no*)

Nếu có thì ở đâu (*if yes, where?*)  
\_\_\_\_\_

---

Vì sao? (For what reason?) \_\_\_\_\_

1.10 Có thành viên nào của gia đình đã di cư đến nơi khác ở trong nước không? (Have any household members permanently migrated to a different part of the country?)

\_\_\_\_có (yes)                      \_\_\_\_không (no)

Nếu có thì hiện tại họ đang ở đâu? (If yes, where have they settled )

\_\_\_\_\_

Tại sao họ lại bỏ nơi này ra đi? (Why did they leave here?)

\_\_\_\_\_

## Phần II. An toàn dinh dưỡng của nông hộ (Household Food Security)

.. ✦ Nhà ông/bà đủ gạo ăn mấy tháng/năm? (kể cả mua)  
*For how many months each year does your household have sufficient rice to eat? (plus buying rice)* \_\_\_\_\_ tháng (months)

2.2 Mỗi năm nhà ông/bà bị đói mấy tháng? (kể cả độn sắn và ngô)

*For how many months each year does your household suffer from hunger (i.e. you do not have enough rice, other foodstuffs mixed with rice, or replacement food such as cassava or corn to eat)?*

\_\_\_\_\_ tháng (months)

2.3 Nhà ông/bà còn đủ gạo ăn trong mấy tháng nữa (tính từ thời điểm này)? (How many months supply of rice do you currently have in storage?)

\_\_\_\_\_ tháng (months)

2.4 Mỗi tháng nhà ông/bà ăn thịt, cá mấy lần? (How many times each month does your household eat meat or fish?)

Số lần (number of times):    0            1            2            3            4            >4

2.5 Nhà ông/bà có dùng muối Iốt không? (Does your household use iodized salt?)

\_\_\_\_\_ Có, thường xuyên (Yes, all the time)

\_\_\_\_\_ Thỉnh thoảng (sometimes)

\_\_\_\_\_ Chưa bao giờ (never)

## Phần 3. Khả năng tiếp cận thông tin với bên ngoài cộng đồng (Interaction / accessibility to outside world)

3.1 Trong tháng qua ông/bà có (During the past month did you):

	Không	Có	Số lần (Number of times)

	(no)	(yes)					
			1	2-5	6-10	11-14	≥15
Nghe đài không? (Listen to the radio?)							
Xem ti vi? (Watch TV?)							
Đọc báo? (Read a newspaper?)							
Nghe tin từ loa truyền thanh? (listen to the public speaker?)							
Xem phim/video (See a movie/video?)							
Nhận hoặc gửi thư? (Receive or send a letter)							
Tham gia hội họp trong bản/làng? (Attend a community meeting?)							
Gặp gỡ cán bộ khuyến nông (Cán bộ Nhà nước) (Meet an agricultural extension agent?)							
Karaoke / (Billiards)?							
Internet							
Mobifone							
Không (no)							

3.2 Nguồn thông tin chủ yếu về những sự kiện chủ yếu xảy ra ngoài cộng đồng của ông bà:  
(What is your main source of information about events outside of your community?)

*(có thể chọn đến 2 chỉ tiêu nếu người được phỏng vấn không chọn được một chỉ tiêu duy nhất-  
2 sources can be selected if the interviewee did not choose one)*

\_\_\_\_\_ trò chuyện với khách (Talking with visitors to your community)

\_\_\_\_\_ cán bộ nhà nước (Government cadre)

\_\_\_\_\_ đài hoặc ti vi (Radio or TV)

\_\_\_\_\_ báo chí (Newspapers)



- \_\_\_\_\_ gặp gỡ ở chợ (Meeting people in the market)
- \_\_\_\_\_ kết nối internet (Connecting to the internet)
- \_\_\_\_\_ sử dụng điện thoại (Using mobile phone)
- \_\_\_\_\_ khác (mô tả) (Other (describe)): \_\_\_\_\_
- \_\_\_\_\_ không có nguồn thông tin (No source of information)
- 3.3 Khoảng cách từ nhà đến đường ô tô gần nhất? (đến đường ô tô thường xuyên chạy qua) (*What is the distance from your house to the nearest all-season auto road?*)  
\_\_\_\_\_m hoặc (or)\_\_\_\_\_km
- 3.4 Khoảng cách từ nhà đến đường gần nhất, xe máy có thể đi được? (*What is the distance from your house to the nearest road on which a motorcycle can pass?*)  
\_\_\_\_\_m hoặc (or)\_\_\_\_\_km
- 3.5 Trong năm qua thành viên trong gia đình ông/bà có đến (During the past 12 months how many times did members of your household go to):
- \_\_\_\_\_ Trụ sở xã (the village center) Số lần (times) \_\_\_\_ Lý do (reason): \_\_\_\_\_
- \_\_\_\_\_ Chợ gần nhất (the nearest market) Số lần \_\_\_\_ Lý do: \_\_\_\_\_
- \_\_\_\_\_ Thị trấn huyện (the district town) Số lần \_\_\_\_ Lý do: \_\_\_\_\_
- \_\_\_\_\_ Thị xã tỉnh (the province capital) Số lần \_\_\_\_ Lý do: \_\_\_\_\_
- \_\_\_\_\_ Hà Nội (Hanoi, Ho Chi Minh city, Hue, Da Nang) Số lần \_\_\_\_ Lý do: \_\_\_\_\_
- \_\_\_\_\_ Sang Lào (went to Laos PDR) Số lần \_\_\_\_ Lý do: \_\_\_\_\_
- 3.6 Ông/bà thường đi chợ gần nhất bằng cách nào? (By what means do you usually travel to the nearest market town)
- \_\_\_\_\_ Đi bộ (On foot)
- \_\_\_\_\_ Đi ngựa /trâu (Horse/buffalo)
- \_\_\_\_\_ Xe đạp (bicycle)
- \_\_\_\_\_ Xe máy/xe ôm (motorbike/xe om)
- \_\_\_\_\_ Xe khách hoặc xe tải (Bus or truck)
- \_\_\_\_\_ Thuyền (boat)
- \_\_\_\_\_ Khác (mô tả) (*Other (describe)*): \_\_\_\_\_

- 3.7 Thời gian đi đến chợ gần nhất? (How long does it take you to travel to the nearest market town?)  
 \_ \_ \_ giờ (hours)

#### Phần 4. Kinh tế hộ (Household Economy)

##### Hoạt động sản xuất nông nghiệp (Agricultural Activities)

- 4.1 Trong năm vừa qua gia đình sử dụng bao nhiêu đất nông nghiệp? (In the past 12 months how much agricultural land did you cultivate?)

Loại đất (Landuse type)	Số mảnh (No. of fields)	Diện tích (Area: m <sup>2</sup> )	Sản lượng (yield: kg)	Số đỏ (red book)	
				Yes	No
<b>Ruộng lúa nước</b> (Paddy fields)					
Vụ xuân (Spring season)					
Vụ mùa (Summer season)					
Vụ thứ 3? (Third crop?)					
<b>Ruộng cây màu hàng năm</b> (Other annual crops on permanent land)					
<b>Nương lúa (Upland rice)</b>					
Năm đầu ( <i>1<sup>st</sup> year</i> )					
Năm thứ 2 ( <i>2<sup>nd</sup> year</i> )					
Năm thứ 3 ( <i>3<sup>rd</sup> year</i> )					
<b>Nương sắn (Cassava)</b>					
Năm đầu ( <i>1<sup>st</sup> year</i> )					
Năm thứ 2 ( <i>2<sup>nd</sup> year</i> )					
Năm thứ 3 ( <i>3<sup>rd</sup> year</i> )					
<b>Nương ngô (Maize swidden)</b>					

Năm đầu ( <i>1<sup>st</sup> year</i> )					
Năm thứ 2 ( <i>2<sup>nd</sup> year</i> )					
Năm thứ 3 ( <i>3<sup>rd</sup> year</i> )					
<b>Nương khác (Other swidden)</b>					
Năm đầu ( <i>1<sup>st</sup> year</i> )					
Năm thứ 2 ( <i>2<sup>nd</sup> year</i> )					
Năm thứ 3 ( <i>3<sup>rd</sup> year</i> )					
<b>Vườn nhà (Home garden)</b>					
<b>Vườn cây (cây ăn quả, tre, nứa, gỗ) (Tree garden)</b>					
Chè (Tea)					
Cà phê (Coffee)					
Đồng cỏ (Pasture)					
Khác (Other)					

4.2 Ông/bà có đủ đất nông nghiệp để nuôi sống gia đình không? (Do you have sufficient land to support your household?)

\_\_\_\_\_ có (yes)                      \_\_\_\_\_ không (no)

4.3 Nếu không đủ, Ông/bà cần thêm bao nhiêu đất nữa? (If no, how much more land would you need?)                      \_\_\_\_\_m<sup>2</sup>

4.4 Trong 5 năm qua gia đình Ông/bà có được thêm đất hoặc bị mất đất không? (Has your household gained or lost land in the past 5 years?)

**Ruộng lúa nước (Paddy land):**

\_\_\_\_\_ không được, không mất (no gain/no loss)                      Tại sao (Why?):

\_\_\_\_\_ được (gain)                      diện tích-area (m<sup>2</sup>)\_\_\_\_\_                      Tại sao (Why?):

\_\_\_\_\_ mất (loss)                      diện tích-area (m<sup>2</sup>)\_\_\_\_\_                      Tại sao (Why?):

**Nương rẫy (Swidden land):**

\_\_\_\_\_ không được, không mất (no gain/no loss)      Tại sao (Why?):  
 \_\_\_\_\_ được (gain)      diện tích-area (m<sup>2</sup>)\_\_\_\_\_      Tại sao (Why?):  
 \_\_\_\_\_ mất (loss)      diện tích-area (m<sup>2</sup>)\_\_\_\_\_      Tại sao (Why?):

**Loại đất khác (Other land):**

\_\_\_\_\_ không được, không mất (no gain/no loss)      Tại sao (Why?):  
 \_\_\_\_\_ được (gain)      diện tích-area (m<sup>2</sup>)\_\_\_\_\_      Tại sao (Why?):  
 \_\_\_\_\_ mất (loss)      diện tích-area (m<sup>2</sup>)\_\_\_\_\_      Tại sao (Why?):

4.5 Trong năm qua gia đình Ông/bà có nuôi (In the past 12 months did your household raise livestock)?

Loại vật nuôi (Type of livestock)	Số lượng (Number of head)		Ông (bà) lấy thức ăn từ đâu để nuôi gia súc?*		Để ăn (No. of consumed)	Để bán (No. of sold)	Lấy phân (for collecting manure)	Sức kéo (Draft animal power)	Khác (Other)
	Nuôi riêng (per individual)	Nuôi chung (Shared product)	(Source of feeds)						
			Mùa mưa (Rainy season)	Mùa khô (Dry season)					
Trâu (Buffalo)									
Bò (Cattle)									
Lợn (Pigs)									

Gà (Chick ens)									
Dê (Goats )									
Vịt (Ducks )									
Khác (Other )									

\*Ghi chú: Có thể ghi tắt: Rừng rậm hay rừng nguyên sinh (**PF**), Rừng già thứ sinh, có khai thác (**SF**); Rừng tre nứa (**Bam**); Rừng cây bụi cao >2 m (**BC**); Rừng cây bụi thấp (**BT**); Đồng cỏ có thể có 30% cây bụi (**CO**); Từ nương rẫy (**NR**)

\*Note: Index can be used: Dense or primary forest (**PF**), Secondary forest having logging (**SF**); Bamboo forest (**Bam**); Tall grass + bush>2m (**BC**); Low grass + Bush (**BT**); Pasture having up to 30% bushes (**CO**); Swidden field (**NR**)

4.6 Trong năm qua gia đình Ông/bà có nuôi cá không? (In the past 12 months did your household raise fish?)

\_\_\_\_\_ không (no)      \_\_\_\_\_ có (yes)      diện tích ao (area of pond)\_\_\_\_\_m<sup>2</sup>

Sản lượng cá nuôi trong năm qua (Amount of fish raised in past year)\_\_\_\_\_kg

(Chú ý trường hợp cá lồng-Including fish case in the river)

Tài nguyên rừng

..▲ Trong năm qua gia đình Ông/bà có thu nhập sản phẩm tự nhiên ở trong rừng không? (In the past year, did your family have income from forest resource?)

Loại sản phẩm (Type of product)	Nơi thu hoạch sản phẩm (Where)*	Để bán (for sold)	Để sử dụng (Own use)	Cả hai (Both)
Gỗ (Timber)				
Củi (Firewood)				
Tre nứa (Bamboo)				
Măng (Bamboo shoot)				
Nấm, mộc nhĩ (Mush room)				
Cây thuốc (Medicinal plants)				
Động vật (Wild animals)				
Bông chít (Broom grass)				
Mật ong (honey bees)				
Phong Lan (Orchit)				
Cá từ sông (Fish from the river)				

Khác (Other)				

\*Ghi chú: Có thể ghi tắt: Rừng rậm hay rừng nguyên sinh (**PF**), Rừng già thứ sinh, có khai thác (**SF**); Rừng tre nứa (**Bam**); Rừng cây bụi cao >2 m (**BC**); Rừng cây bụi thấp (**BT**); Đồng cỏ có thể có 30% cây bụi (**CO**); Từ nương rẫy (**NR**)

\*Note: Index can be used: Dense or primary forest (**PF**), Secondary forest having logging (**SF**); Bamboo forest (**Bam**); Tall grass + bush >2m (**BC**); Low grass + Bush (**BT**); Pasture having up to 30% bushes (**CO**); Swidden field (**NR**)

Gia đình Ông/bà có quyền quản lý/sử dụng đất rừng không? (*Does your household have the right to use any forest land (non-agricultural land)?*)

Loại rừng (Forest type)	Diện tích (m <sup>2</sup> ) (Area)	Sổ xanh (Green book)	Giấy chứng nhận (Certificate)	Hợp đồng (trong bao nhiêu năm?) (No. of years for contract)
Rừng tự nhiên (Natural forest)				
Rừng tái sinh (Regenerating forest)				
Rừng trồng (Planting forest)				
Đồi trọc (Barren land)				
Rừng sản xuất (Productive forest)				
Rừng đặc dụng (Special use forest)				

Rừng phòng hộ (Protected forest)				
Rừng khác (Other forest)				

Trong 5 năm qua, gia đình Ông/bà có được thêm hoặc bị mất quyền quản lý /sử dụng đất rừng không? (Has your household gained or lost forest land in the past 5 years?)

\_\_\_\_\_ không được, không mất (no gain/no loss)      Tại sao (Why?):

\_\_\_\_\_ được (gain)      diện tích-area (m<sup>2</sup>)\_\_\_\_\_      Tại sao (Why?):

\_\_\_\_\_ mất (loss)      diện tích-area (m<sup>2</sup>)\_\_\_\_\_      Tại sao (Why?):

### Các hoạt động sản xuất khác? (Other Productive Activities?)

... Trong năm qua gia đình Ông/bà có tham gia sản xuất hàng thủ công để bán hoặc để dùng không?  
(In the past 12 months did your household engage in any handicraft production for sale or own use?)

Loại hàng (Type of products)	Bán (Sale)	Sử dụng (Own use)	Cả hai (Both)
Dệt vải (Weaving cloth/clothing)			
Đan lát (rổ, rá, chiếu) Making mats or baskets			
Chế biến thực phẩm/làm rượu (Food/alcohol processing)			
Mộc (carpenter)			
Khác (Other)			



--	--	--	--

4.10 Trong năm qua gia đình Ông/bà có thu được tiền từ dịch vụ buôn bán thương mại?

(In the past 12 months did your household engage in any trade or service?)

Dịch vụ buôn bán thương mại	Có (yes)	Không (no)
Máy sẵn hoặc may đo (Seamstress/tailor)		
Cửa hàng bán đồ tiêu dùng (Shop for consumer goods)		
Nhà hàng (Local restaurant)		
Xe ôm (Motorbike taxi)		
Thợ cắt tóc (Barber)		
Cửa hàng chữa xe máy (Motorbike repair shop)		
Cho thuê xe tải (Truck rental)		
Nhà nghỉ (House for rent)		
Chở thuyền (Boat for rent)		
Sửa thuyền (Boat repair)		
Karaoke / video		
Khác (other)_____		

4.11 Trong năm qua có thành viên nào trong gia đình Ông/bà đi làm thuê kiếm tiền? (In the past 12 months did any member of your household work as a hired worker for wages?)

\_\_\_ không (no)\_\_\_ c ó (Yes).

Nếu có, bao nhiêu ngày/năm? (If yes, how many days per year? \_\_\_ ngày (Days)

4.12 Trong năm qua gia đình Ông/bà thu được bao nhiêu tiền mặt từ tất cả các nguồn? (On average how much cash income does your household earn each month from all sources?)\_\_\_\_\_ VND (có thể tính sau khi đã có số liệu từ 4.13; Section 4.13 can be used for calculation)

4.13 Trong năm qua nguồn thu tiền mặt chính của gia đình là gì ? (During the past year what were the main sources of your household's cash income?)

\_\_\_\_\_ bán nông sản (Sale of crops-describe): \_\_\_\_\_

Số tiền (Amount): \_\_\_\_\_ VND

\_\_\_\_\_ bán vật nuôi (Sale of livestock-describe): \_\_\_\_\_

Số tiền (Amount): \_\_\_\_\_ VND

\_\_\_\_\_ bán gỗ từ đất của nhà (Planting forest): \_\_\_\_\_ VND

\_\_\_\_\_ bán gỗ từ rừng (Forest Timber): \_\_\_\_\_ VND

\_\_\_\_\_ bán củi từ rừng: (Forest firewood): \_\_\_\_\_ VND

\_\_\_\_\_ bán các sản phẩm phi gỗ (Sale of NTFPs): \_\_\_\_\_

Số tiền (Amount): \_\_\_\_\_ VND

\_\_\_\_\_ làm thuê (Wage labor) \_\_\_\_\_ VND

\_\_\_\_\_ bán hàng thủ công (Sale of handicrafts): \_\_\_\_\_ VND

\_\_\_\_\_ thu nhập từ cửa hàng hoặc dịch vụ (Income from shop or service) \_\_\_\_\_ VND

\_\_\_\_\_ lương chính phủ (Government salary) \_\_\_\_\_ VND

\_\_\_\_\_ lương hưu chính phủ (Government pension): \_\_\_\_\_ VND

\_\_\_\_\_ các trợ giúp khác của chính phủ (other government assistance) \_\_\_\_\_ VND

(ví dụ: Program 661, 135, v.v...)

\_\_\_\_\_ thực phẩm và các hàng hoá khác được chính phủ cung cấp (Free food or other goods supplies by government): Mô tả (describe)

loại hàng và số lượng: (Kind and amount of goods) \_\_\_\_\_

\_\_\_\_\_ khác (other): \_\_\_\_\_ Số tiền (Amount): \_\_\_\_\_ VND

4.14 Trong năm qua gia đình Ông/bà đã chi vào những khoản chính gì? (During the past year what were your household's main cash expenditures?)

(kê khai tất cả các khoản chi tiêu bằng tiền mặt-Please, list all expenditure sources by cash!)

**Lương thực, thực phẩm (Food)**

\_\_\_\_\_ gạo (Rice) \_\_\_\_\_ VND

\_\_\_\_\_ lương thực, thực phẩm khác (other food) \_\_\_\_\_ VND

\_\_\_\_\_ Mắm, muối, mì chính, dầu ăn (Fish source, salt, Ajinomoto, cooking oil) \_\_\_\_\_ VND

**Đầu tư cho sản xuất nông nghiệp (Agricultural investment)**

\_\_\_\_\_ cây trồng (crops) \_\_\_\_\_ VND (breeding seeds)

\_\_\_\_\_ phân bón (fertilizer) \_\_\_\_\_ VND

\_\_\_\_\_ thuốc trừ sâu (Pesticide) \_\_\_\_\_ VND

\_\_\_\_\_ thuê lao động (Hired labor) \_\_\_\_\_ VND

(No. of days: ..... for land preparation, transplanting, weeding, harvesting, etc)

\_\_\_\_\_ thuỷ lợi (*Irrigation*) \_\_\_\_\_ VND

\_\_\_\_\_ chăn nuôi (*Livestock*) \_\_\_\_\_ VND (Breeders, feeds, veterinary service, etc.)

**Chi phí cho sinh hoạt (Social activities and furniture.)**

\_\_\_\_\_ quần áo (cloths) \_\_\_\_\_ VND

\_\_\_\_\_ đám cưới , đám tang và các nghi lễ khác (Weddings, funerals, and other rituals) \_\_\_\_\_ VND

\_\_\_\_\_ các hàng hoá tiện nghi tiêu dùng khác (furniture) \_\_\_\_\_ VND

**Các lệ phí, quỹ**

\_\_\_\_\_ thuế (*Taxes*) \_\_\_\_\_ VND

\_\_\_\_\_ phí học đường (*School fees*) \_\_\_\_\_ VND

\_\_\_\_\_ phí y tế (*Medical care*) \_\_\_\_\_ VND

\_\_\_\_\_ các loại Quỹ (*Funds*) \_\_\_\_\_ VND

\_\_\_\_\_ các loại phí khác (*Others*) \_\_\_\_\_ VND

**Các khoản chi tiêu khác (Other expenditures)**

\_\_\_\_\_ trả nợ (*Payments on loans*) \_\_\_\_\_ VND

\_\_\_\_\_ xây/sửa nhà (*Construction of house*) \_\_\_\_\_ VND

\_\_\_\_\_ khác (liệt kê): *Other expenditures (describe):* \_\_\_\_\_ VND

4.15 Ông/bà đánh giá tình trạng kinh tế của gia đình mình như thế nào? (*How would you rate the economic status of your household?*)

\_\_\_\_\_ giàu (*Wealthy*)

\_\_\_\_\_ trung lưu (*middle*)

\_\_\_\_\_ nghèo (*poor*)

\_\_\_\_\_ rất nghèo (*very poor*)

4.16 So với các hộ khác trong bản /làng , mức kinh tế của gia đình Ông/bà (*Compared to other households in this community what is the economic level of your household?*):

\_\_\_\_\_ hơn phần lớn các hộ khác (*Better than most*)

\_\_\_\_\_ trung bình (*average*)

\_\_\_\_\_ nghèo hơn các hộ khác (*poorer than most*)

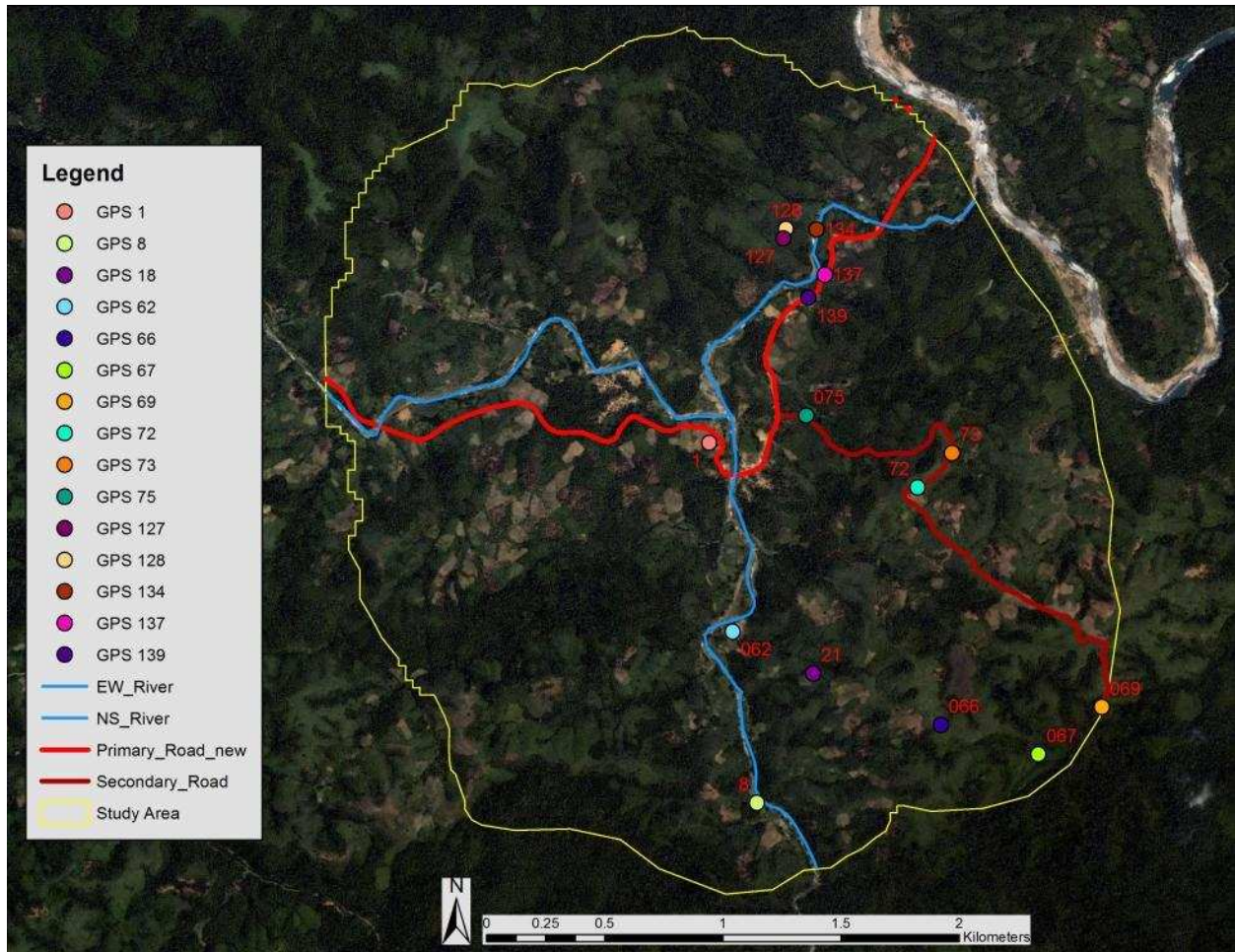
Xin trân trọng cảm ơn ông/bà đã dành thời gian cho cuộc phỏng vấn!

(Thank you very much for your time on this questionanire)

## **Appendix B. Store-owner Interviews**

Questions for store owners include questions such as: When did they open? Where owners are from? Why did they come to the village? And what spurred the opening of the shop? More specific questions related to the shop and its' products included: What products do you sell? Where do they come from? How many daily customers do you have? Do you get customers from outside of the village? Do you do more business in particular seasons? And is there a correlation between season and product sales? Other questions attempted to address changes over time and future prospects: How has the customer based changed since you opened? Do you have plans to expand your shop?

## Appendix C. Ground Truth Points and Location Map



GPS Point: 62

This was taken next to the river (name) facing East. It captures paddy rice on the flat land next to the river, cassava on the hill, and wild banana trees scattered around the hill.

90 degrees



Figure 15

GPS Point: 62

This photo was taken from the same point as Figure 1 but facing southeast. It shows paddy rice in the lowland, cassava on the hill up from the paddy rice, and fallowed land as well as some upland rice beyond that.

145 degrees



*Figure 16*

GPS Point: 62

Photo 3 faces west and shows cassava both in the lowland and on the hill. Next to the cassava on the hill is bamboo on one side and trees on the other.

290 degrees



*Figure 17*

GPS Point: 67

This shows a field of upland rice in the middle, tall and dense trees at the top, and banana trees at the bottom. The small hut located on the side of the hill is used by the farmer to sleep in so that they don't have to make the same hike the next morning.

190 degrees



*Figure 18*

GPS Point: 67

This photo shows the intercropping of upland rice and maize. Banana trees and other trees and bushes are located towards the bottom of the hill.

260 degrees



*Figure 19*

GPS Point: 66

This photo shows some of the land where households allow their cattle to graze. The photo shows a hillside with a large area of wild grass.

340 degrees



*Figure 20*

GPS Point: 69

Figures 7-9 were taken from the new upland road in Ta Rec. Looking NW, Figure 7 shows rice in the immediate vicinity on a steep slope descending from the road. Beyond that are farmers weeding a cassava plot.



*Figure 21*



GPS Point: 69

Figure 8 shows a large cassava plot to the right and a small upland rice plot to its left on a steep, eroded piece of land.



*Figure 22*

GPS Point: 69

Figure 9 is a picture of the new upland road that researchers came upon after hiking up a mountain from the paddy land pictured in Figures 1-3.



*Figure 23*

GPS Point: 72

On the very steep slope right next to the road in this photo, upland rice is being grown. Beyond that on a more moderate slope, cassava is grown. The land that stretches from the top right of the photo diagonally towards the center is used to graze livestock.

140 degrees



*Figure 24*

GPS Point: 73

Taken along a part of the landscape that was carved out for the upland road, this picture shows cassava grown on the hillside directly adjacent to the road.



*Figure 25*

GPS Point: 75

This photo shows broom grass on the left and different ages of acacia trees to the right of the broom grass, with the much more mature trees on the far right



*Figure 26*

No GPS Data Available- Known to be located on upland road.

This photo shows an example of the intercropping of acacia and cassava, a technique suggested to farmers by agricultural extension agents.



*Figure 27*

GPS Point: 139

Located along the road leading into Ta Rec, this picture shows a couple paddy plots with acacia trees planted to the right of the photo and a jack fruit tree on the left.

160 degrees



*Figure 28*

GPS Point: 134

This plot of cassava is planted every year due to the high soil fertility. It is located along the banks of the river in the north part of the village, which is also near the road leading out of the village to the Ho Chi Minh Highway.

260 degrees



*Figure 29*

GPS Point: 137

This area, located along the main incoming road, is a plot where cassava, coffee and jackfruit were planted. In this photo, cassava is in the foreground and coffee trees are on the left of the photo.

240 degrees



*Figure 30*

GPS Point: 137

This is a picture of the same plot as above, but with a more precise look at the close intercropping of fruit trees, cassava, and coffee.



*Figure 31*

GPS Point: 127

This plot, which was only recently planted after four years of fallow, contains upland rice and wild banana trees.

340 degrees



*Figure 32*

GPS Point: 62

This photo was taken from the riverbed and depicts cassava immediately to the left and on the hillside to the right. Upland rice is visible higher up on the mountain in the center of the picture.



*Figure 33*

GPS Point: 8

This photo depicts wet rice along the flat land adjacent to the river that runs north-south.



*Figure 34*

No GPS Point Available

A view from the mountainside overlooking the river that runs north to south. At the bottom of the valley is wet rice. On the sloped area directly above the wet rice and adjacent to the river is cassava. To the right and left of the sloped cassava fields (darker green) are upland rice fields that are towards the top of that mountainside.



*Figure 35*

GPS Point: 8

Taken from the top of a mountain, this photo shows a number of upland rice fields to the right and in the foreground. The valley bottom is visible in the top left where wet rice is being cultivated.



*Figure 36*

GPS Point: 1

This is a picture of the schools that were built right next to residential areas in Ta Rec.



*Figure 37*