This is to certify that the

dissertation entitled
POPULATION PRESSURE,
DEFORESTATION, LAND DEGRADATION
AND POPULATION REDISTRIBUTION
IN THE PLAN SIERRA REGION OF THE CORDILLERA CENTRAL,
DOMINICAN REPUBLIC
presented by

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has been accepted towards fulfillment
of the requirements for

Doctorate degree in Geography

Major professor

Date July 15, 1992

POPULATION PRESSURE, DEFORESTATION, LAND DEGRADATION AND POPULATION REDISTRIBUTION IN THE PLAN SIERRA REGION OF THE CORDILLERA CENTRAL, DOMINICAN REPUBLIC

By

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A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirement
for the degree

DOCTOR OF PHILOSOPHY

Department of Geography

1992

ABSTRACT

POPULATION PRESSURE, DEFORESTATION, LAND DEGRADATION AND POPULATION REDISTRIBUTION IN THE PLAN SIERRA REGION OF THE CORDILLERA CENTRAL, DOMINICAN REPUBLIC

By

Richard Alan Sambrook

Accelerated population growth, deforestation, and land degradation are a major concern of development planners in the Third World. Environmental experts study the cutting of trees to determine the extent as well as the impact of forest conversion on such physical processes as erosion and stream and reservoir silting. However, a major social-human dimension interfaces with these physical processes and poses many questions. What effect, if any, does population pressure have on deforestation, the intensity of agricultural practices, and population redistribution? Do these relationships change over time? Despite the obvious importance of these queries, few researchers have attempted to explain interrelationships between two or more of these processes.

Within the framework of a conceptual model, a series of research hypotheses was formulated to define the nature of the relationships between these principal themes: agricultural intensity, deforestation, human carrying capacity, land degradation, population pressure, and population redistribution. This research was conducted at two spatial scales: the political "section," the smallest organized unit below the municipality for which Dominican census data is published, and the rural farm household. Interval-ratio data from the national census and farm level sample surveys were evaluated by means of bivariate regression and simple correlation analysis.

Results confirm a strong positive relationship between population pressure and out-migration at the political section scale. On the farm level, a moderately strong positive relationship is established between population pressure and deforestation. A similar strength causal linkage is established between deforestation and land degradation. In contrast, only on larger farms is evidence of a weak positive relationship confirmed between population pressure and Boserupian measures of agricultural intensity. Lickert scaling was employed to assess Wolpert's concept of "place utility" in a rural

environment. Migrants who define their occupation as farming reveal a positive correlation between land degradation and the decision to migrate. The role of land degradation, an ecological "push" factor, increases with age. Finally, weak positive correlations among the variables age, education, occupation levels and migration destinations indicate that population redistribution is significantly less selective than anticipated of a "late transitional society," within the context of Zelinsky's mobility transition model.

Dedicated to
Everett A. Benjamen Sambrook
Born
March 20, 1987
Clinica Corominas
Santiago de los Caballeros
Dominican Republic

ACKNOWLEDGEMENTS

A number of individuals need to be recognized for their contributions toward the successful completion of this dissertation. My sincere gratitude is expressed to the members of my doctoral committee: Dr. Robert N. Thomas, Chair; Dr. David J. Campbell; Dr. Bruce W. Pigozzi; and Dr. Jack F. Williams, all of the Geography Department. Dr. Lee M. James, former Chair of the Forestry Department, served as a committee member and Dean's representative from the Graduate School. Dr. Judy M. Olson, Chair of the Department of Geography, graciously provided office space in the Urban Planning Building after my return from the Dominican Republic.

This research would not have been possible without the generous help of many individuals in the Dominican Republic. Geographer Rafael Emilio Yunén introduced me to the problems of deforestation, land degradation, and population pressure in the Plan Sierra region of the Cordillera Central. His encouragement and guidance during the formative phases of this research were invaluable. Rector Nunez of the Pontificia Universidad Católica Madre y Maestra in Santiago de los Caballeros was a gracious host and constant source of support and spiritual inspiration during my twenty-two month stay in the Dominican Republic. Domingo Franciso, a graduate of the Sociology Department at PUCMM, worked closely with me during the field work phase of the research. He was largely responsible for the selection and training of the twelve students who conducted over 450 farm household interviews. Pedro Juan del Rosario of the Center for Urban and Region Studies (CEUR) offered many useful suggestions for conducting survey research in the Plan Sierra region. Frekye Olivo, staff cartographer of CEUR helped with forest cover map compilation. Dr. Eduardo Luna, formerly of the Mathematics Education Department at PUCMM, assisted with preliminary data compilation and statistical analysis. Señor Blas Santos, Director of Plan Sierra, generously gave me access to aerial photography, maps, and sample survey data collected by his staff. Domingo Fortuna, staff member in charge of the air photo archives and mapping section at Plan Sierra was very helpful. Finally, I wish to express my thanks to the following people in Santo Domingo: Señor Pichardo of the Dominican Office of National Statistics (ONE); Señor José Joaquín Hungria Morell, Director of the Pan American Institute of Geography and History, and; Señor Orlando Adams of the National Cartographic Institute.

My wife, Stephanie Wilson Sambrook, designed the layout and typed the final version of the field questionnaire. She critically reviewed the pre-test and pilot sample survey responses, prepared base maps for section level data analysis, and compiled forest cover maps. In addition, my spouse actively participated in the processing and compilation of questionnaire data. Finally, Stephanie unselfishly reviewed various drafts of the dissertation and made many useful suggestions for improving both the data analysis and the writing.

Since my return from the Dominican Republic the following individuals merit my gratitude. Mr. Mel Taylor of the Computer Center at Central Michigan University served as a SAS consultant and greatly contributed to the statistical analysis of the data. Dr. John Patton of the Computer Center at Miami University facilitated the transfer of SAS data and program files to Oxford, Ohio, which allowed me to complete the research. Several of the maps found in the earlier chapters of the dissertation were prepared by the Graphics Department at Central Michigan University. The majority of the maps found in the latter chapters of the text were prepared by the Center for Cartographic Research and Spatial Analysis at Michigan State University. These maps are to be included in a series of articles currently being prepared by the author and select members of his doctoral committee. During the last two years in Oxford, Dr. Richard V. Smith and Dr. John C. Klink, Chair of the Department of Geography and Planning, have been especially supportive of my research interests in Latin America. Finally, I owe a special thanks to Mrs. Peggy Christian for helping me put the final draft of this document together.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Preface

Contents and Objectives
of Dissertation

Introduction

Since the end of the Second World War (1945), explosive population growth in developing areas of the world has stimulated accelerated deforestation. Rapid conversion of primary forest has taken place to provide for: the expansion of lands for food production; fuelwood and charcoal production for household cooking and heating; and logwood and construction timber, with some commercial lumber exports intended specifically to generate foreign exchange. In a few countries, change in natural forest canopy has been carefully managed to facilitate long-term socioeconomic development. Unfortunately, in most localities of the Third World, rapid tree removal, in conjunction with poor silviculture and poor soil conservation practices, results in large-scale environmental degradation. Extensive soil loss, primarily in the form of gullying and mass wasting, subjects rural residents to decreased food production and deprives them of vital natural vegetation growth, especially in ecologically sensitive areas; all combine to further increase population pressure on the land.

In developing areas where agroforestry or appropriate silviculture and farming systems lead to sustainable ecosystems, land degradation is minimized. In some cases, human carrying capacity may be increased to generate in-migration. In contrast, in areas where land degradation negatively impacts biomass productivity, rapid deforestation may ultimately lead to a decrease in population-supporting capacity. Subsequently, out-migration may occur as a major social response to these dynamic interrelated processes. An explanation of these competing social responses to population pressure and their associated impacts on both the physical environment and population redistribution are worthy of spatial analysis.

Accelerated population growth, deforestation and land degradation are a major concern of development planners in the Dominican Republic (Antonini and others 1974, 1975; Hartshorn and others 1981; Kemph and Hernandez 1987; Lang 1988). Environmental experts have studied the extent as well as the impact of deforestation on such physical processes as erosion and stream and reservoir silting (Hartshorn and others 1981). However, a major social-human dimension interfaces with these general physical processes and poses many related questions. What effect, if any, does population pressure have on deforestation, land degradation, and ultimately, population redistribution? Do these relationships change over time? Moreover, how are incipient agricultural intensification practices (in response to pervasive population pressure) related to environmental change? Has population density already exceeded the carrying capacity of the traditional hillslope farming system, especially in more marginal mountainous areas? If so, is the rural environment of the Dominican Republic becoming a degraded place to live, one which no longer satisfies the "place utility" of traditional farming households? Consequently, does land degradation act as a resource "push" factor which may trigger a decision to migrate? If so, who moves where and why? More importantly, perhaps, why do some people choose to stay behind? Finally, what are the short and long-term implications, both national and international, of an increasing number of ecological refugees fleeing traditional small farm areas of the Dominican Republic?

Research Goals

The primary objective of this dissertation is to answer these related research questions and explain the linkages between these dynamic processes and variables. To accomplish this task a conceptual model is proposed that will serve as the theoretical framework for the research. This model draws heavily from conventional population-economic, people-environment, and behavioral-migration theory. Within the framework of the conceptual model, a series of research hypotheses is formulated to define the nature of relationships and associations between the principal themes examined in this dissertation: agricultural intensification, carrying capacity, deforestation, land degradation, population pressure and population redistribution.

Relevance of Research

Despite the obvious importance of these themes in the Third World, few researchers in the natural or social sciences have attempted to explain the nature of the interrelationship between two or more of these processes or variables. This dissertation attempts to both critically examine these related processes in a single conceptual model and empirically assess the model in a representative developing country (the Dominican Republic) spatially at two different scales of analysis (the political section and the farm household) and temporally over approximately a thirty year time frame.

Research Organization and Field Work

The presentation of this research is organized into seven chapters, following a brief preface which details the contents and intent of the dissertation. The first chapter functions as an historical overview of population distribution, growth, and patterns of internal and external migration, changing states of natural forest and vegetation cover, and land use and degradation in the Dominican Republic. Chapter Two provides a critical review of appropriate selections of published research pertaining to the problem. This literature can be grouped into three general theoretical bodies. One is people-environment theory or human-cultural ecology. Within this body lie the social causes of land degradation, viewed from the perspective of small farm managers. Another is economic theory, specifically that dealing with population and resource relationships. Included in this body are the concepts of human carrying capacity, population pressure, and agricultural intensification. Last is behavioral and conventional migration theory, pertaining to perceptions of "place utility" and the propensity to migrate as well as to resource push factors or environmental stresses that actually trigger migration decisions.

Chapter Three introduces the proposed conceptual model that serves as the theoretical framework for this research. As noted, the model attempts to link conventional population-economic, people-environment, and behavioral-migration theory in order to explain the processes addressed in the related research questions. The strength of the associations, or linear relationships among variables paired by hypotheses that predict the direction of the relationships proposed in the model, will be tested by means of simple correlation or bivariate regression analysis.

The fourth chapter initially characterizes the Plan Sierra region of the Cordillera Central as the study area. The balance of the chapter will discuss, in order: definitions of key variables, terms, and equations; the field survey, including sampling strategy and questionnaire design; and methods of analysis. In the fifth and sixth chapters, summary results of both the field questionnaire, simple bivariate regression, and correlation analysis are discussed in order to assess the various links in the conceptual model and their contributions to prevailing theory. Chapter Five focuses on results related to population pressure and resultant land use; Chapter Six on the motivations for migration and destination choices. The last chapter discusses the conclusions and important implications of this dissertation and makes recommendations for future research. Following that, the field sample questionnaire and variable directories for the various data sets analyzed in this dissertation are included as appendices.

Field work for this dissertation was conducted over an extended visit to the Dominican Republic, which lasted approximately from August 15, 1986 through May 15, 1988. The formal questionnaire was administered during the month of February 1987, with the pilot sample, pre-testing and training of interviewers accomplished in January of the same year.

Chapter One

Population Dynamics and Forest Resources in the Dominican Republic

Introduction

The Dominican Republic has experienced rapid population growth, like most developing countries since the end of the Second World War which apparently has stimulated deforestation and population redistribution. The relationship between accelerated population growth and rapid depletion of natural resources on the Island of Hispaniola was first reported by Crist in 1950 and Dyer in 1954. From 1965 through 1975 the rate of natural increase ranged from a high of 3.24%, for the five-year period 1965 to 1970, to 3.09% for the five-year period 1970 to 1975 (Loaiza C. 1983). However, the average intercensal natural growth rate from 1970 through 1981 was 2.9%, indicating a gradual decline in the natural growth process. Specific reference to population growth and increased forest conversion in the Dominican Republic resulted from the United Nation's Food and Agriculture Organization (FAO) baseline studies conducted during the early 1970s (United Nations 1973; Antonini and others 1975).

The accelerated population growth generated a number of social, demographic, economic and ecological problems. For example,

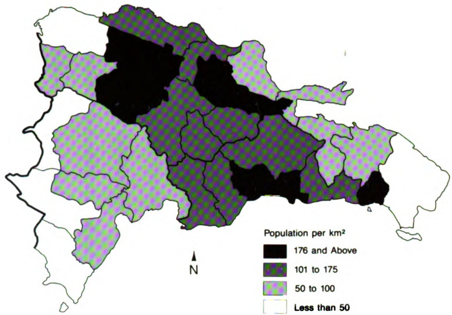
> The baby boom of the '50s and '60s put the economically active population (15-64 years of age) in the minority (49%) in 1978. In that same year 48% of the population was under 15 years of age. In the past few years the birth rate (per 1000) has risen to 45--the highest in the Caribbean region. Infant mortality of 83 per 1000 live births is one of the highest in Latin America (Hartshorn and others 1981, 11).

By the year 1980 the Dominican population had soared to over 5.6 million. Crude birth rates slowed, somewhat, to 34.6 per 1000 and total fertility rates fell below five (4.8), demonstrating the success of large-scale family planning efforts. Crude death rates declined to 9.1 per 1000 with life expectancy at birth averaging 60.3 years.

By the early 1980s the Dominican Republic already was one of the most densely populated countries in Latin America (crude density), averaging over 115 persons per square kilometer (Figure 1.1). This figure, realistically, should be set much higher, as much of the land in the Dominican

Figure 1.1

Crude Population Density by Province, the Dominican Republic, 1981



Republic is not considered suitable for agriculture (Hartshorn and others 1981, 57). Estimates of physiological density for the republic were set at 267 inhabitants per square kilometer, based on arable land measures (Hartshorn and others 1981, 11).

The majority of the population is concentrated in urban corridors of the central lowland valleys, which generally separate the country into three parts. Low population densities are found along the mountainous border with the Republic of Haiti and at the extreme eastern end of the island. The highest population concentrations in the country are found in the National District, which contains the capital city of Santo Domingo. In 1970, this area had surpassed 550 persons per square kilometer; by 1980 the density in the district soared to 1050 persons per square kilometer, an increase of over ninety percent. The provinces of Santiago, Valverde, and San Pedro de Macoris demonstrate similar growth patterns (Beetstra 1983). In 1990, the population of the Dominican Republic broke the seven million mark; roughly a third of the people live in the National District, over 675,000 live in the province of Santiago.

Population Redistribution

Historically, population redistribution in the Dominican Republic has been characterized by three general migration streams. The first, and most important in terms of numbers of internal migrants, is defined as rural out-migration from highland areas toward the central valley urban corridors (Figure 1.2). The Sierra region of the Cordillera Central and mountainous southwest (Sierra Barouco) are the most important migrant source areas for these flows (Ramírez, Tactuk and Bretón 1977). A second important external migration stream originates from the mountainous Haitian border area where both legal and illegal immigrants gravitate toward coastal villages and cities. Thirdly, there is a general movement of people from small coastal city areas toward the larger urban centers found in the lowland valley corridors of the republic. Finally, and most recently, there is a well defined international flow of Dominican emigrants to the United States, specifically to New York City.

Within the Dominican Republic, the two primary urban destinations are the capital, Santo Domingo, located along the Caribbean coast, and the major regional center of Santiago de los Caballeros, located at the terminus of the western Cibao valley. Migration patterns to these

Figure 1.2

Migration Streams in the Dominican Republic

destinations differ in a number of important ways. Traditionally, the movement to Santo Domingo is characterized as step-wise migration, where migrants "stepped" their way up through the urban hierarchy sequentially over a number of moves. For example, recent studies determine that slightly less than two-thirds (62%) of the in-migrants to the capital city are from urban centers with populations greater than five thousand people; fifty-six (56%) percent of the in-migrants are from the North-Cibao Region, presumably from the city of Santiago (Ramírez 1981).

Although some migrants from the north coast still move step-wise fashion to Santiago, in anticipation of a future move to the capital, most migration flows to Santiago now appear to be primarily "direct" rather than the step-wise pattern. Recent research indicates the in-migrants are not from the smaller cities in the hinterlands but come directly (59%) from the rural political sections and parishes of the countryside (Ramírez 1981). Explanations for these direct moves include: close proximity of rural source areas; general economic problems and overall lack of opportunities in the intermediate sized cities; the traditionally high standards of living and employment opportunities in Santiago; and finally changing perceptions toward the capital which is losing its popularity as an internal destination (Duarte 1980, 1986; Grasmuck 1984).

As mentioned before, Santiago de los Caballeros has traditionally been a widely-chosen temporary home for migrants who have eventually taken up permanent residence in Santo Domingo. Additionally, Santiago's popularity is growing both as a final destination and as a "staging area" for international migration. Migrants from the mountainous areas surrounding the city frequently move to Santiago prior to migrating to the United States.

The international out-flow of Dominicans, especially to the United States, is both noteworthy and well documented (Ugalde, Bean and Cardenas 1979; Morrison and Sinkin 1982). For a country of only seven million inhabitants, the Dominican Republic ranks seventh as a source area for immigration to the United States; this is outstanding when one considers the low levels of refugee migration and comparatively small population base. Moreover, Dominicans are well known to manipulate U.S. immigration laws to their advantage through the extended family system (Bryce-Laporte 1979).

Consequently, the process of "chain migration" has been established for almost thirty years, facilitating the eventual movement of Dominican family members to the United States.

Population redistribution is considered the primary demographic response to accelerated population growth in developing countries. Consequently, it is likely that the dynamic migration streams in the Dominican Republic may be attributed to increasing population pressure on natural resources over the past forty-five years. On the other hand, traditional rural societies also employ a number of economic strategies in response to pervasive population pressure on food production resources. Customarily, conversion of primary forest vegetation to agricultural land is considered an important initial response. The following section will assess recent changes within major vegetation complexes of the Dominican Republic.

Overview of Forest Cover

The natural vegetation of the Dominican Republic is classified according to the Holdridge system of life zones. This system is based upon two independent climatic parameters, mean annual rainfall and bio-temperature, where bio-temperature "differs from regular temperature in that it substitutes zero for all unit values above 30 C. and below 0 C. For example, bio-temperature in the Dominican lowlands is lower than the standard temperature" (Hartshorn and others 1981, 13).

Nine ecological zones were delimited by the OAS's natural resources inventory in 1967 (Figure 1.3), based on a first order classification (Hartshorn and others 1981). The two major life zones--subtropical moist forest and subtropical dry forest--cover about sixty-eight percent of the surface area of the republic. However, the subtropical lower montane wet life zone--covering about seven percent of the surface area--is cited as being the most important for the future development of the country; it contains the headwaters of the major rivers in the Cordillera Central, which are critical for irrigation in the lower western Cibao valley and the generation of hydroelectric power for the major urban center in Santiago de los Caballeros (Hartshorn and others 1981, 1).

In all, seven of the nine Holdridge Life Zones are found in varying degrees in the Cordillera Central (Table 1.1). The subtropical dry forest--second most extensive in the country (20.72%)-- is found in the western Cibao valley and effectively covers the lower Rio Yaque del Norte watershed.

Figure 1.3

Holdridge's Life Zones in the Dominican Republic

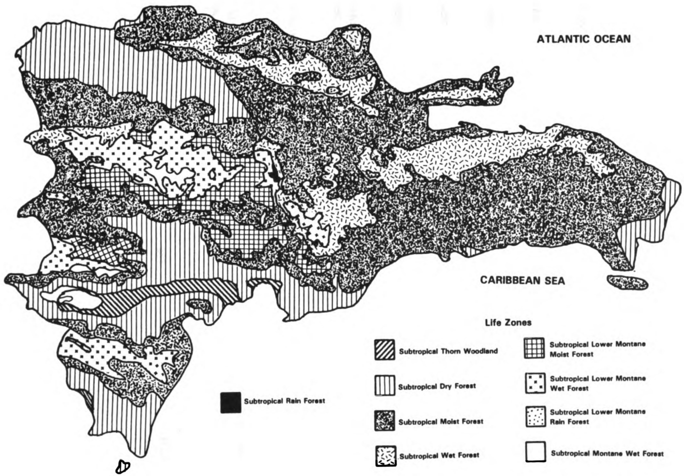


Table 1.1

Area of Holdridge Life Zones in the Dominican Republic
(OAS Natural Resources Inventory 1967)

Life Zone	Area in Km(sq.)	Percentage
Subtropical Thorn Woodland	1,001	2.08%
Subtropical Dry Forest	9,962	20.72%
Subtropical Moist Forest	22,794	47.42%
Subtropical Wet Forest	6,834	14.22%
Subtropical Rain Forest	56	0.12%
Subtropical Lower Montane Moist Forest	3,480	7.24%
Subtropical Lower Montane Wet Forest	3,577	7.44%
Subtropical Lower Montane Rain Forest	36	0.08%
Subtropical Montane Wet Forest	303	0.63%

Sources: Hartshorn and others 1981, Environmental Profile, 13; OAS 1967, Reconocimiento y Evaluación de los Recursos Naturales de la República Dominicana: Estudio para su Desarrollo y Planificación, Washington, D.C.

Rising from sea level, near Monte Cristi, to about 700 meters near Santiago the life zone receives a range of 500 to 1000 mm. of rainfall annually. Mean annual bio-temperatures range from eighteen to twenty-four degrees Celsius. The natural vegetation is comprised of a "low, single-stratum forest with an abundance of sclerophyl-leaved species" (Hartshorn and others 1981, 16). Moreover,

> These dry forests are the major source areas for charcoal, as well as the primary browse for goats. Indiscriminate and uncontrolled cutting of trees for charcoal and an open-range approach with goats has led to significant degradation wherever natural vegetation is accessible. Slash and burn farmers ("conuqueros") who have traditionally avoided this Life Zone due to the high risk of drought-caused crop failure, are now beginning to advance the "agricultural frontier" into the dry forests (Hartshorn and others 1981, 16)

The subtropical moist forest life zone is found in the foothills (anti-Sierra) of the Cordillera Central below an elevation of 850 meters. This is the largest life zone in the country covering almost half the surface area (47.42%). Throughout the zone mean annual rainfall ranges from 1000 to 2000 mm. with bio-temperatures ranging from eighteen to twenty-four degrees Celsius. In addition, it appears that yearly rainfall trends generally increase from west (less than or equal to 1500 mm) to east (greater than 1500 mm). Natural vegetation is described as a "well developed, heterogeneous forest of broad-leafed trees," and because this life zone traditionally has been considered the most suitable for agriculture, only fragments of the natural flora remain (Hartshorn and others 1981, 16).

The third most important life zone--subtropical wet forest--covers approximately fifteen percent (14.22%) of the surface area of the republic and is found in the southeastern portion of the Cordillera Central. In addition, there is a concentration of subtropical wet forest along the northwestern flank of the Cordillera Central. Although this life zone does extend to sea level in a few locations, it is usually found in elevations above the subtropical moist forest zone where mean annual rainfall ranges from 2000 to 4000 mm. with bio-temperatures ranging from eighteen to twenty-four degrees Celsius. The natural vegetation of the subtropical wet forest life zone "is a heterogeneous multi-stratal forest usually dominated by broadleaved tree species" (Hartshorn and others 1981, 16). However, "natural vegetation has been largely destroyed, leaving minor remnants only in the most inaccessible places" (Hartshorn and others 1981, 17).

The subtropical lower montane moist forest life zone is found primarily on the eastern, southern, and to a lesser extent on the northern slopes of the Cordillera Central. This life zone covers approximately seven percent (7.24%) of the surface area of the country. Mean yearly precipitation ranges from 1000 to 2000 mm. with average bio-temperatures of between twelve to eighteen degrees Celsius. Natural vegetation in the life zone consists primarily of open pine forests that occur above 800 meters in elevation, however:

> the majority of the land in this Life Zone has been deforested or seriously degraded by slash and burn agriculturalists. Inappropriate hillside farming on poor, shallow soils has resulted in serious erosion and loss of fertility, with the consequence of substantial abandonment of land or conversion to poor pasture. (Hartshorn and others 1981, 18).

As noted earlier, the subtropical lower montane wet forest is considered by development planners to be crucial for future watershed management. The life zone covers approximately seven and one-half percent (7.44%) of the surface area in the republic. It is specifically found in the middle portions of the Cordillera Central at elevations between 850 and 2100 meters, where mean yearly precipitation ranges between 2000 and 4000 mm. with bio-temperatures ranging between twelve and eighteen degrees Celsius. The native plants are typified by a complex mixture of broadleaved forests, which occur in valleys and on lower slopes, and pine forests that develop on the ridges and upper slopes (Hartshorn and others 1981, 18). Ecologists note that this vital life zone

> is receiving considerable pressure from slash and burn agriculturalists, who are advancing deeper into the major mountain ranges. There are precious few patches in the Life Zone with soil suitable for permanent agriculture. (Hartshorn and others 1981, 18).

Finally, the subtropical lower montane rain forest life zone is found exclusively in the Cordillera Central. However, this vegetation type is particularly rare and is found only in three isolated patches totaling no more than thirty-six square kilometers. Here, the natural vegetation is "characterized by the dominance of broadleaved species, and the abundance of tree ferns and epiphytes" (Hartshorn and others 1981, 18).

Three of the Holdridge life zones are found within the thirty-four political sections that define the Plan Sierra region (forestry and resource management area) of the Cordillera Central. The subtropical dry forest blankets approximately twenty-five percent of the surface area in the northernmost political sections, extending from Gurabo and Cacique in the west through the Section of Mesetas in the east (Figure 4.3). Roughly thirty-five percent of the Plan Sierra management area is covered by the subtropical lower montane moist forest life zone at higher elevations. The balance of the management area is covered by the subtropical moist forest at elevations below 800 meters.

Overview of Deforestation

Through the early 1920s the Dominican Republic possessed untapped timber resources important for national development. In 1921, "closed" forests alone were estimated to cover at least seventy-five percent of the country's land surface (Durland 1922). Significant deforestation in the Dominican Republic began after the political rise to power in 1930 of General Rafael Trujillo. Prior to the start of the Second World War, Trujillo and close members of his family largely controlled, actively promoted and financially profited from the rapid development of timber resources. However, by 1943, this figure (75%) had decreased only minimally to approximately sixty-nine percent forest cover (Fundación Florenda 1986). On the other hand, as early as 1937, his Secretary of Agriculture, Carlos Chardon, raised public awareness to the dire consequences of deforestation and soil erosion (Antonini and others 1974; 1975).

During Trujillo's reign which lasted from 1930 until 1961, the Dominican government did little to manage their forest resources despite convincing scientific evidence that a major ecological problem was in the making. For example, it is estimated that between the years 1943 and 1958 Dominican forest reserves decreased by one-third (Sachtler 1974). This represents a forest conversion rate of 2.24% annually for the fifteen-year period or the equivalent of 75,000 hectares per year. Furthermore, within the thirty-year period from 1941 to 1971 Dominican forest cover diminished by approximately fifty percent (Sachtler 1974). In addition,

> When compared with actual forest cover according to FAO [1973], the pure pine forest [has] decreased in area about 30% while the mixed pine-broadleaved forest lost over 70%. The striking difference in rates of presumed deforestation is probably due to the topographically lower location of the mixed forest, hence it was more accessible for logging and the better soil under the mixed forest.
>
> Further extrapolations of the primeval broadleaved forests using Life Zones suggests 86% of the humid broadleaved forests and 69% of the sub-humid broadleaved forests have been deforested. These very crude estimates of deforestation do indicate the pressures for

> conversion of lowland forests to non-forest use. Only in the highlands are the deforestation pressures less on the pure pine forests (Hartshorn and others 1981, 19).

Throughout the Trujillo era, the tree-covered frontier was placed under the legal jurisdiction of a select number of lumber companies, especially commercial interests owned outright by Trujillo or close family members. Consequently, rights to land and water as well as forest products were controlled by the President or quasi-independent companies (Antonini and others 1975, 53-56). The dictator attempted to restrict access to the highland frontier and thereby limit competition from small farmers and others for forest resources. As a result, population pressure in the older established agricultural areas reached an explosive level. With Trujillo's death in 1961, the land- hungry agriculturalists and small scale timber cutters invaded the forested slopes with little regard for the prior legal claims of the large lumber companies. However, as a result of the uncontrolled forest cutting that occurred after Trujillo's death (1961) the Dominican Government, in 1967, banned all commercial lumbering and outlawed the cutting of live trees.

This dramatic action by the Dominican government set a global precedent for developing countries. It was the first occasion where an elected civilian government banned all commercial lumbering activities and made unlicensed cutting of trees a crime. The legislation has been somewhat effective, where we find:

> The 1967 law closing sawmills and prohibiting the cutting of trees certainly is a major factor in reduced deforestation. It should be noted that pine forests occur on poor soils in remote and rugged terrain, hence of negligible interest to agriculturalists. Consequently the closing of sawmills took away the major threat and FORESTA [Forest Service] has done an excellent job protecting the remaining pine forests (Hartshorn and others 1981, 19).

Since 1967, governments of other developing countries also have restricted commercial lumbering and tightly controlled the sale of precious hardwoods.

Despite these bold legislative actions in the Dominican Republic, several recent reports indicate that the accelerated rate of deforestation continued after 1967. The results of a 1980 FAO national forest inventory estimated that only 1,846,000 hectares of forested land remained--about (38%) thirty-eight percent of the total land area of the Dominican Republic--pointing out a loss of 379,000 hectares since 1958. These losses are not encouraging and indicate that Dominican forests continued to decrease at a rate of 17,227 hectares annually or about one percent per year (Olson and others 1984, 16).

In the early 1980s deforestation once again became a sociopolitical issue of national importance. A depressed economy and pronounced increase in the price of oil-based fossil fuels placed even greater demands on the Dominican forest reserves. In addition, extensive physical damage to large financial investments in the infrastructure were reported:

> Regional and national developments, including irrigation systems, hydroelectric projects, and aqueducts, are being severely affected by rapid siltation, poor water quality, and downstream floods. To illustrate the huge losses involved, siltation has cut the projected operational life of two recently constructed dams by at least half.
>
> The Valdesia reservoir has 22 meters of sediment at the heel of the dam, only 8 meters from the intake. The Tavera reservoir, completed in 1973, already has 18 meters of sediment behind the dam, causing a 40% reduction in dead storage capacity and a 10 to 15 meter loss of active storage. In short, the degraded condition of the country's watersheds is a national catastrophe (Olson and others 1984, 24).

As a consequence of these events, the Dominican government took renewed action. In cooperation with USAID, it laid the groundwork for a National Forest Management Plan and 1983 was declared the "Year of Reforestation."

Recently, Canadian geographer Fournier, in association with Dominican resource economist, Arturo-Russell, analyzed regional land use/land cover change for the period 1972 to 1986. Their study area comprised the western third of the Dominican Republic and covered a 150 by 210 square kilometer area, the equivalent of two adjoining LANDSAT frames. Over the fourteen-year period, they observed a high rate of deforestation in both the broad-leaf deciduous and pine forests (30%) and in the dry-shrub forests (29%). They also detected significant increases in pasture land (26%) and overall cultivated land (68%). Moreover, according to their calculations, while the percentage of productive (timber-quality) forest in their study area was twenty-eight percent or about 767,800 hectares in 1972/73, it had dropped to twenty-three percent of the land area or 619,900 hectares by 1979, and to about twenty percent by 1985/86.

In total, approximately 230,600 hectares of both broad-leaf deciduous and pine forest had been cleared during the fourteen years--an average of 14,475 hectares annually, significantly higher than the national average based on earlier FAO statistics. The rate of deforestation in the dry-shrub forest was estimated even higher at 17,000 hectares per year. Nevertheless, Fournier and Arturo-Russell did observe a slowing of the forest conversion process during this time; for example, the annual rate of deforestation had dropped to 2.4% or about 18,500 hectares per year between 1972/73 and 1979. In the period 1979 to 1985/86 the rate of deforestation declined to 1.8% per year or about 11,800 hectares annually. The combined rate of deforestation for the fourteen-year span was 15,300 hectares per year, or about two percent annually (Fournier and Arturo-Russell 1987).

Land Use

Current land use in the Dominican Republic clearly perpetuates the traditional dominance of agriculture on the landscape. Based upon the most recent complete agricultural census available (1971), approximately eighty-five percent of the land area is dedicated to agriculture (Table 1.2), with the greatest majority of the farmland dedicated to pasture-grazing (43.7%) and permanent cultivation (28.1%); remaining land use includes: seasonal cultivation, monocrop, (7.8%); seasonal cultivation, mixed, (3.1%); fallow (5.3%); woods and forests (9.4%); and other uses (2.6%). Similar results were produced from the Comprehensive Resources Inventory and Evaluation Survey (CRIES 1980), where (82.6%) of the land use or cover is attributed to some form of agricultural activity (Table 1.3).

Land use in the Plan Sierra management area reflects similar trends, with a notable increase in the percentage of land dedicated to commercial grazing. Based on figures from the 1971 agricultural census (Table 1.2) almost sixty percent (57.98%) of the land was classified as pasture-rangeland. On the other hand, only a little more than seven percent (7.28%) of the land was listed in permanent cultivation, with approximately fourteen percent classified as seasonal cultivation--both mixed and monocrop combined. Other land uses include: fallow (10.39%); woods/forests (9.37%); other (1.01%).

The most recent land use survey in the Plan Sierra management area (1983) reveals some notable differences. For example, about ten percent less territory (46.92%) is classified as pasture and approximately twelve percent more land is categorized as woods and forests (22.96%). This difference, most likely, is a result of open pine forest classified as rangeland in 1971 rather than reflecting an

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Table 1.2

**Land Cover/Use in the Dominican Republic
and the Plan Sierra Study Area
(in Tareas*)**

Land Use Type	Dominican Republic	Plan Sierra
Total Land Area	42,572,378	1,375,198
Seasonal Cultivation (Monocrop)	3,327,598	104,787
Seasonal Cultivation (Mixed Cropping)	1,331,571	(combined)
Fallow Land	2,251,303	125,129
Permanent Cultivation	8,550,812	83,452
Pasture Land	22,835,814	876,665
Woods/Forests	4,006,385	255,235
Other Land	268,895	11,131

* A tarea is a Dominican unit of land, where 15.6 tareas is the equivalent of one hectare.

Source: Bretón, Agron. Pedro A. 1978. Plan de Desarrollo La Sierra, Santo Domingo: Secretarial de Estado de Agricultura, page 132.

Table 1.3
Yearly Forest Conversion Rates for the Political Sections in Plan Sierra

	1960/70	1960/81
Baitoa	-1.406	N.D.
Lopez	-1.485	N.D.
Sabana Iglesia	-0.645	+0.387
Cagueyes	-0.955	-2.136
Cebú	-0.984	-1.247
Dicayagua Abajo	-1.635	-1.374
Franco Bido	-2.013	-1.308
La Guama	-1.995	-1.016
Jagua Abajo	-1.571	-1.372
Janey	-4.508	-1.502
Juncalito Abajo	-1.421	-1.631
Loma del Corral	+0.458	-1.203
Mesetas	-0.500	-0.771
Pinalito	-2.005	-1.284
Celestina	-2.982	-1.671
Cuesta Abajo	-6.209	-2.629
La Diferencia	-1.245	-2.151
El Rubio	-1.090	-2.423
Eugenio Perdomo	-1.524	-1.859
Guama	-4.820	-2.621
Inoa	-2.123	-1.612
Jicome	-1.228	-1.590
Las Piedras	-4.176	-1.782
Las Placetas	-2.232	-1.926
Los Montones Abajo	-1.577	-1.768
Mata Grande	-0.538	-3.070
Pedregal	-1.032	-1.553
Yerba Buena	-1.714	- 1.258
Palmarejo	N.D.	-2.874
Toma	N.D.	-1.285
El Mamoncito	N.D.	-1.835
Gurabo	N.D.	-2.069
Cacique	N.D.	-1.584
Rodeo	N.D.	-3.722

Source: 6to. Censo Nacional Agropecuario 1971 (ONE) and the Author.

increase in forest cover in 1983. Regardless, other agricultural land uses in the area include: permanent cultivation (21.3%); seasonal cultivation (8.16%); and prepared for cultivation (0.66%). In total, slightly more than seventy-five percent of the land in the Plan Sierra management region of the central Cordillera Central is used for agricultural purposes.

Agriculture is cited as the most important factor in the forest conversion process. This also applies to the Dominican Republic, where, for all practical purposes, the country is still an agrarian society with sixty-five percent (1981) of the working population participating in the rural sector. Santo Domingo and the country as a whole traditionally have depended upon small farmers for their basic food needs (Antonini and others 1975). Small farmers are blamed for the deforestation and related environmental degradation (Antonini and others 1974; 1975).

> Families raise most of their yearly food needs by slash and burn agriculture. The tools and techniques of this type of production system in the Southwest are remarkably similar to those used by the peasants of the Cordillera Central. Of all the different activities carried out by the peasants of the Southwest it is slash and burn agriculture that has the broadest negative impact on local resources. Damage is particularly noticeable on the steep hillsides of the Sierra de Martin Grande, Sierra de Baoruco and the southern slopes of the Cordillera Central, and also in crucial watersheds such as the Río Yaque del Sur, Río del Medio and Río Ocoa. (Hartshorn and others 1981, 87).

Despite these accusations, the social causes deforestation and soil erosion are as poorly understood by the average Dominican farmer as they are by the government administrator, natural or social scientist who blame them for environmental degradation.

The literature review in the next chapter will lay the theoretical ground work for the introduction of a conceptual model that attempts to explain the linkages between these interrelated physical and social processes. Therefore, it will be necessary to first define the concepts of population pressure and human carrying capacity and discuss their application within the context of competing population growth models. In addition, it is important to critically evaluate current research findings on the process of deforestation and land degradation in developing countries, and consider new social explanations from people-environment theory. Finally, the next chapter will discuss the concepts of "place utility" and resource "push" and "pull" factors in order to explain the process of population redistribution in the Plan Sierra Region of the Cordillera Central.

Chapter Two

Population Pressure and Environmental Degradation in Developing Countries

Introduction

The preface and previous chapter made reference to the notion of population pressure as the causal link in explaining the dynamic processes of forest conversion, land degradation, and population redistribution. Although a controversial concept in the social sciences, population pressure historically has been labeled as a crucial agent to explain a host of social ills in developing countries:

> Gullied and eroding hillsides, deforestation, siltladen rivers, landlessness, and a swelling flow of urban bound migrants all have something in common in Third World countries. They manifest rural population pressure, an imbalance between humans and the resources which support them. These consequences function as neither discrete nor linear variables. Instead they interact synergistically, accelerate, and compound exponentially. As populations grow and require more from a limited resource base, pressures gain momentum with pervasive impact. Man--land and man--man balances tilt. Deterioration of rural resources progresses with lasting effect. Conditions of life worsen into the next generation (Anzagi and Bernard 1977, 63).

For some investigators, a conceptual problem with the term population pressure lies in the fact that the working definition must be based upon two equally controversial terms, carrying capacity and optimum population (Brush 1975; Hardesty 1977). Consequently, these related terms will be discussed prior to developing the concept of population pressure.

The Concept of Carrying Capacity

Carrying capacity is defined as "the theoretical limit to which a population can grow and still be permanently supported by the environment" (Hardesty 1977, 286). Furthermore,

> the essence of carrying capacity is the axiom that a given piece of ground can support a specific number of people, their tools, institutions, and wants, without seriously depleting the environment or the human interaction with it (Hart 1970; Bernard, Campbell and Thom 1989, 400).

The concept of carrying capacity has been borrowed from the animal and biological sciences. The term is currently used in a number of research and planning arenas with several variations. Researchers in the animal and biological sciences recognize three levels of carrying capacity: subsistence density, security density, and optimum density (Igbozurike 1981). People in planning and recreation studies define four separate types of carrying capacity: physical, economic, ecological, and perceptual (Igbozurike 1981). Of these, "far more relevant in explanation of [human] behavior is the perceived carrying capacity, in a situation where such capacity has clearly been exceeded" (Bayliss-Smith 1980, p. 61). In addition, Igbozurike notes,

> carrying capacity frequently is used interchangeable with such expressions as maximum population, absorptive capacity, environmental limit, supportive ability, and productivity. Most often, however, it is interchanged with productivity, with the implication that a statement on carrying capacity is largely or entirely a statement on productivity (Igbozurike 1981, 141).

This is largely due to the conceptual association between carrying capacity and the term environmental potential. Porter points out,

> that the terms "carrying capacity" and "environmental potential" have differing but kindred meanings. Carrying capacity is specific and suggests an optimal density of some sort--people per square kilometer, livestock per hectare--while environmental potential has a more general frame of reference (Porter 1970, 202).

An exercise in environmental potential would attempt to determine the maximum number of people that theoretically could be supported based on an optimal combination of climate, soil and crops.

Early criticisms of the carrying capacity concept noted the absence of "underlying forces" such as hopes for the future and perceptions of the quality of life (Mabogunje 1970). Thom and Bernard (1981) cite these "underlying forces" as including:

> (1) accommodating aspirations and needs beyond basic subsistence; (2) accounting for life-sustaining imports and exports in a region; (3) allowing for human activities beyond food production; and (4) assessing the role of political, institutional, social, economic, and cultural constraints (p. 387).

In response to these legitimate criticisms, geographers recently defined carrying capacity as "the number of people and the level of their activities which a region can sustain in perpetuity at an acceptable quality of life and without land deterioration" (Bernard and Thom 1981, 386).

The Concept of Population Pressure

Population pressure is understood as an imbalance between a population, the food production system and the available resources in an area. The term has been characterized as "a rather vague notion of what happens when population size approaches the carrying capacity" (Hardesty 1977, 298). Geographers have been rather specific in this regard: "population pressure is a long-term process of deteriorating physical and human conditions occurring at many scales as a result of excess numbers of human and or animals in relation to the ability of the land to support them" (Bernard 1977, 44). In addition, population pressure affects,

> social services, education, employment, housing, water supply, and nutrition...[and ultimately contributes to] soil erosion, overgrazing, bush clearance, excision of forests, and despoliation of river systems [that] are serious environmental problems (Bernard and Thom 1981, 381).

The consequences of population pressure are perhaps more readily recognizable than the boundaries of the definition. However, at one extreme it is clear that population pressure is delimited by maximum carrying capacity. For example, population pressure gradually increases as population growth first approaches and then exceeds the carrying capacity. When carrying capacity is surpassed the area is appropriately termed "overpopulated," or:

> the state which prevails...as a condition sometimes recognizable through various objective symptoms, such as malnutrition, emigration, social disorder, but usually only definable by reference to subjective states of mind, such as overcrowding, unpleasant diet, excessive work-load, unacceptable distribution of settlement, etc. (Bayliss-Smith 1980, 62).

In this sense "extreme population pressure" would imply population numbers in great excess of the carrying capacity. An important distinction occurs when this threshold is surpassed, the quality of the social and physical environment is compromised; these effects may be long-term, catastrophic and irreversible.

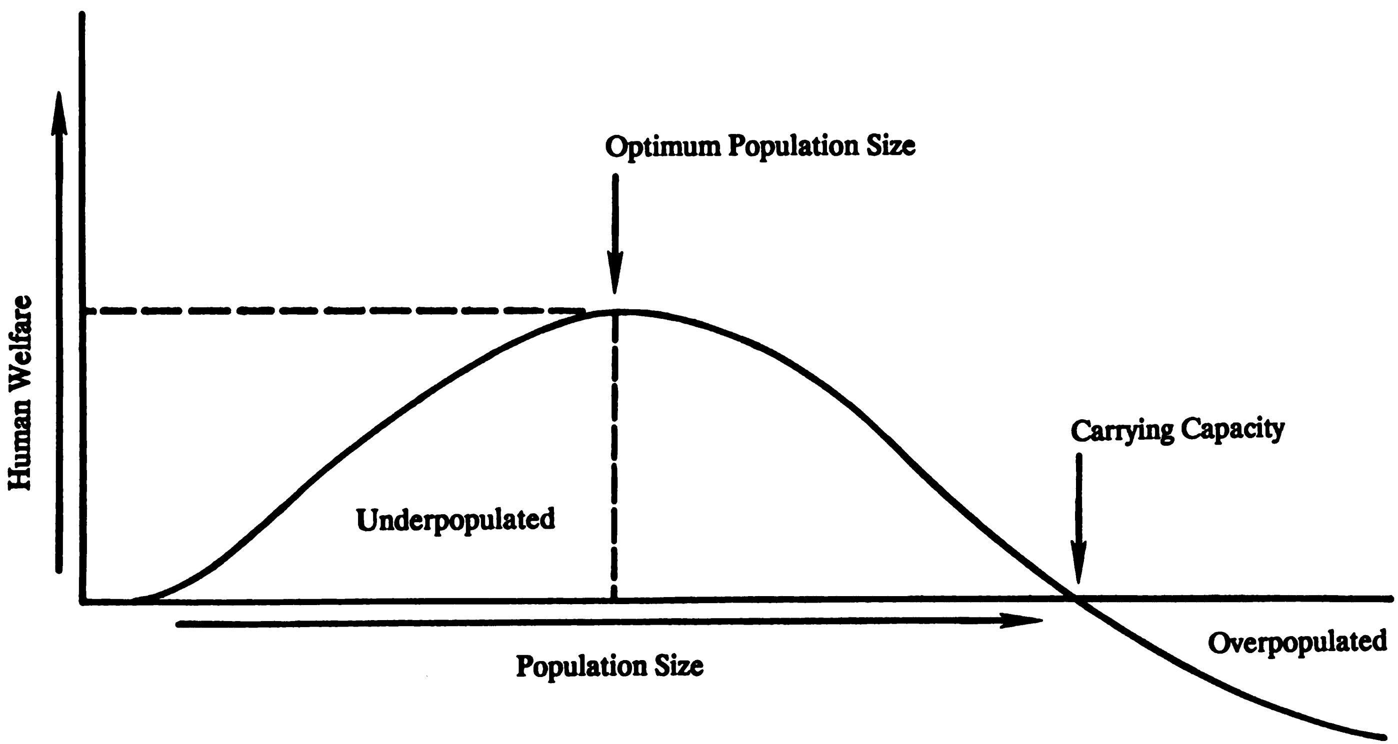
At the other extreme, population pressure is apparent when the welfare or "quality of life" has been compromised. Two questions may be posed to define this other threshold:

> how many people would the technology of a given society support in a particular environment at a certain welfare level?, at what stage, therefore, would population growth be likely to result in a deterioration in welfare?... We can assume that it is this latter symptom, the deterioration in welfare, which is likely to be perceived as 'population pressure,' and which will therefore trigger off various social responses in an attempt to improve the situation (Bayless-Smith 1980, 62).

Figure 2.1 illustrates how "optimum population" may be defined as the population size that maximizes human welfare (Newman and Matzke 1984, 204). By implication, population sizes on either side this optimum are seen to minimize welfare. However, "since 'optimum' relates to the external needs and technical capacities of a population as well as their perceived needs and expectations, it has proven to be an illusory idea" (Bernard 1977, 44). As an alternative,

Figure 2.1

Newman and Matzke's Concept of "Optimum Population"



> [Hart] suggests that 'comfortable density' is more appropriate. He defines it as the maximum population size in a given area for perpetual, peaceful living, without stress and without exhaustion of available resources (Bernard 1977, 44; Hart 1970).

Despite the conceptual and operational problems, planners have attempted to define the optimum population size for Transamazonian settlement schemes. These prescribed "limits" are designed to safeguard "sustainable" carrying capacity levels. Fearnside writes:

> A clear distinction is often lacking between the "sustainable" and "instantaneous" uses of the term "carrying capacity." The term has frequently been employed to refer to the population that can be supported on a resource at a given point in time, in addition to its use--as in the present study--to refer to populations that can be supported indefinitely (Fearnside 1985, 333).

In this instance planners use simulation modeling to specify the optimum population. The model simulations are then compared with colonist propensities for failure in their agricultural attempts (Fearnside 1985). Geographers Bernard and Thom (1981) and Bernard, Campbell and Thom (1989) likewise assisted the Kenyan government in assessing sustainable carrying capacity levels for rural development planning in marginal areas of the eastern ecological gradient. Both the definition and determination (measure) of human carrying capacity and population pressure, as developed by Bernard, Campbell and Thom are applied in this dissertation to the traditional hillslope farming system in the Dominican Republic. Furthermore, as forest conversion is commonly considered the primary economic response to the ongoing pressures of accelerated population growth, causes and rates of deforestation in developing countries will be considered next.

Deforestation in Developing Countries

Prior to the year 1972, there was a trend in developing countries toward greater usage of oil-based fossil fuels. In fact, oil use often was considered a factor in an index of socioeconomic development. With the formation of crude oil cartels and the crude oil embargo of 1972, the trend toward greater oil fuel usage in the Third World reversed. An environmental impact of the "energy crisis" in the 1970s and 1980s has unfortunately meant an even greater reliance on traditional fuel sources such as firewood and charcoal.

This increased dependence on forest resources for cooking and heating fuel, in addition to demands for commercial lumber, land for agriculture, roads, dams, and settlements, places extreme pressure on forest reserves of developing countries. It is not surprising many government administrators, natural and social scientists are doubtful that national forest reserves will meet these needs; rapid deforestation currently causes increased prices and shortages of fuels such as firewood and charcoal. For example, in many developing countries the wood extraction rate exceeds five cubic meters per hectare, which is the rate of biomass renewal for average forest productivity (Bowonder 1985, 171).

Two geographers, Allen and Barnes, recently assessed deforestation in developing countries at several spatial scales. On the global scale they formed rather limited determinations concerning the process of deforestation in developing countries, due primarily to widespread disagreement within the scientific community regarding the magnitude, causes, and consequences of forest conversion. Estimates of world forest cover vary greatly; since 1961 global forest estimates ranged from 2,393 to as high a 6,050 million hectares. They conclude that global estimates of forest cover area over time show no meaningful trend, especially no downward trend (Allen and Barnes 1985, 167). On the other hand, Bowonder notes,

> a recent study by the United Nations Environment Programme and Food and Agricultural Organization shows that seventy-six developing countries deforest jointly 11.3 million hectares of forests every year whereas the rate of tree planting in these countries is depressingly low, about 0.52 million hectares every year...[and]. It is estimated that by the year 2000, the world population will be 6.4 billion and wood availability per capita would decrease to 40 cubic meters from the current level of 76 cubic meters per year (Bowonder 1985, 172).

As a result of these various findings, deforestation on a worldwide basis has been associated with changes in wood supply, genetic resources, the hydrologic balance, and global cycles of carbon and other elements (Allen and Barnes 1985; Bowonder 1985; Williams 1989).

Allen and Barnes drew more meaningful conclusions from linear regression analysis of national level data. Using published data from the FAO Production Yearbook, the FAO Yearbook of Forest Products, and the World Bank, the authors used deforestation variables, socioeconomic indicators, land use data, and wood use data to construct regression equations for a cross-national panel analysis. The authors derive the following generalizations from their results:

> Deforestation is associated in the short term with rising population and expansion of agriculture and in the long term with wood harvesting for fuel and export. Deforestation through extensive wood use does not occur as quickly as it does through population growth and expansion of arable land. Intensive wood harvesting does result, however, in

> deforestation; a country that has high wood production and high wood exports tends to lose forest area within about a decade. The delayed appearance of net deforestation might be due to the gradual, cumulative effect of exceeding sustainable yields in forests and woodlands (Allen and Barnes 1985, 180).

Bowonder offers that "deforestation is a consequence of low per capita income, non-availability of fossil fuels, high population density, and poverty; hence it is intricately linked to socioeconomic process" (Bowonder 1985, 179). The literature cites the following common causes for deforestation in developing countries: climate, agriculture, logging, fuel, burning and grazing, and forest management (Allen and Barnes 1985).

The ecological consequences of forest conversion are hotly debated; a central issue focuses on the practice of professional forestry in developing countries. Those who support the principles of managed forestry and their practice see forest conversion as the logical economic development of a renewable resource. Others, who doubt the role or question the motives of commercial forestry, see deforestation as the exploitation of a valuable resource for the short term benefit by a few ruling elite. Regardless, even at the national level of analysis, it is difficult to generalize about the effects of deforestation, but in selected instances these effects appear to be quite severe:

> It should be remembered that the consequences of deforestation are to a great extent location-specific. It is extremely difficult to infer the losses--be they of species diversity, wood production potential, soil fertility, or watershed protection--from an analysis of the overall rate of deforestation. Nevertheless, these factors determine the severity of the impact of forest loss on the quality of life in developing countries (Allen and Barnes 1985, 181).

In a number of developing countries these findings variously support the notion that rapid deforestation is somehow directly related to land degradation.

Deforestation and Environmental Degradation

Is there reason to believe that forest conversion has contributed to significant environmental degradation in the past? If so, have the outcomes of these events generated out-migration? An historical example from Latin America demonstrates an association between population growth, deforestation, environmental degradation and emigration:

> Licenciado Rodolfo Brena Torres, Governor of Mexican State of Oaxaca, wrote in a personal communication: "The problem of the land is acute here. Lack of foresight started the destruction of the forests that covered the state in the XVIIIth Century; the lands stripped of their vegetation were eroded by wind and rain, leaving this desolate landscape, sad to look at and even sadder from the economic aspect--since there remains regions so dead that one can

> get nothing useful from them. The population increase makes the situation more distressing and in the face of the impossibility, for a great part of the population, to satisfy here the necessities of existence, it has no alternative but to emigrate to other places, at times on a temporary basis as when the "braceros" [migrant farm workers] go to work in the United States, or at other times to settle in Mexico City or neighboring states' (Vogt 1970, 177).

The negative consequences of rapid forest conversion also have been linked with the demise of aboriginal empires:

> The late George Vaillant suggested that conflict, revolt, and crop failure contributed to the downfall of Teotihuacan, and that the crop failure was largely the result of deforestation, erosion, and consequent disruption of the hydrologic cycle. The decay of the Mayan 'empire' has been postulated on more or less the same mismanagement of the land; but there seems to have been no widespread disruption of the structure of the land in Mexico and Central America before the arrival of the European (Vogt 1970, 181).

Furthermore, the negative consequences of overpopulation were recently associated with deforestation and land degradation in a contemporary developing country. Karan and Iijima describe environmental stresses within the Himalayas and also observe population redistribution as a result of these processes:

> With increased population, forests have been depleted, and the consequent runoff produces erosion and loss of cultivable land. As much as 40% of former farmland in eastern Nepal has been abandoned because it is no longer fertile enough to produce crops. One-fourth of the forest in the country has been cut in the past decade. If this trend persists, the remaining forested area may be denuded in another twelve to twenty years. These statistics are disturbing for a predominantly agricultural economy... The lack of land leads poor people to extend the frontiers of agriculture into marginally productive areas of the mountains (p. 90).
>
> The fragile mountain environments are being subjected to uses that cannot be sustained, and the middle Himalayan slopes are becoming nonproductive. The farmers become ecological refugees who move to the foothills and the piedmont plain (Karan and Iijima 1985, 71).

Nevertheless, the precise nature of the relationship between population pressure and deforestation remains unknown, and the process leading ultimately to environmental degradation is seriously questioned by social scientists also working in developing countries:

> For the present, then, we adopt an open approach to the relation of population pressure to land degradation. Degradation can occur under rising [population pressure on resources] PPR, under declining PPR, and without PPR. We do not accept that population pressure leads inevitably to land degradation, even though it may almost inevitably lead to extreme poverty when it occurs in underdeveloped, mainly rural, countries... PPR is something that can operate on both sides [of the equation], contributing to degradation, and aiding management and repair (Blaikie and Brookfield 1987, 34).

Moreover, Brookfield and Blaikie propose that land degradation fundamentally is of social origin, where the "principal" (decision maker) farmer actually plays a critical role in determining the overall impacts of natural geomorphological processes. For example, natural land degradation may be greatly minimized, as a result of investments in "landesque" capital, innovative or improved farm management techniques, and skillful investments in labor. In contrast, rates of natural land degradation may be greatly accelerated as a result of inappropriate farm management and inputs of labor, which function to strain the resiliency of the soils and overall capacity of the land resource base. Unfortunately, this more common scenario will likely have the effect of further increasing population pressure on the land, as larger amounts of farmland become degraded and are afforded a non-productive rank (Brookfield and Blaikie 1987). In addition, a number of general conceptual models have been developed that attempt to explain the relationship between population growth and the natural resource base within traditional agricultural economies.

Conceptual Models of Population Growth

A number of general population growth models have been devised that both describe and illustrate the concepts of population pressure and carrying capacity. At least in the biological sciences, the two most common models are the S-shaped (sigmoid) and the J-shaped (exponential) curve Igbozurike relates:

> In the sigmoid growth form, environmental resistance, whether inherent in the population itself and its "home base" or brought in from the outside, is gradually introduced and becomes noticed only after a relatively long period of growth. From that time onward, however, its impact increases as the population density rises. Later, influenced by the increasing weight of the detrimental factors, the rate of growth tapers off, and the population reaches or, more realistically, comes close to the carrying capacity, which is referred to as K, asymptote, or equilibrium level.
>
> The J-shaped curve, sometimes labeled as the exponential growth form, represents a condition in which, from a beginning that may or may not be slow, there is a remarkably accelerated population increase that persists until a relatively sudden intervention of an adverse factor halts the upward spiral. Again, the cessation of growth may derive from circumstances innate in the growing population, or it may be induced by phenomena essentially external to the population. Further, when growth is halted abruptly the population size may flatten out at the maximum level attained, thus remaining approximately static as shown ...by L1. Alternatively, as indicated by L2, it can decline if the operational constraints that led to the cessation of growth continue to exert an influence of adequate strength (Igbozurike 1981, 144).

Although there appears to be a conceptual dichotomy between these two curves, any population over a given period of time may demonstrate characteristics of both curves. Consequently, the sigmoid curve may be more representative of long-term trends whereas the J-shaped curve may be more representative of the short-term scenario (Igbozurike 1981, 144).

Alternative carrying capacity consequences can be manifested in at least four ways (Newman and Matzke 1984, 197). The first of which is the traditional notion of carrying capacity as expressed by an extension of the S-shaped curve over time (Figure 2.2A). In this scenario population growth increases over time but is gradually slowed by environmental resistance (constraints) until growth stabilizes just below carrying capacity. Finally, with the assumption of "homeostasis" this level of population will be maintained indefinitely, with minor fluctuations above and below the homeostatic plateau defining population supporting capacity.

Frame B of Figure 2.2 depicts an extended version of the J-shaped curve. In this sequence, population density increases rapidly over time with little or no decline until carrying capacity has been exceeded. Subsequently, there is an rapid decline of population that eventually slows, rebounds slightly and stabilizes somewhere below carrying capacity. The authors indicate:

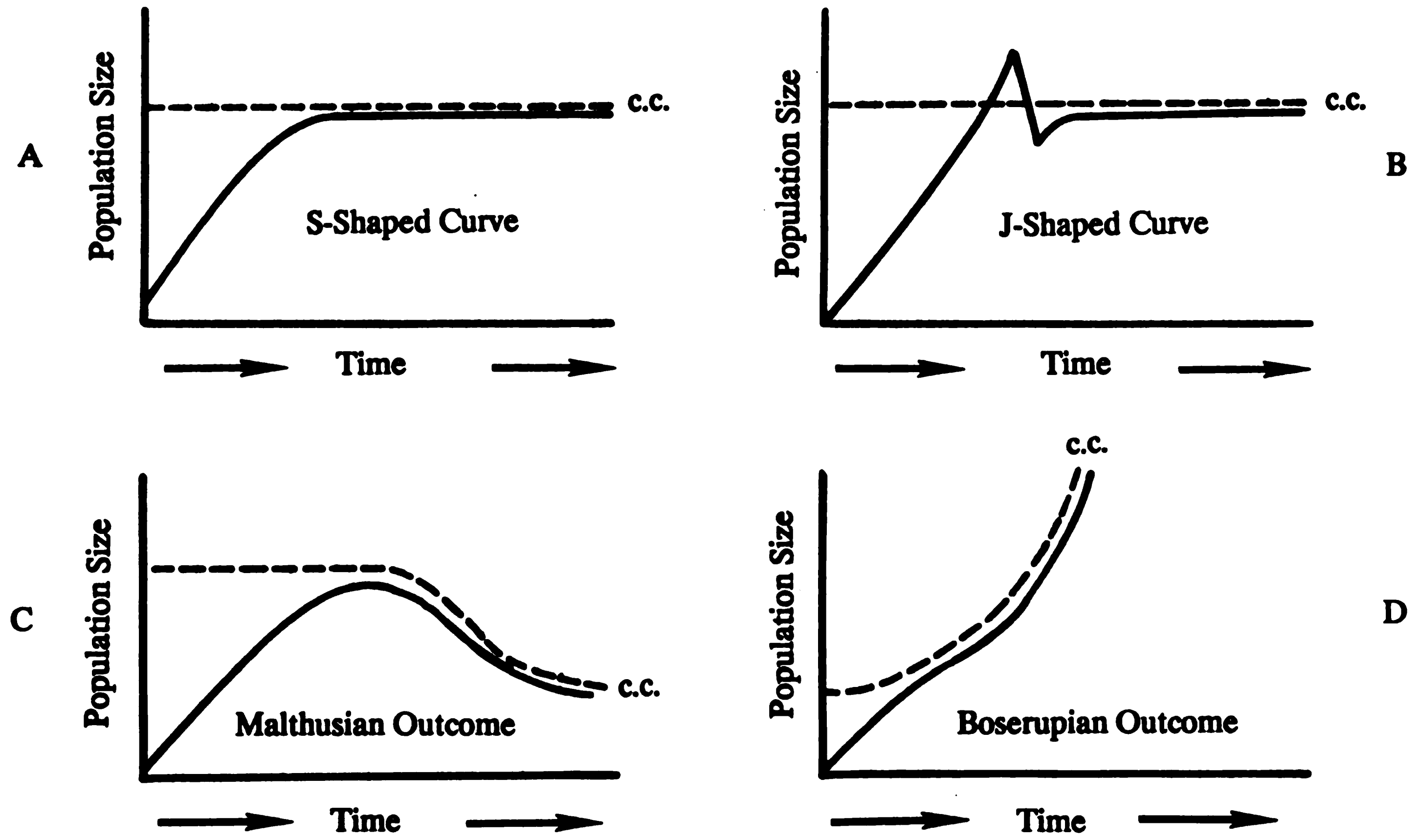
> one possibility is that the population will suffer a decline, imposed by resource limitation, until it is lowered below carrying capacity. In this scenario the effects are on the population, not the environment (Newman and Matzke 1984, 197).

This pattern of growth somewhat characterizes the earlier predictions of British cleric and economist, Thomas R. Malthus, in 1798, where he viewed the rapid growth of the human population as being held in check by catastrophic events, such as plague and famine, when other social controls such as abstinence were ignored (Kleinman 1981).

The third graph (Figure 2.2C) symbolizes the general population-economic theory supported by neo-Malthusian followers. In his latter formulations, based upon the assumption that population growth is exponential whereas growth in agricultural productivity is arithmetic or rather limited (fixed technology), Malthus believed that population growth repeatedly would exceed the capability of the resource base to support it and as a result of over-exploitation the agroenvironment would gradually deteriorate. Under these conditions both population growth and carrying capacity decrease over time as the food production system collapses.

Figure 2.2

Newman and Matzke's Alternative Carrying Capacity Consequences



However, frame 2.2D depicts the antithesis authored by Ester Boserup (1965). In this instance, as growth in human populations approach the carrying capacity, population pressure is viewed as the stimulus for creative adjustments in the food production system. These adjustments largely are expressed in a hierarchical sequence of agricultural labor intensification and social/technological change, perhaps followed by developments in other economic sectors at some point in the future. In this carrying capacity alternative, population growth stimulates greater ingenuity and efficiency in the food production system therefore carrying capacity increases with growth over time. Bilsborrow claims that Boserup's conceptualization directly challenges the classical Malthusian-Ricardian assumption of constant technology, where:

> As arable land becomes scarce relative to population, it is used more intensively. Boserup describes five stages or systems of increasingly land-intensive technology (i.e., increased labor inputs per unit of land): (1) forest or long fallow (20-25) years between crops); (2) bush fallow (6-10 years); (3) short fallow (1-2 years); (4) annual cropping; and (5) multiple cropping (more than one crop per year on the same land). As population grows, societies move from (1) towards (5), each representing an increasingly land-intensifying technology (Bilsborrow 1987, 184).

Finally, many of the themes (concepts) presented in her first major work were eventually expanded and elaborated, where we find,

> Boserup (1981) has developed a persuasive argument in which she essentially reverses the order of priority and sees growing populations as creating conditions favorable to many technological changes. Stated simply, she maintains that critical population sizes and densities are needed before certain technological changes become possible (Newman and Matzke 1984, 63).

Despite the popularity of Boserup's competing theory of population pressure, particularly among economists and associated (pro-growth) Third World development specialists, many social scientists and ecologists argue that pervasive population pressure largely contributes to underdevelopment and despair. Subsequent models from the social science literature have attempted to further link population pressure with the processes of environmental degradation and population redistribution. The following flow diagram (Figure 2.3) characterizes one of these models and is directly related to the conceptual framework of analysis in Chapter Three of the dissertation.

Models of Population Pressure and Environmental Degradation

Bernard suggests that a systems view of population pressure should be "put forth as an integrated approach to the problem" (Bernard 1977, 43). He offers,

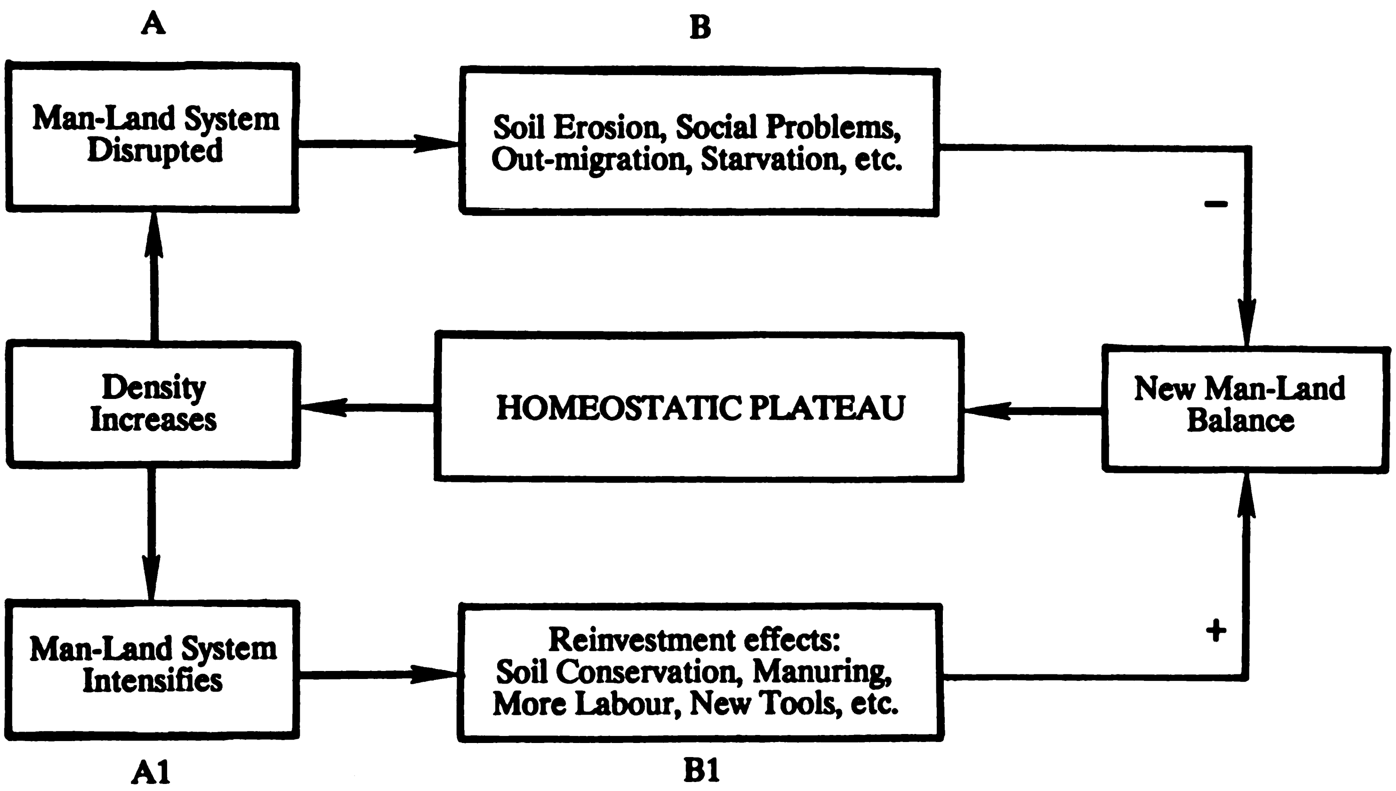
> from the foregoing it should be apparent that concentrating exclusively upon either carrying capacities or indices of population pressure produces at best a fragmentary picture of what should be viewed as a unified man-land system. Initially, what we seem to need is a far clearer conceptual picture of the structure of the system of population pressure, of the linkages and flows among its parts, and of the way it functions as a whole (Bernard 1977, 55).

Citing the classic work of Harvey (1969) he proclaims "systems concepts are ideal for providing a workable conceptual framework for the analysis of complex geographical situations" (Bernard 1977, 56)

Figure 2.3 illustrates Bernard's general systems model for explaining two alternative outcomes of population pressure. Theoretically, a population may be envisioned as existing with a fluctuating growth pattern along a homeostatic plateau, where there is an apparent equilibrium between population size, the food production system, and available natural resources. With continued population growth, population density may increase and the balance among the variables in the system becomes upset. The model illustrates that at least two courses of social action may take place; the man-land support system is disrupted or the man-land support system is intensified. If the man-land system is disrupted (A), either as a result of apathy, lack of knowledge, inability or unwillingness to effect change or adjust to their increasing members, a number of negative environmental and social consequences may occur (B), ultimately leading to a decrease in the human population with a new equilibrium established at a lower population supporting capacity. On the other hand, if the man-land system is intensified (A1), as a result of increased efficiency and ingenuity, a number of positive consequences may occur (B1). The application of increased labor and new technology with emphasis on soil conservation and re-investment may act to greatly improve the agroenvironment thereby increasing the population supporting capacity. Consequently, a new equilibrium state is achieved at a higher carrying capacity. Both of these circuits originate from the general population growth models discussed earlier, and are currently both supported and debated in the literature (Boserup 1965, 1981; Brookfield 1972, 1984; Geertz 1963; Grigg 1979). Finally, in his seminal work, Bernard (1977) includes

Figure 2.3

BERNARD'S POPULATION GROWTH HYPOTHETICAL MAN-LAND SYSTEM



a separate diagram detailing the components and linkages between boxes A and B noted above, "so-called consequences of population pressure operating in [a] rural African context" (Bernard 1977, 57).

Newman and Matzke (1984) characterize this general systems model somewhat more eloquently as "development or disaster" but offer that "the world is not as simple as either alternative suggests" (Newman and Matzke 1984, 200). Despite this caveat,

> this [conceptual] framework has practical application. It can serve as an agenda for programmatic research aimed at testing interrelationships in the real world and discovering the detailed mechanisms of the process (Bernard 1977, 61).

In their version, the gently fluctuating growth pattern along the homeostatic plateau is referred to as the "stable population." Moreover, they greatly expand upon the array of consequences of increased population density in either circuit of the model. For example, under conditions where the people-environment support system is disrupted three classes of negative consequences are anticipated: 1) environmental deterioration, manifested by soil fertility declines, soil erosion increases, and progressive deforestation; 2) subsistence deterioration, manifested by changes to hardier crops, yield declines, income declines, and increasing malnutrition, and; 3) demographic depression, manifested by rising mortality, and increasing out-migration. On the other hand, three classes of positive outcomes are anticipated when the people-environment system intensifies: 1) resource enhancement, manifested by manuring, irrigation, and soil conservation; 2) productivity increases, manifested by increasing yields, improved nutrition, and rising income, and; 3) demographic moderation, manifested by improved opportunities for women, delayed nuptials, and increased use of contraceptives (Newman and Matzke 1984, 200). Citing empirical examples, they demonstrate how Iceland historically has cycled through both legs of the "disaster or development" model. In addition, carrying capacity may change over time in response to changes in the food production system or in the environment. For example, Maro (1975) found that carrying capacities near Mt. Kilimanjaro were significantly increased as a result of intensification due to participation in a cash crop economy (Newman and Matzke 1984, 198-199). The theoretical association between rural based natural resources and the migration process is the subject of the next section.

Population Redistribution

From earlier discussions of both population-economic and people-environment literature, it appears that the "long-term" ecological soundness of social responses to population pressure determine whether or not land degradation likely occurs. Consequently, intensive forms of agriculture may be seen to both increase population supporting capacity and minimize environmental degradation. In this case, natural resource enhancement occurs as a result of improved farming skills and innovative reinvestment in the land. Subsequently, the intensified farming area may be perceived as having a "resource pull" factor generating voluntary in-migration. According to the conceptual framework of migration decisions established by Lee (1966), rural migrants should be drawn to areas conducive to successful agriculture.

Conversely, land degradation more commonly is recognized as a compelling economic or "resource push" factor from traditional farming areas and may be seen to generate a type of "primitive" out-migration (Petersen 1958), where the migrants are referred to as "ecologically displaced persons" or occasionally known as "ecological refugees" (Standing 1984, 45). According to prevailing behavioral-migration theory, the decision to migrate is made in order to maximize the "place utility" of the individual or entire household. The various aspects of individual decision- making and are couched in Brown and Moore's intra-urban migration model of place utility:

> A basic concept in the Brown and Moore model is that of place utility, which refers to an individual's (or household's) overall level of satisfaction or dissatisfaction with respect to a given location. If the place utility of the present residential site diverges sufficiently from the individual's immediate needs, that person will consider seeking a new location. Thus, migration is viewed as a process of adjustment whereby one residence or location is substituted for another in order to satisfy the needs and desires of each migrant better, that is, in order to increase the place utility experienced at the residential site (Brown and Sanders 1981, 150).

Research in developing countries indicates that levels of population pressure in most rural areas generally are high and are likely to remain so, therefore "resource push may be expected to remain a significant factor in rural-to-urban migration until development brings a better balance between core and periphery areas" (Brown and Sanders 1981, 176).

As the agroenvironment deteriorates and people become increasingly less able to successfully employ or modify the existing farming system, the environment may become a dominant stress factor in the decision to migrate (Wolpert 1966). Brown and Sanders (1981) indicate that individuals go through a rather complicated decision making process regarding migration; there are two distinct phases, whether or not to migrate, and, if one decides to move, where to migrate. Ultimately the decision of where to move will also be affected by changing environmental conditions. Traditionally, a change in the food production system or out-migration have been plausible choices. However, with no available agricultural frontier available and where innovative changes in the food production system are prohibitive due to large capital and labor investments, the move to urban centers is an attractive alternative.

The concepts of resource "push" and "pull" factors are derived from Lee's theory of migration which is viewed as a classic extension of Ravenstein's laws of migration (Lee 1966; Ravenstein 1885, 1889). The processes of population pressure and environmental degradation generally are considered "underlying" causes of population redistribution, especially rural to urban migration (Oberai and Bilsborrow 1984). By examining these underlying causes of population redistribution exclusively in a rural environment, this dissertation will not review the conventional theories of rural to urban migration which focus primarily on the "pull" factors of urban areas, specifically: the dual economy model (Lewis 1954); Sjaastad's human investment theory (1962); and Todaro's model of rural-urban migration (Todaro 1969, 1976). The next chapter will introduce a conceptual model of population pressure, establishing its linkages with the processes of deforestation, land degradation, and population redistribution.

Chapter Three

Statement of Problem, Framework of Analysis and Hypotheses

Statement of Problem

For developing countries in general, and specifically in the case of the Plan Sierra region of the Dominican Republic, it may be inferred from population-economic theory that there are at least three responses to population pressure: 1) forest conversion to bring nearby new land into food production based upon existing or traditional--extensive--agricultural practices, 2) labor intensification or innovative modification of agricultural practices on existing cleared land, and 3) out-migration, which would involve a move to the forested agricultural frontier or to a more productive farming area. In contrast, it also might involve abandoning the land and farming as an occupation altogether, necessitating a move to the city. In addition, age, education, and level of occupational preparedness logically would be associated with the propensity to migrate in the face of environmental degradation and its associated stresses. Moreover, these key sociological variables should be associated with the migration destination selected and the condition the rural agroenvironment (land degradation) plays in the decision to migrate.

Innovative agricultural intensification and conservation may be implemented to improve the resource base and actually attract migrants by increasing human carrying capacity. However, if land degradation is sufficiently pronounced and population supporting capacity decreases then two distinct conditions may result. Some individuals will leave the affected area--become out-migrants--while those who remain will be adversely affected socioeconomically, as the ability to satisfy basic subsistence needs continues to decline. Of those who leave, it is inferred from population theory that there will be three general migration streams: one directed toward forested frontier areas, one toward agriculturally intensified areas and another to the country's urban centers.

It can be inferred that the migration streams will be selective. Among the adult population, movement to the cities and frontier areas will likely involve young adults, whereas those people remaining in the original rural source areas are expected to represent older age cohorts. It can be further argued that selectivity based on occupational preparedness will occur among the migrant and non-migrant groups. It is proposed that the best educated people will move to more intensified agricultural areas or cities while the least trained people will remain in the rural source area, forgoing even the choice to pioneer new land (Thomas 1970; Zuiches 1980).

Model of Population Pressure in Plan Sierra

Designed for this dissertation, the following model relates the association among population pressure, deforestation, land degradation and migration. It serves as a springboard for more specific hypotheses which relate pairs of variables that are designed to test the empirical inferences previously described. The model builds upon competing theories from conventional population-economic literature, and may also be seen as a logical extension of the "systems model" of population pressure conceived by Bernard (1977). It incorporates concepts from both people-environment, classic and behavioral migration theory, pertaining to perceptual aspects of the population redistribution process. The model addresses the notions of "place utility" and "environmental" stress factors which, along with "push and pull" factors, may trigger a decision to migrate.

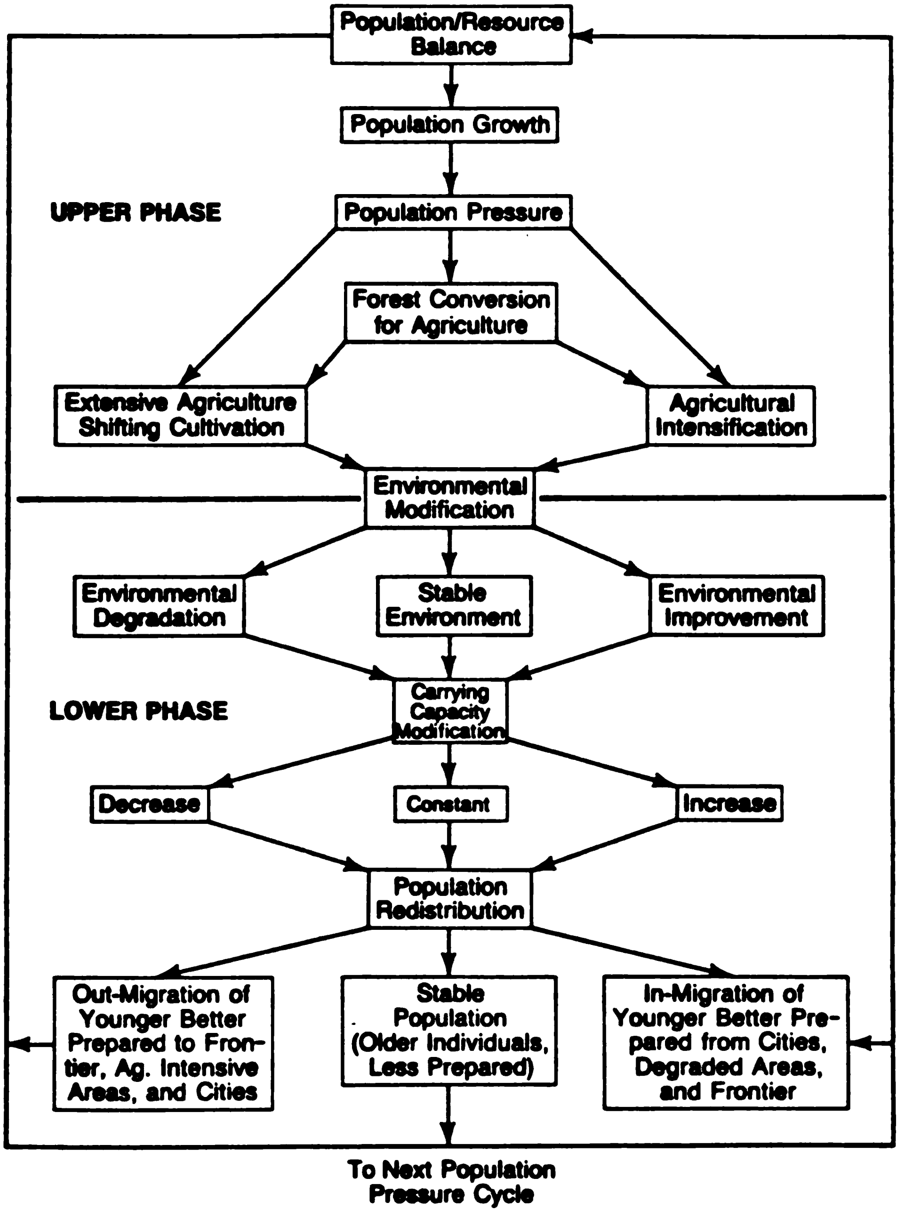
Furthermore, the dissertation's model is logically consistent with the prevailing conceptual framework of Bilsborrow (1987), concerned with the broader consequences of accelerated population growth and increasing physiological density in developing countries:

> It is desirable to take a broader approach, categorizing the possible types of responses [to population pressure]: (1) demographic, (2) economic, and (3) "demographic-economic." The types of responses under (1) include changes in nuptials and declines in marital fertility. Among the economic responses (2) we can cite increasing the land area under cultivation; switching from land-intensive methods such as slash-and-burn agriculture or grazing cattle to raising permanent crops; increasing the use of fertilizer or the percentage of land under irrigation, etc. It is also quite possible for technological changes to be stimulated which involve the substitution of relatively more labor-intensive methods. The major "demographic-economic" response (3) is out-migration from increasingly dense areas, whether in the form of net rural-urban migration, rural-rural migration to other rural areas, or even out-migration from the country. All such out-migration may be "permanent" or seasonal (Bilsborrow 1987, 185).

In Figure 3.1, both the right and left hand portions of this dissertation's model indicate that there are two distinct alternatives or scenarios--one positive the other negative--in response to

Figure 3.1

Model of Responses to Population Pressure in the Plan Sierra Region



pervasive population pressure. The more optimistic circuit proposes that population pressure may or may not involve forest conversion for food production but in either case will generate agricultural intensification, which in turn will improve the agroecosystem or at least provide for a stable condition. An improved environment for food production will likely increase the population supporting capacity and thereby reduce population pressure, restoring the population resource balance to the system. The less optimistic circuit proposes that population pressure will involve forest conversion, especially for more extensive forms of agriculture that are unlikely to be sustainable under conditions of rapid population growth. In this situation, the agroenvironment is modified in a negative manner, which may force some people to migrate in order to restore the population-resource balance at a reduced carrying capacity level. In addition, the logical temporal order of this conceptual model is also consistent with the theoretical framework established by Bilsborrow:

> I would hazard a guess that people historically have tended to exhaust, first, the economic responses (at least those available to them in terms of their knowledge/capabilities and access to information and credit) and then the "economic-demographic" response (out-migration, involving the loss of a household member, which is painful for the household; or of the whole household, which involves psychic loss from leaving one's "home" area, one's roots), with fertility adjustments last (Bilsborrow 1987, 190).

The lowermost portion of the model pertains to the population redistribution process. In areas where intensified farming strategies provide for stable and improved environments, it is likely that population supporting capacities will be increased, thereby attracting migrants. The question is, who will be attracted to these areas and where is their origin? On the other hand, areas suffering from land degradation and decreasing carrying capacities are likely to generate out-migration. The question here is who will be the first to leave and where will they go? How are the younger and better prepared individuals likely to respond to changing conditions in the ecological climate for agriculture? Moreover, is it likely that older, less prepared individuals will remain in the rural source area, regardless of changing environmental conditions? In order to evaluate this conceptual model, it is necessary to determine the role of population pressure in the processes of deforestation, the intensification of traditional agriculture, land degradation and population redistribution, especially if the residual rural population becomes increasingly less prepared to cope technologically with environmental change.

Research Hypotheses

According to the literature of conventional population-economic theory, deforestation commonly is regarded as the first social response to rapid population growth. Nevertheless, the precise nature of the relationship between pervasive population pressure and deforestation generally is unknown and largely misunderstood by most people, administrator, farmer, natural and social scientist alike. Competing theories prescribe various choices in response to population pressure, which may or may not involve forest conversion. Bilsborrow notes,

> One would expect the increase in arable land to have come at the expense of land under permanent pasture and forests. This would be consistent with the cross-country evidence of Boserup [1981], who observes a negative tabular relationship between ratios of pasture land to arable land and population density (Bilsborrow 1987, 191).

This dissertation will contribute to the bodies of population-economic and people-environment theory by attempting to define the nature of the relationship between population pressure and the forest conversion process. Because the Plan Sierra region of the Cordillera Central (Figure 4.2) generally is recognized as an area of high population pressure and accelerated forest conversion, a positive linear relationship logically is predicted between these key variables. Hence, the first research hypothesis (1A) reads as follows: deforestation is dependent upon population pressure. In other words, as population pressure increases forest conversion for agriculture increases.

The second research hypothesis (1B) will examine a number of traditional rural society's other choices in reaction to the increasing stresses of population pressure. These are customarily recognized under the rubric of "agricultural intensification," and by definition encompass the intensification of land use and labor, investments in the land resource base, and innovations in farming skills (Boserup 1965, 1981; Brookfield 1971, 1984; Brookfield and Blaikie 1987). Brookfield notes,

> the primary purpose of intensification is the substitution of these inputs for land, so as to gain more production from a given area, use it more frequently, and hence make possible a greater concentration of production (Brookfield 1971, 51).

Within the conceptual framework of this dissertation, intensification logically may be employed by small farm agriculturalists in direct reaction to pervasive population pressure, irrespective of deforestation. As a result of the high levels of population pressure documented for the Plan Sierra region of the Cordillera Central, it is likewise logical to predict a positive linear relationship between population pressure and heightened food production strategies. Consequently, research hypothesis (1B) reads as follows: agricultural intensification depends upon population pressure. Hence, as population pressure increases, land use intensity, the frequency of the adaptation of innovative farming skills, and the frequency of long-term investments in the land resource base increase.

Simple bivariate regression analysis will be employed to determine the precise nature of the relationship between these key variables. In an analysis of deforestation in a sample of developing countries, Allen and Barnes (1985) found that,

> an increase in population is associated with a loss of forest area... The negative coefficients in the regression (b and beta) and the negative correlation coefficients (r) mean that developing countries with high rates of population growth also have higher-than-average rates of deforestation... Population growth in connection with expansion of arable land has been regarded as one of the contributors to deforestation... The bivariate correlation coefficients indicate that population growth is related to agricultural expansion, which in turn is related to forest loss (Allen and Barnes 1984, 177).

In addition, Turner and others (1977) also used linear regression techniques to define the nature of the relationship between population densities and agricultural intensities for twenty-nine groups of tropical subsistence cultivators. The results of their analysis establish a significant positive relationship on the national level for a representative group of traditional farmers in developing countries. They found:

> To be consistent with the Boserup thesis, agricultural intensity was chosen as the dependent variable. Correlation coefficients were calculated for arithmetic, exponential, and power functions. The exponential model gave the greatest amount of explained variation (r squared = .580). This form of the model is $\log A = a + bp$, where A represents agricultural intensity, and P is population density; a and b are parameters. The resulting equation (and standard error of estimate) are $\log A = 1.06 + 0.0049P$ (0.0008). The positive regression coefficient, which is significant at the 0.01 level on the basis of a t-test with twenty-seven degrees of freedom, demonstrates that agricultural intensity does increase as population density increases (Turner and others 1977, 389).

In her second book on the effects of population pressure, Boserup (1981) provides evidence to support a positive linear relationship between "the estimated percentage of land under multiple cropping and population density in 130 developing countries" (Bilsborrow 1987, 192). In keeping with prevailing notions of traditional agriculture and land degradation in developing countries (Brookfield and Blaikie 1987), it is necessary to examine and explain the nature of these relationships on the farm level scale of analysis.

Research hypothesis (2A) will expand upon the theoretical groundwork of people-environment literature by explaining the nature of the relationship between deforestation and land degradation. According to evidence from scientists working in developing countries, especially in mountain ecosystems, rapid and mismanaged deforestation appears to be positively related with widespread land degradation, especially soil erosion (Karan and Iijima 1985; Ives and Pitt 1987). However, professional foresters protest that,

> it is misleading and counter-productive to treat as though they were alike the impacts of the very disparate array of activities that have been labeled 'deforestation.' The consequences of fuelwood cutting and product removal by non-mechanized methods are vastly different than those of mechanical clearing of forest and converting the area to maize or rice (Hamilton and Pearce 1988, 92).

Nevertheless, there remains considerable disagreement regarding the various impacts (both cost and benefits) of forest alteration and conversion to other land uses. For example, "fuelwood harvesting, unless followed by a true conversion that attempts sedentary agriculture, can be sustainable forest use" (Hamilton and Pearce 1988, 80). On the other hand, in an analysis of fuelwood use and environmental degradation in Sudan, it was found,

> the principal environmental costs of deforestation ...include: the loss of the excess nitrogen produced by Acacia, available to promote the production of palatable grasses and crops grown on traditional agroforestry farm plots; the loss of animal feed from the foliage of the destroyed trees and the subsequent overgrazing of the ground cover; the nutrients lost from the soil through erosion after the ground cover has been destroyed; the removal of nutrients stored in the wood and lost to recycling when transported to the market or burned in charcoal kilns, and loss of moisture storage due to the removal of surface and soil organic material through overgrazing and erosion. Before this [tree] removal, the moisture in the soil would have enhanced the growth of palatable grasses and crops grown in the traditional farming system, and maintained water levels in wells (Whitney 1987, 133-134).

Foresters actively debate whether "areas prone to shallow debris slides because of steep slopes and soils with low or no cohesion are provided with a degree of stability by tree roots," and whether, "reduction of the upper tree canopy increases the throughfall of rain but does not necessarily increase raindrop impact and 'splash' erosion" (Hamilton and Pearce 1988, 82-83). Finally it is argued,

> forest canopy reductions through tree cutting reduce the evapotranspiration losses from the water budget of forest watersheds, resulting in increased water yield in streams from the harvested area (Hamilton and Pearce 1988, 81).

Because of both the high rates of deforestation and land degradation frequently reported for the Plan Sierra region, it is logical to predict a positive relationship between these key variables. Research hypothesis (2A) reads as follows: land degradation depends upon deforestation. Hence, as forest conversion for agriculture increases, land degradation increases.

In direct contrast, Hypothesis (2B) defines the nature of the relationship between the process of "agricultural intensification" and farm level environmental (land) degradation. Although Boserup (1970) cautions that some forms of intensified food production, especially on steep slopes, may lead to erosion as a result of reduced fallow lengths and poor land preparation, it is fairly well established and widely promoted that agricultural intensification, combined with ecologically sound conservation techniques, will lead to a largely improved or at least stable farming landscape (Simon 1975, 1977, 1981); this is essentially the logic of Boserup's (1965) "intensification of agriculture" thesis. Based on competing Boserupian theory from the conventional population-economic school of thought, one anticipates an inverse relationship between increasing levels of agricultural intensification and reductions in associated land degradation, directly as a result of investments in landesque capital and improved food production skills. Therefore, research hypothesis (2B) is of the following form: land degradation depends inversely upon agricultural intensification. Hence, as the intensification of agriculture increases, land degradation decreases.

The first part of the third hypothesis set (3A) will define the nature of the relationship between the process of deforestation and population redistribution, specifically in-migration. According to the conceptual framework developed in this dissertation, one can argue that in-migrants will be drawn to forested frontier areas, perhaps representing strong resource "pull" factors, in response to ongoing population pressure in established rural source areas; this action is taken in order to maximize "place utility" of the traditional farming household. As the Plan Sierra region of the Cordillera Central is known for both high rates of deforestation and population redistribution, it is logical to predict a direct linear relationship between deforestation and in-migration. Consequently, research hypothesis (3A) is of the following form: in-migration depends upon deforestation. Hence, there is a positive relationship between forest conversion and population redistribution, in the form of in-migration.

In contrast, research hypothesis (3B) defines the nature of the relationship between the process of land degradation and population redistribution, in the form of out-migration. Rapid forest conversion combined with food production strategies that do not emphasize conservation, improvement and innovative reinvestment in the land resource base may soon lead to a degraded agroenvironment. As less land remains available for cultivation, due to erosion and soil nutrient deterioration, rural people will be forced to seek their livelihood elsewhere. Moreover, according to the conceptual model designed for this dissertation, land degradation as a result of pervasive population pressure will likely generate both resource stresses and dissatisfaction with local "place utility," which together may trigger a decision to migrate. Nevertheless, citing an empirical example of land degradation in Nepal, Blaikie notes,

> it is not claimed that environmental degradation is directly accelerating migration from the hills to the fast-disappearing new lands of the "terai," but it is claimed that it is "one" option given population growth and declining yields per hectare and hours worked--just as effective land management for sustainable yields is another (Blaikie 1988, 154).

Because of the elevated levels of land degradation and out-migration cited for the Plan Sierra region of the Cordillera Central, a positive relationship is predicted between farm level land degradation and out-migration. Therefore, research hypothesis (3B) reads as follows: out-migration depends upon land degradation. There is a positive relationship between land degradation and out-migration.

The fourth research hypothesis will define the nature of the relationship between the process of population pressure and migration. Occasionally, principal farmers are forced to decide among several choices in an attempt the maximize the "place utility" of the household, this is especially true under conditions of pervasive population pressure. Following Boserupian beliefs, one choice mandates agricultural intensification by means of increased land and labor intensity, improvements in food production techniques and investments in landesque capital. These efforts may be seen to reduce "resource push" factors and thereby greatly increase the sense of "place utility." In contrast, heads of rural households may choose out-migration, being compelled by the "resource pull" of the forested frontier, signifying a decision to maximize "place utility" in a new location. Because of the elevated rates of out-migration reported for the Plan Sierra region of the Cordillera Central, it is reasonable to expect a positive relationship between population pressure and out-migration. Consequently, research hypothesis (4) reads as follows: out-migration depends upon population pressure. There is a positive relationship between population pressure and out-migration. In conjunction, these three hypotheses (3A, 3B, 4) both contribute to and establish further linkages between migration and people-environment theory.

The next three hypotheses (5A, 5B, 5C) pertain to the population redistribution process, and thereby contribute to the literature of conventional and behavioral-migration theory. Based primarily upon the migration literature for Latin America (Thomas and Hunter 1980; Zuiches 1980), and developing countries in general (Lee 1966; Oberai and Bilsborrow 1984; Standing 1984), it appears that level of occupational preparedness, education, and age are important factors in the population redistribution process, especially the propensity toward cityward migration. Hypotheses (5A) and (5B) predict a positive correlation between occupational preparedness, education, and cityward migration. In general, the young, better educated and more highly skilled individuals leave rural generating centers for the larger cities. In contrast, out-migrants with few skills and little education may feel more secure in an agricultural or rural village setting. They realize the shortcomings they face in an urban environment. Consequently, research hypothesis (5A) reads as follows: there is a positive correlation between the variation in corresponding values of occupational preparedness and cityward out-migration. Those better prepared individuals tend to migrate to the larger urban areas, while those less prepared tend to migrate to frontier areas or choose to stay behind. Research hypothesis (5B) reads as follows: there is a positive correlation between the variation in corresponding values of education (years in school) and cityward out-migration. Furthermore, those individuals who leave the countryside for the "big city" are not only more educated and better trained in technical skills but are also younger than those who remain behind. Therefore, research hypotheses (5C) reads as follows:

there is a positive correlation between the variation in corresponding values of age and population redistribution, in the form of out-migration to large urban areas.

The last two hypotheses (6A, 6B) will further elaborate on the concepts linking behavioral-migration and people-environment theory by defining the nature of the association between level of occupational preparedness, age, and the influence or role of land degradation in the decision to migrate. Investigators have long argued that environmental factors act as an impetus to migrate (Brown and Moore 1970; Brown and Sanders 1981; Fuller 1978; Petersen 1958; Wolpert 1965). For example, drawing from behavioral-migration theory, Wolpert (1965) proposes that a combination of degrading conditions, both social and physical, in certain "urban environments" produce psychological stresses, triggering a decision to migrate. Ultimately, the decision to migrate is made in an attempt to maximize "place utility" as proposed by Brown and Moore (1971) and Fuller (1978).

Expanding on both notions from migration theory, the conceptual model in this dissertation argues that a degrading rural environment also functions as a stress impetus stimulating behavioral responses, especially the decision to migrate. It is further argued that one's age and level of occupational preparedness prior to out-migration vary directly with the perception of degrading conditions in the local economy for agriculture. Hypothesis (6A) predicts a positive correlation between occupational preparedness and the role of the environment (land degradation) in the decision to migrate. Those individuals with the best occupational skills will be both the first to perceive the significance of, and subsequently to leave, a rural area suffering from environmental degradation. This hypothesis suggests that less prepared individuals will remain--become the stayers--in a gradually deteriorating landscape for longer periods of time until the agroenvironment ultimately becomes the dominant stress or "resource" push factor in the decision to migrate.

Moreover, older people are less likely to move than their younger counterparts. Where social structures usually are better defined than those of the young, it takes a higher level of stress to enable them to leave their rural security. Hypothesis (6B) predicts a positive correlation between age, at the time of migration, and the role of the environment (land degradation) in the decision to migrate. Generally, young and capable individuals with rural backgrounds will be drawn to the large cities where both opportunities for education and employment are perceived to be high regardless of the condition of the environment.

In summary, this chapter introduces a framework of analysis that is designed to account for the various social responses to pervasive population pressure, within the context of traditional hillslope agriculture in the Dominican Republic. The importance of these responses will be evaluated in chapters five and six by means of a series of research hypotheses designed to assess the direction and strength of key relationships, as specified in the new conceptual model. First, chapter four introduces the Plan Sierra region of the Cordillera Central as the study area for this research, and discusses data sources in the Dominican Republic, as well as key measures, methods of analysis, and the sample survey design.

Chapter Four

The Plan Sierra Study Area, Data Sources, Measurements and Methods of Analysis

Introduction

Watersheds are logical units for the examination of human-environment interactions, and have become an accepted framework for analysis in the natural and social sciences (O'Sullivan 1979). Traditionally, geographers have observed the drainage basin as a fundamental physical unit (Chorley 1969), which also has an historical basis for human activity (Smith 1969). In the Dominican Republic, geographers working with other ecologists developed a simulation model of a tropical watershed to serve as a guide for regional analysis (Antonini and others 1974). Subsequently, development planners proposed a national level strategy that is based on the systematic management of fourteen regional hydrogeographic divisions (Figure 4.1), which delimit the country's major river basins (Hartshorn and others 1981).

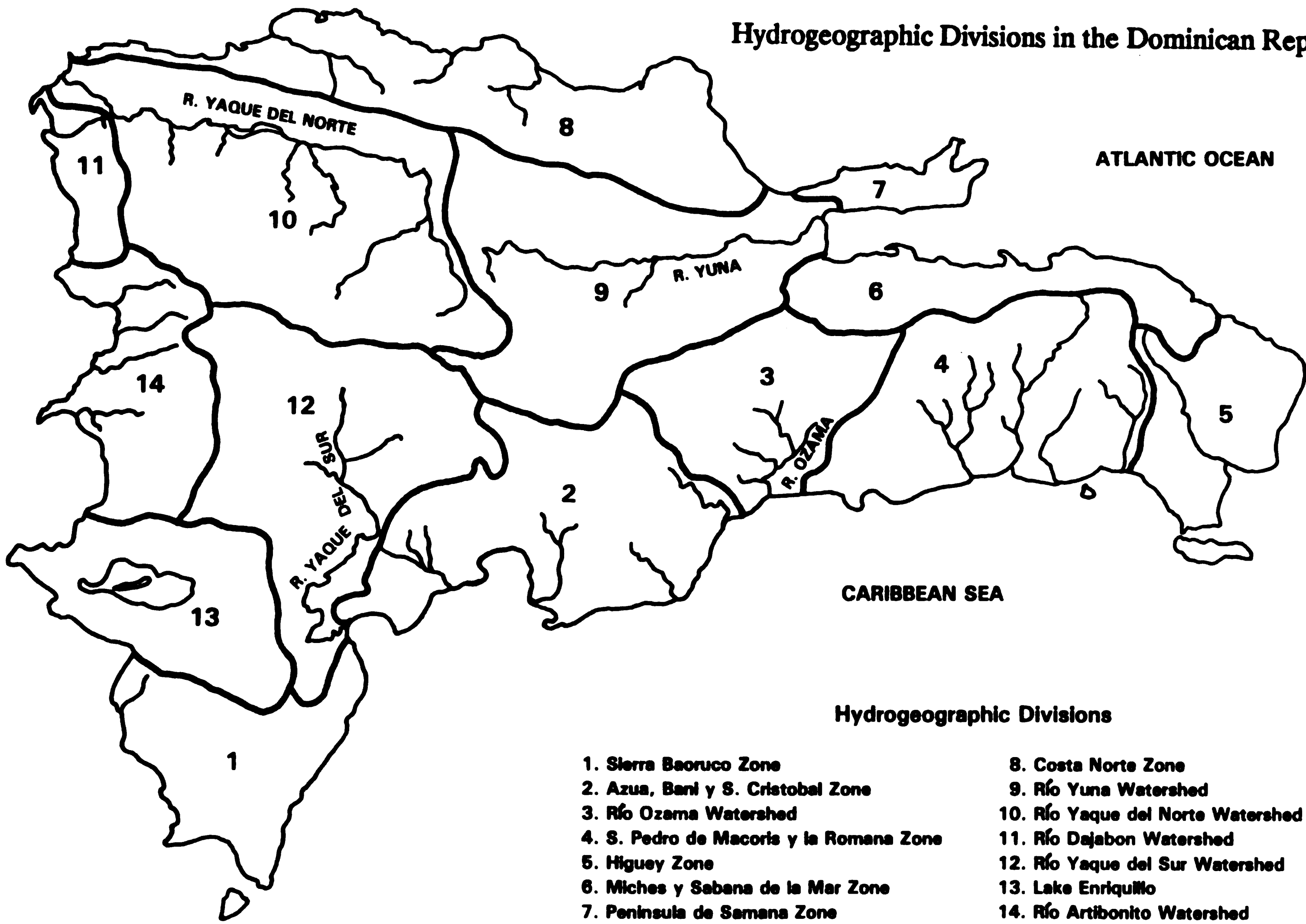
Study Area

The research in this dissertation also approaches dynamic social and physical processes from a regional, river basin level. Specifically, the Río Yaque del Norte watershed was selected from among the fourteen hydrogeographic regions for the following reasons: 1) the Yaque del Norte river basin contains the western Cibao, second largest agricultural region in the country (Van Royen 1940); 2) as a major food producing area, the Yaque del Norte basin has a high percentage of small privately-owned farms (Antonini 1971); 3) the area contains several major hydroelectric projects that show evidence of reduced storage life due to excessive erosion (Olson and others 1984); 4) natural resource inventories document environmental degradation as a result of deforestation in this watershed (Hartshorn and others 1981); and finally, 5) the Dominican government has established two natural resources management areas (Plan Sierra and Project Bao) to address sustainable silviculture and soil conservation in this central region of the Cordillera Central (Bretón 1978; Hartshorn and others 1981).

As a result of both the planning and implementation of these two resource management areas, and earlier hydroelectric projects, a large data base exists for the upper-most portions of the Río

Figure 4.1

Hydrogeographic Divisions in the Dominican Republic



Yaque del Norte watershed. This is particularly true of the Plan Sierra management area, which is largely nested within the Province of Santiago, with an extension into the easternmost portion of the Province of Santiago Rodriguez (Figure 4.2 & 4.3). The management area contains thirty-four political "sections" in their entirety. The political "section" is the smallest administrative unit below the provincial level for which published census data is regularly available, and fortunately, within this mountainous region, the political boundaries have not changed since the 1950 national census. Consequently, the thirty four political sections within the Plan Sierra region allow for the compilation of comparable variables for three national censuses, 1960, 1970, and 1981; "sections" therefore serve as one spatial level of analysis in this dissertation.

Data Sources

A recent publication by the Population Studies Center at the University of Texas evaluates all the available Dominican census materials in detail (Larson 1987). Population and agricultural data for the Dominican Republic are available from the National Statistics Office (ONE) in Santo Domingo at several political scales, including: national, regional, provincial, municipal, sectional, and occasionally the parish. The first Dominican census was taken in the year 1920, followed by decennial censuses in 1940, 1950, 1960, and 1970. Results from the 1981 population census are currently available, with detailed maps and statistics published for the Province of Santiago and the Federal District. Unfortunately, as of Fall 1990, the results of the 1981 agricultural census were still generally unavailable, with only a limited number of national level tables in print. In contrast, (Antonini and others 1975) have observed that the 1950 census is the most accurate and population projections often are based on this year. On the national, regional and provincial level, summary demographic-economic data and projections are published on a quasi-yearly basis as "statistical briefs."

Owing to the irregular coverage and release of the national census, it is fortunate that the Dominican Department of Agriculture (SEA) authorized a number of household surveys for rural areas which came under the jurisdiction of cooperative international resource management projects. Project Bao and Plan Sierra are among these. In lieu of the 1981 national agricultural census, detailed

Figure 4.2

The Sierra Study Area, Cordillera Central, the Dominican Republic

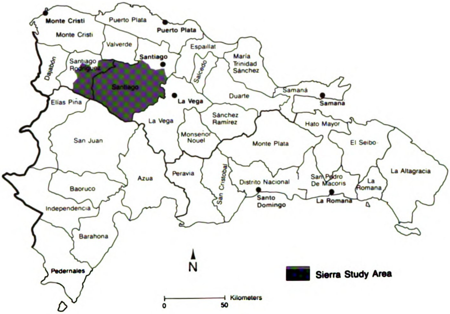
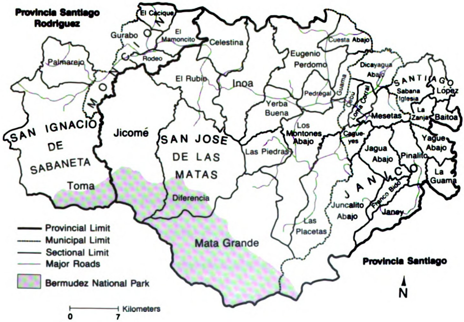


Figure 4.3

Political Divisions of the Sierra Study Area, Cordillera Central, the Dominican Republic



farm data are available for analysis for the year 1983 from the archives at the Plan Sierra headquarters in San José de las Matas (Abeu and Hernandez 1983).

Natural resource inventories often provide forest cover information, usually in map form, at the national and, occasionally, the regional level. Resource inventories of the Dominican Republic also are available for a number of years. Of these, the 1967 OAS natural resources inventory is clearly the most comprehensive, including sixteen color maps at a scale of 1:250,000 and numerous tables. A detailed combination land cover-use map of the Plan Sierra management region was prepared in 1983 by Belgian geographer, Franz Gielfus.

A frequent problem, encountered in comparing the natural resources inventories, is definition of key terms and change of map scale. The various national and international agencies that have made inventories of the Dominican Republic often used different criteria for land cover classification; this is particularly true of forest cover. For example, FAO required a minimum of twenty percent crown closure--twenty percent of the ground surface area is shaded by the trees--for forest designation. At the other extreme, the 1980 Comprehensive Resources Inventory and Evaluation Survey (CRIES) of the Dominican Republic used seventy-five percent crown closure. Finally, the medium scale format used for the 1967 OAS national level analysis (1:250,000) is generally inadequate for precise measurement at larger regional scales, such as the watershed level.

In order to minimize these problems, standardized large scale (1:50,000) topographic sheets were employed as the overlay mapping base in conjunction with reference land cover-use maps, and aerial photography as a secondary information source, which allowed forest cover measures to be made at two points in time (1960 and 1980). Forest cover definition was based upon a minimum measure of fifty-percent crown closure; this is the standard convention used by the U.S. Army Map Service, the agency responsible for mapping the Dominican Republic at the 1:50,000 scale.

Fairly complete aerial coverage of the Dominican Republic exists at several scales: (1:20,000), (1:24,000), (1:50,000), and (1:60,000) for a representative sample of years. Antonini used imagery from 1948, 1958 and 1966 in an analysis of the Jagua Bao watershed (Antonini and others 1974, 1975). The CRIES project at Michigan State University (MSU) documented changes in land cover in the Ocoa watershed with imagery from 1946, 1963 and 1983. At the Plan Sierra agricultural research station in San José de las Matas, imagery is available for reference purposes at scales of (1:20,000) and (1:24,000) for the years 1946, 1963 and 1980. A growing inventory of aerial photography and other imagery presently is being archived by the Center for Urban and Regional Studies (CEUR), housed within the Catholic University in Santiago. Aerial photography and topographic maps also are available for purchase from the National Cartographic Institute in Santo Domingo.

Measures of Population Pressure and Carrying Capacity

In 1966 an international symposium on population pressure on resources (PPR) was held, where it was observed that little consensus existed regarding definition or measurement:

> The beast we call PPR (population pressure on resources) is too large, ambiguous and ambulatory to be simply catalogued. It is bigger than we suspected previously; it has too many appendages, angles, and wrinkles for comfort, and it may travel in herds. We have succeeded only in demonstrating that it is truly multidirectional, that it involves relationships among many different sets of variables--ecological, social, technological, psychological, and historical It is impossible to produce a simple, universal definition that subsumes all the many kinds of pressure situations observed at different places and in different periods. But we are all uneasily aware that it exists (Zelinsky and others 1970, 581-582).

Fortunately, despite its ambiguities the study of population pressure has continued to function as a conceptual framework for population-resource relationships (Bernard 1977, 47). Moreover, regarding carrying capacity measures, geographers now claim, "no other method so effectively assesses the productive potential of the environment in relation to current and potential human uses" (Bernard, Campbell and Thom 1989, 400). In part, this may largely be due to the fact that "carrying capacity is conceptually inseparable from density" (Igbozurike 1981, 147).

By definition, assessments of population pressure or calculations of carrying capacity require a density measure of the relationship between people and a unit area of the land resource base that must support them by providing subsistence. Population density is rather simply depicted based on the formula ($D = N/A$), where D symbolizes the population density, N defines the population for the designated time period and (A) represents the spatial dimension (Igbozurike 1981, 147). Population data mathematically manipulated in this fashion are then mapped, usually by the choropleth method. This technique produces useful but rather "crude density" representations because the technique assumes an (unrealistic) equal distribution of population throughout the unit area mapped, which often produces abrupt and artificial boundaries between data class intervals. "Surprisingly, this simple expression of crude population density is clearly the most popular form in use in geographic, demographic, and other literature, as well as atlases and wall maps" (Igbozurike 1981, 147). Attempts to improve the technique for representing population density by dasymetric mapping were first proposed by Wright in 1936, and although his method may still be criticized for giving greater emphasis to area rather than people, it has served "as a springboard for the emergence of a large group of density measures referred to as physiological densities, or, less commonly, economic densities" (Igbozurike 1981, 147).

The conceptual basis for mapping human populations based on "physiological" rather than "crude" density rests on the premise that more realistic measures of population pressure may only be based on the land area upon which the population depends for food production. In this manner population density is often a function of people to the unit area of arable land that must support them (Turner and others 1977). However, in a broader perspective,

> these [physiological measures] relate population size to one or more resources, to the specific portion of land or water in which the resources are located, to particular resource exploitation systems, and even to degrees of success attained in resource utilization activities as measured by current standards of living (Igbozurike 1981, 147).

In the early 1980s, major methodological improvements were introduced by Bernard and Thom (1981) and recently reiterated by Bernard, Campbell and Thom (1989), who assessed population pressure and carrying capacities at the sub-district level in Kenya. They note, "examples at the sub-provincial scale demonstrate that even using present crude ecological, land use, yield, price, and demographic data, we can make meaningful estimates" (Bernard and Thom 1981, 338). These beliefs were first supported by Porter (1970) based upon field research examining population pressure on resources (PPR) in Machakos District, Kenya. The proposed calculations of minimum farm size (1) to determine carrying capacity (2) and assess population pressure on resources (3) are as follows:

S = ((rf * pc) + rl) divided by (y * s) (1)

where,

S = minimum farm size in ha necessary to sustain an average household each year.

y = average yield per ha of food crops in millions of kilocalories per annum.

pc = percent of calories derived from crops.

rf = total subsistence food crop requirement for an average household in millions of kilocalories per annum.

s = season

rl = livestock requirement in ha per family.

C = (A - aw) divided by S (2)
where,

C = carrying capacity in number of households

A = total area of location in ha.

aw = area of location in ha neither suitable for grazing nor cultivation.

S = minimum farm size necessary to sustain an average household (computed from first formula)

For the population pressure formulation (3), the actual number of households is divided by the carrying capacity (C). The resulting ratio is an effective measure of population pressure on land resources, with values over one indicating that the carrying capacity of the farming system in households has been exceeded; in contrast, values below one indicate that excess capacity remains. As a further refinement, they note,

> a spatially more explicit expression of these data required conversion of households to persons and computation of surplus and deficit densities. The population pressure ratio provides a comparative index of the degree of pressure over the study area (Bernard and Thom 1981, 397)

An important contribution in their formulation lies in the fact that the carrying capacity model may be based upon full and partial subsistence. For full subsistence an assumption is made that 100% of "basic subsistence needs" are provided from the land available to each household. As this assumption, in most cases, is not realistic and was a major criticism of earlier formulations, Bernard, Campbell, and Thom have provided a partial subsistence option. As a result of field surveys, estimates for partial subsistence were obtained and averaged. For example, if average households obtained eighty percent (80%) subsistence needs locally and twenty percent (20%) from the market place then twenty percent (20%) of the land required for each household could be deducted from the minimum farm size (variable S, Formula 1).

Notice also, that the (aw) variable (Formula 2) measures land not suitable for grazing or cultivation. This measure accounts for land that is both physically and socially not suitable for agricultural production. A change in the (aw) variable could also be an effective measure of environmental degradation over time. Ultimately, a general lack of accessibility to land, on a per household basis, could greatly affect the population pressure within an area. Consequently, formulas two and three above were employed in the case study of the Plan Sierra region of the Cordillera Central, as a basis for determining "section" level population pressure based upon the carrying capacity of the traditional hillslope farming system.

The 1987 Plan Sierra Farm Household Sample

Household level data also were obtained in the areas of agriculture, demography, economics, and education, by means of a sample survey. The convention in survey research has to this point been to interview individual out-migrants at the destination in order to explain the migration process. However, with this technique, much information about pre-existing socioeconomic and environmental conditions in the rural source areas, perhaps, pertaining to the causes of out-migration, is lost. In order to acquire additional data for out-migration at the source, a procedure known as a "multiplicity design" was used in this research. Aragon (1984) notes how this technique probes mutual aid and survival strategies based upon communication through kinship ties:

> In this way it is possible to obtain data using multiplicity surveys with heads of households, who can provide crucial information about the spatial mobility of their relatives, making possible the reconstruction of part of the total flow to which the informants themselves belong. An interview schedule was designed to 1) register a detailed migration history of heads of households, and 2) document part of the migration history of their relatives (parents, siblings, spouse and children), from information provided by the head of household about the places of birth and present residence of those relatives and their passage by the place of interview. Once the information is processed, it will be possible to identify seven groups of individuals related to the place of interview (Aragon 1984, 1).

The seven groups related to the place of interview are listed in Table (4.1). A more detailed discussion of the utility of multiplicity survey designs is found in the Papers of the East-West Population Institute (Goldstein and Goldstein 1981).

Guidelines for survey and questionnaire design, specifically related to agriculture and migration in low-income countries were obtained from a text published by the International Labour Organization's (ILO) World Employment Programme (Bilsborrow, Oberai and Standing 1984). The authors recommend that new research questionnaires be patterned after successful survey instruments that have been thoroughly field tested. Systematic areas of interest, for example agriculture, are presented as questionnaire modules with specific types of questions being grouped into "submodules." For the Plan Sierra farm level survey instrument, an agriculture, household characteristics, and migration module was designed, employing a select number of questionnaire "submodules" in modified form (Appendix B).

Sample Survey Design

The Plan Sierra sub-region of the Cordillera Central, located in the upper drainage basin of the Río Yaque del Norte, serves as the population (estimated universe of 105,000 in 1987) for this sample. Within the Plan Sierra management project, political sections were ranked according to a simple index of population pressure, often called "physiological population density" (Bernard and Thom 1981). From the rank ordering, three political sections were selected from each of following three groups: less than average, average, and greater than average population pressure. In each of the sample units, a systematic unaligned random sample was taken to minimize locational bias in the selection of farm households. The sampling was based on the location of residential unit structures, as initially identified on the most recent (1981) large scale census maps. Statistical sampling tables were consulted to determine the number of respondents for each sample unit. For example, at a selected confidence level of ninety-five percent, for each political "section" a minimum of fifty households were sampled. This ensured that the critical number of households, in this case 384, for the ninety-five and five option was exceeded by sixty-six households (Sheskin 1985, 35).

Table 4.1

Seven Groups Obtained from the Multiplicity Survey
(Aragon 1984)

	Migrant Groups	Direct Information (Households)	Indirect Information (Relatives)
01.	Born in household and not emigrated.	X	X
02.	Born in household, emigrated and returned.	X	X
03.	Born outside of household, immigrated and survived until date of interview.	X	X
04.	Born in household and emigrated.	X	
05.	Born outside of household, immigrated and left to the place of birth.	X	
	or to another place.	X	
06.	Born outside of household and not emigrated.	X	
07.	Born outside of household and emigrated to a place different than the household.	X	

Methods of Analysis

This research employs simple correlation and bivariate regression analysis to determine the precise nature of the relationships under investigation. These quantitative methods were selected because they are both statistically powerful and appropriate for the analysis of ordinal and interval-ratio data. The overall objectives of simple bivariate regression analysis can be summarized as follows: (1) to determine whether or not a relationship exists between two variables, a criterion (dependent) and predictor (independent) variable; (2) to describe the precise nature of the relationship, should one exist, in the form of an equation; and (3) to assess the accuracy or degree of prediction of the equation (Kachigan 1986).

In the first stage of quantification, the various data sets prepared for this research were subjected to a "univariate" analysis using commercial (SAS Version 5) statistical software. This routine produces a multitude of diagnostic statistics for individual variables, including: sample n, mean, standard deviation, skewness, kurtosis, etc. Histograms and normal probability plots provide for ample assessment of data normality. Based on this evidence, base ten log transformations occasionally were applied to selected key variables. A large number of frequency distribution tables were produced from the household questionnaire data.

Commercial (SAS) software also was employed to produce simple bivariate coefficients and residuals, via the regression procedure. For each regression equation, a scatter plot was generated to verify the linearity or near-linearity of the relationship. Within the regression procedure, supplementary "residual probability plots" and related statistics were evaluated to ensure that other assumptions of the linear regression model were upheld. To the best of my knowledge, all of the various data sets both analyzed and discussed in the following chapter comply with the assumptions of the linear regression model: linearity, normality, means of conditional distributions are equal to zero, homoscedascity, and lack of measurement error (Johnston 1978; Kachigan 1986; Poole and O'Farrell 1970).

Chapter Five

Results of Analysis, Part 1:
Population Pressure and Land Usage in the Cordillera Central

Introduction

This chapter begins with an overview of the major trends in population pressure and deforestation observed on the "political section" scale. The time frame applied to this level of analysis extends from 1960 (as the benchmark year for this study) until 1983, the most recent year for which data are available for the entire Plan Sierra management area. A description of the contents and findings of the 1987 farm household questionnaire follows, including a discussion of farm level trends in population pressure, the intensity of innovation in agriculture, deforestation and land degradation. A review of the results pertaining to the first two sets of research hypotheses concludes the chapter. Section and farm level trends in population redistribution are subsequently introduced in chapter six, generating a consideration of migration subgroups: out-migrants, in-migrants, return migrants, potential migrants and non-migrants. Chapter six continues with a discussion of the results of the quantitative analysis for the remaining four sets of hypotheses.

Assessment of Section Level Population Pressure

Measures of population pressure on maximum carrying capacity were determined for five separate years on the political section level. Three of the years, 1960, 1971 and 1981 represent data from the Dominican national census; the third and fifth years (1977 and 1983) reflect data gathered for special surveys conducted in the Plan Sierra management area. Carrying capacity and population pressure measures are based upon the following: 1) the amount of arable land in each political section, as determined by an international research team under the auspices of the Dominican Department of Agriculture (Grupo de Trabajo 'La Sierra' 1977); 2) a minimum farm size of eighty tareas (five hectares) necessary to support an average household size of six persons (adults and children), based upon the traditional hillslope farming system and environmental potential of the region (Grupo de Trabajo 'La Sierra' 1977; Yunén 1986), and finally; 3) the actual number of persons and estimated number of households recorded for each of the sample years. Population pressure is measured as the ratio of the number of households to the carrying capacity, expressed as 100% population supporting capacity when converted to a percentage.

Despite significant amounts of international emigration and internal out-migration from the Plan Sierra study area, population pressure at the political section scale tends to increase gradually from 1960 up to the year 1977. This trend is followed by a slight decline in mean population pressure in 1981 and a return to the 1977 density levels by 1983. For example, starting in the year 1960, mean population pressure stood at just below forty-five percent (44.1%) of carrying capacity, ranging from a low of slightly below six percent (5.6%) to a high of 168.5%, indicating overpopulation in the political Section Baitoa at the far eastern end of the study area (Figure 5.1).

Essentially this pattern is duplicated in 1971, where the statistics range from a low of approximately six percent (5.5%) to a high of 165.5% (Figure 5.2). Despite a minor decrease in the maximum population pressure level recorded for Section Baitoa between these national census years, mean section level population pressure increased to almost one-half (49.1%) of population supporting capacity. By this date, two sections (Baitoa and Cebú) exhibit population densities over the 100% threshold for carrying capacity. With the notable exception of Pedregal, there is a general trend toward increasing density in most political sections. Six year later (1977) three political sections (Baitoa and Cebú in the east and Palmarejo in the west) reflect population densities over 100% of carrying capacity, and mean population pressure reaches its highest recorded level at just below fifty-five percent (54.6%) of carrying capacity (Figure 5.3).

By 1981, population pressure ranged from a low of a fraction under seven percent (6.8%) to a noticeable high of 192.7% of carrying capacity (Baitoa) but with a slightly lower mean of just over fifty percent (52.1%). In contrast, population pressure in Pedregal continued to decline, as well as several isolated political sections, for example: Cebú, Cuesta Abajo, Guama, Palmarejo and El Rubio, which had declined drastically (Figure 5.4). In 1983, population pressure on land resources ranged from a new low of five percent (5.1%) to approximately the same high density as experienced in 1981, and the mean population pressure rose to almost fifty-five percent (54.2%) of carrying capacity. By 1983, three

Figure 5.1

Population Pressure, Sierra Study Area, 1960

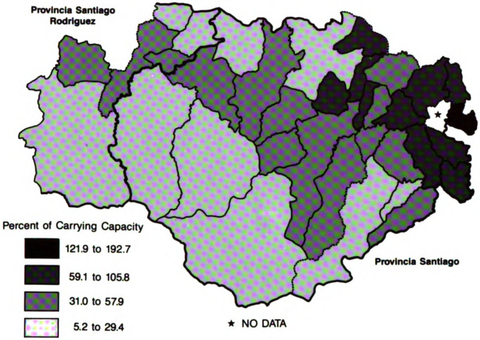


Figure 5.2

Population Pressure, Sierra Study Area, 1971

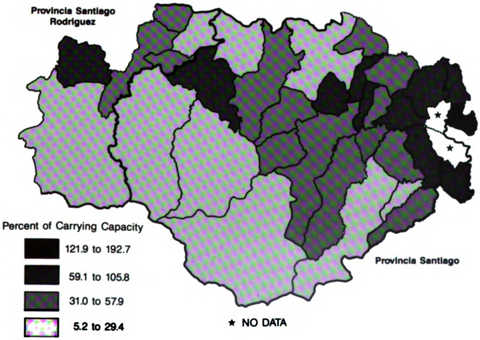


Figure 5.3

Population Pressure, Sierra Study Area, 1977

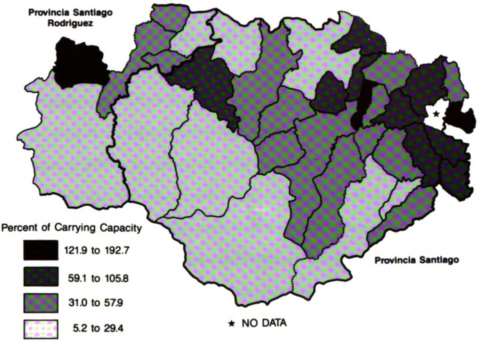
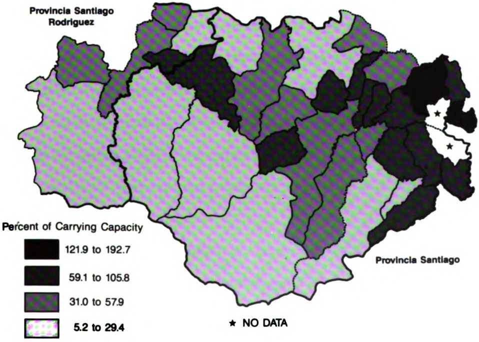


Figure 5.4

Population Pressure, Sierra Study Area, 1981



political sections (Baitoa, Mesetas and Sabana Iglesia) in the eastern portion of the study area illustrate population densities over 100% of population supporting capacity. In summary, between 1960 and 1983 mean levels of population pressure on the political section level rose approximately ten percent (10%) while maximum population pressure levels for individual political sections rose about (25%) twenty-five percent.

A linear settlement pattern is commonly found in rural areas of the Dominican Republic, where settlement tends to take place initially along major transportation lines connecting villages and cities and subsequently diffuses perpendicularly away from these lines of communication and transport (Antonini and others 1975). This general pattern is reflected in the population pressure maps for the above mentioned years. For example, high population densities are found in the political sections of Baitoa, Sabana Iglesia, Mesetas, Cebú, Guama and Pedregal, which all contain portions of the main road leading from the upper Cibao Valley to the nodal villages of Jánico, in Section Mesetas, and San José de las Matas in the Section of Pedregal.

Assessment of Deforestation in the Sierra, 1960 to 1980

The year 1960 serves as the baseline for forest cover measures, also calculated on a political section basis (Figure 5.5). At that time the Plan Sierra study area was largely forested with political section level percentages ranging from a low of sixteen percent forest cover in Sabana Iglesia in the far eastern portion to over ninety-five percent (97%) forest cover in one of the far western sections (Toma). A mean of seventy percent (70%) forest cover indicates that this area was essentially a forested frontier in 1960. For example, twenty-five out of thirty-two political sections demonstrate forest cover over fifty percent (50%) of their surface area. In addition, the forest cover map for 1960 also denotes the traditional linear settlement process with the incipient diffusion of settlers into the forested upland areas.

Agricultural settlement over the twenty year period, as reflected by deforestation, generally has evolved in close proximity to lines of transportation and in a radial pattern from the larger settlement nodes (Sabana Iglesia, Jánico and San José de las Matas), with the highest percentages of deforestation gradually advancing toward the periphery of the Plan Sierra study area (Figure 5.6).

Figure 5.5

Forest Cover, Sierra Study Area, 1960

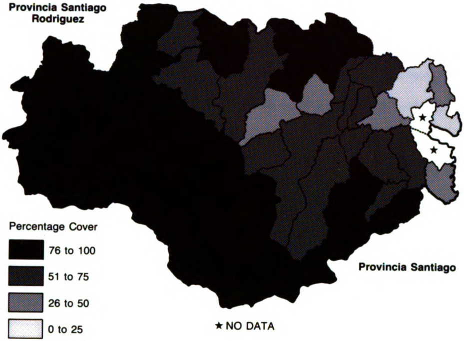
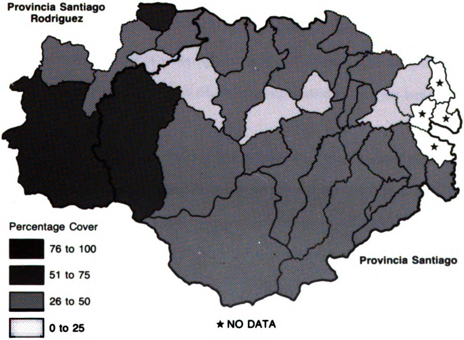


Figure 5.6

Forest Cover, Sierra Study Area, 1980



Percentage forest cover change rates vary from under ten percent (Sabana Iglesia) in the easternmost portion of the study area to slightly less than seventy-five percent (Rodeo) in the west (Figure 5.7), with a mean deforestation rate of thirty five percent (35%) since 1960.

Forest cover change rates in Plan Sierra also reflect a moderation of the deforestation process. The 1971 census indicates that between 1960 to 1971 the eastern two-thirds of the study region, an area including the municipios of Jánico and San José de las Matas, demonstrate a mean forest cover change of (-21.24%), equal to (-1.94%) annually. Yearly forest conversion rates range from a low of (+0.4%) in Loma de Corral to (-6.2%) in Cuesta Abajo, revealing an exceptionally high rate of deforestation. Average yearly forest conversion rates for the entire twenty year period (Table 1.3) also reflect slight increases in forest cover (+0.4%) and a lower annual maximum deforestation rate (3.7%). The twenty year average deforestation rate equals somewhat less than two percent (1.74%) per year, slightly lower than previous readings.

Farm Level Trends in Population Pressure and Deforestation

In order to assess the linear relationships between population pressure and deforestation, farming system intensity, and land degradation on an individual household scale, the first portion (module) of the questionnaire was designed to probe these themes. The survey instrument was systematically administered to approximately 450 rural households. From this group, 435 questionnaires were found suitable for compilation and data processing. The principal farmer, the individual who is responsible for most, if not all, farm management decisions, was targeted as the main respondent.

Population pressure was determined by first calculating carrying capacity on an individual farm basis, assuming an average household size of six persons on an average farm size of eighty tareas. The value of 13.33 tareas (.85 hectares) per person was compared to the actual ratio of farm size and number of persons in the household. The Plan Sierra farm sample revealed a mean population pressure of (85.57%) eighty-six percent of carrying capacity, indicating the average farmstead in the sample area was somewhat below the theoretical supporting capacity. In 1987, farm level population pressure ranged from a low of approximately (25%) twenty-five percent to a high of 250% of carrying capacity.

The average farm in the Plan Sierra sample study area contains a mean of eighty-two tareas (82.15) and ranges in size from two to 2000 tareas (.13 to 125 hectares). Generally, farm sizes less than one-half hectare are referred to as "microfundios." Most farmers (72.5%) claim to own their own land, with the average farmer holding title to approximately sixty five tareas. Ownership ranges in size from as little as two up to 2000 tareas. In addition, the average farmer rents almost seven (6.9) tareas from other landholders, accounting for about eighteen percent (18.3%) of the farmstead. The amount of farmland rented ranged as high as 400 tareas. Finally, a large amount of agricultural land is occupied by some farmers, without legal title to ownership; this practice is frequently referred to as squatting, and is becoming a serious problem in rural areas:

> Problems in rural areas have brought about an increase of squatters to both national and private lands. While in 1979 there were only five invasions of private property, 30 invasions had taken place in the first nine months of 1980. Invasion of land is not a minor disorder, but an organized confrontation involving hundreds of squatter families; some 5000 peasant households were involved in 1980... If the present trend in land invasion continues, it will pose serious potential for political confrontation within Dominican society (Hartshorn and others 1981, 86).

In the case of the Plan Sierra sample area, the average farmer illegally occupies a mean of slightly over ten (10.15) tareas or a little more than nine percent of the area designated as farmland. The amount of farmland occupied in this fashion ranges from none to as high as 1000 tareas (sixty-four hectares).

On the average farm in the Plan Sierra sample study area there were fifty-five (54.3) tareas of land in production in 1987, accounting for slightly more than seventy-five percent of the average farm size. Approximately twelve (11.98) tareas are used for crops, a little over forty (42.3) tareas, on average, for grazing purposes and the balance of about thirty (28.34) tareas are in fallow. The average annual production per tarea, measured in kilograms for both animal and crop production, is 96.3 kilograms (1502.28 kilograms per hectare); the upper limit of the range is 3,746.2 kilograms per tarea (58,440.72 kilograms per hectare). The average farm household derives about eighty-six percent of its subsistence food consumption from the farm.

Of the three general classes of farmland in Plan Sierra, slope, ravine and flat, most (69.36%) of the food production takes place on the "loma" or slope land. The average farm contains a mean of slightly over sixty-five (65.24) tareas in this class. The second category, lands in ravines, account for slightly more than nine percent of the farmland and average somewhat less than five (4.56) tareas per farm. Lastly, the highly desired "flat" lands comprise a little more than twenty percent of the arable land in this area and average slightly more than twelve tareas per farm. Antonini observes:

> Dominican farmers generally classify land into three categories: "haida," sometimes referred to as "lo pendiente," are hill slopes; "hoya" refers literally to hollows or intervales; and "llanos," plains. "Haida" lands are of less potential agricultural value and warrant no additional clearing aside from occasional weeding during the cultivation period. Higher valued "hoya" and "llanos" may provide the added incentive to complete land clearance by removing tree stumps and roots, but at times even "llanos" sites remain unimproved. Though the majority of peasants use hand tools such as the machete, hoe, axe and digging stick, one may occasionally see ox-drawn plows being used on higher valued lands (Antonini 1971, 3).

Principal farmers were asked to estimate the average amount of new land (forested) put into production each year. Farm level forest conversion ranged from no new lands cleared to a high of 150 tareas; mean farm level deforestation registered slightly more than one-half hectare or about nine tareas annually. This value represents a significant decrease in the annual rate of forest conversion for agriculture from the early 1970s, estimated by Werge (1974) at twenty tareas per year for the traditional hillslope farming system in the Sierra. Forests are converted by traditional methods; for example, over forty percent of the farmers (41.0%) practice slash-and-burn using a machete to clear the land. A larger majority (57.6%) claim to use a combination of oxen and machetes. A few (1.4%) have access to tractors and modern machinery for clearing the land of trees.

The principal farmers were asked to evaluate whether or not their individual rates of forest conversion had increased or decreased over the past ten years. The majority (45.8%) indicate that no change has taken place in their pattern of farm level deforestation. A few farmers report slight increases in their practices of forest conversion (11.5%) and even fewer (8.7%) report that deforestation had substantially increased. Larger numbers of farmers indicate that their forest conversion behavior reflects slight and substantial decreases, (17.4%) and (16.5%) respectively, since 1977. Two conclusions may be drawn from these responses, either farmers generally are under reporting the amount of new forest land cleared each year or farm level rates of deforestation decreased rapidly from the early to the late 1970s with declining forest cover itself.

Principal farmers were asked to estimate the average annual amount of arable and grazing land lost from production as a result of environmental degradation. The purpose was to obtain a simple field measure both defined by, and meaningful to, the person most affected by land degradation:

> Such simple field measures will never be fully respectable amongst the more technologically minded of the scientific fraternity, and quite valid criticisms can be made of the accuracy of measurements so obtained. However, the very strength of field measurements lies in the possibility of taking large numbers of them cheaply, with only semi-skilled technical assistance, and giving results that are probably more meaningful and visually impressive to the farmer and the extension worker than some super-sophisticated experimental facility at a distant research station. There would appear to be a lot of scope for development in this area of measurement of land degradation because increasingly it is the user of the land who must be convinced that degradation is a problem (Stocking 1987, 57).

The average farmer claims to be losing approximately two tareas (mean of 1.95 tareas) of land from production each year as a consequence of deteriorating soil conditions. This equates to about three percent of the farmstead being lost from food production annually. When asked about specific reasons for the changes in land use, over a third cited problems with poor soils (33.7%). Almost ten percent offered that the land was no longer productive. Moreover, over two-thirds (69.3%) of the principal farmers claimed that their neighbors are losing land from production for like reasons. Similar observations were made in the early 1980s, where:

> With his rudimentary technology the small farmer is forced to extract as much as possible from his land; this can easily lead to overutilization and soil degradation and as soils deteriorate productivity decreases. The rudimentary technology the peasants use does not necessarily lead to deterioration of the soil and/or other natural resources. The regions where peasant technology is causing the greatest ecological damage are the steep slopes of the Cordillera Central unsuitable for seasonal crops, particularly beans. Even if a peasant is in a position to take soil conservation measures, his individual effort is lost when the problems are widespread and affect whole regions (Hartshorn and others 1981, 86).

Most farmers (85.4%) in the Plan Sierra study area agree that, overall, the environmental conditions for agriculture have deteriorated since 1977. The majority (48.2%) respond that the conditions for agriculture have deteriorated considerably, while others (37.2%) support the contention that conditions have deteriorated to some degree. Less than five percent (4.6%) indicate there has been no change in the conditions for agriculture. Approximately ten percent believed the conditions in

1987 were more conducive to agriculture, with a very small percent (2.8%) believing that conditions had improved considerably. These more optimistic assessments, perhaps, reflect the successes of Plan Sierra soil conservation programs.

Regarding specific reasons for the deteriorating conditions, almost two-thirds (61.7%) of the principal farmers cite the incipient drought as the source of their ecological problems. Although meteorological data do not support, as yet, that climatic conditions are significantly drier than twenty or thirty years ago, the physical absence of trees makes conditions appear drier. Most small farmers generally are unaware of the role that trees play in the hydrologic cycle. Nevertheless, over twenty percent (21.1%) realistically believe that the land is over worked, and almost ten percent single out rapid deforestation as the cause for the major soil loss and their erosion problems.

There appears to be a wide range of opinion among principal farmers regarding change in the condition of the forest over the period from 1977 to 1987. One-third (33.3%) express the opinion that the condition of the forest has deteriorated to a large degree; an additional (28.7%) offer that the forests have deteriorated at least some. Less than ten percent believe there has been no change. Slightly more than twenty percent (21.3%) indicate that the condition of the forest has improved somewhat, and about eight percent (7.6%) argue that conditions have largely improved during the decade in question. These more optimistic assessments most likely reflect the minor successes of reforestation projects within the Plan Sierra management area and major efforts outside of the management area, especially along the major highway between the cities of La Vega and Santo Domingo.

Principal farmers were asked a number of specific questions pertaining to agricultural intensification. In order to place intensification within the conceptual framework of the small-scale agriculturalist of the Sierra, the basic farm unit must first be identified:

> The "parcela," a slash-and-burn farm [field] formerly called a "conuco," serves as the basic agricultural production unit for most Dominican peasants. Varying widely but generally approximating six "tareas," this unit provides the basis for family subsistence and supplies an additional cash income accrued from seasonal cash crop sales. The peasant farms his "parcela" using simple hand tools and employing agricultural practices learned from his forefathers (Antonini 1971, 3).

The most obvious traditional measure of intensity reflects the frequency with which fields are allowed to rest in fallow. Antonini found,

> Land rotation is practiced throughout the northwest. The peasant gauges the tillage period by physical site characteristics. Thus "parcelas" [individual field plots] located in the "haida" are cultivated solely for one year and then placed in fallow for five to eight years. During this latter period, the forest is allowed to regenerate. "Hoya" and "llanos" sites are often treated similarly--cultivated for two to three years and then planted in guinea or pangola grass and used as pasture for two to four years (Antonini 1971, 4).

Werge (1974) found the average small farmer maintains five or six "parcelas" in rotation each year, in addition to a large amount of land in pasture, where:

> The Dominican farmer has a wide variety but a small number of animals. Most are unimproved breeds. Two distinct classes are noted: "patio," yard animals; and the "potrero" or pastured stock. On the average farm, yard animals include chickens, a few turkeys, ducks and perhaps a sow and a pair of suckling pigs. The fowl are raised as scavengers within the farmhouse yard and pigs are kept in nearby sites. A limited amount of corn, cassava and sweet potatoes in addition to the kitchen refuse are used for animal feed. Cattle, horses and donkeys are restricted to small pastures which may be seeded in guinea grass but often are unimproved. These animals together with goats are also placed in abandoned and worked-out "parcelas" and permitted to graze. The land rotation system associated with slash-and-burn agriculture gives the Dominican farmer ample opportunity to shift grazing areas just as he staggers farm production from field to field (Antonini 1971, 7).

Furthermore, during the agricultural year the farmer exploits an equal amount of old land as new land put into food production. As the fallow time for the individual field plots is alternated, they produce enough to satisfy the various subsistence needs of the farm household. For example, the "parcelas" from last year produce "yuca" and "yautia" while those that are several years old produce (guineos) bananas and (platanos) cooking bananas. The field plots used most intensively are those closest to the household, producing potatoes. By working these parcelas and planting as many fruits as possible, the small farmer minimizes the risk of crop failure (Werge 1974, 54-55). Finally, however, Antonini cautions:

> The Dominican peasant faces the challenge of earning a livelihood burdened with archaic farming practices that retard any type of large-scale increase in farm production. A rapidly expanding population has increased pressure on the land, necessitating a changeover from extensive slash-and-burn agriculture to more intensive cultivation. The present day tendency to shift to growing cash crops and purchase staple food commodities has made the peasant increasingly dependent on the complex price-market structure of such fluctuating demand items as tobacco (Antonini 1971, 9).

The large number of farmers in the Plan Sierra sample area (40.6%) admitted their fields are in a fallow state for periods less than one year; reflecting a high level of land use and labor intensity. An additional number (28.7%) indicate that their fields are rotated in a fallow state for periods greater than a year but less than two years. Almost twenty-five percent indicate that a "bush fallow" system is in place, where fields lie in fallow from two to four years. A few farmers claimed to have longer fallow lengths of from five to seven years (4.4%) and eight to twelve years (2.5%), approaching the traditional forest fallow system of extensive "slash and burn" agriculture, as described above. It appears that the fallow lengths observed and described in the early 1970s, especially the rotation cycles practiced on mountain slopes, were no longer maintained by Plan Sierra farmers in the late 1980s. Perhaps, this partially accounts for the relatively high rates of farm level land degradation.

However, most principal farmers (40.6%) believe that fallowing practices have not changed over the decade since 1977. Almost equal numbers of farmers indicate that fallow lengths have either increased or decreased. For example, roughly twenty-five percent claim fallow lengths have increased; almost sixteen (15.8%) percent say that fallow lengths increased a little and somewhat more than ten percent (10.6%) say fallow lengths increased a lot. On the other hand, over thirty percent designate that fallow cycles are decreasing; almost sixteen (15.8%) percent say fallow periods are decreasing a little and fifteen percent (15.1%) say fallow periods are decreasing a lot.

The majority of the farmers in the Plan Sierra sample study area are not using most of the modern food production technology that is available. For example, almost ninety-five percent (94.7%) sampled indicate a dependence upon rainfall for their crops. The farmers who use irrigation techniques generally pump water to the fields through pipes (2.5%) or use a variety of other strategies. Almost thirty percent (29.8%) of the farmers sampled said they had used chemical fertilizers over the preceding twelve months.

Most Dominican farmers, moreover, have not invested in major land improvements. Slightly over ninety percent (90.4%) admit they do not attempt to level their land prior to cultivation. An even higher percentage (91.1%) do not use terracing for erosion control, however, a little more than half (56.2%) plant trees in groups to function as soil anchors, thereby reducing erosion. Roughly twenty-five percent of the farmers reveal they use some specially treated seed (20.4%) with a few (6.6%) indicating their frequent use. A number of institutional factors may help to explain the apparently slow rate of technological intensification:

> The small farmer still relies on rudimentary agricultural technology. He uses basic tools and little if any mechanization or fertilizer. In the Dominican Republic fertilizers are used primarily by the cash crop export sector. At the same time several studies have shown a positive and open attitude of small farmers to modern technology, including fertilizer, but they do not use it because they can not afford it. Loaning institutions generally consider the small farmers a risky credit subject; hence they have a hard time acquiring credit for production (Hartshorn and others 1981, 85).

Resolution of Hypotheses 1A - 2B

According to conventional population-economic theory, deforestation, in order to convert new land into food production, is considered the primary social response to increasing population pressure on carrying capacity. However, the precise nature of the relationship between population pressure and deforestation generally is unknown or largely misunderstood. Moreover, competing theories in the population literature alone propose alternate social responses to pervasive population pressure, irrespective of deforestation. This dissertation will contribute to population-economic and people-environment theory by explaining the nature of this relationship within a case study from the Dominican Republic. For example, as the Plan Sierra region of the Cordillera Central is commonly cited for both accelerated rates of deforestation and high levels of population pressure, it is logical to predict a positive linear relationship between these variables. Regardless, null hypothesis (1A) takes the following form:

> Ho, there is no linear relationship between the variation in corresponding values of population pressure and forest conversion. Hence, regression coefficient ($b = 0.0$) is equal to zero.

The alternative hypothesis counters:

> H1, there is a positive linear relationship between the variation in corresponding values of population pressure and forest conversion. Hence, deforestation depends directly upon population pressure, therefore regression coefficient ($b > 0.0$) is greater than zero.

The significance or rejection level for the pair of hypotheses was predetermined at ninety-five percent (95%).

At the "political section" scale, the lowest sub-level below the "provincia" for which published census data are generally available, a small series of statistics were compiled to define the nature of the linear relationship between changes in population pressure and forest cover from 1960 to 1980. Political "section" level population pressure is defined as the ratio of the number of farm households (based on a constant of 5.95 persons per household) to the maximum household carrying capacity, calculated for the years 1960, 1971, 1981, and standardized as a percent (PR1960, PR1971, PR1980). For example, the variable PR1960 defines section level variation in population pressure for the year 1960, measured as a percentage of maximum household carrying capacity. Therefore, seventy-five percent population pressure indicates that a section has a density value equal to three-quarters its of theoretical capacity. Next, a related set of variables measure the variation in population pressure over the time frames 1960 to 1971 (CH6071), 1971 to 1981 (CH7181), and 1960 to 1981 (CH6081). For example, the variable CH6081 defines section level variation in the percentage change in population pressure density over the twenty-one year time period from 1960 to 1981.

Likewise, standardized forest cover measures on the political section level were arrayed for the years 1960, 1971 and 1980 (FOC60, FOC71, FOC80). Forest cover estimates for the years 1960 and 1980 were determined by planimetric methods based upon existing forest-land cover maps (Gielfus 1982), supplemented with photo interpretation. Forest cover statistics for the year 1971 also were obtained from the agricultural census (Dominican Republic 1975). For each of the years, the measured amount of forest cover was estimated in hectares and recorded as a percentage of the total surface area in each political section. In addition, a related set of variables measures the percentage change in forest cover for the following time frames: 1960 to 1971 (CVCH6071); 1971 to 1981 (CVCH7180); and 1960 to 1980 (CVCH6080).

Results of simple bivariate regression analysis establish a weak positive relationship between population pressure and rates of deforestation on the political section scale (HYP. 1A Eq. 1, Table 5.1). An equation that probes variation in the linear relationship between the key variables over the twenty year time frame produces a significant (.0216) moderately weak positive relationship (r = .359) between the predictor variable (CH6081) and the criterion variable measuring deforestation

(CVCH6080). In this instance, the regression coefficient (b = .48) is greater than zero with a significant t-test value (t = 2.11). However, the adjusted r square value of (.100) indicates that only ten percent of the variation in deforestation is explained by increases in population pressure on the "political section" scale.

This dissertation also contributes to existing population-economic theory by defining the nature of the relationship between population pressure and deforestation at the farm household level. According to Brookfield and Blaikie (1987), comprehension of the social aspects of these processes and their linkages with higher management levels must be made at the individual farm (decision making) scale as a result of broad based case studies. Therefore, average yearly farm level rates of deforestation (TCLRD = number of forested tareas cleared) are determined from the responses of principal farmers, based on forest clearing practices since 1977. In order to compensate for variation in farm size, the yearly average number of tareas deforested is compared with the actual farm size and standardized as a percent (PTCLRD = percent forested tareas cleared). As noted earlier, all variables were subjected to a "univariate" analysis in order to assess the distribution (normality) of data values. Variables that exhibited a skewed distribution, based upon a probability plot, were transformed prior to further statistical analysis. Typically, a base ten log transformation was executed to normalize the variable, therefore (LPTCLRD = log of percent forested tareas cleared).

Building on the methodology established by Bernard, Campbell and Thom (1981; 1989), the following new social measure is proposed, where farm level population pressure (FPPR87) is defined as the ratio of the actual farm level physiological density to the household carrying capacity. Assuming a minimum farm size of eighty tareas, based on the traditional hillslope farming system in the Plan Sierra region, and an average household size of six persons, the constant of (13.333) tareas is produced, which defines the minimum subsistence area per person. To determine the carrying capacity of the household, the actual farm size is divided by the theoretical subsistence density per person. The farm level population pressure ratio is calculated by dividing the actual household size in tareas by the carrying capacity, as indicated in the following formula:

$$FPPR87 = \text{household} / (\text{farm size}/13.333) \qquad (4)$$

A base-ten log transformation was required to correct for (normalize) positive skewness in the derived data values.

Simple bivariate regression analysis confirms a moderately strong positive relationship (r = .721) between Base 10 log measures of farm level population pressure (LFPPR87) and the rate of deforestation (LPTCLRD). The statistics for the entire farm sample, significant at the (.0001) level indicate that the regression coefficient (b = .604) is greater than zero with a high t-test value (t = 18.766). Moreover, the coefficient of determination (r square = .520) reveals that approximately fifty two percent of the variation in the log value of forest conversion is explained by the log value of a new farm level measure of population pressure (HYP. 1A Eq. 2, Table 5.1). In order to assess the effect of farm size on the key variables, the entire household sample was partitioned into three groups. Large farms are defined as those operations larger than 200 tareas up to 2000 tareas while medium sized farms range from greater than eighty tareas up to 200 tareas. The smallest of these size groupings, farms that range from a minimum of two up to eighty tareas, produces a significant correlation coefficient of (r = .529) at the (.0001) level (HYP. 1A Eq. 3, Table 5.1). In this case, about twenty-eight percent of the variation in deforestation is explained by farm level population pressure, with a fairly large sub-sample (n = 233). In addition, the regression coefficient (b = .256) also is greater than zero with a significant t-test value (t = 9.57). The regression coefficients alone suggest that the strength of the positive relationship between population pressure and rates of deforestation should increase with farm size. However, no meaningful results were realized for the medium and large farm groups at the required confidence level. This may be attributed to the comparatively low sub-sample sizes, at (n = 57) and (n = 31) respectively. Nevertheless, significant results provide convincing evidence for a moderately strong positive relationship between population pressure and deforestation, including rural households containing less than the traditional minimum farm size of eighty tareas required for subsistence.

According to conventional population-economic theory, both forest cover and the amount of fallow land vary in response to increases in population pressure. These changes were documented in the farm household questionnaire in order to create a new variable measure, the deforestation-fallow ratio (TDEFAL87). This statistic is defined as the ratio of the number of tareas cleared (TCLRD) to the number of tareas in fallow (TFALLOW). Conceptually, a value close to zero indicates a traditional forest fallow farming system, where there is a relatively small amount of forest land being cleared compared to a large amount of land in long term fallow. A computed value of one indicates that an equal amount of area on the various farm parcels is being used for each purpose. Values greater than one signal that rapid deforestation is taking place and the amount of long term fallow land is rapidly decreasing. This variable relates to the crop-fallow ratio as first proposed by Boserup (1965) but, by definition, is more sensitive to changes in forest cover. This is an important measure conceptually because it is not influenced by variation in farm size.

A positive relationship is predicted between farm level population pressure and the deforestation-fallow ratio. Under social conditions of low population pressure one would expect to see relatively small amounts of forested land being cleared and large amounts of land in fallow. As population pressure increases, deforestation will accelerate and land area in fallow will decline. Results of simple bivariate regression analysis (r = .546), confirm a moderately strong positive relationship between these variables, significant at the (.0001) for the entire farm household sample (HYP 1A Eq. 4, Table 5.1). In this instance, the regression coefficient is greater than zero (b = .601) with a significant t-test value (t = 7.90). This dissertation also provides meaningful evidence on the individual farm level that increases in population pressure have the effect of decreasing the deforestation-fallow ratio. Consequently, based on the above results, the null hypothesis of "no relationship" between population pressure and deforestation should be rejected and the alternative hypothesis (H1) accepted at the (.05) level of significance.

Linear regression analysis employing national level data for a select group of developing countries already supports a strong positive relationship between population growth and deforestation (Allen and Barnes 1985). This research demonstrates that the linear relationship also holds on the farm household scale. On the "political section" level, however, results confirm a weak positive relationship between changes in population pressure and rates of deforestation over a twenty year time frame. This may be the result of measurement error in determining either population pressure or

Table 5.1

Significant Results of Bivariate Regression
(Hypotheses 1A and 1A*1)

	Dep. & Ind. Var.	r	Prob.	a	b	n
Hyp. 1A						
Eq. #1	CVCH6080 & CH6081	.359	.0216	-38.51	0.480	31
Eq. #2	LPTCLRD & LFPPR87	.721	.0001	1.13	0.604	324
Eq. #3	LPTCLRD & LFPPR87	.529	.0001	0.26	0.256	233
Eq. #4	LTDFAL87 & LFPPR87	.546	.0001	-0.55	0.601	149
Hyp. 1A*1						
Eq. #1	FOC60 & PR1960	-.782	.0001	97.25	-0.690	31
Eq. #2	FOC71 & PR1971	-.720	.0001	69.60	-7.060	27
Eq. #3	FOC80 & PR1981	-.567	.0001	47.80	-0.270	31

forest cover change at this scale. For example, the reliability of the forest cover statistics from the 1971 Dominican agricultural census are questionable (Larson 1986).

Perhaps a series of static forest cover estimates (examined over time as a surrogate measure of deforestation) may also be significantly related with variation in population pressure. This related research question (1A*) requires the formulation of new hypotheses, as follows:

> Ho, there is no linear relationship between the variation in corresponding values of population pressure and forest cover. Hence, the regression coefficient ($b = 0.0$) is equal to zero.

The alternative hypothesis counters:

> H1, there is an inverse linear relationship between the variation in corresponding values of population pressure and forest cover. Hence, changes in forest cover depends inversely upon population pressure therefore the regression coefficient ($b < 0.0$) is less than zero.

The key variables, as defined above, for the small series of data on the political section level are employed. They include standardized forest cover measures for the years 1960, 1971, and 1980 (FOC60, FOC71, FOC80) and standardized measures of population pressure (PR1960, PR1971, PR1981).

The results of simple bivariate regression analysis reveal a highly significant relationship for each of the years in question. Starting with the base year 1960, a negative regression coefficient ($b = -.690$) establishes that (b) is less than zero, with a significant t-test value ($t = -.7.06$). A correlation coefficient of ($r = -.782$) establishes a strong inverse relationship between population pressure and forest cover; in this case high values of population pressure are spatially associated with low forest cover values. The square of the correlation coefficient (r square = .612) indicates that sixty-one (61%) percent of the variation in the criterion variable (forest cover) is explained by the variation in the predictor variable (population pressure). From the equation (HYP 1A*1 Eq. 1, Table 5.1), we find that for every one percent increase in population pressure there is an associated decrease of over one-half of one percent forest cover. The intercept value (97.3) indicates the percentage of forest cover we would expect to see, in 1960, if population pressure were zero (Johnston 1978, 28). Zero population pressure would indicate that the political section was an unpopulated frontier.

A map of the standardized residuals from the regression equation (Figure 5.8) indicates that forest cover was largely under-predicted in the highly populated Section of Sabana Iglesia (containing the city of Sabana Iglesia) and in the centrally located Section of Yerba Buena, which contains the village of San José de las Matas. Forest cover was considerably over-predicted in the eastern Section of Guama and western Section of Rodeo, where both political sections were largely forested in 1960. Minor over-predictions of forest cover were seen in the western Sections of Palmarejo and El Cacique, and in the centrally located Section of Las Piedras. In general, the regression model over-estimates forest cover in select political sections near nodes of concentrated village settlements, like, San José de las Matas and Sabana Iglesia. On the other hand, the regression model is under-estimating forest cover in several "sections" already identified as the forested frontier. The Section of Guama is especially noteworthy, still eighty percent forested and near to the evolving east-west linear settlement pattern, it clearly was an important incipient frontier destination in 1960.

Similar results were obtained for the years 1971 and 1980, where in 1971, a strong inverse relationship between population pressure and forest cover is indicated by a negative regression coefficient (b = -.480) again significant at the (.0001) level with a t-test value of (t = -5.48). In addition, a correlation coefficient of (r = -.720) also reveals a moderately strong inverse relationship (HYP. 1A*1 Eq. 2, Table 5.1). In this case, the square of the correlation coefficient (r square = .518) drops somewhat to the point where approximately fifty-two (52%) percent of the variation in the criterion variable is explained by the predictor variable (population pressure). By 1971, therefore, a one percent increase in population pressure is directly related with slightly less than a one-half of one percent decrease in forest cover.

A map of the standardized residuals from the regression equation (Figure 5.9) indicates that forest cover in the western Sections of Rodeo, Jicome, and especially the large Section of Mata Grande, are over-predicted (although less than two standard errors in the case of Mata Grande and less than one-and-one-half standard errors in the others). The larger Sections (Jicome and Mata Grande) were still largely inaccessible at this time and subsequently were partially incorporated into the Bermudez National Forest. There also are minor over-predictions of forest cover in the eastern

Figure 5.7

Decrease in Forest Cover, 1960 to 1980

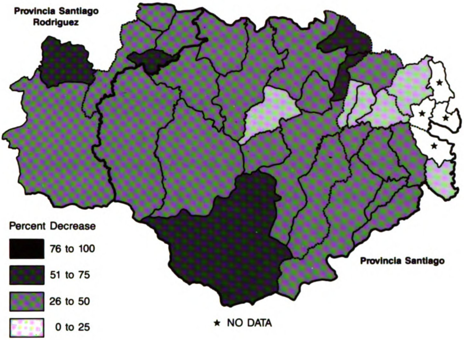
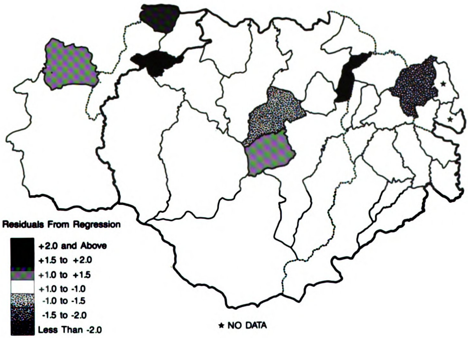


Figure 5.8

Residuals from Regression, Forest Cover (Y) with Population Pressure (X), 1960



Sections of Cebú and Baitoa. Minor under-predictions of forest cover are experienced in the highly populated eastern Sections of Lopez, Sabana Iglesia and Janey, and in the central Section of Yerba Buena. Once again, the regression model is generally over-estimating forest cover in selected political sections near the east-west linear band of settlement and in an important coffee production area in the southeast (Janey); in contrast, the regression equation is under-estimating forest cover in frontier areas, especially the larger western sections that were being partially incorporated into protected forest reserves.

By 1980, the strength of the linear relationship between population pressure and forest cover on the political section level declines to a moderate status, as illustrated by the regression coefficient ($b = -.270$) still highly significant at the (.0001) level, with a t-test value of ($t = -3.96$). The correlation coefficient of ($r = -.567$) indicates a moderately strong inverse relationship (HYP. 1A*1 Eq. 3, Table 5.1). A one percent increase in population pressure in 1980 is inversely related with slightly more than one-quarter of one percent loss in forest cover. By the early 1980s, the predictor variable (population pressure), alone, is still accounting for thirty-two percent of the variation in the forest cover (criterion) variable, at least on the political section level.

A map of the standardized residuals from the regression equation (Figure 5.10) indicates that forest cover is considerably over-predicted in two western Sections, El Cacique and Toma. The larger Section, Toma, is still rather isolated and also forms a part of the Bermudez National Forest, it is therefore somewhat protected from the ill-effects of population pressure, as reflected by over seventy percent forest cover as late as 1980. El Cacique was over sixty percent forested but did not have protected forest status, it perhaps represents an isolated frontier area (deviant case) that requires further field investigation. The eastern Section of Sabana Iglesia illustrates a minor over-prediction (within one and one-half standard errors) corresponding with a slight increase in forest cover since 1971. It appears that population redistribution over the twenty year period (1960-1980) from the important emigration source area of Sabana Iglesia had decreased the section level pressure on land resources. The large Section of Mata Grande is considerably under predicted (between one-and-one-half and two standard errors) by the regression equation for 1980. This Section experienced a forest

Figure 5.9

Residuals from Regression, Forest Cover (Y) with Population Pressure (X), 1971

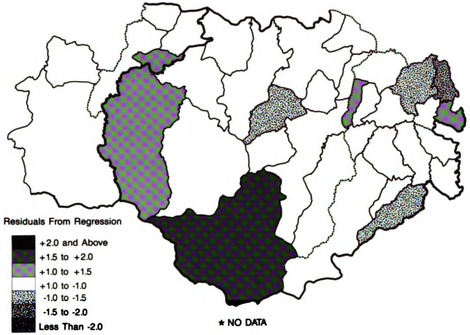
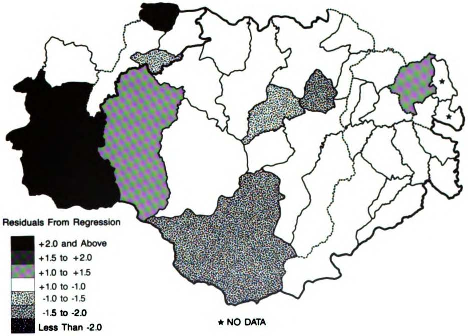


Figure 5.10

Residuals from Regression, Forest Cover (Y) with Population Pressure (X), 1980



over loss of over fifty percent since 1960, due to intense settlement in the lower northeastern portion of the section, and currently suffers from illegal trespass on the protected reserves of the Bermudez National Forest. The interior sections of Yerba Buena and Pedregal illustrate the anticipated under-predictions in forest cover found in the more highly populated rural areas near villages and small cities.

This dissertation provides evidence (at the sectional level) for the decline in the strength of relationship between population pressure and deforestation over time. In 1960, the Plan Sierra study area was largely a forested frontier, with much of the original tree cover still intact; by the late 1980s, this mountainous area was largely deforested and in a degraded state. Common sense and empirical evidence (Sachtler 1974) argue that accessibility to the forests plays an important role in land cover change. The more accessible forests are likely to be converted earlier and at a faster rate than the more inaccessible. Likewise, gently forested slopes are likely to be converted to farmland earlier and at a faster rate than steeper slopes. Additionally, Dominican farmers often use forest composition as an indicator of soil quality and, therefore, certain forest complexes/types are removed more quickly than others. In combination, these results are noteworthy in light of recent findings from research in other mountainous environments, which question the prime role of population pressure in the deforestation process, especially in more advanced stages of deforestation (Ives and Pitt 1988, xii). Based upon the Plan Sierra case study, it is apparent that the strength of the relationship between population pressure and deforestation changes significantly over time (twenty to thirty years), when measured at larger scales of analysis such as the political section in the Dominican Republic. When measured on the individual household level, the relationship appears to be stronger with increasing farm size, although a moderately strong positive relationship was established for farms smaller than eighty tareas. Perhaps the decline in strength of this relationship, temporally, indicates the rising importance of one or more alternative responses to pervasive population pressure.

Bilsborrow proposes that societal responses to sustained population pressure evolve over time, grading from economic to economic-demographic to exclusively demographic responses (Bilsborrow 1987). For the case study from the Plan Sierra region of the Cordillera Central, it appears that accelerated forest conversion for food and fuelwood production has been the primary response to sustained population pressure, at least from 1960 to 1987. Nevertheless, with the greatly reduced levels of forest cover experienced throughout the 1980s, perhaps now we should, according to the conceptual framework proposed by Bilsborrow (1987), expect to see evidence of alternate responses to population pressure. The alternate choices are proposed in the conceptual model detailed in chapter three and are examined below.

Research hypothesis (1B) examines several of the alternative responses to population pressure, which are collectively defined as agricultural intensification. These responses include the intensity of land and labor inputs, innovations or inputs into the land resource base, and innovations in or inputs of new food production skills (Boserup 1965, 1981; Brookfield 1971, 1984; Brookfield and Blaikie 1987). According to conventional population-economic theory, "the primary purpose of intensification is the substitution of these inputs for land, so as to gain more production from a given area, use it more frequently, and hence make possible a greater concentration of production" (Brookfield 1971, 51). According to the model proposed in this dissertation, agricultural intensification logically will be exercised by traditional farmers in response to increasing population pressure, irrespective of, or as an alternative to, forest conversion.

In order to appraise the various aspects of agricultural intensification, the original research hypothesis will be specified in the following ways to account for the distinction between the terms intensity and intensification. In this research, static measures of agricultural intensity are employed in lieu of measures that assess changes in farming practices over time. The first modified hypothesis (1B*1) will examine the more common notion of land use intensity, as first proposed by Boserup (1965).

> Ho, there is no relationship between the variation in corresponding values of population pressure and land use intensity. Hence, the regression coefficient ($b = 0.0$) is equal to zero.

The alternative hypothesis offers:

> H1, there is a positive relationship between the variation in corresponding values of population pressure and land use intensity. Hence, land use intensity depends upon population pressure, therefore the regression coefficient is ($b > 0.0$) greater than zero.

The second modified hypothesis (1B*2) will examine the relationship between population pressure and intensity of innovative farming skills, where:

> Ho, there is no relationship between the variation in corresponding values of population pressure and intensity of innovative farming skills. Therefore, the regression coefficient (b = 0.0) is equal to zero.

The alternative hypothesis offers:

> H1, there is a positive relationship between the variation in corresponding values of population pressure and the intensity of innovative farming skills. Hence, the intensity of innovative farming skills depends upon population pressure, therefore the regression coefficient is (b > 0.0) greater than zero.

The third modified hypothesis (1B*3) will examine the relationship between population pressure and intensity of investments in the land resource base, referred to by Brookfield and Blaikie (1987) as landesque capital.

> Ho, there is no relationship between the variation in corresponding values of population pressure and intensity of innovative improvements in the land resource base. Hence, the regression coefficient (b = 0.0) is equal to zero.

The alternative hypothesis offers:

> H1, there is a positive relationship between the variation in corresponding values of population pressure and intensity of innovative improvements in the land resource base. Hence, the intensity of investment in landesque capital depends upon population pressure, therefore the regression coefficient is (b > 0.0) greater than zero.

The fourth modified hypothesis (1B*4) will examine the relationship between population pressure and agricultural intensity in the form of combined innovative skills and improvements to the land resource base. However, the null hypothesis is of the following form:

> Ho, there is no relationship between the variation in corresponding values of population pressure and agricultural intensity, in the form of combined innovative skills and improvements to the land resource base. Hence, the regression coefficient (b = 0.0) is equal to zero.

The alternative hypothesis offers:

> H1, there is a positive relationship between the variation in corresponding values of population pressure and agricultural intensity, in the form of combined innovative skills and improvements to the land resource base. Hence, the combined intensity of innovative skills and investment in landesque capital depends upon population pressure, therefore the regression coefficient is greater (b > 0.0) than zero.

Likewise, the rejection or significance level for the pairs of hypotheses was predetermined at ninety-five (95%) percent.

Results of simple bivariate regression analysis on the "political section" level are meaningful, however, in several instances the direction of the relationship between the key variables is the reverse from that predicted in the modified research hypotheses (Table 5.2). Data to assess the relationship between population pressure and intensification practices (agricultural intensity) are only available for the year 1983. Nevertheless, significant results are produced from four equations. The first equation (HYP. 1B*1 Eq. 1) examines the linear relationship between population pressure (LPR1983) and land use intensity. In this case, land use intensity is defined by the variable (CULT83), which is a standardized version of the crop/fallow ratio, as re-defined by Turner and Doolittle (1979). Results indicate that a very weak (r = .283) positive relationship is established between the predictor and criterion variables, where the regression coefficient (b = .001) is greater than zero, with a t-test value (t = 1.62) significant at the (.0576) level. The second equation (HYP. 1B*2 Eq. 1) probes the causal relationship between a normal log of population pressure (LPR1983) and improved food production skills (SKILLS83). The variable (SKILLS83) measures the percentage of farms per section that made use of fertilizers and insecticides in 1983. However, in contrast to the research hypothesis, results of bivariate regression analysis reveal a moderately strong inverse relationship (r = -.567) between the predictor and criterion variables. The regression coefficient (b = - 37.99) is less than zero with a t-test value (t = -3.77) significant at the (.0007) level. Likewise, a third equation (HYP. 1B*3 Eq. 1) probes the relationship between population pressure (LPR1983) and investments in landesque capital (INNOVA83). In this case, intensified land resource management is defined by the percentage of farms per section that made innovative use of irrigation and erosion control methods in 1983. Results of simple bivariate regression analysis also reveal a moderately strong inverse relationship (r = -.409), where the regression coefficient (b = - 16.59) is less than zero, with a t-test value (t = - 2.69), significant at the (.0058) level. The fourth equation (HYP. 1B*4 Eq. 1) combines the two intensity measures (SKILLS83 + INNOVA83 = TECH83), in order to correlate their summary variation with population pressure. This combined variable equation produces the strongest inverse relationship (r = -.584), having a regression coefficient (b = - 5.37) less than zero, with a t-test value of (t = - 4.132), significant at the (.0002) level.

In direct contrast to conventional population-economic theory (Boserup 1965, 1981), the results indicate that on the political section level, low levels of population pressure are more likely to be related with the intensity of innovation in farming practices than high population pressure. If we can assume lower levels of population pressure are found on the larger farms, it is likely that variation in farm size aggregated on the section level accounts, in part, for the inverse relationship between the key variables. The intensity of agricultural innovation appears to be taking place within political sections with a high number of larger farms, which experience comparatively lower levels of population pressure. These results also indicate that factors other than population pressure, such as access to information and capital (agricultural loans) directly account for increasing intensity of innovative farming technology. Perhaps a clearer sense of the relationship between population pressure and agricultural intensity may be gained at the individual farm level.

The following variables were created to measure the various aspects of agricultural intensity at the farm household scale. Improvements in farming skills (SKILLS87) are evaluated in a summary measure of the following: use of special seeds, planting in rows, weeding, use of insecticide and use of fertilizer. Individuals farms range in value from zero to five, if all of the enhanced farming techniques were in use within twelve months prior to the 1987 interview. In addition, investments or innovations in the resource base (landesque capital) also are determined in a summary measure (AGINOV87) of the following: leveling of land for planting, use of irrigation, building of terraces and planting of trees as soil anchors. Both of these measures are summed (AGINOV87 + SKILLS87 = AGINT87) to assess their combined variation correlated with population pressure. Land use intensity is measured by variation in the percentage of tareas cropped (PTCROP) and a frequency of cultivation ratio (AGFREQ), as defined by Doolittle and Turner (1979).

Results of simple bivariate regression analysis for the entire farm level sample are somewhat limited regarding the relationship between population pressure and the various measures of agricultural intensity. Land use intensity is a major exception, where a highly significant relationship is supported with population pressure. For example, a strong positive relationship (r = .764) is evident between farm level population pressure (LFPPR87) and a standardized measure of cropped land (LPTCROP = log of percent tareas cropped). Here, the regression coefficient (b = .587) is greater than zero, with a high t-test value of (t = 24.40), significant at the (.0001) level, where (n = 423). The square of the correlation coefficient indicates that over fifty-eight percent of the variation in the percentage of farm area cropped can be explained by variation in population pressure (HYP. 1B*1 Eq. 2). In addition, a moderately strong positive relationship (r = .537) exists between farm level population pressure (LFPPR87) and a frequency of cultivation measure (AGFREQ). Here, the regression coefficient (b = .370) also is greater than zero, with a t-test value (t = 13.04) significant at the (.0001) level. In this instance, almost twenty-nine percent of the increases in the ratio (intensity) of cropped land over fallow land are explained by population pressure (HYP. 1B*1 Eq. 3, Table 5.2).

The relationships between population pressure and innovative measures of farm intensity are not as clearly defined. When the entire farm household sample is examined, no significant relationship can be established between population pressure and either intensity of new farming skills (SKILLS87) or land resource improvements (AGINOV87) at the designated confidence level. Nevertheless, if the log of average farm output food production per tarea (AVPRODPT) is used as a surrogate measure of combined agricultural intensity, a moderate positive relationship is established (r = .406). In this case the regression coefficient (b = .422) is greater than zero, with a t-test value of (t = 9.075) significant at the (.0001) level (HYP. 1B*2 Eq. 2). Similar results were encountered within two farm size sub-groups, those farms that ranged in size from forty to eighty tareas and those ranging from over 200 to 2000 tareas.

The relationships between population pressure and innovative measures of farm intensity are somewhat more clearly defined when variation in farm size is examined. On the smallest sized farms, those ranging in size from two to forty tareas, a weak positive relationship (r = .122) can be established between population pressure and a log measure of innovative farming skills (LSKILS). In this instance, the regression coefficient is greater than zero, with a t-test significant at the (.0253) level. At the medium farm size scale, those farms ranging from eighty to 200 tareas, a weak positive relationship (r = .330) is established between population pressure and the log of SKILLS. In this case, the regression coefficient also is greater than zero, with a t-test significant at the (.0019) level. Finally, on the largest farms, those greater than 200 tareas, a weak positive relationship (r = .271) is established between population pressure and the intensity of investments in landesque capital (AGINOV87). As noted above, the regression coefficient is greater than zero with a t-test significant at the (.0519) level. These results, on the various farm levels, differ in direction from the findings found on the political section scale.

It is strongly evident that the positive relationship between population pressure and land use intensity is significantly established at the farm household scale. The null hypothesis (Ho) of no relationship between population pressure and land use intensity, for modified hypothesis (1B*1), therefore should be rejected and the alternative hypothesis (H1) accepted at the (.05) level of significance. In contrast, significant positive relationships between population pressure and the more innovative forms of agricultural intensity on the household level, such as improved farming skills and investments in landesque capital are weak when compared with the strength of the relationship established with land use intensity. Only when the farm average food production per tarea is examined, as a surrogate measure of improved farming skills, is there an indication of the predicted positive relationship for the entire farm sample. However, the variable (AVPRODPT) most likely reflects the combined intensity of increased land use, improved farming skills and improvements in the land resource base.

When the entire household sample is partitioned by farm size, weak positive relationships are established between population pressure and innovative measures of agricultural intensity, on at least three of the farm size groups: mini, small and large farms. Based upon the statistically significant farm sub-sample level results alone, the null hypotheses (Ho) of no relationship between population pressure and intensity of farming skills, for modified hypotheses (1B*2) and between population pressure and intensity of investments in landesque capital, modified hypothesis (1B*3), and the combined measure (1B*4) of innovative agricultural intensity should be rejected, and the alternative hypotheses (H1) accepted at the ninety five percent level.

Table 5.2

Significant Results of Bivariate Regression
(Hypotheses 1B*1, 1B*2, 1B*3, 1B*4)

	Dep. & Ind. Var.	r	Prob.	a	b	n
Hyp. 1B*1						
Eq. #1	CULT83 & LPR1983	.283	.0576	0.36	0.001	31
Eq. #2	LPTCROP & LFPPR87	.764	.0001	1.20	0.587	434
Eq. #3	LAGFREQ & LFPPR87	.537	.0001	-0.43	0.370	417
Hyp. 1B*2						
Eq. #1	SKILLS & LPR1983	-.567	.0004	78.29	-37.990	31
Eq. #2	LAVPRODPT & LFPPR87	.406	.0001	1.41	0.422	413
Eq. #3	LSKILS & LFPPR87	.122	.0253	1.40	0.048	257
Eq. #4	LSKILS & LFPPR87	.330	.0020	2.43	0.174	65
Hyp. 1B*3						
Eq. #1	INNOVA83 & LPR1983	-.409	.0058	36.78	-16.590	31
Eq. #2	AGINOV87 & LFPPR87	.272	.0519	14.09	5.770	36
Hyp. 1B*4						
Eq. #1	TECH83 & LPR1983	.584	.0002	11.33	-5.37	31
Eq. #2	AGINT87 & LFPPR87	.160	.1000	35.95	6.05	65

A comparison of the conflicting results between political section and farm level analyses indicates that causal factors other than population pressure are related to increasing levels of innovative agricultural intensity. These factors most likely include access to information about innovative technology, access to financial credit, and out-migration (brain drain) of likely innovators, among others.

These findings tend to support the notion of an evolutionary progression of social responses to population pressure over time, as conceived by Bilsborrow (1987). In the case study from the Plan Sierra region of the Cordillera Central, the progression of social responses customarily is as follows: 1) deforestation, to place new land into food production; 2) farm labor and land use intensification, manifested by reduction of fallow lengths as well as fallow areas and to a limited extent the reduction of traditional grazing areas, associated with increases in cropped land; 3) the rather negligible intensification of agricultural skills, manifested by some limited use of improved seeds, fertilizers, and improved cultivation practices, and; 4) very limited innovations and investments in landesque capital, manifested by the use of irrigation, the planting of trees as soil anchors, leveling of fields and the building of terraces on steep slopes.

Most of the principal farmers, especially on smaller farms, employ the first two choices in response to increasing population pressure, whereas the third and fourth strategies are employed only to a modest degree. On the larger farms, under comparative conditions of lower population pressure, is where investment in landesque capital is taking place. This may be a reflection of higher socioeconomic status or the economies of scale that are usually realized with larger farm sizes. Perhaps, in the near future (1990s) when the first choice (forest conversion) is no longer a viable option for traditional hillslope farmers, we may logically expect to see greater efforts to improve food production skills and permanent investments in the land resource base. Consequently, additional field studies are in order, at five year intervals, and should be planned for 1992 and 1997.

Hypothesis (2A) builds upon the conceptual framework established above and prevailing people-environment theory, by attempting to define the nature of the relationship between deforestation and farm level land degradation. Based on contradictory research from developing countries, especially those with mountainous biomes, rapid and mismanaged forest conversion appears to be directly correlated with equally accelerated and uncontrolled environmental degradation, primarily in the form of soil erosion and mass wasting (Ives and Pitt 1987). According to competing population-economic and people-environment theory, as well as research by academic foresters, these two processes (deforestation and land degradation) are not necessarily related in a cause and effect manner (Brookfield and Blaikie 1987). Therefore, the initial null hypothesis assumes the following form:

> Ho, there is no linear relationship between the variation in corresponding values of deforestation and farm level environmental (land) degradation. Hence, the regression coefficient (b = 0.0) is equal to zero.

The alternative hypothesis poses:

> H1, there is a positive relationship between the variation in corresponding values of deforestation and farm level environmental (land) degradation. Hence, farm level land degradation depends upon deforestation, therefore the regression coefficient (b > 0.0) is greater than zero.

The significance or rejection level for this hypothesis was predetermined at the ninety-five percent (.05) level.

Statistical analysis was conducted at the farm household scale, where standardized (normal log) values for annual rates of forest conversion (LPTCLRD) were directly related with annual rates of land degradation (LPTCHNG). Percentage figures were employed in order to control for variation in farm size; a base-ten log transformation was required to normalize both data values. In this analysis, farm level degradation was defined as the average yearly rate of arable land lost from food production as a result of erosional processes. Adhering to guidelines sanctioned by Brookfield and Blaikie (1987), land managers (in this case study the principal farmers) were requested to estimate the amount of arable land degraded (defined as farm area assigned the lower rank of non-productive land from among their parcels) and effectively lost from food production since 1977.

Results of simple bivariate regression analysis demonstrate a moderately strong positive relationship (r = .559) between the criterion variable (land degradation) and the predictor variable (deforestation). The regression coefficient is greater than zero (b = .548), with a t-test value (t = 8.825) significant at the (.0001) for the entire household sample. In this instance, approximately thirty-one (31%) percent of the variation in the criterion variable is explained or accounted for by the predictor variable (HYP. 2A Eq. 1, Table 5.3). A somewhat weaker positive relationship is realized when the household sample is partitioned into four groups by farm size. The smaller farm groups, those that range from two to forty tareas and those that range from forty to eighty tareas reflect meaningful correlation coefficients of (r = .446) and (r = .433) respectively (HYP. 2A Eqs. 2 & 3, Table 5.3). For the mini-farms, the regression coefficient is greater than zero (b = .400), with a t-test value of (t = 4.55) significant at the (.0001) level. In addition, the regression coefficient for the equation from the small farms also is greater than zero (b = .670), with a t-test value (t = 2.93) significant at the (.0037) level. In contrast, no meaningful relationships are established for the medium and large farm groups at the designated confidence interval. Based on an evaluation of the regression coefficients alone, it appears that the strength of the relationship between deforestation and land degradation increases with farm size. Consequently, based on these results, the null hypothesis (Ho) of no relationship should be rejected and the alternative hypothesis (H1) accepted at the (.05) level of significance.

These results support personal field observations that comparatively few efforts are being made to improve traditional hillside farming practices. Occasionally new forest plots are haphazardly cleared in isolated forested areas, frequently on very steep slopes, for the illegal short term production of marijuana or other highly valuable cash crop. After the initial harvest, fields often are abandoned and exposed to wind and water erosion, as the entrepreneurs move on or successfully finance a move out of the country. High rates of deforestation combined with increasing crop-fallow ratios, in conjunction with the stark absence of investments in landesque capital or improvements in farming skills, contribute to accelerated land degradation. To continue on this slow course to improved farm management or experience further involution within the traditional hillside farming system would doom the rural landscape of the Dominican Republic to the same agroecological disaster now being experienced in the mountainous environments of neighboring Haiti.

Table 5.3

Significant Results of Bivariate Regression
(Hypotheses 2A)

	Dep. & Ind. Var.	r	Prob.	a	b	n
Hyp. 2A						
Eq. #1	LPTCHNG & LPTCLRD	.559	.0001	0.78	0.548	169
Eq. #2	LPTCHNG & LPTCLRD	.446	.0001	1.02	0.400	79
Eq. #3	LPTCHNG & LPTCLRD	.433	.0037	0.54	0.670	31

Table 5.4

Significant Results of Bivariate Regression
(Hypotheses 2B)

	Dep. & Ind. Var.	r	Prob.	a	b	n
Hyp. 2B						
Eq. #1	LPTCHNG & LAGIN87	.183	.0172	0.77	0.64	131
Eq. #2	LPTCHNG & LSKILS	-.108	.0582	1.99	-0.360	213
Eq. #3	LPTCHNG & LSKILS	-.327	.0183	4.18	-2.020	40
Eq. #4	LPTCHNG & LAGINOV	-.242	.0636	1.36	-0.023	40

In contrast, Hypothesis (2B) attempts to establish a linkage between innovative agricultural practices and farm level land degradation. According to population-economic theory, one may anticipate there is an inverse relationship between increasing intensity of agricultural innovation and reductions in associated land degradation, due to investments in landesque capital and improved farming skills, both leading to better overall management of the agroecosystem. Regardless, the initial null hypothesis is of the form:

> Ho, there is no relationship between the variation in corresponding values of intensity of agricultural innovation and land degradation. Hence, the regression coefficient is ($b = 0.0$) equal to zero.

The alternative hypothesis states:

> H1, there is a negative relationship between the variation in corresponding values of intensity of agricultural innovation and land degradation. Hence, land degradation inversely depends upon the intensity of agricultural innovation, therefore ($b < 0.0$) the regression coefficient is greater than zero.

The significance or rejection level for this pair of hypotheses was likewise, predetermined at ninety-five percent (.05) level.

Results of simple bivariate regression analyses generally confirm that the relationship between the intensity of innovations in agriculture and farm level land degradation are inverse in direction, however, weak in strength, at least on larger farms within the Plan Sierra farm sample. Contradictory results were demonstrated, however, within the entire household sample. A positive regression coefficient was derived ($b = .640$), with a t-test value ($t = 2.132$) significant at the (.0174), from an equation that regresses log values of intensity of innovative investment (LAGINV87) with land degradation (HYP. 2B Eq. 1, Table 5.4). The correlation coefficient ($r = .183$) defines a weak positive relationship between the variables. On the other hand, a weaker inverse relationship ($r = -.108$) was realized between log values of intensity of innovative farming skills (LSKILS87) and land degradation. In this case, the regression coefficient is less than zero ($b = -.355$), with a t-test value ($t = -1.576$) significant at the (.0582) level (HYP. 2B Eq. 2, Table 5.4).

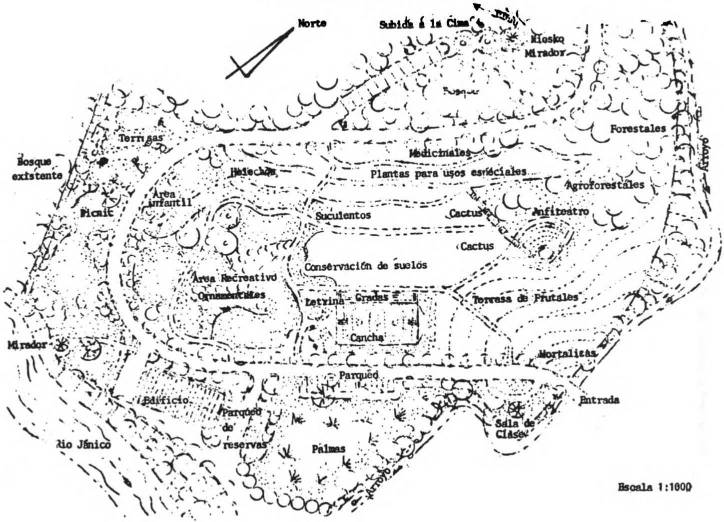
More conclusive results are produced when this relationship is examined by the different farm size groups. For example, an equation from the medium sized farms, those ranging from eighty to 200 tareas, also produces a negative regression coefficient (b = - 2.02), with a t-test value (t = - 2.17) significant at the (.0172) level (HYP. 2B Eq. 3). A correlation coefficient of (r = -.327) indicates a much stronger inverse relationship between the predictor variable (LSKILS87) and the criterion variable (LPTCHNG). A somewhat weaker correlation coefficient (r = -.242) was produced for the landesque capital variable (LAGINOV87). In this instance, the regression coefficient (b = -.023) also is less than zero, with a t-test value (t = -1.56) significant at the (.0636) level. In conjunction, these results indicate that the strength of the inverse relationship between intensity of innovative improvements in agriculture and land degradation may increase with farm size. Nevertheless, the rather weak nature of the strength of these relationships suggests that variables other than the intensity of innovative inputs into the traditional hillslope farming system are inversely related with land degradation. Based on the above results, the null hypothesis of no relationship should be rejected and the alternative hypothesis (H1) accepted at the (.05) level of significance.

These results further support the notion that farm managers in the Plan Sierra region of the Cordillera Central generally are doing little to minimize the impact of accelerating land degradation in the face of pervasive population pressure. This impression also is supported by personal field observation, despite the founding of an agricultural school in the regional center of Jánico with educational workshops and working models of irrigation systems, terraces, contour planting and agroforestry tree-crop management strategies (Figure 5.11). Unfortunately, in the immediate slopes surrounding the small city of Jánico there are numerous recent examples of gullies and slumps that could have easily been prevented. Perhaps a longer time frame or easier access to credit for land improvement is necessary before the technical innovations displayed at the this school, and elsewhere in the Plan Sierra management area, diffuse more thoroughly into the rural hinterland.

In summary, this chapter has elaborated the spatial patterns of population pressure and deforestation observed on the "political section" scale. In addition, a description of the contents of the 1987 farm household questionnaire followed, including a discussion of farm level trends in population pressure, agricultural intensity, deforestation and land degradation. Subsequently, a review of the results pertaining to the first two sets of research hypotheses ensued. In the next chapter, section and

Figure 5.11

Parque Educativo de Jánico



farm level trends in population redistribution are introduced, generating a discussion of migration subgroups: out-migrants, in-migrants, return migrants, potential migrants and non-migrants. Chapter six concludes with a detailed review of the quantitative analysis for the remaining four sets of hypotheses.

Chapter Six

Results of Analysis, Part 2: Motivations for Migration and Destinations

Introduction

This chapter begins with an overview of prevailing patterns of population redistribution on the political section level, starting with the year 1960. Several standard methods for determining population redistribution are considered. A discussion of farm level trends in migration follows, based upon tabulations of household questionnaires administered in selected rural parishes of political sections in the Plan Sierra region during the winter of 1987, which specifically detail demographic and socioeconomic characteristics of the migration sub-groups identified in this dissertation. These groups include: out-migrants, in-migrants, return migrants, potential migrants, and non-migrants. The chapter concludes with a discussion of the results of simple bivariate regression and simple correlation analysis for the remaining hypotheses.

Assessment of Population Redistribution 1960-1981

The Plan Sierra region of the Cordillera Central is commonly regarded as a major source region for both internal and international migration. Two maps were prepared to illustrate net migration between 1960 and 1970 and again from 1970 to 1981 on the political section scale, specifically for the Plan Sierra management area. Three methods are employed to determine net migration for a designated area and time frame; they are the residual, the survival ratio and national growth rate methods. Although the residual method is the most commonly used for developing countries, age specific birth and death records are difficult to obtain and may be of questionable reliability on the political section level. Likewise, the stratified age data necessary to calculate survival ratios also are not generally available in the Dominican Republic (Pitchardo 1987). Consequently, net migration was determined by means of the natural growth rate method, as described by Standing (1984, 47),

> For any area population growth will be more or less than the national average. It is assumed that natural increase is at the same rate in all areas, and that if the population growth rate in any area is greater than the average rate there has been net in-migration in the period, if less than the average then there has been net out-migration. Quite simply, the net migration rate, m, of area i is estimated from the following, where n refers to the national figure:

$$m_i = ((P^i_t - P^i_{t+1})/P^n_{t+1} - (P^n_t - P^n_{t+1})/P^n_{t+1}) \times 100$$

where, P = Population

t = beginning of time period

t + 1 = end of the time period

Moreover, the rate of natural increase was adjusted for four (five year) intervals between 1960 and 1980, according to Dominican national census calculations (Loaiza C. 1983). Subsequently, directional migration rates were calculated by Zuiches' guidelines, where: the out-migration rate equals the number of out-migrants in the time interval divided by the population at the beginning of the time interval, usually multiplied by a constant (K), and; the in-migration rate equals the number of in-migrants in the time interval divided by the population at the beginning of the time interval, also multiplied by a constant (Zuiches 1980, 5).

Net migration for the 1960 to 1970 period ranges from a high of over seventy-five percent (+76.27%) in-migration to a low of sixty percent (-60.51%) out-migration with a mean of negative twenty-five percent (-25.5%), indicating an overall negative trend (Table 6.1). The far western political section of Palmarejo demonstrates a very high rate of in-migration of slightly over seventy-five percent. Significant increases of in-migration also are evidenced in the sections of Cebú, Cuesta Abajo and El Rubio. However, Diferencia, Rodeo and Juncalito Abajo experienced considerable turnover, approximately sixty percent of the population left during this time period. Antonini also observed a similar trend for the sections of Juncalito Abajo and Las Placetas, in the southeast portion of the Cordillera Central (Figure 6.1). Reasons often cited for out-migration include: (1) limited access to land formerly controlled by the lumber industry; (2) perceived employment opportunities in large urban centers, including New York City; and (3) the socioeconomic disruptions resulting from the 1965-66 OAS occupation (Antonini and others 1975).

Furthermore, Antonini observed moderate rates of in-migration into Pinalito but this was over a twenty-five year period beginning in 1945 (Antonini and others 1975). In addition, Sachtler offers an important explanation for in-migration between 1960 and 1971, where commercial lumbering

Table 6.1

Average Yearly Net Migration for the Sierra Section Level Study Area

	1960/1970	1970/1981
Baitoa	-3.9	-1.7
Lopez	-4.1	-2.1
Sabana Iglesia	-3.4	+1.6
Cagueyes	-2.7	-1.6
Cebú	+3.1	-5.3
Dicayagua Abajo	-4.1	-3.9
Franco Bido	-3.3	-0.9
La Guama	-3.1	-3.8
Jagua Abajo-	-3.9	-1.1
Janey	-3.0	+0.0
Juncalito Abajo	-6.0	+0.4
Loma de Corral	-4.2	-0.9
Mesetas	-3.1	-1.7
Pinalito	-1.8	-2.7
Celestina	-1.8	-3.4
Cuesta Abajo	+1.2	-4.8
La Diferencia	-6.3	+4.5
El Rubio	+0.6	-4.0
Eugenio Perdomo	-3.9	-0.8
Guama	-2.4	-3.7
Inoa	-1.1	-3.1
Jicome	-2.7	-3.7
Las Piedras	-3.5	-0.0
Las Placetas	-3.1	-2.3
Los Montones Abajo	-0.3	-3.7
Mata Grande	-3.9	-1.2
Pedregal	-4.9	-5.4
Yerba Buena	-4.0	-1.6
Palmarejo	+7.6	-7.0
Toma	-4.1	-0.6
El Mamoncito	-2.1	-3.8
Gurab	-1.2	-5.0
Cacique	-1.1	-2.9
Rodeo	-6.0	+1.4

Source: Oficina Nacional de Estadística (ONE).

operations initially constructed roads into formerly inaccessible forested frontier areas and, subsequently, small-scale farmers utilized these routes to settle the newly opened areas (Sachtler 1974). Out-migration within the southwestern third of the Plan Sierra study area probably reflects government attempts to establish protected national reserves in the region. To this end they prohibited in-migration while forcing others to leave (Hartshorn and others 1981; Breton 1978).

Population redistribution for the 1970 to 1981 period demonstrates the same general patterns as above with some notable exceptions (Figure 6.2). Net migration ranges from a high of almost fifty percent in-migration (+49.34%) to a low of slightly more than seventy-six percent out-migration (-76.92%), with a mean of negative twenty-five percent (-24.2%), also indicating an overall regional trend toward out-migration. Twenty-nine of the political sections experienced losses in population, with five sections (Palmarejo, Pedregal, Cebú, Gurabo and Cuesta Abajo) indicating a loss of over fifty percent in population growth.

Only four political sections (Diferencia, Rodeo, Sabana Iglesia and Juncalito Abajo) demonstrate that in-migration took place. For example, Diferencia, a large political section in the western third of the study area shows a positive in-migration rate, a reversal in pattern from the earlier time period. This reversal probably represents illegal trespass into the protected reserves of the Bermudez National Forest. Moreover, the four political sections in the lowest quartile representing in-migration, which includes Janey at less than one-half of one percent increase, characterize areas of cash-crop agriculture (coffee plantations) and, after an initial phase of out-migration during the earlier (1960-70) period, are now attracting migrants.

Perhaps of greater significance are the reversals represented by even more dramatic changes in net migration. For example, the political sections of Palmarejo and Cebú both placed in the second and third positive quartiles, respectively, during the 1960 to 1970 period, characterizing significant in-migration. In contrast, by the 1970 to 1981 time frame, these same political sections placed in the third negative quartile, representing considerable out-migration. Two other political sections (El Rubio and Cuesta Abajo) reveal a similar transition, although to a lesser extent.

Figure 6.1

Net Migration, Sierra Study Area, 1960 to 1971

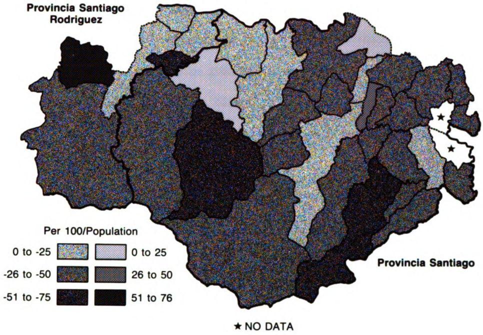
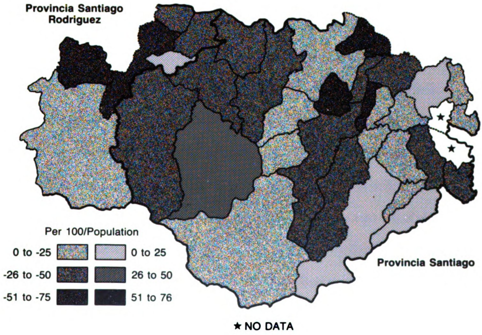


Figure 6.2

Net Migration, Sierra Study Area, 1971 to 1980



Moreover, all four political sections also display significant rates of deforestation during the twenty years from 1960 to 1980. It appears that these migration direction reversals represent former forested frontier nodes of traditional agricultural settlement that experienced rapid deforestation and in-migration, followed, perhaps, by land degradation and subsequent reductions in population supporting capacity; most likely, this action ultimately led to selective out-migration to other frontier areas and cities of the Dominican Republic. Nevertheless, according to Brookfield and Blaikie (1987) a better explanation of these processes may be achieved at the farm household level by means of a detailed case study, interviewing principal farmers.

Farm Household Level Trends in Population Redistribution

In order to assess recent (1977-1987) population redistribution at the scale of the individual household, a portion (module) of the questionnaire was dedicated to the theme of migration. As noted earlier, the survey instrument was systematically administered to approximately 450 rural farm households. From this group, 435 questionnaires were found suitable for data compilation and processing. From these questionnaires, some 3,572 persons were sampled, representing 2,762 adults (persons age twelve years and older) and 770 children. The majority of persons were male (51.52%) and ages ranged from less than one year old to 105 years. Households ranged in size from one to eighteen persons with a mean size of six and one-third (6.33) persons; the mean of 4.58 adult members indicates an average of slightly over four and one-half adults per household, with a standard deviation of about two and one-quarter (2.26) persons, and ranged from one to fourteen adults.

Each adult member of the household was categorized into one of five major groups based on their individual migration behavior. Specifically, these groups included out-migrants, in-migrants, return migrants, potential migrants and non-migrants. For example, out-migrants are defined as former household members who have resided in another location for a period of more than three months (Bilsborrow, Oberai, and Standing 1984). In-migrants are defined as household members who have lived in the present location for at least three months. Return migrants are defined as persons who have returned to the household and have remained for more than three months time, after having previously lived in another location for a period of at least three months. Potential migrants are household members who have not moved in the last ten years but anticipate a move in the near future. The stayer group (non-migrants) represents individuals who do not anticipate a move from their present location. The in-migrant and return migrant groups were, additionally, subdivided into "potential mover" or "stayer" subgroups. Sorting by these classifications yielded the following: 433 adult out-migrants; 116 in-migrants; 83 return migrants; 421 potential migrants and 1709 non-migrants. A mean of four and one-half (4.45) adults per household expressed either an experience or interest in migration; migration ranged from no member up to fourteen members of the household. It is clear then that migration is a vital aspect of collective behavior in the Plan Sierra region of the Cordillera Central.

Out-migrants

The results of political section level analysis for the years 1960 through 1981 indicate that out-migration is the dominant pattern. Fortunately, as a result of the "multiplicity strategy" employed in the questionnaire design, information detailing histories of out-migrants on the farm household level were obtained. Of the 433 out-migrants, females were dominant at somewhat higher than fifty-six and one-half percent (56.6%). Ages ranged from twelve to seventy-nine years, with twenty-three (23.07) years being the mean age at the time of out-migration. The majority of these people were single at the time of migration (52.4%), with one third (33.3%) indicating they were married, and a little more than eleven (11.1%) percent revealing their "free union" status, and finally, only about two percent (1.8%) admitted their separated marital status. Out-migrants received a mean of seven and one-third (7.32) years of education, which ranged from no schooling to fourteen years. Approximately sixty percent (58.5%) of the out-migrants indicated their occupation as "student, housewife or domestic" at the time of departure. A second major occupation group was agriculture (26.6%), followed by the minor classifications of "skilled trades" at just below five percent (4.7%) and "retired or inactive" people at just above two percent (2.1%). All other occupation groups accounted for less than one percent of the out-migrants.

First and second born daughters are the largest types of out-migrants from the household, accounting for slightly above (10.2%) and below ten (9.5%) percent, respectively. First and second born sons place third and fourth at just under nine (8.8%) percent and just above eight (8.1%) percent. The next four ranks belong to female siblings, amounting to a fraction above eight percent to about four and one-half percent (8.1%, 5.5%, 5.5%, 4.6%), in descending order. The ninth and tenth place classifications belong to the third (4.4%) and fourth (4.2%) born males. Heads of household (0.5%) and their spouses (1.6%) appear to play only a minor role in the out-migration process from viable households. However, it should be noted that the multiplicity survey design does not account for whole households that leave, and consequently under-represents the migration patterns of heads of households and their spouses. Regardless, Oberai notes,

> One advantage of this method (relating children to their parents, wives to their husbands, etc.) is that it facilitates identification of family type. This is important since several studies have indicated that family type, such as extended vs nuclear, can influence fertility and migration. Another advantage is that it enables the researcher to relate characteristics of one individual to another. For example, in the analysis of fertility, it is important to identify husbands to examine the effect of their socioeconomic background on fertility (Oberai 1984, 141).

It is clear from the above trends that the out-migration process is primarily taking place within the nuclear family of mature farm households.

The customary pattern in Latin America where there is a greater propensity for females to leave rural households is apparent. The fact that large numbers of third and fourth born sons are also leaving the household may indicate the pressures of farm size fragmentation, vis-a-vis the traditional land tenure system, where in the past farms were equally divided among surviving siblings and occasionally by only the sons. By the late 1980s there is evidence of changes in land tenure toward primogeniture, which would tend to equalize the propensity to migrate among males and females. Many farmers expressed a desire to restrict the further division of family farm holdings by designating joint sibling management or a sole inheritor-inheritress.

Marriage, education and employment are frequently cited as the primary reasons for leaving the household (Table 6.2). These reasons are generally followed, in importance, by a number of familial explanations for the move, which variously include: accompany the family, reunite the family, and social or family problems such as a recent death. All other explanations generally account for less than one percent of the out-migrants. The significance of the association between three of these

Table 6.2

Out-migrants Reason for Departure

Reason for Departure	Frequency	Percent	Cum. Percent
1. Change of Employment	42	9.7	9.7
2. No Employment	12	2.8	12.5
3. Underemployment	22	5.1	17.6
4. Job Dissatisfaction	3	0.7	18.2
5. Purchased Land	4	0.9	19.2
6. Found Better Job	90	20.8	40.0
7. Offered Better Job	32	7.4	47.3
8. Educate Oneself	42	9.7	57.0
9. Educate Children	2	0.5	57.5
10. Marriage	112	25.9	83.4
11. Accompany Family	36	8.3	91.7
12. Join the Family	15	3.5	95.2
13. Family Problems	12	2.8	97.9
14. Bad Social Climate	0	0.0	97.9
15. Land Degradation	0	0.0	97.9
16. Poor Soils	1	0.2	98.2
17. Extended Vacation	2	0.5	98.6
18. Inherited Property	1	0.2	98.8
19. Religious Study	1	0.2	99.1
20. Do Not Know Why	4	0.9	100.0

variables, employment, education and age (at the time of out-migration) with the class of destination will be determined in Hypotheses (5A), (5B) and (5C).

Although roughly ninety percent of the out-migrants were born in rural political sections of the Sierra, the greater majority preferred large cities as their destination (Table 6.3). These large cities are located both within and outside the Dominican Republic, where roughly one-third of the emigrants left the country. Internal destinations also include small cities (13.5%) and rural areas, primarily rural political sections (12.8%) with a very few migrants indicating commercial plantations (0.2%) as their goal. The significance of these preferences with the key variables age, education and employment type will be further assessed in the fifth set of hypotheses.

New York City has traditionally been the most important external destination for Dominicans; this is rather well documented (Gonzalez 1970; Grasmuck 1984; Hendricks 1974; Morrison and Sinkin 1983; Ugalde, Bean and Cardenas 1979). However, the magnitude of migration to the "promised land" is the subject of frequent secular and academic debate (Larson and Opitz 1988; Larson and Sullivan 1988; Mitchell 1988; and Warren 1988). Regardless, it may be argued that a majority of the emigrants, who were listed as leaving the country for the United States (32.9%), were bound for New York City. Some seven and six-tenths (7.6%) percent of the emigrants specifically cited this city as their final destination.

The city of Santiago de los Caballeros now appears to be the primary internal urban destination for out-migrants from the Sierra (Table 6.3). In fact, Santiago was listed as the most important destination, even more important than New York City, by almost thirty percent of the out-migrant sample. On the other hand, Santo Domingo was preferred by only a small percentage of the migrants, indicating that the national Capital has lost much of its former attractiveness for internal migrants (Duarte 1980, 1986).

Small cities are also important destinations for the rural out-migrants of the Sierra (Table 6.3). Important locations include the regional cities of Jánico, San José de las Matas, La Vega, Jarabacoa and Cotui. The rural parish of Botoncillo, in the Section of Las Mesetas near the city of Sabana Iglesia, was listed as the final destination by a little more than one percent of the sample. Although largely overshadowed by the flows to urban areas, rural to rural migration in the Dominican Republic accounted for almost thirteen (12.8%) percent of the out-migrants from the Sierra household sample. Hypotheses (3B) and (4) will examine the strength and verify the direction of the linear relationship between the key variables of farm level land degradation and population pressure on the process of out-migration.

In-migrants

The results of political section level analysis for the years 1960 through 1980 indicate that important nodes (destinations) of in-migration also are found in Plan Sierra. Consequently, a separate portion (submodule) of the household questionnaire recorded detailed responses for the 116 in-migrants to the Sierra sample study area. In contrast to the out-migrants, in-migrants as a group demonstrate a slight male dominance of fifty-one (51%) percent. Ages ranged from thirteen to ninety-two years, with just under twenty-eight (27.95) years the mean age at the time of in-migration. The majority of these people, also, were single (56.2%) at the time of migration with almost seventeen (16.9%) percent indicating they were married, and a surprising twenty (20.2%) percent and four and one-half (4.5%) percent indicating their free union and separated marital status, respectively. In-migrants received just under five (4.96) years of education, which ranged from no schooling to fifteen years. Likewise, fifty-one percent of the in-migrants listed their occupation as "student, housewife, or domestic maid" at the time of migration. The second major occupation group was agriculture (24.0%), followed by an impressive six (6.0%) percent for individuals skilled as "office personnel and teachers." All other occupation groups accounted for only small percentages of the in-migrants.

The results indicate that male heads of households (13%) and their spouses (20%) play a more active role in the process of household in-migration. Unrelated and other male relatives, such as brothers and cousins of the head of household, account for a surprising seven (7%) percent and five (5%) percent of the in-migrant sample. First born male sons and unrelated female domestics represent four (4%) percent each of the in-migrant types. This assemblage is somewhat typical of the diversity of individuals that may be found within a youthful or extended household structure, and may very well indicate that the majority of these households have recently relocated.

Approximately forty-five (45.2%) percent of the in-migrants to Plan Sierra originate in nearby rural parishes, many of which are located in other portions of the surrounding Sierra (Table 6.4). For example, about six (5.9%) percent of the in-migrants indicate they left from the parish of Damajagua, in the Section Cagueyes; almost five percent (4.7%) listed as their source area the parishes of La Boca de Albanita, in the Section La Diferencia, and the parish of Don Juan in the Section Los Montones Abajo. These moves typify close proximity rural to rural migration within the Plan Sierra itself and may reveal areas experiencing elevated rates of land degradation.

A large number of in-migrants (27.4%) also are leaving the small cities to return to the countryside (Table 6.4). Approximately twenty-five (23.5%) percent of this type of migrant originates in the regional city of San José de las Matas. The balance of the in-migrants come from the largest urban centers in the country, where almost thirteen percent (12.9%) give Santiago as their source area and slightly below six (5.9%) percent list the "Capital" as the location of former residence. Unlike the international migration streams, the processes of urban to rural and rural to rural migration in the Dominican Republic are both poorly understood and largely under-reported in the professional literature. Consequently, Hypothesis (3A) attempts to determine the significance of the causal relationship between deforestation and population redistribution, specifically in the form of in-migration. This will contribute to our understanding of the magnitude of resource "pull" factors.

Similar to the situation with the out-migrant group, marriage and family related reasons were frequently registered as the primary explanations for moving to the present household (Table 6.5). In order of importance, these included: marriage, accompany the family and to resolve family or social problems. Employment and education followed as reasons for migrating to the new location. Other explanations accounted for only small percentages of the in-migrants.

Most in-migrants admit to having access to information about the destination prior to their move (Table 6.6). The majority indicate that knowledge about jobs and agricultural opportunities was available from family and friends. An impressive thirty-six percent of the in-migrants visited the area prior to making the move. This prior knowledge of the destination may be reflected by the comparatively large number of in-migrants (82.6%) who indicate they have no intention of migrating in

Table 6.3

Classification of Out-migrant Destinations

Out-migrant Destination	Frequency	Percent	Cum. Percent
1. Santo Domingo (Capital)	29	6.9	6.9
2. Santiago	143	33.6	40.7
3. Small Regional Cities	57	13.5	54.2
4. Rural Sections (Villages)	54	12.8	66.9
5. Commercial Plantations	1	0.2	67.1
6. Left the Country	139	32.9	100.0

Table 6.4

Classification of In-migrant Source Areas

In-migrant Source Area	Frequency	Percent	Cum. Percent
1. Santo Domingo (Capital	6	7.1	7.1
2. Santiago	13	15.5	22.6
3. Small Regional Cities	23	27.4	50.0
4. Rural Sections (Villages)	38	45.2	95.2
5. Commercial Plantations	0	0.0	95.2
6. Left the Country	4	4.8	100.0

Table 6.5

In-migrants Reason for Leaving Source Area

Reason for Departure	Frequency	Percent	Cum. Percent
1. Change of Employment	6	7.5	7.5
2. No Employment	1	1.3	8.8
3. Underemployment	0	0.0	8.8
4. Job Dissatisfaction	3	3.8	12.5
5. Purchased Land	3	3.8	16.3
6. Found Better Job	3	3.8	20.0
7. Offered Better Job	2	2.5	22.5
8. Educate Oneself	6	7.5	30.0
9. Educate Children	0	0.0	30.0
10. Marriage	22	27.5	57.5
11. Accompany Family	11	13.8	71.3
12. Join the Family	6	7.5	78.8
13. Family Problems	11	13.8	92.5
14. Bad Social Climate	1	1.3	93.8
15. Land Degradation	0	0.0	93.8
16. Poor Soils	0	0.0	93.8
17. Extended Vacation	0	0.0	93.8
18. Inherited Property	4	5.0	98.8
19. Do Not Know Why	1	1.3	100.0

the near future. For example, reasons for staying variously include family ties and "have land here." Less important reasons for staying in the household were lack of financial resources and lack of knowledge of better opportunities elsewhere.

Return Migrants

Data for return migrants are available only at the farm household scale. Because this group of people represents frequent movers, they often provide current information on aspects of a migration process known as circulation. As previously indicated, a separate portion (submodule) of the questionnaire recorded responses for the eighty-three return migrants to the rural political sections of the Sierra. Similar to the out-migrants as a group, return migrants share a slight female dominance, fifty-three (53.4%) percent of the participants. Ages ranged from thirteen years to eighty-seven years, with twenty-nine and six-tenths (29.6) years the mean age at the time of return. The majority of these people, likewise, were single (39.7%) at the time of return migration, while a substantial number (37.9%) indicated they were married, with nineteen percent and about three and one-half (3.4%) percent identifying their marital status as "free union" and separated, respectively. Most return migrants have slightly less than five and one-half (5.41) years of education; the range was from no schooling to fourteen years. In addition, the majority of return migrants (59.6%) list their occupation as "student, housewife, or domestic help" at the time they returned.

It is important to note that the second most frequent class of employment among return migrants was not agriculture (10.5%) but "skilled trades" (12.3%), such as an artisan, mechanic, tailor or carpenter. An even smaller portion of this group (3.5%) were in some form of commercial activity. These return migrants, most likely had successful experiences in large urban centers and bring valuable work skills to rural areas. In this manner, counter migration streams function to increase standards of living in rural villages. However, a slightly larger (5.3%) number indicated they were unskilled and could only secure unskilled employment. Perhaps these people represent generally unsuccessful experiences in the larger cities of the republic. Their likely contributions to improved rural living conditions also are rather limited. All other occupation groups accounted for only minor percentages of the return migrants.

Similar to the in-migrant group, the results indicate that male heads of households (17.2%) and their spouses (15.5%) are more obvious active participants in the return migration process. However, like the out-migrant group, immediate family members play a larger role in overall return migration, with the third eldest daughters comprising over eight and one-half percent of the household, and the first sons, second daughters, fourth sons and daughters each comprising just below seven percent of the return migrant household structure. Living in Santiago, one was aware of the very high levels of mobility among young women from rural areas. Many urban households employ a number of young women to work as domestics on a semi-permanent, seasonal and even monthly basis. As a result, there is a constant stream and counter stream of young women from nearby rural areas. Males, on the other hand, have fewer employment opportunities on a short term basis and therefore appear somewhat less mobile. Consequently, the return migration process appears to take place primarily within the nuclear family of youthful to medium aged farm households.

Forty-five percent of the return migrants to Plan Sierra originate in large urban centers, including the national capital (Table 6.7). In addition, significant flows (17.5%) emanate in the small cities. For example: thirty-one percent came from the United States; over twenty percent from Santiago; almost nine percent from the regional city of Cotui; just under seven percent from Santo Domingo; and more than five percent from the regional center of San José de las Matas. However, large numbers (35%) of the return migrants also originate in the numerous rural parishes in the Dominican Republic.

When questioned why they left the household, the majority (27.6%) responded that they departed: to "accompany the family," followed by; change of employment; obtain an education for their children; family or social problems; and finally, either "no work" or "find a better job" respectively (Table 6.8). Prior to out-migration, most individuals (60.3%) listed their occupation in the "student, housewife, domestic" group, while almost twenty-five percent indicated their profession as farmers or in the "skilled trades" (8.6%).

Table 6.6

In-migrants Source of Information

Source of Information	Frequency	Percent	Cum. Percent
1. Family or Relatives	20	47.6	47.6
2. Friends	6	14.3	61.9
3. Newspaper, Radio, TV	0	0.0	61.9
4. Prior Visit	15	35.7	97.6
5. Other Source	1	2.2	100.0

Table 6.7

Classification of Re-migrant Source Areas

Re-migrant Source Area	Frequency	Percent	Cum. Percent
1. Santo Domingo (Capital)	5	12.5	12.5
2. Santiago	13	32.5	45.0
3. Small Regional Cities	7	17.5	62.5
4. Rural Sections (Villages)	14	35.0	97.5
5. Commercial Plantations	1	2.5	100.0

Table 6.8

Return Migrants Reason for Departure

Reason for Departure	Frequency	Percent	Cum. Percent
1. Change of Employment	9	15.5	15.5
2. No Employment	4	6.9	22.4
3. Underemployment	2	3.4	25.9
4. Job Dissatisfaction	2	3.4	29.3
5. Purchased Land	0	0.0	29.3
6. Found Better Job	4	6.9	36.2
7. Offered Better Job	3	5.2	41.4
8. Educate Oneself	1	1.7	43.1
9. Educate Children	6	10.3	53.4
10. Marriage	3	5.2	58.6
11. Accompany Family	16	27.6	86.2
12. Join the Family	1	1.7	87.9
13. Family Problems	5	8.6	96.6
14. Bad Social Climate	0	0.0	96.9
15. Land Degradation	0	0.0	96.9
16. Poor Soils	0	0.0	96.9
17. Do Not Know Why	0	0.0	96.0
18. Illness, Infirmity	2	3.4	100.0

Table 6.9

Non-migrants Reason for Staying

Reasons for Staying	Frequency	Percent	Cum. Freq.
1. Have a Good Job	65	4.5	4.5
2. Family Commitments	560	38.6	43.1
3. Lack of Education	22	1.5	44.7
4. Unaware of Better Jobs	76	5.2	49.9
5. Have Land (Ownership)	150	10.4	60.2
6. Too Old to Migrate	102	7.0	67.3
7. Family too Large	34	2.3	69.6
8. Have Enough Money	5	0.3	70.0
9. Currently in School	137	9.5	79.4
10. Physical Handicap	23	1.6	81.0
11. Soils are Good Here	3	0.2	81.2
12. Lack Money to Move	138	9.5	90.8
13. No Opportunity	0	0.0	90.8
14. Like it Here	64	4.4	95.2
15. Have Animals Here	20	1.4	96.5
16. Fear Social Rejection	1	0.1	96.6
17. Missionary Work	1	0.1	96.7
18. Do Not Like the City	1	0.1	96.8
19. Do Not Know Why	47	3.2	100.0

Potential Migrants

Potential migrants are represented by those household members who have no migration experience as an adult but who plan to migrate in the near future. As a group, they may differ in important ways from adult household members with recent migration histories. Potential migrants make up a small (15.2%) percent of the adult household individuals who have not participated in the migration process since 1977. Migration histories extending beyond ten years from the time of field survey (1987) were not considered in this analyses (Bilsborrow, Oberai, and Standing 1984).

Of the 276 potential migrants, males dominate the group at fifty-six and one-half percent; this is just the opposite of the out-migrant group. Although young males actively express a greater propensity to migrate, the ties to the farm household are stronger than for females, as is reflected in the out-migrant group. Regardless, ages ranged from twelve years to seventy-two years, with twenty-five (25.2) years being the mean age for the group. As expected, the majority of these people were single (68.4%), almost fifteen percent indicated they were married, about fourteen percent lived in a "free union," and only one and one-half percent were separated. Potential migrants' education level ranged from no schooling to sixteen years with a mean of six years. Over fifty-two (52.2%) percent of the potential migrants indicated their occupation as "student, housewife or domestic" at the time of the survey. The second major occupation group was agriculture (31.5%), followed by proportions less than five percent in each of the remaining occupation groups.

Non-migrants

Non-migrants are household members who have not participated in the migration process since 1977 and indicate that they do not plan to leave in the near future. They represent a large (n = 1526) core group of individuals (stayers) that claim, for all practical purposes, to be satisfied with the "place utility" of their land holdings and situation in life. Non-migrants, as a group, demonstrate a small male dominance of slightly over fifty-two (52.5%) percent. Ages ranged from twelve to 105 years, with just below thirty-five (34.92) years being the mean age at the time of the field survey. The majority of these people were single (49.3%), a third were married with an additional eleven percent considered to be "free union." This group also contains a notable proportion of widows and comparatively few people that are divorced or separated. Most non-migrants received a little more than four and one-half (4.64) years of education, which ranged from no schooling to sixteen years. As expected, approximately fifty (49.3%) percent of the non-migrants listed their occupation as "student, housewife or domestic helper". Clearly a third (34.5%) of the "stayers" declare their occupation as farmers, followed by a comparatively high number (3.9%) of retirees or "unable to work" category. All other occupation groups accounted for only small percentages of the non-migrant group.

Male heads of household and their spouses are clearly the most visible members of non-migrant households. Female heads of household also are meaningfully expressed within the non-migrant household group at just over three percent. The non-migrant household is quite diversely represented by all individual types, based on their relation to the head of the household, representing components of both the mature nuclear and extended family (Bilsborrow, Oberai, and Standing 1984, 185).

A variety of responses are given for the preference to remain in the present household (Table 6.9), the most important being family commitments (38.6%) and land ownership (10.4%). These are followed, with lesser frequency, by the standard responses: currently in school; lack the financial resources to leave; age, too old to leave; lack knowledge of better opportunities; have satisfactory employment; no opportunity to leave; and finally, about three percent are not sure about why they want to stay. Regardless, the non-migrant group may very likely serve as the benchmark for comparison among the various migration classes. As anticipated, the "stayers" are the oldest, with a mean age of almost thirty-five years, and the least educated, with approximately four and one-half years of schooling, of the population mobility subgroups.

Resolution of Hypotheses 3A - 6B

The first part of the third hypothesis set (3A) establishes a conceptual linkage between population-migration and people-environment theory. Results of this dissertation confirm a meaningful positive relationship between population pressure and deforestation at the individual farm level. Therefore, with evidence for this causal relationship, a related research question ponders the linear relationship between deforestation and population redistribution, specifically in-migration.

Linking both population-migration and people-environment theory, one can argue that in-migrants will be drawn to forested areas as a destination which represents resource pull factors, in response to pervasive population pressure in the source areas, in order to maximize the "place utility" of the household (Wolpert 1965; Brown and Moore 1970; Fuller 1978). Consequently, one would logically expect to find a positive linear relationship between deforestation and in-migration. However, the null hypothesis is of the following form:

> Ho, there is no linear relationship between the variation in corresponding values of deforestation and in-migration. Hence, the regression coefficient (b = 0) is equal to zero.

the alternative hypothesis counters:

> H1, there is a positive linear relationship between the variation in corresponding values of deforestation and in-migration. Hence, in-migration depends directly upon deforestation, therefore the regression coefficient (b > 0.0) is greater than zero.

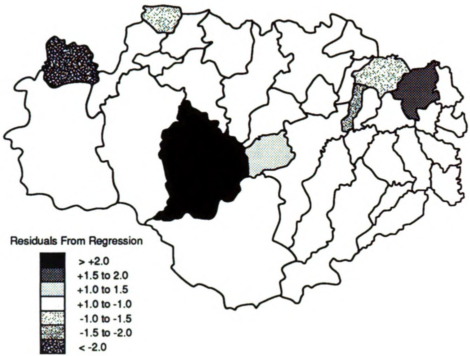
The significance or rejection level for the pair of hypotheses was predetermined at ninety-five (95%) percent.

On the political section level a short series of data (1960 to 1980-81) were compiled to specify the nature of the linear relationship between deforestation and population redistribution, specifically in the form of in-migration. Deforestation is measured as the annual forest conversion rate for the years 1960 to 1980 (FCR1980 = average annual percent change in forest cover). Likewise, population redistribution is measured as the average percentage of in-migrants per political section for the time frame 1960 to 1981 (YPIN6081). Results of simple bivariate regression analysis reveal a meaningful positive relationship, where the regression coefficient is greater than zero (b = 1.103) with a t-test value (t = 2.209) significant at the (.0173) level. The correlation coefficient (r = .364) indicates a moderately weak positive relationship between the key variables, where approximately eleven percent (r square = .105) of the spatial variation in in-migration is explained by the forest conversion process.

A map of the standardized residuals from the regression equation (Figure 6.3) illustrates some meaningful patterns of in-migration. The large Section of Diferencia, in the western portion of the study area, is over-predicted by more than two standard errors. In the past, Diferencia was rather isolated, however, during the 1970 to 1981 period it functioned as an important frontier destination for

Figure 6.3

Residuals from Regression, In-migration 1970 to 1981 (Y) with Deforestation Rate (X), Hypothesis 3A



in-migration. Illegal trespass on the protected reserves of the Bermudez National Forest has frequently been reported within this section. In addition, the eastern Section of Sabana Iglesia also is over-predicted; in contrast, this reflects its historical importance as a staging area for step-wise migration from the Plan Sierra region rather than as a new frontier area. On the other hand, the western Section of Palmarejo and the eastern Section of Cebú are considerably under-predicted by the regression equation. This agrees with very high levels (over fifty percent) of out-migration from 1970 to 1981. Apparently both political sections functioned as important resource pull areas during the 1960 to 1970 time frame, attracting many migrants, however, both sections experienced equally rapid out-migration (reversals) during the latter era, perhaps due to accelerated land degradation.

A similar strength relationship results from the analysis of farm household data for the year 1987, where meaningful results are produced from the large farm sub-sample (n = 31), on those farms exceeding two hundred tareas in size. In this case, the regression coefficient is greater than zero (b = 1.356) with a t-test value (t = 2.553) significant at the (.0080) level. A correlation coefficient of (r = .422) also establishes a moderately weak positive relationship between the criterion variable measuring adult in-migration (PADULTI = percent of adult household members that are in-migrants) and the predictor variable measuring farm level forest conversion (PTCLRD). This moderately weak positive relationship also signifies that slightly more than fifteen percent (r square = .151) of the spatial variation in in-migration on the larger farmsteads can be explained by the forest conversion process. Based collectively on the above results, the null hypothesis of "no relationship" should be rejected and the alternative hypothesis (H1) accepted at the ninety-five percent confidence level.

On both the political section and farm household level, significant results confirm that deforestation is positively related to in-migration. However, the weak nature of the relationship also indicates that factors other than deforestation play an important role in determining in-migration. Nevertheless, it does appear that some in-migrants are directly related, at least moderately so, with larger farms that are experiencing higher rates of forest conversion. Building on theory, migrants are more likely to move from regions of high population pressure, specifically, from areas suffering resource push factors to regions experiencing low population pressure, such as are found in areas with larger farms. For many traditional farm households in the Plan Sierra region, as long as forested frontier areas remain accessible, heads of rural households generally will choose migration, in order to maximize "place utility" (Wolpert 1965; Brown and Moore 1970; Fuller 1978), rather than make the necessary improvements in the farming system and land resource base. Consequently, this conceptual linkage is generally valid.

Research hypotheses (3B) further explores the concepts of "place utility and "resource push" factors, from the realm of people-environment theory and their linkages with population-migration theory. This dissertation provided evidence of a moderate positive linear relationship between deforestation and land degradation on the farm level; what now remains is to define the nature of the relationship between farm level land degradation and population redistribution, specifically in the form of out-migration. Brookfield and Blaikie (1987) argue that land degradation is essentially a social phenomenon, where farm decision makers play a critical role in either minimizing the impacts of natural geomorphological processes, through investments in "landesque" capital, innovative and improved management skills, and investments in labor, or exacerbating these impacts by means of faulty management strategies that strain the resiliency of the soils and overall capability of the land resource base. This later scenario may be seen to have the effect of increasing population pressure, as greater amounts of arable land are degraded and therefore afforded a non-productive rank. In time, as "place utility" on the farm operation is further compromised, the degraded land base will tend to function as a "resource push" factor (Petersen 1958), which most likely will directly lead to a decision to migrate (Wolpert 1965; Fuller 1978). As the Plan Sierra region of the Cordillera Central is generally cited for accelerated rates of land degradation (Hartshorn and others 1981), it is logical to predict a positive relationship between land degradation and population redistribution, in the form of out-migration. Nevertheless, the null hypothesis is of the following form:

> Ho, there is no linear relationship between the variation in corresponding values of land degradation and out-migration. Hence, the regression coefficient ($b = 0$) is equal to zero.

The alternative hypothesis counters:

H1, there is a positive linear relationship between the variation in corresponding values of farm level land degradation and out-migration. Hence, out-migration depends upon land degradation, therefore the regression coefficient (b > 0.0) is greater than zero.

The significance or rejection level for the pair of hypotheses was predetermined at ninety-five (95%) percent.

This analysis is conducted at the household scale, where standardized values for farm level land degradation (PTCHNG = annual percent tareas degraded) are correlated with standardized values measuring out-migration or potential migration. Values are calculated as percentages of the household members who actually participated in the out-migration process (PADULTE) or who expressed an interest to leave (PADULTPO). Results of simple bivariate regression analysis for the entire household data set are generally inconclusive, in fact, no meaningful equations are produced for either the out-migrants or return migrants group at the designated confidence level. In contrast, with the potential migrants group, there is evidence for a very weak positive relationship (r = .083) between land degradation and potential out-migration (PADULTPO = percent household members that are potential migrants). In this case, the regression coefficient is greater than zero (b = .07) with a t-test value (t = 1.714) significant at the (.0437) level. However, the square of the correlation coefficient (r square = .0046) indicates that less than one percent of the variation in the criterion variable is being accounted for by the regression equation (HYP. 3B Eq. 1, Table 6.10).

Similar results, indicating a very weak positive linear relationship between land degradation and potential out-migration were generated from the four farm size sub-samples. For example, on the smallest farms, those ranging in size from two tareas up to forty tareas, an equation that correlated potential migrants (PADULTPO) with the predictor variable (PTCHNG) produced a correlation coefficient of (r = .101) at the (.0540) level (HYP 3B Eq. #2). On the other hand, no meaningful relationships are evidenced from the remaining middle level farm size groups. The results for the Sierra farm sample indicate that explanatory factors other than land degradation are directly related with the process of out-migration. Based on the above results, the null hypothesis (Ho) of "no relationship" should be accepted at the (.05) level of significance. This decision also avoids the likelihood of a Type II error.

Table 6.10

Significant Results of Bivariate Regression
(Hypotheses 3A, 3B, and 4)

	Dep. & Ind. Var.	r	Prob.	a	b	n
Hyp. 3A						
Eq. #1	YPIN6080 & FCR1981	.364	.0173	-0.54	1.103	33
Eq. #2	PADULTI & PTCLRD	.422	.0080	0.8	1.357	31
Hyp. 3B						
Eq. #1	PADULTPO & PTCHNG	.083	.0437	14.03	0.070	423
Eq. #2	PADULTPO & PTCHNG	.101	.0540	13.15	0.078	251
Hyp. 4						
Eq. #1	YPO6070 & CH6071	.932	.0001	-3.67	0.227	33
Eq. #2	YPO7081 & CH7081	.742	.0001	-2.59	0.129	33

Several observations need to be added in order to help account for the difficulties encountered in establishing a meaningful positive relationship between farm level land degradation and out-migration. Despite the advantages gained from a "multiplicity" survey design (Aragon 1985), out-migrants are still under-represented in the sample to some degree, at least by ten percent for the Plan Sierra farm sample. This is primarily the result of entire households that relocate and therefore are unaccounted for in the sample. Current householders were not asked to comment on their neighbors' or prior household owners' migration behavior. Nevertheless, it is my belief that the "multiplicity" survey design could be vastly improved by additional questions that probe, at least in a general way, the migration histories of adjacent households. Perhaps land degradation has a greater cumulative impact on entire household migration decisions, which are less likely to be reflected by the migration behavior of individual household members. A principal farmer and spouse, unable to successfully cope with pervasive land degradation will likely become dissatisfied with "place utility" and move the entire household to a new location, or abandon agriculture altogether and move to the city.

Although the magnitude is unknown, there also is evidence from the Plan Sierra region that farm abandonment is taking place, which may be attracting some migrants. In this situation, abandoned areas are rather quickly reoccupied by new farming households willing to try their luck. Unfortunately, the itinerant farmer often is unwilling or unable to reverse an ongoing process of accelerating soil erosion. As a result, "place utility" is not likely to be sustained and "resource push" factors trigger yet another move as a consequence of pervasive farm level population pressure. This scenario was observed in the field, hence, the association between land degradation and in-migration is not conceptually inconsistent but indicates greater social complexity, as a series of farm households successively fail to sustain "place utility", in a long term cycle of resource deterioration. Furthermore, this observation provides additional evidence that Brookfield and Blaikie (1987) are correct in believing that land degradation is a social process, in this case, one that is directly tied to resource push and pull factors associated with population redistribution.

The fourth hypothesis also contributes to the body of literature on population-migration theory by defining the precise nature of the relationship between population pressure and population redistribution, in the form of out-migration. Customarily, rural heads of household are frequently faced with a number of choices in order to maximize "place utility" when challenged by pervasive population pressure. According to Boserupian population theory, one option involves the intensification of subsistence food production by means of land use intensity, innovations in farming skills and improvements in the land resource base, which tend to minimize resource push factors and thereby maximize place utility. Principal farmers may opt for out-migration, being compelled by the resource pull of the forested frontier, thereby choosing to maximize "place utility" elsewhere. As a result of the high rates of out-migration already documented in this dissertation for the Plan Sierra region, it is logical to predict a positive relationship between population pressure and out-migration. Once again, the null hypothesis is of the following form:

> Ho, there is no linear relationship between the variation in corresponding values of population pressure and out-migration. Hence, the regression coefficient (b = 0) is equal to zero.

The alternative hypothesis counters:

> H1, there is a positive linear relationship between the variation in corresponding values of population pressure and out-migration. Hence, out-migration depends upon population pressure, therefore the regression coefficient (b > 0.0) is greater than zero.

The significance or rejection level for the pair of hypotheses was predetermined at ninety-five (95%) percent.

Results of simple regression analysis for the entire household (1987) data set are, in general, inconclusive. In contrast, on the political section level regression analysis reveals a highly significant relationship between the key variables for each of the paired years in question, 1960 to 1970 and 1970 to 1981. The criterion variables (YPO6070) and (YPO7081) measure standardized annual rates of out-migration for the paired years. For example, (YPO6070) defines the average annual percentage of out-migrants per section between the years 1960 and 1970. Likewise, the variables (CH6070) and (CH7081) measure standardized yearly changes in population pressure, for example, (CH6070) measures the average annual percentage change in population pressure between the years 1960 and 1970. Starting with the first ten year pair (1960 to 1970), a correlation coefficient of (r = .932) firmly establishes a very strong positive relationship between the criterion and a predictor variable. The regression coefficient is greater than zero (b = .227) with a t-test value (t = 14.66) significant at the (.0001) level. The square of the correlation coefficient (r square = .874) signifies that eighty-seven percent of the spatial variation in values of out-migration are explained by a measure of population pressure on human carrying capacity.

The equation may be interpreted as follows, for each one percent increase in population pressure we would expect to see a one-quarter-of-one (.23) percent increase in annual out-migration over the ten year period 1960 to 1970. The intercept value of (-3.67) indicates the annual percentage of in-migrants we would expect to see if there was no (zero) population pressure over the ten years. A map of the standardized residuals from the regression equation reflects a pattern similar to that found for net migration during the period 1960 to 1970 (Figure 6.4). The regression equation accurately predicts that the overall trend is toward out-migration. However, out-migration is over-predicted in the far western section of Palmarejo and the northern section of Cuesta Abajo. These sections actually attracted migrants during this time period, therefore fewer people left than was predicted. In contrast, out-migration is under-predicted in the sections of Diferencia and Juncalito Abajo indicating that greater numbers of people left than was predicted by the regression equation. Diferencia had become part of a protected forest reserve and Juncalito Abajo, a traditional coffee growing area, is known to have been a major source area for out-migration during this time period (Antonini and others 1975).

Similar results are achieved from the analysis of the second pair of years (1970 to 1981). Here, a correlation coefficient of (r = .742) reaffirms a strong positive relationship between increasing pressure on population supporting capacity and out-migration. Once again, the regression coefficient is greater than zero (b = .129) with a t-test value (t = 6.44) highly significant at the (.0001) level. The square of the correlation coefficient (r square = .551) supports that, for the period 1970 to 1981, slightly more than fifty-five percent of the variation in the criterion variable measuring out-migration is explained by the predictor variable measuring pressure on maximum human carrying capacity.

This equation may be interpreted as follows, for each one percent increase in population pressure we would expect to find slightly less than two-tenths of one percent increase in out-migration. The intercept value of (-2.59) indicates the annual percentage of in-migrants we would expect to see, if

Figure 6.4

Residuals from Regression, Out-migration 1960 to 1970 (Y) with Population Pressure (X), Hypothesis 4, Equation 1

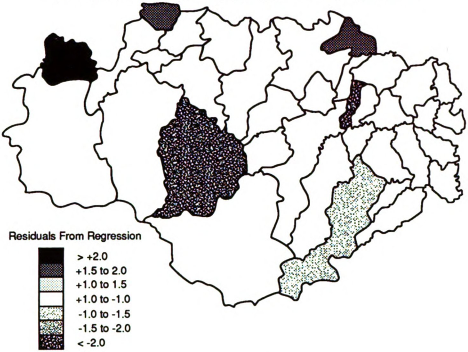
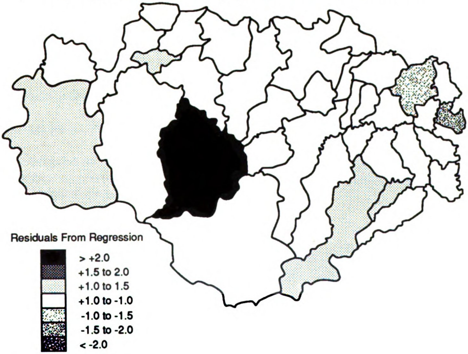


Figure 6.5

Residuals from Regression, Out-migration 1970 to 1981 (Y) with Population Pressure (X), Hypothesis 4, Equation 2



there were no (zero) measure of population pressure over the ten year time frame. A map of the standardized residuals from the regression equation also illustrates a pattern similar to that for net migration during the period 1970 to 1981 (Figure 6.5). Large numbers of rural migrants are drawn to the western Sections of Diferencia and Rodeo (as new frontier areas for settlement) as well as to the more established agricultural centers in the southeast Sections of Janey and Juncalito Abajo. Out-migrants from the northeastern interior sections appear to be drawn to the traditional staging area in the Section of Sabana Iglesia. Consequently, based upon the above results, the null hypothesis (Ho) of "no relationship" should be rejected and the alternative hypothesis (H1) accepted at the (.05) level of significance (HYP. 4 Eq. 1, Table 6.10).

The balance of the research hypotheses in this chapter probe specific aspects of the population redistribution process and thereby largely contribute to population-migration theory in conventional and new distinct ways. Because the logical causality is less certain and the data for measuring occupation, migration destination, and role of the environment in the decision to migrate are ordinal rather than interval or ratio, simple correlation analysis was employed to determine significant associations between these key variables. Correlations between occupation, education, age and the propensity toward cityward migration are explored in the first hypothesis set (5A, 5B, 5C). According to population-migration theory, the young, better educated, and more highly skilled individuals generally will leave rural generating areas for the larger cities (Lee 1966; Thomas and Hunter 1980). Older out-migrants with limited technical skills and little formal education may prefer to seek a livelihood in rural areas. Therefore, the null hypothesis is of the following form:

> Ho, there is no correlation between the variation in corresponding values of occupational preparedness and cityward migration. Hence, the Spearman's rank correlation coefficient is ($r = 0$) equal to zero.

The alternative hypothesis counters:

> H1, there is a positive correlation between the variation in corresponding values of occupational preparedness and cityward migration. Hence, the Spearman's rank correlation coefficient is ($r > 0.0$) greater than zero.

The significance or rejection level for this pair of hypotheses was predetermined at ninety-five (95%) percent.

This series of analysis is conducted at the farm household scale employing several of the separate migration data sets, out-migrants, return migrants and potential migrants. In the first hypothesis (5A), the variables JOB (occupation at the time of the interview) or JOBAWAY (occupation at the source area) measure occupational preparedness, based on the International Census Classification System. By definition, this classification system measures a continuum of increasing occupational skills (ranging from 1 as the highest professional level to 9 as the lowest), however, numerical values are converted to grade from low to high in order to test for a positive correlation, as predicted in the research hypothesis. On the other hand, the variable MIGDEST provides an ordinal measure of internal migration destinations (grading from rural to urban), based on settlement size classifications according to the Dominican Census Bureau (Larson 1987).

Results of simple correlation analysis reveal a weak positive association between occupational preparedness and cityward migration from the Plan Sierra study area. For example, from the out-migrants group, a weak positive association is established between occupation (JOB) prior to migration and the population density (MIGDEST) of the final destination. In this instance, the Spearman's rank correlation coefficient ($r = .181$) defines a weak positive association, significant at the (.0012) level (Table 6.11). Perhaps these weak results reflect the fact that students are classed in the lowest category of the International Census Code, along with those people who are unemployed or working as household domestics. It is well established in the Latin American migration literature that students, as well as highly skilled individuals, are attracted to major urban centers for their professional training (Thomas and Hunter 1980). In contrast, the International Census Code places principal farmers, as rural land owners and managers (decision-makers), rather high on the occupational continuum. These findings indicate that factors other than occupational preparedness may be more strongly correlated with cityward migration. Despite the weak nature of these results, the null hypothesis of "no association" should be rejected and the alternative hypothesis (H1) accepted at the (.05) level of significance.

It may be argued that the number of years in school is more strongly associated with internal migration. Therefore, Hypothesis (5B) probes the association between level of education and

Table 6.11

Significant Results of Bivariate Correlation Analysis
(Hypotheses 5A, 5B, 5C, 6A, 6B)

	Associated Variables (Spearman's)	r	Prob.	n
Hyp. 5A				
Eq. #1	MIGDEST & JOB (Out-migrants)	.181	.0012	284
Hyp. 5B				
Eq. #1	MIGDEST & SCHOOL (Out-migrants)	.082	.0082	284
Eq. #2	MIGDEST & EDURET (Re-migrants	.460	.0001	39
Hyp. 5C				
Eq. #1	MIGDEST & AGE (Out-migrants)	.026	.6440	274
Eq. #2	MIGDEST & AGELEFT (Re-migrants)	-.126	.4430	39
Hyp. 6A				
Eq. #1	INFLU & JOBLEFT (Re-migrants)	.606	.0001	57
Eq. #2	ENVIRON & JOBAWAY (Re-migrants)	.338	.0072	52
Eq. #3	INFLU & JOB (Out-migrants)	.437	.0012	424
Hyp. 6B				
Eq. #1	INFLU & AGE (Out-migrants)	.141	.0020	414
Eq. #2	INFLU & AGE (Re-migrants	.299	.0120	57

* Spearman's Rank Correlation Coefficients

classification of final destination among the various migrant groups. According to population-migration theory, we would expect those individuals with the highest number of years in school to be directly drawn to the nation's largest urban centers, for either additional professional training or direct employment. Those individuals with little, if any, formal schooling may be expected to seek rural destinations, where indigenous knowledge is of higher value. However, the null hypothesis is of the following form:

> Ho, there is no correlation between the variation in corresponding values of education (years of schooling) and cityward migration. Hence, the Spearman's rank correlation coefficient is equal ($r = 0$) to zero.

The alternative hypothesis offers:

> H1, there is a positive correlation between the variation in corresponding values of education (years of schooling) and cityward migration. Hence, the Spearman's rank correlation coefficient is ($r > 0.0$) greater than zero.

The significance or rejection level for the pair of hypotheses was predetermined at ninety-five (95%) percent.

Results of simple correlation analysis confirm a positive association between years of formal education and cityward migration. Once again, a very weak positive association is established for the out-migrants group, with a Spearman's rank correlation coefficient of ($r = .082$) significant at the (.0820) level. As the responses for the out-migrants group are second-hand (provided by the head of the household and other household members) the more direct responses of the return migrants group should be weighed stronger. Even stronger results are derived from the return migrants group, where a Spearman's rank correlation coefficient of ($r = .460$) establishes a moderately strong positive association between the number of years of formal education prior to the return to the household (EDURET) and cityward migration (MIGDEST). Return migrants, as a group, generally have less formal education than either out-migrants or potential migrants. Their return to the rural household, associated with lower levels of formal education may indicate socioeconomic difficulties at more densely populated urban source areas and is therefore consistent with the research hypothesis. Consequently, based on these results, the null hypothesis of "no association" should be rejected and the alternate hypothesis (H1) accepted at the ninety-five percent confidence level.

Hypothesis (5C) correlates class of destination with age at the time of migration. In addition to occupational preparedness and education, age is an obvious factor which may be associated with the choice of final destination. According to migration theory, younger individuals are particularly attracted by the "pull" factors of large urban centers, for education, jobs and related opportunities, both real and perceived. On the other hand, as an individual ages and acquires additional indigenous knowledge, based upon life experience in a rural setting, urban pull factors may be seen to become less important while local resource factors become more important. Regardless, the null hypothesis is of the form:

> Ho, there is no association between the variation in corresponding values of age and cityward migration. Hence, the Spearman's rank correlation coefficient ($r = 0$) is equal to zero.

The alternative hypothesis counters:

> H1, there is an inverse association between the variation in corresponding values of age and cityward migration. Hence, the Spearman's rank correlation coefficient ($r < 0.0$) is less than zero.

The significance or rejection level for the pair of hypotheses was predetermined at ninety-five (95%) percent.

Results of simple correlation analysis indicate that no meaningful association can be established between age and cityward migration within the farm household survey conducted in the Plan Sierra region of the Cordillera Central. No significant Spearman's rank correlations were produced from any of the various migration groups at the required confidence level. Consequently, based upon the above results, the null hypothesis of "no association" should be accepted at the ninety-five percent confidence level.

The lack of evidence for an inverse association between age and migration destination may be explained by the position of the Dominican Republic within the context of its "mobility transition." According to Zelinsky (1971), societies experience five distinct migration phases, passing from a "premodern traditional" and ultimately evolving into a "future superadvanced" society. Each of the various phases are identified by fairly distinct migration patterns. For example, the Dominican Republic may be classified as a "late transitional society," having the following characteristics:

> 1) Slackening, but still major, movement from countryside to city; 2) Lessening flow of migrants to colonization frontiers; 3) Emigration on the decline or may have ceased altogether; 4) Further increases in circulation, with growing structural complexity (Zelinsky 1971, 230-231).

In addition, Zelinksy defines changing levels of mobility through time, including: international, frontierward (domestically), rural-urban, urban-urban and intraurban, circulation, potential migration absorbed by circulation, and finally potential circulation absorbed by communication systems (1971). Over the past thirty years, the Dominican Republic has largely passed through both the domestic frontier and rural to urban migration levels.

The dominant migration stream in the Dominican Republic has been rural to urban for some time, however, there are signs that this phase is past its peak, as both real and perceived opportunities in Santo Domingo and other urban centers rapidly decline. Assuming the Dominican Republic is entering the fourth of five phases in this process, migration may currently be viewed as an important part of collective behavior, it is the expected norm and is primarily driven by the social momentum of the masses (Petersen 1958). Consequently, discriminating factors such as age, education, occupation, or sex no longer have the same explanatory power that was experienced during earlier phases of the migration process, typified by innovating pioneers. Opportunity costs alone now appear to be the major limiting factor to out-migration and still largely affect domestic rural to urban migration, which was frequently observed in the field by the author.

The last set of hypotheses (6A) and (6B) further expand the linkages between population-migration and people-environment theory by defining the nature of the correlations between the variables age, occupational preparedness and the role of land degradation in the decision to migrate. Drawing from behavioral-migration theory, Wolpert (1965) proposes that a combination of both degrading physical and socioeconomic conditions in certain urban environments produces psychological stresses that trigger behavioral responses, specifically, the decision to migrate. These associated stresses are generally characterized as the ill effects of population pressure in the people-environment literature. Regardless, the decision to migrate is made, theoretically, in order to maximize one's "place utility", as first proposed by Wolpert (1965), and later expanded upon by Brown and Moore (1971) and Fuller (1978). Expanding on these theoretical notions, the proposed conceptual model in this dissertation argues that a degrading environment for agriculture also functions as a stress impetus stimulating behavioral responses, especially the decision to migrate. It is further argued that one's age and level of occupational preparedness prior to out-migration are associated with the perception of degrading conditions in the local farming economy.

Hence, Hypothesis (6A) defines the nature of the association between levels of occupational skills and the perception of (land degradation) environmental stresses. Building on theory, it may be argued that the advancing level of an individual's occupational preparation may cause one to be particularly sensitive to resource stresses (land degradation) in the rural environment. This is especially true, if the chosen profession is agriculture. Regardless, the null hypothesis is of the following form:

> Ho, there is no association between the variation in corresponding values of occupational preparedness and the role of land degradation in the decision to migrate. Hence, the Spearman's rank correlation coefficient ($r = 0$) is equal to zero.

The alternative hypothesis offers:

> H1, there is a positive association between the variation in corresponding values of occupational preparedness and the role of land degradation in the decision to migrate. Hence, the Spearman's rank coefficient ($r > 0.0$) is greater than zero.

The significance or rejection level for the pair of hypotheses was predetermined at ninety-five (95%) percent.

Once again, the most meaningful correlations are realized from the return migrants group. The perception of degrading conditions aggravating the decision to migrate is quantified by the ordinal variable (INFLU), which is a Lickert scaling measure ranging from absolutely "no importance" to "much importance," in a five step gradation. Occupational preparedness is measured, as defined above, by the variables (JOB) and (JOBAWAY), and (JOBLEFT), which defines a return migrant's occupation prior to leaving the household for the first time. A Spearman's rank correlation coefficient of ($r = .606$), significant at the (.0001), establishes a moderately strong positive association between the key variables, where high values for occupational preparedness, in this case (JOBLEFT) are directly correlated with higher values (some and much importance) of the variable "influence." A similar association is established for the return move to the rural household, where a Spearman's rank correlation coefficient of (r = .338) significant at the (.0072) is evidenced between the variables JOBAWAY and ENVIRON (influence of the environment in migration decision to return to the household). Finally, somewhat stronger results are produced for the out-migrants group, where a Spearman's rank correlation coefficient of (r = .437), significant at the (.0012) level reaffirms a moderately strong positive association between the variables. Consequently, the null hypothesis (HO) of "no association" should be rejected and the alternative hypothesis (H1) accepted at the ninety-five percent level.

These results tend to confirm that principal farmers in the Plan Sierra region generally are sensitive to land degradation, however, they also appear to be opting for migration rather than long term occupation and intensification of the land in their attempts to maximize "place utility." This preference is likely due to a number of factors, including: a long history of difficulties in both access to credit and information for land resource investment and management; low prices paid for both rural labor and excess farm production and therefore little capital for investment; customary land tenure practices that tend to disaggregate economies of scale in the farming system; and finally, social costs, the low levels of both personal esteem and opportunity associated with the traditional agricultural sector.

Finally, Hypothesis (6B) examines the nature of the association between variation in age, at the time of departure from a rural source area, and the role land degradation in the decision to migrate. According to theory, the age of an individual at the time of out-migration is critical, for one's perceptions of the world and local physical environment change with time (Thomas and Hunter 1980; Wilkie and Wilkie 1980). However, the null hypothesis is of the following form:

> Ho, there is no association between the variation in corresponding values of age and the role of land degradation in the decision to migrate. Hence, the Spearman's rank correlation coefficient (r = 0) is equal to zero.

The alternative hypothesis offers:

> H1, there is a positive association between the variation in corresponding values of age and the role of land degradation in the decision to migrate. Hence, the Spearman's rank correlation coefficient (r > 0.0) is greater than zero.

The significance or rejection level for the pair of hypotheses was predetermined at ninety-five (95%) percent.

The results of simple correlation analysis confirm a weak positive association between the variables age and (INFLU) a measure of the role of land degradation in the decision to migrate. For example, an equation from the out-migrants group produces a weak positive association, with a Spearman's rank correlation coefficient of (r = .141) significant at the (.0020) level. Moreover, stronger results are derived from the return migrants group, where a Spearman's rank correlation coefficient of (r = .299), once again, confirms a weak positive association, significant at the (.0120) level. These findings generally confirm the author's field impressions and interviews where older farmers appeared to express the most concern for land degradation. Consequently, based on the above results the null hypothesis of "no association" should be rejected and the alternate hypothesis (H1) accepted at the (.05) level of significance.

The role of the environment (land degradation) in the decision to migrate appears to play a minor part for most out-migrants. Questionnaire responses indicate that the majority of out-migrants attribute little or no importance to the environment in their migration decision. On the other hand, almost twenty percent have assigned "much importance" to the condition of the local environment, and an additional twelve percent attached "some importance" as part of their decision. Finally, the remaining eleven percent indicated their decision was neutral regarding the vitality of the local agricultural landscape.

The role of the environment in the decision to migrate also appears to have played only a minor consideration for most in-migrants. Likewise, individual responses indicate that the majority of in-migrants assigned little (13.8%) or no importance (69.6%) to land degradation in their personal migration decision. Only slightly more than six (6.3%) percent of the in-migrants claimed the state of land degradation had "much importance" in their decision to migrate to the current location. The balance of the individuals (13.9%) assigned a neutral status to the role of the environment as a factor in the decision to migrate. These responses contradict personal field observations, where a majority of farmers expressed great concern about land degradation. Moreover, many migrants justified their most recent move on the basis that their occupation (agriculture) at their former place of residence was insufficient to support the family (place utility). Perhaps individual migrants either fail to enunciate or fully recognize the importance of land degradation in their decision-making process to move or to stay (Fuller 1978).

When asked if land degradation influenced their decision to leave the household originally, once again, the majority (57.9%) of return migrants, assigned "no importance." An additional ten and one-half percent expressed that the environment had "little importance" in their decision, and three and one-half percent were neutral. On the other hand, an equal fourteen percent credited land degradation as having "some" and "much importance" as a basis for changing location the first time. Generally, first moves from rural households are made by younger members and are equally if not largely motivated by the socioeconomic pull factors of large urban centers. However, there are reasons to believe these factors change over time. Therefore, it is important to determine the explanations for subsequent moves to and from the household, in order to determine if the role of land degradation in the migration decision increases with age, education and occupation.

Explanations for the return to the household differ in many respects from other migrant groups (Table 6.8). The majority of the return migrants (15.5%) claim to do so for "rest and relaxation," which amounts to an extended vacation lasting for more than three months. Moreover, over ten percent reveal they had always planned to return to the household after earning a satisfactory amount of money or a professional degree. One is given the impression, based upon the importance of these responses, that perhaps a "birds of passage" (circulation) component is embodied by many return migrants. This expression was first applied to European immigrants who migrated to the United States for short periods of time--usually three to five years--for the expressed purpose of earning dollars. Upon returning home, these "birds of passage" frequently purchased property and lived very well on the money earned overseas. Occasionally, the process was repeated as the money ran low. Finally, an additional ten percent indicated their return was a family decision.

Over eight and one-half percent admitted they had recently inherited property. Impressions from the field indicate that changes in land tenure appear to be of rapidly increasing importance, and although extensively researched in Latin America the issue of land tenure is worthy of future investigation in the Plan Sierra region. Finally, the balance of explanations cite the frequent disappointments and family problems related to unsuccessful migration experiences. Regardless, most return migrants (70%) plan to remain in the household for an unspecified amount of time, however, many are uncertain about the specific reason (Table 6.12). A large number do express familial reasons for staying, including land ownership and satisfaction with employment. Only small percentages of these people offer despairing reasons for staying in the household, for example, lack of financial resources or lack of specific knowledge regarding better opportunities.

Regarding the decision to return to the household, environmental considerations also appear to have had little affect on the decision making process for most migrants. For example, the majority (78.8%) responded "no importance" with an additional four percent keying "little importance," two percent were neutral regarding the role of land degradation in the decision to migrate. Conversely, slightly less than ten percent indicated the environment played a major role as a deciding factor and only about six percent of the return migrants felt the environment held "some importance" in their decision. Once again, these responses are somewhat inconsistent with general field impressions and personal discussions with farmers, who consistently expressed genuine concerns for land degradation and their continued ability to procure a living from the land.

Finally, the environment (land degradation) appears to be of greater importance to potential migrants than any other group sampled (Table 6.13). Almost half of the potential migrants claim the condition of the physical environment does factor into their decision to leave; over one-quarter said the environment was of "much importance" in the decision, a few less offered that the environment was of "some importance" in their decision. An even smaller group (8.8%) was neutral. On the other hand, over thirteen percent said land degradation had little influence on their possible leaving, and finally, a little less than thirty percent professed the environment was of "no importance" in their decision.

In summary, after a brief discussion of the conventional methods for determining net migration, this chapter began with a description of the prevailing patterns of population redistribution in the Plan Sierra region on the political section level from 1960 to 1981. A detailed description of

Table 6.12

Return Migrants Reason for Staying

Reasons for Staying	Frequency.	Percent	Cum. Frequency.
1. Have a Good Job	3	5.2	5.2
2. Family Commitments	19	32.8	37.9
3. Lack of Education	2	3.4	41.4
4. Unaware of Better Jobs	3	5.2	46.6
5. Have Land (Ownership)	1	1.7	48.3
6. Too Old to Migrate	1	1.7	50.0
7. Family too Large	0	0.0	50.0
8. Have Enough Money	0	0.0	50.0
9. Currently in School	0	0.0	50.0
10. Physical Handicap	1	1.7	51.7
11. Soils are Good Here	0	0.0	51.7
12. Lack Money to Move	2	3.4	55.2
13. No Opportunity	1	1.7	56.9
14. Like it Here	1	1.7	58.6
15. Have Animals Here	1	1.7	60.3
16. Do Not Know	23	39.7	100.0

Table 6.13

Potential Migrants Reason for Leaving

Reason for Departure	Frequency	Percent	Cum. Percent
1. Change of Employment	28	10.1	10.1
2. No Employment	16	5.8	15.9
3. Underemployment	33	12.0	27.9
4. Job Dissatisfaction	11	4.0	31.9
5. Purchased Land	0	0.0	31.9
6. Find a Better Job	45	16.3	48.2
7. Offered Better Job	14	5.1	53.3
8. Educate Oneself	40	14.5	67.8
9. Educate Children	17	6.2	73.9
10. Marriage	3	1.1	75.0
11. Accompany Family	21	7.6	82.6
12. Join the Family	9	3.3	85.9
13. Family Problems	2	0.7	86.6
14. Bad Social Climate	2	0.7	87.3
15. Land Degradation	3	1.1	88.4
16. Poor Soils	7	1.4	89.9
17. Do Not Own Land	0	0.0	89.9
18. Look for a Better Life	11	4.0	92.4
19. Do Not Know Why	10	3.6	100.0

farm level trends followed, based on calculations from the household questionnaire administered in randomly selected rural parishes within political sections during the winter of 1987. Detailed demographic and socioeconomic characteristics for each of the migrant sub-groups were considered and compared. The chapter concluded with the presentation and explanation of the results of statistical analysis for the four final groups of hypotheses. Chapter Seven provides a brief summary of the results and conclusions of this dissertation and introduces a number of recommendations for future research in the Plan Sierra region of the Cordillera Central, Dominican Republic.

Chapter Seven

Summary of Results, Conclusions, and Recommendations for Further Research

Introduction

Like most developing countries, the Dominican Republic has experienced rapid population growth during the post World War II era, which in turn has led to pervasive population pressure in areas of traditional hillslope agriculture. It is also clear that the vast timber reserves of the 1920s have been largely depleted. The major share of the forest removal occurred as a result of commercial lumbering, beginning in earnest during World War II and extending through the year 1967 when the Dominican government banned the cutting of live trees. Despite some initial successes in forest management, primarily by means of the military's enforcement of this legislation, deforestation has continued but at a somewhat slower pace. Simultaneously, mountainous areas of the country also experienced accelerated levels of environmental degradation and unprecedented population redistribution, particularly in the form of out-migration.

In spite of the obvious importance of these events in the Dominican Republic and elsewhere in the Third World, few natural or social scientists have attempted to explain the essence of the interrelationships between two or more of these processes. The objective of this dissertation therefore became the design of a conceptual model and accompanying research hypotheses in order to accomplish this important task. Thus, this dissertation represents the first case study to critically evaluate the nature of the relationships and associations among these processes in a single conceptual framework, spatially at two different scales of analysis and temporally over approximately a thirty year time frame. Results of this dissertation provide substantial evidence that this conceptual model is a useful framework of analysis to characterize the disposition of these interrelated physical-human forces in the Plan Sierra region of the Cordillera Central. Finally, the findings from this research contribute to existing bodies of population-economic, behavioral-migration and people-environment theory in the following ways.

Summarized Results with Conclusions and Implications

Government officials, as well as scientists in both the natural and social sciences, commonly claim that forest conversion is the primary social response to increasing population pressure. In reality, the actual nature of the relationship between population pressure and deforestation in most developing countries generally is unknown or largely misunderstood. In fact, competing theories reveal that a number of social responses to population pressure exist, irrespective of forest conversion. Results from research hypothesis (1A), reviewed in the following four paragraphs, contribute to an understanding of the linear relationship between population pressure and deforestation, especially how and why this relationship changes over time.

Simple bivariate regression analysis confirms a moderately weak positive relationship between population pressure and rates of deforestation on the political section scale. This direct linear relationship is established for the twenty year time frame from 1960 to 1980. Prevailing thought on the process of land degradation in developing areas argues that social forces, such as population pressure, must be examined on the individual farmstead scale in order to provide satisfactory explanation (Brookfield and Blaikie 1987). Therefore, a new measure of population pressure was devised based on methodology developed by Bernard and Thom in 1981 for larger sized political districts. Results of simple bivariate regression analysis using this new farm-level population pressure variable provide highly significant evidence to support a strong positive relationship between a measure of population pressure and annual rates of deforestation. Large farms, by their very nature, will tend to have greater forest cover and lower population pressure, while small farms will have less area reserved for forest (fallow) and greater population pressure. To control for farm size, the relationship between deforestation and population pressure was reassessed for three subgroups of farms, stratified by farm size (small, medium, and large). In this case, the relationship remains strong only for the subgroup of small farms. This may be explained in a number of fashions. For one, farmers with large holdings may be wealthier and have alternative means of obtaining (basic needs) income when their dependents become large in number. Regardless, there is convincing evidence for a reasonably strong positive relationship between population pressure and rates of deforestation.

A deforestation-fallow ratio was created and tested to examine the simultaneous effect of population pressure on forest conversion and long term fallow lengths. Within the context of the traditional hillslope farming system, it is argued that relatively small amounts of primary forest land are cleared and large areas of land remain in long term fallow during social conditions of low population pressure. As population pressure increases forest conversion accelerates and long term fallow land declines. Results of simple bivariate regression between the new deforestation-fallow ratio and population pressure establish a moderately strong positive relationship between these variables. Consequently, this dissertation also provides evidence to support the notion that increases in farm level population pressure have the combined effect of simultaneously decreasing local forest cover and reducing farm fallow area. Finally, because the deforestation-fallow ratio is not influenced by variation in farm size, conceptually it is an important measure.

Additional insights pertaining to the nature of the linear relationship between population pressure and deforestation are realized on the political section level of analysis. Although the correlation between changes in the key variables (population pressure and rates of deforestation) over the twenty-year time frame (1960 to 1980) produces a weak positive relationship, much stronger correlations are achieved when a small series of static forest cover measures are employed as surrogate measures of deforestation. For example, an equation that regresses population pressure with forest cover for the year 1960 reveals that political sections experiencing high levels of population pressure are indirectly related with low percentages of forest cover. Similar results are realized for the other pairings. The decrease in the strength of the relationship over time, is in part explained by the decline in available forest cover itself. That is to say, as forest cover recedes, there is (1) less forest available to cut, (2) forest reserves may increase in value, and (3) remaining stands are increasingly likely to be located in highly inaccessible or unfarmable areas.

This dissertation, therefore, offers an explanation for the change in the strength of the relationship between population pressure and rates of deforestation over time and, consequently, provides some tangible evidence in support of Bilsborrow's (1987) notion of an evolutionary sequence of social responses to pervasive population pressure in developing areas. Forest conversion, in response to increasing population pressure will likely be the primary choice of decision makers in traditional farming societies until the environmental constraints of slope, soils, and accessibility become limiting, necessitating a change in social response. Once again, according to the conceptual framework proposed by Bilsborrow (1987), we should be attuned to other economic-demographic or perhaps demographic responses to population pressure (during the 1990s) as the strength of the relationship with deforestation further declines.

In this vein, research hypothesis (1B) critically evaluates a number of the other social alternatives to population pressure. These choices variously come under the rubric of agricultural intensification, and by definition include the intensity of land use and labor inputs, innovations in landesque capital, and technological improvements in farming skills. Within the Plan Sierra case study region, however, simple bivariate regression analyses produces results that (to some extent) contradict conventional population-economic theory. Data from a 1983 agricultural survey (on the political section level) reveal that intensity in the frequency of improved farming skills and innovative improvements in the land resource base are more likely to occur under conditions of low population pressure, the reverse of the Boserup thesis. On the other hand, the expected positive linear relationship between population pressure and land use intensity is confirmed on the political section level. It appears that factors other than population pressure are directly related with the intensity of adaptation of innovations in agriculture.

It is likely that variation in farm size accounts, in part, for the inverse relationship observed on the political section level. From a number of sources, including observations made in the field, it is evident that population pressure is less severe on the larger farms, and it is generally on the larger farms where the most important efforts to intensify the farming system are taking place, as measured by land improvements and use of modern technology. It may be argued this is essentially a function of wealth and access to credit and information. The larger land holders are in both a better social position to learn about modern farming technology and a better financial position to obtain credit. On the other hand, population density is generally highest on the smaller farms, where one is least likely to see modern intensive farming techniques being employed. Customarily, the small farm agriculturalists are both considered a bad credit risk and usually have less access to information pertaining to modern food production techniques. Historically, rather than intensify their labor inputs toward subsistence crop output, farmers with small holdings have opted to incorporate market oriented "cash" crops into the traditional farming system, requiring a gradual intensification of their labor inputs and some minor improvements in cultivation methods. Nevertheless, the returns have not allowed for major environmental improvements resulting from reinvestment in the land resource base.

Alternatively, meaningful results provide evidence in support of a positive linear relationship between farm-level population pressure and agricultural intensity. A strong positive relationship is confirmed between both population pressure and land-use intensity, defined as the percentage of farmland cropped ($r = .764$), and land-use labor intensity, defined as the frequency of cultivation ($r = .537$), respectively. In addition, when population pressure is correlated with variation in average (output) food production per tarea, a moderate positive relationship also is realized. Production per tarea most likely results from the cumulative effect of labor intensity, improved farming skills, and investments in landesque capital. Finally, weak positive relationships between population pressure and the intensity of innovations in agriculture are confirmed for mini-farms, small farms, and large-farm size groups.

These results further our understanding of the social responses to population pressure within the context of a traditional farming society and thereby make an important contribution to both population-economic and people-environment theory. By identifying the evolving sequence of social responses to population pressure, employed by traditional hillslope farmers in the Dominican Republic, these results further support the prevailing temporal thesis proposed by Bilsborrow (1987). For the Plan Sierra case study region, the various economic responses to pervasive population pressure, listed from most to least commonly employed, appear as follows: 1) deforestation, to place new land into food production; 2) farm labor intensification, manifested by reduction of fallow lengths as well as fallow areas and to a limited extent the reduction of traditional grazing areas, associated with increases in cropped land; 3) the rather limited intensification of agricultural skills, manifested by some use of improved seeds, fertilizers, and improved cultivation practices, and; 4) very limited investments and innovations in landesque capital, manifested by the use of irrigation, the planting of trees as soil anchors, leveling of fields, and the building of terraces on steep slopes. The majority of small farmers currently choose the first two options, whereas the third and fourth alternatives appear to be executed to a limited degree by the larger farm operators. In the near future when deforestation is no longer a viable option for traditional hillslope farmers, logically we should anticipate increased efforts to improve sustainable food production skills and permanent investments in landesque capital. As noted earlier, perhaps additional field studies are in order, at five-year intervals from the first investigation, and should be planned for 1992 and 1997.

The next set of research questions (2A & 2B) define the linkages between the primary economic responses to population pressure and environmental (land) degradation. According to contradictory research on deforestation in developing countries, mismanaged forest conversion appears to be directly related to equally uncontrolled land degradation, especially soil erosion and mass wasting. On the other hand, both professional foresters and competing social theory argue that these forces are not necessarily related in a cause and effect fashion. Following the less optimistic or "disaster" circuit of the conceptual model introduced in this dissertation, it is proposed that rapid forest conversion (deforestation) is positively related with land degradation.

Hypothesis (2A) does, in fact, establish a positive linear relationship between these key variables. This analysis was conducted at the farm household scale, where standardized values for annual deforestation rates are significantly correlated with annual rates of land degradation. In this case, farm level land degradation is defined as the average yearly amount of arable land lost from food production. Results of simple bivariate regression analysis confirm a positive, moderately strong relationship between the criterion and predictor variable, where approximately one-third of farm level land degradation is explained by prevailing forest conversion practices.

Within the traditional hillslope farming system found in Plan Sierra, average annual farm level forest conversion ranges from no new lands cleared to a high of 150 tareas. Mean farm-level deforestation registers slightly above one-half hectare or about eight tareas annually, representing a noticeable decrease from estimated rates of deforestation in the early 1970s of about twenty tareas

(Werge 1976). Moreover, the average farmer claims to be losing approximately two tareas of land from production each year, as a consequence of erosion and deteriorating soil conditions. These observations are consistent with research findings in the early 1980s (Hartshorn and others 1981), and in the middle to latter 1980s by investigators at the Center for Urban and Regional Studies (CEUR) of the Catholic University in Santiago. Consequently, it is little wonder that over eighty-five percent of the principal farmers interviewed claim that conditions for agriculture have deteriorated to some degree since 1977. Many (with whom I spoke) single out deforestation as contributing to their erosion and soil loss problems.

According to conventional Boserupian population-economic theory, one may argue for an inverse relationship between advancing levels of innovative farming technology and land degradation, which theoretically contributes to improved management of the land resource base. The more optimistic or "development" circuit of this dissertation's conceptual model proposes that socioeconomic responses to population pressure attempting to intensify the farming system will likely improve the agroecosystem. Results of simple bivariate regression analysis generally confirm that the linear relationship between the intensity of innovation in agriculture and land degradation are inverse in direction. The results, however, are weak in strength and are only established on larger farms within the Plan Sierra sample. The stratified farm level results indicate that the strength of the inverse relationship between intensity of innovative improvements in agriculture and land degradation may increase with farm size. Regardless, the rather weak nature of the strength of the relationship suggests that variables other than the intensity of agricultural innovation are inversely related with land degradation to a larger degree.

As noted earlier, small farmers in the Sierra have consistently adapted "cash" crops to the traditional hillslope farming system, which in most cases act to reduce customary fallow cycles but generally have not been accompanied by the necessary soil conservation and improvements in the land resource base, often leading to soil exhaustion or erosion. Moreover, based upon observations and discussions in the field, although knowledge of the modern technology generally is available locally, few farmers can afford to take advantage of soil conservation and land improvement strategies that would tend to minimize land degradation. They claim access to credit is a major problem. Only in the few cases of the larger farm groups, which have employed irrigation techniques and other improvements such as terracing and erosion control, is an inverse relationship established between these intensification practices and farm level land degradation. These findings are consistent with observations that comparatively few innovative efforts have been employed in order to improve the traditional hillslope food production system. In summary, it is evident that high rates of forest conversion combined with both decreasing long and short-term fallow lengths, in conjunction with the absence of investments in landesque capital or improvements in farming skills, ultimately contribute to increasing rates of land degradation.

The third hypothesis set (3A & 3B) pursues the linkages between the concepts of "place utility" from conventional behavioral-migration theory and natural resources push and pull factors, adapted from Lee's classic conceptual framework for migration. In hypothesis (3A), it is argued that in-migrants logically will be drawn to forested frontier areas, which likely are perceived positively as having a strong natural resource attraction, especially in response to pervasive population pressure in the generating rural source areas. This action maximizes the "place utility" of the traditional farming household, and in this case, the attractiveness of the forested frontier is perceived much stronger than that of other available choices.

Results of simple bivariate regression analysis on the political section level support a weak positive relationship, explaining a little more than ten percent of the variation in in-migration. Similar significant results are derived from analysis of the largest farm size group, which support a stronger positive relationship between farm level deforestation and in-migration. These weak positive correlations very likely reflect the fact that there are few remaining forested frontier areas to attract migrants in the Plan Sierra region, due to a number of limiting environmental and political factors.

These findings do indicate that at least some in-migrants are directly related (at least moderately so) with larger farm operations that are experiencing higher rates of forest conversion. Rural migrants are more likely to move from regions of high population pressure, especially from generating source regions suffering natural resource push factors, to regions experiencing lower levels of population pressure such as in areas with larger farms. Consequently, an understanding of the decision making process of principal farmers contributes collectively to several bodies of theory, where we find that as long as forested frontier areas generally remain accessible, heads of traditional farming households frequently choose migration, in order to maximize "place utility", rather than make the necessary innovations in the farming system and improvements in the land resource base.

Hypothesis (3B) further mines the linkages between the concepts of "place utility" and natural resources push factors, which ultimately may trigger a decision to migrate. Brookfield and Blaikie (1987) explain land degradation as a social phenomenon, where traditional small scale farmers make resource management decisions that either minimize or exacerbate natural forces. The latter case has the effect of increasing population pressure, as increasing amounts of arable land eventually become non-productive. Subsequently, as "place utility" on the individual farmstead level is further compromised, the degraded land base will tend to function as a "resource push" factor, which leads to a decision to migrate. As the Plan Sierra region of the Cordillera Central is frequently cited for both accelerated rates of out-migration and high levels of environmental degradation, a positive linear relationship was predicted.

Results of simple bivariate regression analysis are largely inconclusive, however, and reveal that only weak correlations can be established on the farm household scale. In fact, no significant relationships can be confirmed at the designated ninety-five percent confidence level. One equation that correlates potential migrants with the predictor variable (land degradation) produces evidence for a very weak positive relationship. In addition, similar findings are encountered when these key variables are examined under the constraints of various farm sizes.

In order to account for the apparent absence of a meaningful relationship between land degradation and out-migration on the farm level, an important observation must be reiterated. In spite of the methodological advantages to be gained from a "multiplicity" questionnaire design, out-migrants are still largely under-sampled, perhaps by more than ten percent in the Plan Sierra case study. This is primarily a function of entire farming households that relocate and therefore are unaccounted for in the sample. In future field research this situation could be corrected, if current householders were asked to comment on their immediate neighbor's migration behavior.

Finally, although the magnitude of this pattern is unknown, there is evidence from the Plan Sierra region that farm abandonment is taking place, which concurrently may attract some migrants. In this situation, abandoned areas are rather quickly reoccupied by new farming households willing to try their luck. Unfortunately, the itinerant farmer often is unwilling or unable to reverse an ongoing incidence of accelerating soil erosion. As a result, "place utility" is not likely to be sustained and resource push factors trigger yet another household move, as a consequence of pervasive farm level population pressure. This scenario was observed in the field, hence, the relationship between land degradation and in-migration is not logically inconsistent but indicates greater social complexity in the overall land degradation process, as a series of farm households successively fail to sustain "place utility" in a long-term cycle of resource deterioration. This pattern may also account for some of the considerable amount of squatting that is taking place in the Sierra; a number of these themes were recently discussed by Rodriquez in Campesinos sin Tierra (1987). Furthermore, this finding provides additional evidence that Brookfield and Blaikie (1987) are correct in believing that land degradation is a social phenomenon, one that is directly tied to resource push and pull factors associated with population redistribution.

A related goal of this dissertation is to offer an explanation of how variation in population pressure, specifically measured against the carrying capacity of the traditional hillslope farming system, is directly related with population redistribution. According to the conceptual model, the natural reproductive growth process in human populations gradually increases the demand on the food production support system. Consequently, population pressure either stimulates social responses that modify the farming system in positive and innovative ways or elicits ambivalent social responses that often lead to negative ecological consequences. In either case, a new population-resource balance is achieved which allows for population redistribution.

Customarily, rural heads of household frequently face a number of choices in order to maximize "place utility" when challenged by pervasive population pressure. According to competing theories from the population-economic literature, one economic option involves forest conversion to place new land into food production, however, a second economic option requires the intensification of agriculture by means of improvements in farming skills and innovations in landesque capital, which are likely to minimize natural resource push factors and thereby sustain or even maximize "place utility." On the other hand, farm household decision makers may prefer the primary demographic option, out-migration, thereby choosing to maximize "place utility" elsewhere, perhaps being compelled by the resource pull of the forested agricultural frontier or by the employment and education opportunities of the city. Regardless, because of the high levels of population pressure and unusually high rates of out-migration documented for the Plan Sierra region, a positive linear relationship is predicted between these key variables.

The results of simple bivariate regression analysis on the political section level reveal a set of highly significant correlations for a small series of data. Starting with the first pair of census years (1960 to 1970), a very high correlation coefficient firmly establishes evidence for a very strong positive linear relationship between the criterion and predictor variables. In addition, similar results are achieved from the analysis of the second pair of census years (1970 to 1981). On the other hand, results of simple bivariate regression analysis for the entire household (1987) sample are generally inconclusive. Despite the utility of a multiplicity questionnaire design, the amount of information pertaining to the out-migration process on the farm household scale is still somewhat limited. Regardless, results from this dissertation on the political section level alone provide sufficient evidence to strongly support the demographic option of out-migration in response to pervasive population pressure.

The balance of the hypotheses pertain to the population redistribution phase of the conceptual model designed for this dissertation. Consequently, concepts from both behavioral and conventional migration theory are linked in order to explain contemporary migration streams and assess the influence of land degradation in the migration decision making process. For example, the correlations between occupation, education, age and the propensity toward cityward migration are explored in the first hypothesis set (5A, 5B, and 5C). According to the conceptual framework for migration established by Lee (1966), the young, better educated and more highly skilled individuals leave rural generating centers for the larger cities. In contrast, older out-migrants with few marketable urban skills and little formal education feel more secure in an agricultural setting, realizing the difficulties they face in an urban environment (Thomas and Hunter 1980).

Results of simple correlation analysis conducted at the farm household scale confirm a weak positive association between occupation and cityward migration. These results reflect, perhaps, the fact that students are classed in the lowest category of the International Census Code, along with those people who are unemployed or working as household domestics. It is well documented in the migration literature that students also are attracted to major urban centers for their professional training, in addition to individuals with highly valuable professional skills. Regarding the relationship between increasing levels of education and cityward migration (5B), there are somewhat stronger results. In this case, an equation from the return migrants group confirms a moderately weak positive correlation. However, no meaningful results are derived from the out-migrants or potential migrants group at the desired confidence level.

The last hypothesis in this conventional migration theory triad (5C), correlates class of destination with age at the time of out-migration. Logically, in addition to one's occupational preparedness and education, age is an obvious factor likely to influence the choice of final migration destination. According to theory, younger individuals are attracted by the pull factors of large urban centers, for jobs and related opportunities, including education, marriage and to reunite family members. In contrast, as an individual living in a non-urban setting matures and acquires knowledge of the traditional farming system and related rural lifeways, urban pull factors may appear less important and local natural resource factors more important. Therefore, an inverse relationship is predicted, where, as age of the out-migrant increases the propensity for cityward migration decreases. Results of simple correlation analysis, however, indicate that no meaningful association can be confirmed between age and cityward migration.

Nevertheless, there does appear to be an association between education, age and population redistribution in the sample study area. Out-migrants from the Plan Sierra source area generally are younger, with a mean age of twenty-three (23.07) years and better educated, with a mean of over seven (7.32) years in school, than all other migrant groups. In addition, potential migrants (as a group) are only slightly older and less educated than out-migrants, averaging twenty-five (25.2) years of age with a mean of six years of school. In contrast, return migrants to rural households are the oldest group, almost thirty years at the time of return, and have a lower (5.41) mean number of years in school. First time in-migrants to the Sierra also are older, averaging almost twenty-eight (27.95) years at the time of migration, and are the least educated of the recent migration groups, with slightly less than five (4.96) years of formal education. Finally, the non-migrant stayers, those individuals who have not participated in the migration process since before 1977, are the oldest and least educated group in the study, with a mean of almost thirty-five (34.92) years of age at the time of interview and slightly more than four and one-half (4.64) years of formal education.

Regarding traditional migration streams, it is clear that the majority of first time out-migrants are drawn to larger urbanized areas, both internal and external to the Dominican Republic. For the period 1977 to 1987, one-third (33.8%) of the out-migrants from the Plan Sierra region left for the largest urban centers in the republic. An additional one-third (32.9%) left the country altogether, presumably for the United States. The balance of internal out-migration was equally directed toward small cities (13.5%) and rural political sections of the republic (12.8%). Therefore, the migration stream to the remaining agricultural frontier is quite limited in magnitude, and the migration stream to commercial plantation areas is practically non-existent, attracting less than one-half of one (0.2%) percent of the out-migration flows by 1987.

The preference for large urban centers is even more apparent among the potential migrants group, where over eighty-five percent of those interviewed specified a desire to move to the "big city." Almost forty-five (44.3%) percent of this youthful group also plan to leave the country altogether, while another thirty percent (28.4%) target the internal destination of Santiago de los Caballeros, with a few individuals (3.1%) signaling an interest in the national capital, Santo Domingo. Only ten (10.4%) percent of the potential migrants indicate a migration preference for small cities, while only four percent (4.1%) expressed any interest in a move to the forested agricultural frontier. The trend toward the pattern of direct rural to urban migration to the largest urban centers also is apparent from the results of this dissertation.

Nevertheless, this research provides evidence for circular or return migration streams to rural areas of the Sierra. Approximately forty-five percent of the individuals returning to Plan Sierra came from large urban centers of the republic, with roughly eighteen (17.5%) percent more coming from intermediate and small cities. Finally, over one-third of the return migrants left other rural parishes and villages of the countryside. Furthermore, approximately forty-five percent of the first time migrants came from other rural areas, with an additional thirty (27.4%) percent migrating from small cities and villages. Finally, almost twenty percent of the in-migrants to the Plan Sierra region, likewise, came from the large urban centers of the republic, including thirteen percent from Santiago and six percent from Santo Domingo. The dynamics of the spatial process of rural to rural and urban to rural migration in the Dominican Republic are generally undocumented or unknown, both represent fertile territory for future research

The last set of linkages of this dissertation's conceptual model probe the correlations between the variables age, occupational preparedness and the influence of land degradation in the decision to migrate. According to behavioral-migration theory, Wolpert (1965) proposes that both degrading physical and social conditions combine in certain urban environments producing psychological stresses, which often may trigger a decision to migrate. As noted earlier, these associated stresses generally signal the ill effects of population pressure referred to in the people-environment literature. Furthermore, the decision to migrate is made, theoretically, in order to maximize the "place utility" of the household. Building on these concepts, it likewise may be argued that a combination of degrading physical and social conditions in certain rural environments also function to produce psychological stresses illiciting the decision to migrate. Finally, it is further hypothesized that one's age and level of occupational preparedness prior to out-migration vary directly with the local perception of degrading conditions in the traditional farming economy.

Hypothesis (6A) defines the nature of the relationship between increasing levels of occupational preparedness and the influence of land degradation in the decision to migrate. Advancing levels of one's occupational training, both formal and informal may cause an individual to be particularly sensitive to natural resource stresses in rural environments. In fact, results of simple correlation analysis confirm a meaningful positive relationship for both the return and out-migrants group. In addition, somewhat weaker positive results are produced from the out-migrants group. Together, these results tend to confirm that principal farmers in the Plan Sierra region generally are sensitive to environmental degradation, however, they also opt for out-migration rather than long-term occupancy and intensification of the land-resource base in their attempts to maximize "place utility."

Furthermore, hypothesis (6B) defines the nature of the association between variation in age, at the time of departure from a rural source area, and the influence of land degradation in the decision to migrate. This argument proposes that the age of an individual at the time of out-migration is critical, for one's perceptions of the world and local environment change with the passing of time. Results of simple correlation analysis, however, confirm only a weak positive association. Stronger results are realized with the return migrants group.

It was reported that over thirty percent of the out-migrants indicate land degradation factored either strongly or at least in some way in their decision to migrate. This was also true for approximately twenty and twenty-five percent of the in-migrants and return migrants sampled, respectively. Moreover, almost fifty percent of the potential migrants said the condition of the local environment was important in their decision to leave. In the field, people I talked with genuinely seemed concerned about land degradation and the government's efforts to control soil erosion and manage the republic's remaining forests. There is a common held sense that the agricultural frontier is rapidly disappearing, if not already gone for all practical purposes. In the near future, small farm decision makers in the Plan Sierra region of the Cordillera Central will no longer be able to simply opt for forest conversion or out-migration as a means of maximizing the "place utility" of the household, they will be forced to turn to other economic-demographic choices in the face of pervasive population pressure in order to survive.

Critique of the Conceptual Model

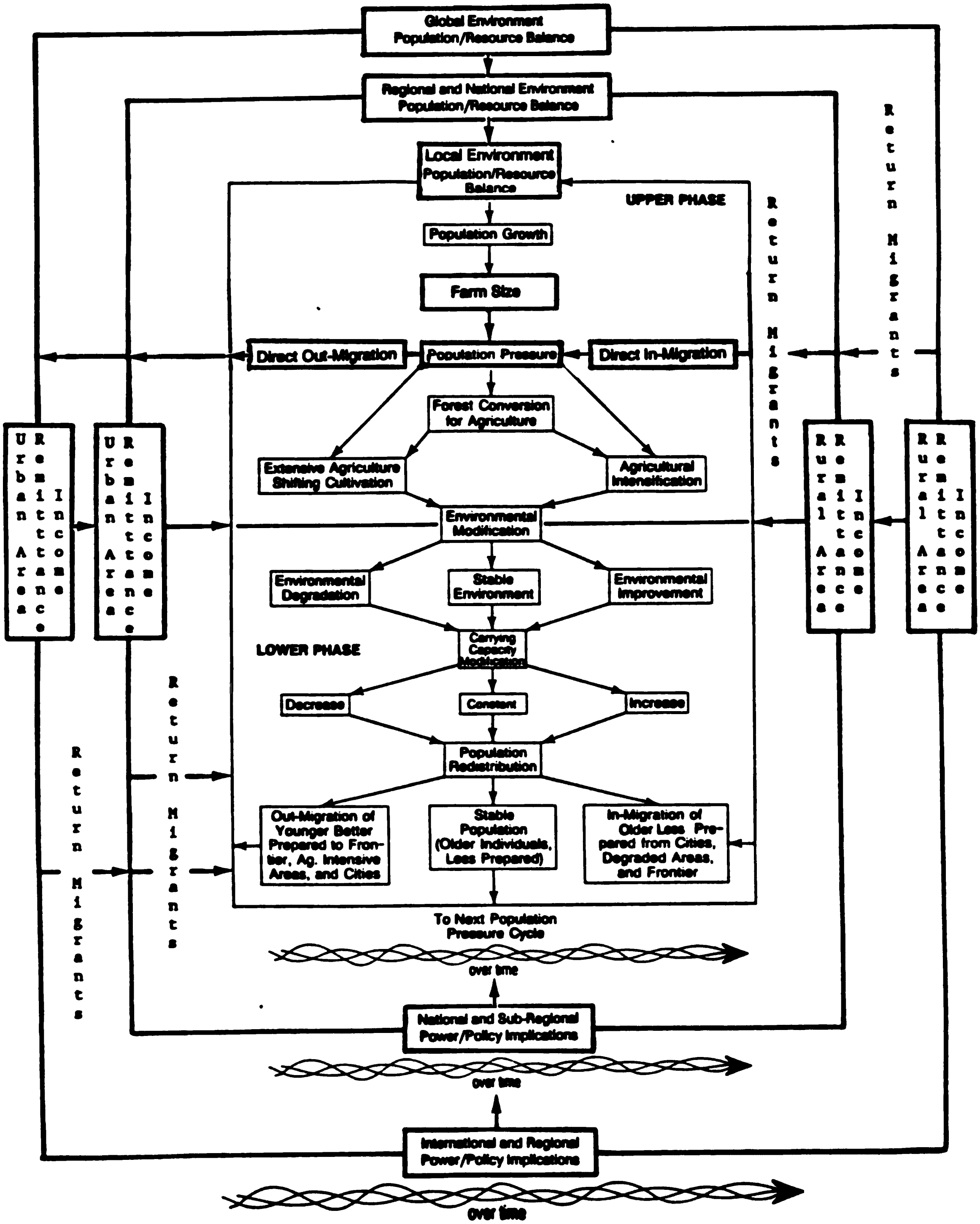
Results of this research indicate that a number of revisions need to be made in the conceptual model developed for this dissertation (Figure 3.1). Findings from simple bivariate regression analysis reveal that variation in farm size is a critical factor in determining the strength of several key relationships. The correlation between population pressure and deforestation increases in magnitude with farm size. Farms larger than the minimum subsistence threshold of 80 tareas are associated with the relationship between deforestation and in-migration, and large farms appear to be associated with innovative farming techniques and investments in landesque capital. Consequently, a consideration of farm size should be added to the conceptual model intermediate to the boxes indicating the linkages between population growth and population pressure (Figure 7.1).

Out-migration as a primary social response to population pressure also should be indicated in the "upper phase" of the revised conceptual model. Lines should be added to the "population pressure" box indicating both the out-migration of individuals in response to pervasive population pressure and the in-migration of individuals from outside of the local area, which contributes to local population pressure when added to natural rates of population increase. Reference to "potential migrants" as a separate group of individuals that were sampled in the questionnaire should be included within the "population redistribution" box found in the lower phase of the conceptual framework. Finally, "return migrants" are an important group of individuals in this research that need to be accounted for. On the local level "return migrants" should be listed in the box with "in-migrants" found in the lower right-hand corner of the model. They represent "older, perhaps, less prepared individuals returning from national urban centers or degraded rural environments" outside of the Plan Sierra region.

The revised conceptual model must also attempt to address the impacts and interrelationships of processes that operate at spatial scales beyond the local level (Figure 7.1). Return migrants as a group demonstrate the linkages that exist between "stayers" in rural households and both major domestic and international urban centers, such as the national capital of Santo Domingo or New York City. While away from the rural farmstead, migrants are frequently responsible for small scale capital investment in the farm operation in the form of remittance income. They may return from urban

Figure 7.1

Revised and Expanded Model of Social Responses to Population Pressure



experiences with increased technical knowledge applicable to farming or new employment skills altogether, as well as savings from job earnings. Return migrants also represent the linkages between rural households and other agricultural areas, both domestic as well as rural farming regions outside of the republic. Seasonal migration for temporary work in the international agricultural sector draws many rural individuals from Middle America and the Caribbean to domestic export plantations and to the United States annually. Remittance income derived from this employment is increasingly vital to rural households in developing countries.

A broader-based consideration of spatial scales allows for the examination of the impacts of political power within the context of population-resource relationships (Campbell and Olson 1991). On regional and national levels, the influence of political power may be felt locally through policies that variously control: access to forested land for agricultural development; the prices of agricultural output at the market place, thus reducing capital (accumulation) earnings and the potential for rural reinvestment; access to capital for investment in the form of low interest short term loans; access to information and technology transfer via agricultural extension agencies; investment in rural infrastructure to facilitate the marketing of excess agricultural production; access to alternative forms of employment; and access to general education and health care. On the international and global scale the influence of political power likewise may be felt locally by policy designed to control national level: access to low interest long term credit capital; access to international markets via pricing and tariff structures; access to information and technology transfer via international agencies for economic development; access to international aid in education and health care; and access to international markets for migrant labor's social response to domestic problems of unemployment and underemployment related to pervasive population pressure.

A broader-based view of the temporal dimension also is required of the revised conceptual model. Recent evidence from developing countries reveals that, as a result of the greatly reduced time frames in which traditional rural economies have had to respond to rapid population growth, there has not been sufficient time for innovations to take place within subsistence based farming systems as first proposed by Boserup. Therefore, the time factor may contribute to an explanation of the low intensity levels in the adaptation of innovative farming technology found in the Plan Sierra region of the Dominican Republic and elsewhere. These greatly reduced time frames have serious political implications for both national and international power structures, where it may be seen that future technological innovations in agriculture will be artificially (exogenously) introduced and administered on the local level by means of joint policy decision making at higher spatial scales (Lele and Stone 1989). The time dimension could be added to the bottom of the revised conceptual model in a manner similar to the "spiral braid" originally proposed by Campbell and Olson (1991).

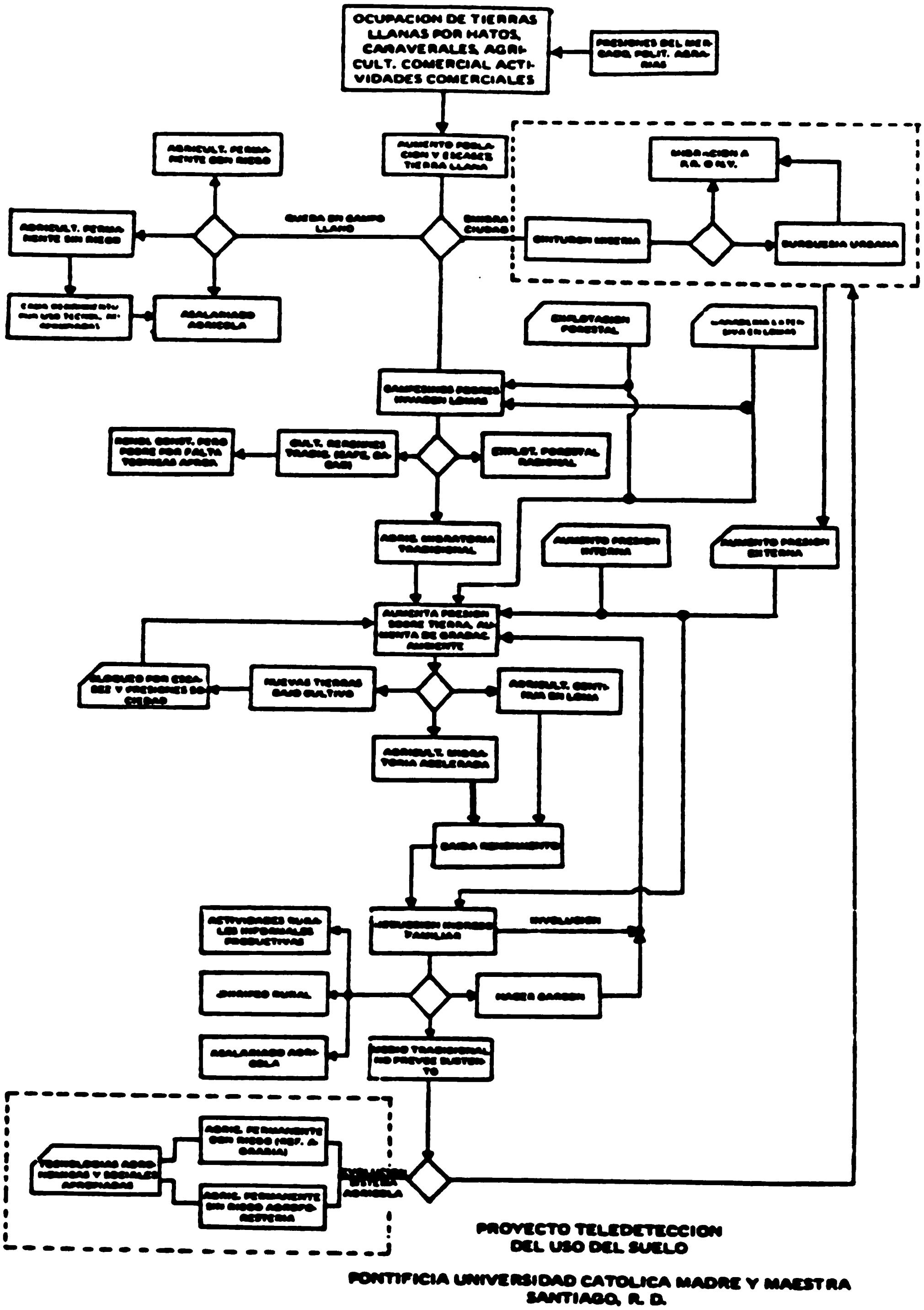
Recently, working within the conceptual framework of political economy, Brookfield and Blaikie (1987) proposed that many hill and mountainous regions within developing countries historically have been marginalized both politically and economically as part of the European colonial experience. The various forms of sociopolitical marginalization, in addition to the fact that sensitive hill and mountain environments also are ecologically marginal for agriculture, has allowed for conditions conducive to accelerated land degradation. This situation has acted to cause these upland areas to function as backward "cultural refuges," systematically isolated from the process of modernization taking place in agriculture on the low lying plains and industrialization in the cities. The development bias away from the insular hill and mountainous areas, by means of seasonal and permanent migration for wages, tends to obviate or greatly divide laborers' own traditional family farming efforts, thereby reducing their ability to be "self provisioning" and sustain their investments in the land resource base (Brookfield and Blaikie 1987, 117-119). Unfortunately, Brookfield and Blaikie argue that marginalization has not improved since post WWII independence:

> In more recent post-colonial times political and economic marginalization continued, if not deepened, although it tended to take new forms. Today, as repositories of the last remnants of surviving pre-capitalist economies, they exhibit a syndrome of environmental degradation, out-migration, demographic pressure, dependency and neglect (Brookfield and Blaikie 1987, 114).

This process, in effect, sets up a chain of events contributing to environmental degradation and ultimately population redistribution. Investigators working at the Catholic University's Center for Urban and Regional Studies (CEUR) in Santiago developed a complex flow model (Figure 7.2) of the

Figure 7.2

CEUR's Model of the Dominican Small Farmer and the Environment



linkages between the traditional Dominican hillslope farmer and the environment (Schorogmayer 1987).

Consequently, an expanded theoretical framework should also attempt to account for multi-causal linkages among and between the key relationships under consideration in this dissertation. Which variables combined with population pressure contribute to an understanding of the forest conversion process? What are the multiple causes of land degradation on the small farm level? Which social forces other than population pressure stimulate population redistribution? Finally, results indicate that factors other than population pressure contribute to the intensity of adaptation of innovative farming technology in traditional hillslope areas. These factors may include: farm size; investment capital, in the form of low interest loans or remittance income; and technology transfer in the form of agricultural extension. Methods for future statistical analysis include step-wise multiple regression or perhaps path analysis should be explored for more complete explanations of the nature of these relationships.

Recommendations for Future Study

The results of this dissertation generate a number of suggestions for future research in both the Plan Sierra region of the Dominican Republic and Third World, in general. Traditional patterns of migration are changing, the capital of Santo Domingo is no longer perceived as a viable and promising destination for the majority of rural migrants from the Plan Sierra region. Many prefer to leave the country altogether after, perhaps, only a brief stay in Santiago de los Caballeros (Georges 1990; Grassmuck and Pessar 1991). It is likely that potential migrants' perceptions of capital cities throughout Latin America and the developing world are changing for similar reasons. Primate cities, suffering from both high rates of unemployment or underemployment, inadequate housing and public services, air and water pollution, violence and crime, may no longer be perceived as offering many opportunities for potential rural migrants. Current research indicates the increasing importance of secondary cities as primary migration destinations.

The process of migration also is rapidly changing as the Dominican Republic passes to a more advanced phase of the mobility transition. Consequently, critical variables such as age, education and occupation may no longer have the strong associations found during earlier frontierward or cityward phases. The process of return migration, both to the Dominican Republic itself and specifically to the Plan Sierra region of the Cordillera Central, requires additional study to comprehend the continuous circular flow of migrants to and from the larger urban centers of the republic.

Recent evidence indicates that successful emigrants "Dominican-Yorks" are buying property and building vacation and retirement homes, as well as investing in family farms and ranches in the mountains of the Dominican Republic. The large flow of U.S. dollars directly to the Sierra may have a positive impact on both the natural physical environment and traditional hillslope agriculture in the years to come. Little research has been done in this arena with the exception of Rosario's (1987) study on the economic impact of remittance income in the area around the city of Jánico. In addition, customary patterns of land ownership and tenure appear to be changing in Plan Sierra, which require additional study (Meyer 1989).

Finally, as the trend toward increasing population density in the political sections of the Plan Sierra region continues through the 1990s, there will be even greater challenges placed on small farmers to intensify the traditional hillslope farming system in new and creative ways. For all practical purposes, there are few remaining primary forests to be converted to agriculture and these are protected by the government. Additional field work should be conducted, at five year intervals (1992 and 1997), throughout the 1990s in order to assess this evolving process, and further test the new farm measures (population pressure and deforestation-fallow ratio) introduced in this dissertation. Finally, conditions in the 1990s might place even greater constraints on rural Dominican households to modify their fertility behavior, as the next step in a sequence of responses to population pressure (Bilsborrow 1987).

APPENDIX A

APPENDIX A

Variable Directories

Political Sections File

REL1971 = Relative Population Pressure in 1971: Relative Population Pressure is defined as the Ratio of the estimated number of households, based on an average household size of 5.95 persons, to the carrying capacity, based on the amount of land in production for the census year. For example, Relative Capacity equals 32,744 Tareas in production divided by 80 Tareas, the number of Tareas needed for a subsistence farm household. In a sense, this is a Relative measure of Physiological Density because it is based on the relative measure of carrying capacity for a single year of production.

Relative Capacity = 32,744/80 = 409.3 Farms;
Estimated # of Farms = 4336/5.95 = 728.7 Farms;
Relative Population Pressure = 728.7/409.3 = 1.78
Also REL1977, REL1983, (** Did not use in analysis)

FCR1981 = Forest Conversion Rate for Years Listed: Measures the Percent Forest Cover Change over the Designated Years. Also FCR1980(FCR711980), and FCR1971 (FCR601971).

AG1971 = Agriculture Crop/Fallow Ratio for 1971: Ratio of Cropped Land to Fallow Land for the census year in question, after Boserup. Also see AG1983.

MAX1971 = Maximum Population Pressure in 1971: Maximum Population Pressure is defined as the Ratio of the number of estimated farm households, based on the constant of 5.95 persons per household, to the maximum population supporting (carrying capacity), based on the total amount of land available for production (physiological density). This is the more conventional measure of density and is appropriate for change over time measures.

NET6070 = Net Migration for the Census Year 1960: Percent Change in Population attributed to Migration between the two Census Years. Regard as measuring Out-migration and consider label change.

PR1960 = Percent Population Pressure in 1960: This represents the MAX19?? data standardized by 100. Can also be viewed as a measure of carrying capacity, where 100% equals a theoretical limit of capacity. Therefore the variable is seen to measure decreasing population supporting capacity as percent population pressure increases. Increasing population pressure signifies decreasing carrying capacity.

CH6071 = Percent Change Maximum Pop. Pressure: Percentage change in the percentage measure of maximum population pressure for the designated time interval, determined from the variable PPOPPR19?? above. This data reveals that population pressure is increasing over the time period.

FOC60 = Percent Forest Cover 1960: Percentage of Forest Covered Tareas for the designated year, based on hectare level forest measures.

CVCH6071 = Percent Forest Cover Change for Years: Percentage change in forest cover for the designated time frame. Calculated for three sets of dates.

PCROP71 = Percent Fallow Land to Cropped Land: Calculated the percentage Fallow land to Cropped land for the designated year.

PCHFCP = Percent Change in Fallow Versus Cropped
Land between Years 1971 to 1983: Calculates the percentage change in the ratio of Fallow to Cropped Land for the designated time period.

PCHRCC = Percent Change in Relative Carrying Capacity for the Years 1971 to 1983. Calculated the percentage change in measures of relative carrying capacity, based on the amount of land in production for the given years 1971 and 1983.

YPC7183 = Yearly Percent Average Change in Relative Carrying Capacity for the Years 1971 to 1983.

YPO7081 = Yearly Average Percent Out-Migration for the Designated Years: Calculates the average percent yearly change in out-migration for the designated time period.

YPI7081 = Yearly Average Percent In-Migration for the Designated Years: Calculates the average percent yearly change in in-migration for the designated time period.

CULT71 = Agricultural Frequency of Cultivation: Calculates the frequency of cultivation for the designated year. Frequency of cultivation is a standardized measure of agricultural intensity devised by Turner and Doolittle (1978), based on a measure 0 to 1 for maximum intensity.

PCH7183 = Percent Change in the Frequency of Cultivation 1971 to 1983: Calculates the percentage change in the frequency of cultivation index between the years 1971 and 1983.

FRTUSE83 = Intensity of Fertilizer Use in 1983: Percent of farms that used fertilizer in 1983.

INSUSE83 = Intensity of Insecticide Use in 1983: Percent of farms that used insecticide in 1983.

IRRUSE83 = Intensity of Irrigation Use in 1983: Percent of farms that used irrigation in 1983.

ERCUSE83 = Intensity of Erosion Control in 1983: Percent of farms that used erosion control technique in 1983.

TECH83 = Index of Total Innovative Technology in 1983: Sum total of farm usage of all forms of the intensity practices listed above, these include fertilizer use, irrigation, insecticide use, and erosion control.

SEL83 = Percent Farms that Sold Crops in 1983: Percentage of farm families that indicated crops were sold in 1983.

EAT83 = Percent Farms Who Consumed Crops 1983: Percentage of farm families that indicated crops were consumed by the household members in 1983.

PWOOD83 = Percent Farms using Wood for Cooking 1983. Percentage of farm families that indicated wood was the primary source of cooking fuel.

PCHAR = Percent Farms using Charcoal for Cooking in 1983: Percentage of farm families that indicated charcoal was primary source of cooking fuel in 1983.

PGAS83 = Percent Farms using Propane for Cooking in 1983:
Percentage of farm families that indicated propane gas was the primary source of cooking fuel in 1983.

TOTINT83 = Sum Total of Agricultural Intensity in 1983: Represents all measures of agricultural intensity added
together for each section. This includes the frequency of cultivation added with total technology to form one index.

Farm Household File

PRINFARMER = Principal farmer: Sort by ID number for section and sample area. Numbers used are 0011 (male head of household), 0022 (female head of household) etc.

TAREASOWNR = Tareas owned.

TAREASRENT = Tareas rented.

TAREASQUAT = Tareas squatted.

TOTALTAREA = Total Tareas on Farm.

PTAROWN = Percent Tareas Owned of Total Tareas.

PTARRENT = Percent Tareas Rented of Total Tareas.

PTARSQUAT = Percent Tareas Squatted of Total Tareas.

TAREASIOPE = Tareas Sloped.

PTARSLOPE = Percent tareas sloped of total Tareas

TAREASRAVI = Tareas in Ravine.

PTARRAVI = Percent tareas in Ravine.

TAREASFLAT = Tareas on flat land.

PTARFLAT = Percent tareas on flat land of total Tareas.

TAREASCLRD = Tareas of farmland cleared yearly.

PTARCLRD = Percent of tareas cleared yearly of total farm land (TOTALAREA).

CHNBAMTCLR = Change in the amount of land cleared.

METHCLRFOR = Method for clearing the forest land.

REASONCHNG = Reason for changing land use/abandoning the land.

TAREASCHAN = Tareas degraded or changed land use status.

PTARCHNG = Percent tareas changed/degraded of the total farm area.

OTHERLAND = Other Farmers with degraded land.

CAUSEDEGRD = Causes of land Degradation.

AGCONDIMPV = Agricultural condition improved.

ADULTSWHOM = Number of Adults who expressed a migration preference.

AVEURSDUA = Average years of education of adult out-migrants.

CONDFOREST = Condition of Forest.

AVEFALLOWP = Average fallow period.

CHNGFOLLOW = Change in fallow period.

PERCFOODPR = Percent of food purchased.

TYPEIRRIGA = Type of irrigation.

TYPEFERTL = Type of Fertilizer.

TAREASCROP = Tareas cropped in last year.

PTARCROP = Percent tareas cropped last year of the total farm area.

PERCFARMPR = Percent farm produce sold.

TAREASGRAZ = Tareas grazed.

PTARGRAZ = Percent tareas grazed of the total farm area for sections and sample area.

IRRIGAT = Irrigation.

LEVEL = Level the land.

TERRACE = Terrace the land.

ANCHOR = Use of trees as soil anchors.

SPECISEEDS = Use of special seeds.

ROWS = Plant in Rows.

WEEDING = Practice weeding.

INSECTPEST = Use of insecticides.

HOUSEHOLDS = Household size.

NUMALES = Number of household males.

NUMADULTS = Number of Adults.

AVEAGEHOUS = Average age of household.

AGEOLDESTD = Age oldest household member.

AGEYOUNGD = Age of youngest household member.

AVEYRSEDUC = Average years of education/household.

NUMADULTEM = Number of adult Out-migrants.

NUMADULTIM = Number of adult In-migrants.

NUMADULTRE = Number of adult Return-migrants.

NUMADULTPO = Number of adult Potential migrants.

PRODUCED = Kilograms produced on farms last year.

TAREA = Total Number of Farm Tareas, including owned, rented, and squatted.

PTOWN = Percent tareas owned of the total farm area (Tarea).

PTRENT = Percent tareas rented of the total farm area.

PTQUAT= Percent tareas squatted of the total farm area.

PTSLOPE = Percent tareas on sloped land of the total farm area.

PTRAVE = Percent tareas in ravines of the total farm area.

PTFLAT = Percent tareas of flat land of the total farm area.

PTCLRD = Percent tareas cleared (deforested) of the total farm area over the past year.

PTCHNG = Percent tareas changed (degraded) of the total farm area over the past year.

PTCROP = Percent tareas cropped of the total farm area.

PTGRAZ = Percent tareas grazed of the total farm area.

TINPROD = Tareas in production of the total farm area, including cropped and grazed lands.

PTINPROD = Percent tareas in production of the total farm area.

TFALLOW = Tareas in fallow rotation of the total farm area.

PTFALLOW = Percent tareas fallow of the total farm area.

AGCFR87= Agricultural crop/fallow ratio for 1987. Ratio of fallow to cropped land for the designated year.

PFAL87 = Percent fallow land of the total farm area 1987.

AVPRODPT = Average production per tarea of output, measured in kilocalories for both plant and animal production.

AGFREQ = Frequency of production, after Turner and Doolittle (1978).

AGINT87 = Agricultural Intensification 1987: Measure of the use of intensification technology, such as fertilizer, irrigation, erosion control, special seeds, etc.

TOTAG87 = Total Agricultural Intensification 1987: A cumulative measure of the frequency of production added with the total intensification measure noted above.

PADULTEM = Percent Adult out-migrants of the total household.

PADULTPO = Percent Adult potential out-migrants of the total household.

PADULTIM = Percent Adult in-migrants of the total household.

PADULTRE = Percent Adult re-migrants of the total household.

NETMIG87 = Net Household Migration 1987: Calculated as Percent adult in-migration plus re-migration minus adult out-migration.

OVERMIG87 = Overall Migration 1987: Calculated as percent adult in-migration plus remigration plus out-migration.

FPPR87 = Farm Level Percent Population Pressure 1987: Calculated as the farm level population pressure on the land resource. Determined from the following relationship: TAREA divided by HOUSEHOLD to determine the average farm level density or tareas per person; divided by the constant 13.333 that is derived from 80 tareas divided by the average 5.95 persons per household, taken from Dominican Census data. The ratio is then standardized as a percentage of capacity at 100%.

Potential Migrants File

RELAHEAD = indicates the relationship of individuals with the designated Head of Household.

SEX = indicates numbers of males and females.

AGE = Age of household members.

YEARSCHOOL = number of years in school.

OCUPACION = Occupation of household members.

MARITAL = Marital or Civil Status of the household member.

WHENPLANMI = When is migration planned.

TIMEAWAY = How long is planned migration.

WHYPLANGO = Reason for Planned Migration.

ROLEOFENVI = Role of the Environment in the Decision for Planned Migration--Lickert Scaling.

ANTICACTIV = Anticipated activities in the Destination.

WHEREPLANM = Where is the Planned Destination.

DESTINCLAS = Classification of the Planned Destination.

THEREBEFOR = Have you lived there before?

FAMILTHERE = Have you Family or Friends there?

WHYCHOSDE = Reason for selecting Destination.

WHERESTAY = Where do you anticipate to Stay upon arrival?

Out-migrants File

RELHEAD = relationship of individual out-migrants with the designated Head of the Household.

SEX = males and females.

AGE = Age of out-migrants at the time of departure from the household.

MARITAL = Marital Status of out-migrant at time of departure.

YEARSCHOOL = Number of years of school before departure.

OCUPACION = Occupation of out-migrants before departure.

REASONLEFT = Indicated reason for out-migration.

INFLU = Role of the environment in the decision to migrate.
Lickert Scaling.

DESTINO = Destination of the Out-migrant.

CLASSDESTI = Classification of the Destination for Out-migration.

BIRTHPLACE = Birthplace of the Out-migrant.

AGENOW = Current age of the Out-migrant.

YEARSLEFT = Years since out-migrant departure.

Non-migrant Stayers File

RELAHEAD = Relationship to the head of the household.

SEX = numbers of males and females.

AGE = Age.

YEARSCHOOL = Number of years in school.

OCUPACION = Current occupation of household member.

MARITAL = Civil Status of the household member.

REASONSTAY = Selected reason for staying in the Household or preference for non-migration.

Return Migrants File

RELAHEAD = relationship of the Return Migrant to the designated Head of the Household.

SEX = Males and Females.

AGE = Age of the Re-migrants.

YEARSCHOOL = Years of School of the Return-Migrants.

OCUPACION = Occupation of the Return Migrants.

MARITAL = Marital/Civil Status of the Return Migrants.

JOBBEFLEFT = Occupation Prior to Migration.

TIMEAWAY = Time Away from Household before Return.

LOCARETURN = Place location prior to Return Migration.

CLASSPLACE = Classification of the location prior to Return.

REASONLEFT = Reason cited for original migration from the household.

INFENVIGO = Influence of the Environment in the original decision to migrate from the household. Lickert Scaling.

AGEWHENLF = Age of the Return Migrant when first left the household.

AGEWHENRET = Age of the Return Migrant upon return to the household.

MARITALRET = Marital Status of Return Migrant upon returning to Household.

EDUWHENRET = Years of formal education upon Return to the Household.

JOBWHIAWAY = Occupation of Return Migrant while Away.

REASONRETU = Reason for Return to the Household.

INFENVRET = Influence of the environment in the Decision for Return Migration. Lickert Scaling.

REASONSTAY = Reason indicated for decision to stay in the household, rather than preference for re-migration at a future date.

In-migrants File

RELAHEAD = Relationship of the In-migrant to the designated Head of the Household.

SEX = Males and Females.

AGE = Age of the In-migrants.

YEARSCHOOL = Number of years in school for In-migrants.

OCUPACION = Occupation of the In-migrants.

MARITAL = Marital status of the In-migrants.

BIRTHPLACE = Birthplace of the In-migrants.

AGEWHENINM = Age when in-migrated to household.

SOURCEAINM = Source Area of In-migration.

SOURCECLAS = Classification of Migration Source Area.

REASONCOMI = Reason given for In-migration to Household.

ROLEOFENVI = Role of the Environment in the Decision to In-migrate to the Household. Lickert Scaling.

MARITARRIV = Marital Status of In-migrants upon arrival at the Household.

EDUBEFCAME = Years of Education before In-migration to Household.

OCUBEFCAME = Occupation of In-migrant before coming to Household.

SOURCEJOBI = Source of Information about Jobs and Economic Opportunities.

SOURCEJOBL = Source of information regarding quality of life and facilities in the area of In-migration.

REASONSTAY = Reason cited for preference to stay in the Household rather than plan for future re-migration.

List of Political Sections by Relative Population Pressure
(Grouping based on 1977 Relative PPR Data)

Low Group	Middle Group	High Group
250304 (Franco)	250501 (Cele)	250509 (Pied)
260301 (Mamo)	250506 (Guama)	250309 (Loma)
250503 (Diff)	250514 (Yerba)	250507 (Inoa)
260111 (Toma)	250301 (Cague)	250310 (Mese)
250512 (Mata)	250513 (Pedre)	250302 (Cebú)
250308 (Jagua)	250508 (Jicome)	250511 (Montes)
260303 (Caciq)	250128 (Sabana)	250504 (Rubio)
250120 (Lopez)	260109 (Palmar)	250311 (Pinali)
250505 (Eugen)	250307 (Janey)	250306 (Juncal)
250502 (Cuesta)	250305 (La Gua)	250102 (Baitoa)
250303 (Dicaya)	250510 (Las Pla)	250312 (Yaque)

APPENDIX B

APPENDIX B

Questionnaire

INTRODUCCION DEL CUESTIONARIO:

El tema de investigación trata sobre el fenómeno de la deforestación a la luz de la problemática socioeconómica para sacar conclusiones demogáficas y geográficas con la ayuda de técnicas cartográficas. En otras palabras, el autor cree que hay una interdependencia entre los procesos de deforestación y degradación del ambiente--como erosión y deterioro de la tierra--asociada con migración. Para examinar estas interdependencias es necesario entrevistar viviendas en las áreas rurales para definir los patrones migratorios (emigración, inmigración, remigración, y la migración potencial) de los miembros de sus viviendas. Las entrevistas también preterden detectar las experiencias de los campesinos con el uso de los bosques, ya que ellas ha resultado en una visible degradación ambiental que se percibe en la erosión y desgaste de los suelos de montaña.

El invesitgador principal de este estudio es Richard A. Sambrook, un geográfo de la Universidad del Estado de Michigan, en los Estados Unidos. Sr. Sambrook es un profesor visitante con beca del programa Fulbright. Durante su visita a la República Dominicana, el Profesor Sambrook está enseñando un curso de cartografía temática en la Universidad Católica Madre y Maestra de Santiago (U.C.M.M.) como miembro del Departamento de Historia y Geografía. Este estudio tiene el respaldo de la U.C.M.M. y de la Universidad del Estado de Michigan. La obtención de conclusiones académicas en este estudio son el motivo de la investigación y no hay ninguna relación con proyectos gubernamentales. Los nombres o apellidos de las personas que serán entrevistadas en este estudio no serán revelados. De todas maneras, tampoco es necesario dar su apellido para participar en este estudio. Copias del reporte final serán presentadas al Centro de Estudios Urbanos y Regionales (C.E.U.R.) que actualmente esté iniciándase en la U.C.M.M. También, copias del reporte final serán depositadas en la Sección Dominicana de la Biblioteca de la U.C.M.M.

Attentamente,

R A Sambrook

Profesor R. A. Sambrook

SUB-MODULO A

AGRICULTURA

Instrucciones: Pregunte al jefe del hogar o a otro miembro de la familia que toma las decisiones agropecuarias. Ponga la información en la hoja de respuestas, Sub-módulo A. A suguirese que la persona tenga una descripción de su relación con el jefe del hogar, pero su nombre no debe aparecer en el cuestionario porque éste es anónimo.

1a) ¿Usted o algún miembro de su familia posee u ocupa alguna tierra para cultivar cosechas o para ganadería?

(Sí--1, No--2; si es sí, ponga la relación con el jefe en la Lista A, Parte 1a. Entonces, vaya a la Pregunta 2.)

1b) En los últimos cinco DIEZ años, ¿usted o algún miembro de su familia poseía u ocupaba alguna tierra para cultivar cosechas o para ganadería?

(Sí--1, No--2; si es no, termine esta entrevista. Si es sí, ponga la relación con el jefe en la Lista A, Parte 1b. También, las preguntas siguientes deben ser en el pasado.)

2) ¿Qué cantidad de tierra es suya y/o arrendada y/o ocupada en este lugar? (en tareas)

SUYA:
a) Cultivada por usted _____
b) Rentada a otro _____
c) Se la da a alguien y reparte la cosecha _____
d) Hipotecada en su posesión _____
e) En sucessión _____
f) Otro (especifique) _____

ARRENDADA:
a) Rentada para pagarla en plazos _____
b) Para tomar la cosecha _____
c) Suya y de otros _____
d) Hipotecada en posesión con otro _____
e) A media _____
f) A un quarto _____
g) Otro (especifique) _____

OCUPADA (si no es SUYA o ARRENDADA):
a) Cuánta tierra _____

A-2

3) ¿Cómo clasifica usted generalmente la tierra que usted trabaja?

	# Parcelas	Cantidad en Tareas
1 Cuesta/loma	______	______
2 Hoyo	______	______
3 Llanos	______	______
4 Otros	______	______

4) ¿Qué cantidad de tierra forestada ha usted limpiado generalmente cada año para la siguiente actividad? (en tareas)

1 Agricultura ______ 3 Leña ______
2 Crianza ______ 4 Otros ______

5) En promedio, ¿ha cambiado usted la cantidad de tierra que usted ha limpiado cada año desde 1977?

Aumentado sustancialmente	1
Aumentado pequeñamente	2
No cambió	3
Disminuido pequeñamente	4
Disminuido sustancialmente	5
No aplicable	6

6) Cuando usted limpió los bosques para la agricultura, ¿qué métodos utilizó para preparar la tierra?

Tumba y quema	1
Tractor	2
Arrado de bueyes	3
Desyerbar con (chapeo Y ARADO)	4
Otro (especifique) ______	5
NO APLICABLE	9

7a) ¿Ha usted abandonado o cambiado el uso de su tierra?

(Sí--1, No--2; en caso de sí, pregunte Preguntas 7b y 7c. En caso de no, pase a la Pregunta 8.)
NO APLICABLE 09

7b) ¿Por qué la ha abandonado o cambiado?

Por suelos pobres (OVERWORKED SOILS)	1	CHANGE OF TENURE 07
No sirven ya para nada	2	SOCIAL PROBLEMS 08
La ha cambiado de cultivo a crianza	3	
Erosión	4	
Por se abierto la tierra	5	
Otro (especifique) ______	6	
NO APLICABLE	9	

7c) ¿Qué cantidad de tierra ha tenido que abandonar o cambiar por esa razón? (en tareas) NO SE = 9999

8) ¿Usted cree que otros campesinos han perdido tierra de forma similar? (Sí--1, No--2, No sé--9) POR SUELOS POBRES, POR SE ABIERTO LA TIERRA. O PORQUE LA HA CAMBIADO DE CULTIVO A CRIANZA?

9) ¿Cuál cree usted que es la causa principal de la pérdida de tierra productiva o de la degradación del ambiente?

Sequia (mala temperatura)	1
Se han trabajado mucho	2
Tumba de árboles	3
Erosión, tierra degradada	4
Otro (especifique) ______	5

NO CONSERVATION / MAINTAINING LD

10) En términos generales, ¿las condiciones para sembrar o cosechar en este lugar se han mejorado o deteriorado desde 1977?

Se han mejorado mucho	1
Se han mejorado un poco	2
No cambió	3
Se han deteriorado un poco	4
Se han deteriorado mucho	5

11) En general, ¿las condiciones de los bosques en este lugar se han mejorado o deteriorado desde 1977?

Se han mejorado mucho	1
Se han mejorado un poco	2
No cambió	3
Se han deteriorado un poco	4
Se han deteriorado mucho	5

12) ¿Cuál es el <u>promedio</u> del período de descanso en sus campos?

Menos de un año (barbecho)	1
Menos de 2 años	2
2 - 4 años	3
5 - 7 años	4
8 - 12 años	5

(Diga el <u>promedio</u> de descanso para todos los campos juntos.)

13) Para sus cultivos, ¿cómo ha cambiado el período de descanso desde 1977?

Aumentado sustancialmente	1
Aumentado pequeñamente	2
No cambió	3
Disminuido pequeñamente	4
Disminuido sustancialmente	5
No aplicable	6

14) ¿Qué porcentaje de la comida que consume su familia tiene que comprarse?

0 - 10%	01	51 - 60%	06
11 - 20%	02	61 - 70%	07
21 - 30%	03	71 - 80%	08
31 - 40%	04	81 - 90%	09
41 - 50%	05	91 - 100%	10

15a) ¿Usted a mojado su tierra con agua irrigada en los últimos 10 años?

(Sí--1, No--2; si es <u>sí</u>, haga Pregunta 15b. Si es <u>no</u>, pase a la Pregunta 16a.)

15b) ¿Qué técnico ha utilizado?

Acueducto	1	LAGUNA 6
Canal	2	
Tubería/bomba	3	
Otro (especifique) _____	4	
REGADERA	5	

16a) ¿Ha usted aplicado algún fertilizante durante los últimos 12 meses?

(Sí--1, No--2; en caso de <u>no</u>, pase a la Pregunta 17.)

16b) ¿Qué tipo de fertilizante ha usado usted?

Fertilizante químico	1
Excremento social	2
Otro (especifique) _____	3

(Las Preguntas 17 - 20 están detrás de la hoja de respuestas, Sub-módulo A.)

Sub-módulo A--Pregunta 17

17) Por favor, detalle usted la producción y venta de su cosecha en los últimos 12 meses.

Cultivo	# Veces Cosecha	Area Cultivada (Tareas)	Cantidad Producción (Pesa)	% Cantidad Vendido	% Cantidad Auto-consumido	% Perdida	% Otro
Plátano							
Maiz							
Arroz							
Cebolla							
Papa							
Sorgo							
Algodon							
Habichuelas							
Yuca							
Maní							
Coco							
Cacao							
Café							
Tabaco							
Caña de azucar							
Forraje/yerba							
Legumbres							
Vegetales							
Frutas							
Batata							
Auyama							
Mixta							
Otro (especifique)							

Sub-módulo A--Pregunta 17

(referencia)

TABLE 6
AGRICULTURAL CALENDAR OF FARM CROPS

	Red Beans P	Red Beans H	Tobacco P	Tobacco H	Cassava P	Cassava H	Corn P	Corn H	Sweet Potatoes P	Sweet Potatoes H	Bananas P	Bananas H	Peanuts P	Peanuts H	Upland Rice P	Upland Rice H
January	X_1		X_s	X	X_1		X_1	X_2	X_1	X_1					X	
February				X	X_1		X_1	X_2		X_1					X	
March		X_1		X	X_1		X_1			X_1			X			
April	X_2	X_1		X					X_2	X_1			X			
May	X_2			X	X_2			X_1	X_2	X_1			X			X
June		X_2		X	X_2	one to two years later		X_1		X_1	X	one to two years later		X		X
July		X_2		X				X_1		X_1				X		X
August	X_3	X_2		X	X_3		X_2	X_1			X			X		X
September	X_3		X_s		X_3		X_2		X_1	X_2						
October		X_3			X_3				X_1	X_2	X					
November		X_3	X_t						X_1	X_2						
December	X_1		X_t					X_2	X_1	X_2					X	

P = Planting period
H = Harvest period
X_s = Seedbed planting

X_1 = First cropping (primo)
X_2 = Second cropping
X_3 = Third cropping
X_t = Transplant to farm

Sub-módulo A--Pregunta 18

18) ¿Usted o algún miembro de su familia tiene o ha tenido producción animales/ganadera en los últimos 12 meses?

SI 1 NO 2

¿Me puede dar algunos detalles?

Ganadería	Cantidad de Terreno que Usa para la Ganadería (TAREAS)	Producción Durante los Ultimos 12 Meses (No. de Cabezas)		Vendido en los Ultimos 12 Meses (No. de Cabezas)	Consumido por la Familia en los Ultimos 12 Meses (No. de Cabezas)
		Principio	Fin		
Toro					
Guineas					
Gallinas					
Patos					
Puercos					
Chivos					
Mulo					
Burro					
Palomas/tortalas					
Conejo					
Caballo					
Vaca					
Otro (especifique)					

Sub-módulo A--Pregunta 19

19) MEJORAMIENTO DE LA TIERRA

Tipo de Mejoramiento	¿Ha hecho usted algún mejoramiento en los últimos 12 meses? (Sí--1, No--2)	Si ha hecho mejoramiento en los últimos 12 meses, ¿cuál fue el area cubierta por esos mejoramientos? (en tareas)	Si no ha hecho ningún mejoramiento en los últimos 12 meses, ¿cuándo hizo el último?
Construcción de conductos de agua para irrigación			
Cercas/troncado			
Nivelar la tierra			
Construcción de terrazas			
Plantación de arboles para reducir la erosión (barreras vivas)			
Arrado de bueyes			
Otros (especifique)			

Sub-módulo A--Pregunta 20

20a) USO DE MEJORES PRACTICAS AGRICOLAS.

Cosecha que Producir	Durante los últimos 12 meses			
	¿Trata usted las semillas con productos químicos antes de usarlas? Sí 1 No 2 No aplicable 3	¿Planta usted en fila? Sí 1 No 2 No aplicable 3	¿Cuántas veces des-yerba usted durante la temporada? Ninguna 0 Una 1 Dos 2 Varias veces 3 No aplicable 4	¿Usa usted insecticidas y pesticidas? Sí 1 No 2 No aplicable 3
Plátano				
Maiz				
Arroz				
Cebolla				
Papa				
Sorgo				
Algodon				
Habichuelas				
Yuca				
Mani				
Coco				
Cacao				
Café				
Tabaco				
Caña de azucar				
Forraje/yerba				
Legumbres				
Vegetales				
Frutas				
B Patata				
Auyama				
Mixta				
Otro (especifique)				

20b) ¿Ha usado usted algunas de estas técnicas antes de este año? SI 1 NO 2

SUB-MODULO B

CARACTERISTIC. GENERALES DE LA FAMILIA--MIEMBROS QUE USUALMENTE VIVEN JUNTOS Y COMEN JUNTOS.

Instrucciones: Pregunte al jefe del hogar o a una persona apropriada si el jefe no puede contestar. Ponga la información de cada persona en la hoja de respuestas, Sub-módulo B. Empiece con el jefe del hogar.

MIEMBROS DE LA CASA (SUS RELACIONES CON EL JEFE DEL HOGAR)

1a) Por favor, deme una lista de las relaciones (con el jefe del hogar) de todas las personas que viven usualmente en esta casa, (EN ESTE MOMENTO)

(Ponga las relaciones con el jefe en la Lista B.)

1b) ¿Ha usted olvidado alguna persona de su familia, persona adulta vieja o niño que está viviendo permanentemente con usted (AHORA MISMO) en esta casa?

(Si es sí, ponga la relación con el jefe en la Lista B.)

1c) ¿Ha olvidado usted alguna persona que no es miembro de su familia, como es una doméstica, amigo o conocido, un habitante que está viviendo permanentemente con usted en esta casa?

(Si es sí, ponga la relación con el jefe en la Lista B.)

1d) En adición, ¿con usted ha vivido alguna persona que ha estado de paso temporalmente, de vacaciones o familiares de visita, que haya, por lo menos, pasado tres meses antes de irse?

(Si es sí, ponga la relación con el jefe en la Lista B.)

NOTA: Repite lo siguiente para cada miembro en la Lista B.

SEXO

2) ¿Es esta persona masculina o femenina? (Masculina--1, Femenina--2)

EDAD

3a) ¿Cuál es su edad?

3b) ¿En qué mes y año nació usted/él/ella? (Mes _____, Año _____)

B-2

EDUCACION

4a) ¿Cuál es el último curso de escuela que usted/él/ella completó?

Ninguno	1
Primaria	2
Técnico sin bachillerato	3
Secundaria	4
Técnico con bachillerato	5
Universidad	6
Otros	7
No sé	9
NO APLICABLE. IE HANDICAPPED	99

4b) ¿Cuál es el número de años de escuela que usted/él/ella ha completó?

4c) ¿Cuál es su ocupación?

	Professional, técnico	00	
	Administrador, capataz, servicio público	01	
	Oficinista, profesor, PRIEST	02	
	Vendedor, comerciante, almacenista	03	
	Agricultor, ranchero	04	
	Chofer	05	
COLINDERO	Artesano, mecánico, sastre, carpintero, obrero	06	PINTOR
	Jornalero, ayudante, BRACERO	07	
	Inhábil, chiripero	08	
	Sirviente de casa, ama de casa, estudiante	09	
	No hace nada	10	
	Otro (especifique) _____	11	

STATUS MATRIMONIAL

5) ¿Cuál es su estado marital en este momento?

Nunca se ha casado	1
Casado	2
Unión libre	3
Viudo	4
Divorciado	5
Separado	6
Otro (especifique) _____	7

LUGAR DE NACIMIENTO

6a) ¿Ha nacido usted/él/ella en este lugar? (Sí--1, No--2)

6b) Si no ha nacido aquí, ¿cuándo llegó a este sitio, pueblo, o lugar? (Año _____, Mes _____)

ANEXO

PARENTESCO (CODIGOS)

				RELACION DE OTRAS PERSONAS EN LA FAMILIA			
			CABEZA (1)	ESPOSO(A) (2)	HIJO(A) (3)	HERMANO(A) (4)	PADRE/MADRE (5)
PARENTESCO CON EL CABEZA DE FAMILIA		CABEZA	01	-	-	-	-
		ESPOSO(A)	02	-	-	72	82
	HIJOS/HIJAS	1ro	11	21	31	-	-
		2do	12	22	32	-	-
		3ro	13	23	33	-	-
		4to	14	24	34	-	-
		5to	15	25	35	-	-
		6to	16	26	36	-	-
		7mo	17	27	37	-	-
		8vo	18	28	38	-	-
		9no	19	29	39	-	-
	HERMANO(A)	1ro	41	51	61	-	-
		2do	42	52	62	-	-
		3ro	43	53	63	-	-
		4to	44	54	64	-	-
		5to	45	55	65	-	-
		6to	46	56	66	-	-
		7mo	47	57	67	-	-
		PADRE/MADRE	81	83	-	84	85
		OTRAS RELACIONES	91	-	-	-	-
		PERSONAS IRRELACIONADAS	92	-	-	-	-
		SIRVIENTE	93	-	-	-	-

SUB-MODULO C

IDENTIFICACION DE EMIGRANTES

Instrucciones: Pregunte al jefe del hogar sobre cada emigrante y ponga las respuestas en la hoja de respuestas, Sub-módulo C. Pregunte a una persona apropriada si el jefe no puede contestar. Un emigrante es un miembro regular de la residencia que se ha ido por más de tres meses o intentó irse por más de tres meses. Si no hay emigrantes, vaya al próximo sub-módulo.

1a) ¿Hay alguna persona que vivía en esta casa que se ha ido en los últimos ~~cinco~~ DIEZ años a vivir a otro paraje, pueblo o ciudad?

(si es no, vaya al próximo sub-módulo.)

1b) ¿Cuál es o cuáles son sus relaciones con el jefe de la familia?

(Ponga una descripción de la relación con el jefe de cada emigrante en la Lista C.)

NOTA: Repita lo siguiente para cada emigrante en la Lista C.

2) ¿Es esta persona masculina o femenina? (Masculina--1, Femenina--2)

3) ¿Cuál era su edad cuando él/ella partió de este lugar? (Años Completos)

4) ¿Cuánto tiempo hace que él/ella partió de este sitio? (Meses ______, Años ______)

5) ¿Cuál era su estado civil en el momento de él/ella partir de este lugar?

Nunca se había casado	1
Casado	2
Unión libre	3
Viudo	4
Divorciado	5
Separado	6
Otro (especifique) ______	7
No sé	9

(Sigue)

6a) ¿Hasta qué curso llegó él/ella a completar al tiempo que partió de este lugar?

Ninguno	1
Primaria	2
Técnico sin bachillerato	3
Secundaria	4
Técnico con bacillerato	5
Universidad	6
Otros	7
No sé	9

6b) ¿Cuál es el número de años de escuela que él/ella ha completado?

6c) ¿Cuál era su ocupación antes de salir?

Professional, técnico	00
Administrador, capataz, servicio público	01
Oficinista, profesor	02
Vendedor, comerciante, almacenista	03
Agricultor, ranchero	04
Chofer	05
Artesano, mecánico, sastre, carpintero, obrero	06
Jornalero, ayudante	07
Inhábil, chiripero	08
Sirviente de casa, ama de casa, estudiante	09
No hace nada	10
Otro (especifique) _____	11

7a) ¿Cuál es la verdadera razón para que él/ella partiera de este lugar?

Cambio de trabajo	01
No trabajo	02
El trabajo era insuficiente para el soporte familiar	03
Insatisfacción natural del trabajo	04
Compra de tierra	05
Encontrar un mejor trabajo	06
Oferta de mejor trabajo	07
Para conseguir educación para él/ella	08
Para conseguir educación para sus hijos	09
Para casarse	10
Para acompañar a la familia	11
Para juntar la familia	12
Por problemas sociales o familiares	13
Falta de amabilidad	14
Tierra degradada	15
Suelos pobres	16
Otros (especifique) _____	17
No sé	99
EXTENDED VACATION	18
INHERITED PROPERTY THERE	19

7b) En una escala de 1 a 5, ¿qué papel jugaba la degradación del ambiente (como daño del suelo o suelos pobres) en la decisión ra partir de este lugar?

Ninguna importancia	1
Poca importancia	2
Más o menos importancia	3
Alguna importancia	4
Mucha importancia	5

8a) Cuando él/ella se fueron de aquí, ¿dónde se quedaron a vivir por 3 meses o más? (Nombre o Descripción del Lugar)

8b) ¿Qué tipo de lugar era ese?

Metrópoli/capital	1
Ciudad	2
Pueblo	3
Finca/campo	4
Villa/plantación	5
Otro (especifique) _____	6
OUT OF COUNTRY	7

9) ¿Cuántos años tiene él/ella ahora? (Edad en Años Completos)

10) ¿Dónde nació él/ella? (Nombre o Descripción del Lugar)

SUB-MODULO D

INMIGRANTES

Instrucciones: Un inmigrante DIEZ es un miembro de la residencia que ha llegado en los últimos ~~cinco~~ años y ha vivido en la residencia por más de tres meses. Pregunte a cada inmigrante de 0 - 5 años y ponga la información en la hoja de las respuestas, Sub-módulo D. Si no está en casa, pregunte a una persona apropriada. Si no hay inmigrantes, vaya al próximo sub-módulo.

NOTA: Pregunte la Cuestión 1 al jefe del hogar o a una persona apropriada.

1) ¿Hay algunas personas en casa que ha llegado en los últimos ~~cinco~~ DIEZ años y ha vivido en la residencia por más de tres meses?

(Si es no, vaya al próximo sub-módulo.)

NOTA: Pregunte lo siguiente a cada inmigrante.

2) ¿Cuál es su relación con el jefe del hogar?

(Ponga una descripción en la Lista D.)

3) ¿Dónde nació usted? (Nombre o Descripción del Lugar)

4) ¿Qué tiempo hace que se mudó a este lugar? (Meses ___, Años ___)

5) ¿Cuál era su edad cuando usted se mudó a este lugar? (Edad en Años Completos)

NOTA: Si esta persona tenía menos de doce años, termine este sub-módulo para esta persona.

6a) ¿Dónde vivía usted antes de mudarse a este lugar? (Nombre o Descripción del Lugar)

6b) ¿Cuál era el tipo de sitio de su residencia al tiempo que la dejó?

Metrópoli/capital	1
Ciudad	2
Pueblo	3
Finca/campo	4
Villa/plantación	5
Otro (especifique) _____	6
OUT OF COUNTRY _____	7

7a) ¿Cuál es la verdadera razón para que usted prefieriera mudarse a este sitio?

Cambio del trabajo	01
No trabajo	02
El trabajo era insuficiente para el soporte familiar	03
Insatisfacción natural del trabajo	04
Compra de la tierra	05
Encontrar mejor trabajo	06
Oferta de mejor trabajo	07
Para conseguir mejor educación para usted	08
Para conseguir mejor educación para sus hijos	09
Para casarse	10
Para acompañar a la familia	11
Para juntar la familia	12
Por problemas sociales y familiares - IE DEATH	13
Falta de amabilidad	14
Tierra degradada	15
Suelos pobres	16
Otro (especifique) _____	17
No sé	99
TOO DIFFICULT TO LIVE THERE	18

7b) En una escala de 1 a 5, ¿qué papel jugaba la degradación del ambiente (como daño del suelo o suelos pobres) en la decisić para partir de ese lugar?

Ninguna importancia	1
Poca importancia	2
Más o menos importancia	3
Alguna importancia	4
Mucha importancia	5

7c) ¿Quién tomó la decisión de mudarse a este lugar?

Yo mismo	1
Esposa/esposo	2
Niños	3
Padres	4
Otros relativos	5
Empleados	6
Otro (especifique) _____	7

(Sigue.)

8) Al tiempo de usted salir, ¿cuál era su estado civil?

Nunca se había casado	1
Casado	2
Unión libre	3
Viudo	4
Divorciado	5
Separado	6
Otro (especifique) _____	7

9a) ¿Cuál fue su último curso de escuela completado?

Ninguno	1
Primaria	2
Técnico sin bachillerato	3
Secundaria	4
Técnico con bachillerato	5
Universidad	6
Otros	7
No sé	9

9b) ¿Cuántos años completó usted en la escuela?

9c) ¿C..ál era su ocupación al momento de usted irse?

Profesional, técnico	00
Administrador, capataz, servicio público	01
Oficinista, profesor	02
Vendedor, comerciante, almacenista	03
Agricultor, ranchero	04
Chofer	05
Artesano, mecánico, sastre, carpintero, obrero	06
Jornalero, ayudante	07
Inhábil, chiripero	08
Sirviente de casa, ama de casa, estudiante	09
No hace nada	10
Otro (especifique) _____	11

10a) Antes de usted vivir aquí, ¿tenía usted alguna información de trabajo y oportunidad en este lugar?

(Sí--1, No--2; si es no, vaya a la Pregunta 10c.)

10b) ¿Cómo consiguió usted esa información?

Conocidos, FAMILY	1
Amigos	2
Periódico, radio, televisor	3
Visitó antes el lugar	4
Otro (especifique) _____	5
NO APLICA	9

10c) Antes de vivir aquí, ¿tenía usted información acerca de las condiciones de vida y facilidades que hay en este lugar?

(Sí--1, No--2; si es no, no pregunte la Cuestion 10d.)

10d) ¿Cómo consiguió usted esa información?

Conocidos , FAMILY	1
Amigos	2
Periódico, radio, televisor	3
Visitó antes el lugar	4
Otro (especifique) _____	5
NO APLICA	6

SUB-MODULO E

RE-MIGRANTES

Instrucciones: Pregunte al jefe del hogar si hay re-migrantes-- o sea, personas que vivían en casa, salieron por más de tres meses y regresaron a casa en los últimos ~~cinco~~ DIEZ años. Pregunte directamente a cada re-migrante y ponga las respuestas en la hoja de respuestas, Sub-módulo E. Si un re-migrante no está en casa, pregunte al jefe o a una persona apropriada. Si no hay re-migrantes, vaya al próximo sub-módulo.

NOTA: Pregunte la Cuestión 1a al jefe del hogar o a una persona apropriada.

1a) ¿Hay personas que vivían en casa, salieron por más de tres meses, y regresaron a casa en los últimos ~~cinco~~ DIEZ años?

(Si es no, vaya al próximo sub-módulo.)

NOTA: Pregunte lo siguiente a cada re-migrante.

1b) Desde que usted comenzó a vivir en esta comunidad, ¿había usted vivido en otro lugar, ciudad, pueblo, municipio, o paraje por tres meses o más?

(Si es no, termine este sub-módulo para esta persona.)

1c) ¿Cuál es su relación con el jefe del hogar?

(Ponga una descripción en la Lista E.)

2) ¿Cuál era su principal actividad cuando usted estaba en este sitio antes?

Profesional, técnico	00
Administrador, capataz, servicio público	01
Oficinista, profesor	02
Vendedor, comerciante, almacenista	03
Agricultor, ranchero	04
Chofer	05
Artesano, mecánico, sastre, carpintero, obrero	06
Jornalero, ayudante	07
Inhábil, chiripero	08
Sirviente de casa, ama de casa, estudiante	09
No hace nada	10
Otro (especifique) _____	11

E-2

NOTA: Los siguientes refieren a la última vez que vivía fuera.

3) ¿Cuánto tiempo hace que regresó por la última vez a este lugar? (Meses _____, Años _____)

NOTA: Si más de cinco años, termine este sub-módulo para esta persona.

4) Antes de regresar, ¿cuánto tiempo tenía usted fuera de su presente sitio de residencia? (Meses _____, Años _____)

5a) ¿Cuál era el sitio que usted usualmente residía cuando estaba fuera? (Nombre o Descripción del Lugar)

5b) Cuando usted vivía fuera de aquí, ¿qué tipo de lugar era ese sitio?

Metrópoli/capital	1
Ciudad	2
Pueblo	3
Finca/campo	4
Villa/plant..ión	5
Otro (especifique) _____	6

6a) ¿Cuál era la razón más importante para dejar este sitio?

Cambio de trabajo	01
No trabajo	02
El trabajo era insuficiente para el soporte familiar	03
Insatisfacción natural del trabajo	04
Compra de tierra	05
Encontrar un mejor trabajo	06
Oferta de mejor trabajo	07
Para conseguir educación para usted	08
Para conseguir educación para sus hijos	09
Para casarse	10
Para acompañar a la familia	11
Para juntar la familia	12
Por problemas sociales y familiares	13
Falta de ambilidad	14
Tierra degradada	15
Suelos pobres	16
Otros (especifique) _____	17
No sé	99
ILLNESS. INFIRMITY	18

6b) En una escala de 1-5, ¿qué papel jugaba la degradación del ambiente (como daño del suelo o suelos pobres) en la decisión para partir de este lug?

Ninguna importancia	1
Poca importancia	2
Más o menos importancia	3
Alguna importancia	4
Mucha importancia	5

7a) Cuando dejó usted este sitio, ¿cuál era su edad? (Años Completos)

7b) Cuando llegó usted este sitio otra vez, ¿cuál era su edad? (Años Completos)

8) ¿Cuál era su estado marital cuando llegó aquí la última vez?

Nunca se ha casado	1
Casado	2
Unión libre	3
Viudo	4
Divorciado	5
Separado	6
Otro (especifique) _____	7

9a) ¿Hasta qué curso llegó usted?

Ninguno	1
Primaria	2
Técnico sin bachillerato	3
Secundaria	4
Técnico con bachillerato	5
Universidad	6
Otros	7

9b) ¿Cuántos años completó usted en la escuela?

10) ¿Cuál era su principal actividad cuando usted estaba en otro sitio?

Profesional, técnico	00
Administrador, capataz, servicio público	01
Oficinista, profesor	02
Vendedor, comerciante, almacenista	03
Agricultor, ranchero	04
Chofer	05
Artesano, mecánico, sastre, carpintero, obrero	06
Jornalero, ayudante	07
Inhábil, chiripero	08
Sirviente de casa, ama de casa, estudiante	09
No hace nada	10
Otro (especifique) _____	11

E-4

11a) ¿Cuál es la razón más importante para usted volver a este lugar?

Bajos salario	01
No pudo encontrar trabajo	02
Fin del trabajo	03
Tenía que ahorrar lo que prometí ahorrar	04
Heredó alguna tierra o propiedad	05
Consiguió trabajo aquí	06
Temor a perder su tierra aquí	07
La familia compró más tierras/negocios aquí	08
No le gustaba el trabajo	09
Retirado	10
Enfermedad, accidente	11
Trabajo transferido	12
No le gustaba el sitio	13
Prometió quedarse un tiempo limitado	14
Otro (especifique) _____	15
No sé	99
REST. RELAVATION	16

11b) En una escala de 1 a 5, ¿qué papel jugaba la degradación del ambiente (como daño del suelo o suelos pobres) en la decisión para partir de ese otro sitio?

Ninguna importancia	1
Poca importancia	2
Más o menos importancia	3
Alguna importancia	4
Mucha importancia	5

SUB-MODULO F

MIGRANTES POTENCIALES

Instrucciones: Pregunte directamente a cada persona en la casa. Si no está en casa, pregúnte al jefe del hogar. Ponga las respuestas en la hoja de respuestas, Sub-módulo F.

1a) ¿Cuál es su relación con el jefe del hogar?

(Ponga una descripción en la Lista F.)

1b) ¿Está usted intentando mudarse a vivir o trabajar fuera de esta villa, pueblo, o ciudad?

(Sí--1, No--2; si es sí, vaya a la Pregunta 2a. Si es no, pase a la Pregunta 1c.)

1c) ¿Cuál es la razón para no mudarse?

Tiene un trabajo satisfactorio	01
Lazos familiares	02
Falta de educación	03
No sabe si ahí hay mayor trabajo	04
Tiene tierra aquí	05
Demasiado viejo	06
Familia larga	07
Tiene suficiente dinero	08
Está estudiando	09
Incapacidad física	10
La tierra es buena	11
Falta de dinero	12
Otro (especifique) _____	13
No sé OR <12 YEARS	99

(NOTA: Después de esta Pregunta, termine este sub-módulo para esta persona.)

2a) ¿Cuándo usted piensa salir?

Dentro de 3 meses	1
De 3 a 6 meses	2
De 6 meses a 1 año	3
De 1 año a 2 año	4
En 2 años o más	5
No sé, no estoy seguro	9

2b) ¿Por qué tiempo le gustaría a usted estar fuera?

Menos de 3 meses	
De 3 a 6 meses	2
De 6 meses a 1 año	3
De 1 año a 2 años	4
De 2 a 3 años	5
De 3 a 5 años	6
5 años o más	7
No sé, no estoy seguro	9

3a) ¿Por qué usted intenta salir de este lugar?

Cambio del trabajo	01
No trabajo	02
El trabajo era insuficiente para el soporte familiar	03
Insatisfacción natural del trabajo	04
Compra de la tierra	05
Encontrar mejor trabajo	06
Oferta de mejor trabajo	07
Para conseguir mejor educación para usted	08
Para conseguir mejor educación para sus hijos	09
Para casarse	10
Para acompañar a la familia	11
Para juntar la familia	12
Por problemas sociales y familiares	13
Falta de amabilidad	14
Tierra degradada	15
Suelos pobres	16
Otros (especifique) _____	17
No sé	99
DO LAUD HERE	11

3b) En una escala de 1 a 5, ¿qué papel juega la degradación del ambiente (como daño del suelo o suelos pobres) en la decisión para partir de este lugar?

Ninguna importancia	1
Poca importancia	2
Más o menos importancia	3
Alguna importancia	4
Mucha importancia	5

(Sigue.)

4) ¿Qué usted espera que será su principal actividad tan pronto se mude?

Visita social	01
Estudiar	02
Entrenamiento	03
Agricultura	04
Abrir un negocio	05
Empleado	06
Retirado	07
Ama de casa	08
Otro (especifique) _____	09
No sé	99

5a) ¿Ha decidido usted hacia dónde intenta emigrar?

(Sí--1, No--2; si es no, termine este sub-módulo para esta persona.)

5b) ¿Cuál es el nombre de ese lugar o dónde está ese lugar? (Nombre o Descripción del Lugar)

5c) ¿Qué tipo de lugar es ese?

Metrópoli/capital	1
Ciudad	2
Pueblo	3
Finca/campo	4
Villa/plantación	5
Otro (especifique) _____	6

5d) ¿Ha vivido usted en ese lugar antes? (Sí--1, No--2)

5e) ¿Tiene usted amigos o conocidos en ese lugar? (Sí--1, No--2)

5f) ¿Cuál es la mejor razón para escoger ese lugar?

Cambio del trabajo	01
Mejores trabajos y oportunidades	02
Tiene tierra u otras propiedades ahí	03
Fácil para aumentar los negocios	04
Más facilidades de educación y salud	05
El costo de la vida es mejor ahí	06
Queda cerca de la familia	07
Tiene amigos o conocidos allá	08
Mejor ambientación física allá	09
Tierra no degradada	10
Otro (especifique) _____	11
No sé	99

6) ¿Dónde usted espera quedarse cuando llegue allá?

Con amigos o conocidos	1
Con familiares	2
Rentar una casa o apartamento	3
Hacer un bóhio	4
El trabajo le proviene acomodación	5
Otro (especifique) ______	6
No sé	9
MADE A HOUSE THERE	7

MUCHISIMAS GRACIAS

Número __ Fecha _____ Entrevistador ____________ Sección _______ Paraje _______

Hoja de Respuestas: Sub-módulo A--Agricultura

Lista A	2			3		4
Granjero Principal	Suya (Tareas)	Arrendada (Tareas)	Ocupaba (Tareas)	Clasificación Tierra		Limpiado Generalmente (Tareas)
Relación al Jefe del Hogar				Número Parcelas	Cantidad (Tareas)	
	A	A	A	1	1	1
1a	B	B				
	C	C		2	2	2
	D	D				
1b	E	E		3	3	3
	F	F				
	especif.	G		4	4	4
		especif.				

5	6	7			8	9
Promedio Limpiado Cambiado Desde 1977 (Código)	Métodos Limpiar (Código)	A Tierra Cambiado/ Abandonado (Código)	B Razón Cambiar (Código)	C Cantidad Cambiar (Tareas)	Perdido Otros Campesinos (Código)	Causa Degradación (Código)
	especif.		especif.			especif.

10	11	12	13	14	15	16
Condición Agricult. Desde 1977 (Código)	Condición Foresta Desde 1977 (Código)	Promedio Descanso (Código)	Cambiado Descanso Desde 1977 (Código)	% Compra Consumida (Código)	Irrigada	Fertilizante
					A (Código)	A (Código)
					B (Código)	B (Código)
					especif.	especif.

Sub-módulo A--Pregunta 17

17) Por favor, detalle usted la producción y venta de su cosecha en los últimos 12 meses.

Cultivo	# Veces Cosecha	Area Cultivada (Tareas)	Cantidad Producción (Pesa)	% Cantidad Vendido	% Cantidad Auto-consumido	% Perdida	% Otro
Plátano							
Maiz							
Arroz							
Cebolla							
Papa							
Sorgo							
Algodon							
Habichuelas							
Yuca							
Mani							
Coco							
Cacao							
Café							
Tabaco							
Caña de azucar							
Forraje/yerba							
Legumbres							
Vegetales							
Frutas							
Batata							
Auyama							
Mixta							
Otro (especifique)							

Sub-módulo A--Pregunta 18

18) ¿Usted o algún miembro de su familia tiene o ha tenido producción animales/ganadera en los últimos 12 meses?

SI 1 NO 2

¿Me puede dar algunos detalles?

Ganadería	Cantidad de Terreno que Usa para la Ganadería (Tareas)	Producción Durante los Ultimos 12 Meses (No. de Cabezas)		Vendido en los Ultimos 12 Meses (No. de Cabezas)	Consumido por la Familia en los Ultimos 12 Meses (No. de Cabezas)
		Principio	Fin		
Toro					
Guineas					
Gallinas					
Patos					
Puercos					
Chivos					
Mulo					
Burro					
Palomas/tortalas					
Conejo					
Caballo					
Vaca					
Otro (especifique)					

Sub-módulo A--Pregunta 19

19) MEJORAMIENTO DE LA TIERRA

Tipo de Mejoramiento	¿Ha hecho usted algún mejoramiento en los últimos 12 meses? (Sí--1, No--2)	Si ha hecho mejoramiento en los últimos 12 meses, ¿cuál fue el area cubierta por esos mejoramientos? (en tareas)	Si no ha hecho ningún mejoramiento en los últimos 12 meses, ¿cuándo hizo el último?
Construcción de conductos de agua para irrigación			
Cercas/troncado			
Nivelar la tierra			
Construcción de terrazas			
Plantación de arboles para reducir la erosión (barreras vivas)			
Arrado de bueyes			
Otros (especifique)			

Sub-módulo A--Pregunta 20

20a) USO DE MEJORES PRACTICAS AGRICOLAS.

Cosecha que Producir	Durante los últimos 12 meses			
	¿Trata usted las semillas con productos químicos antes de usarlas? Sí 1 No 2 No aplicable 3	¿Planta usted en fila? Sí 1 No 2 No aplicable 3	¿Cuántas veces des-yerba usted durante la temporada? Ninguna 0 Una 1 Dos 2 Varias veces 3 No aplicable 4	¿Usa usted insecticidas y pesticidas? Sí 1 No 2 No aplicable 3
Plátano				
Maiz				
Arroz				
Cebolla				
Papa				
Sorgo				
Algodon				
Habichuelas				
Yuca				
Mani				
Coco				
Cacao				
Café				
Tabaco				
Caña de azucar				
Forraje/yerba				
Legumbres				
Vegetales				
Frutas				
Batata				
Auyama				
Mixta				
Otro (especifique)				

20b) ¿Ha usado usted algunas de estas técnicas antes de este año? SI 1 NO 2

Hoja de Respuestas: Sub-Módulo B--Caracteristicas Generales de la Familia

	1a-d	2	3a-b			4a-c			5		6a-b		
	Relación de cada Miembro con el Jefe	Sexo (Código)	Edad			Educación			Estado Civil		Lugar--Nacimiento		
			A	B		A	B	C			A	B	
	Lista B--Descripción		Edad	Mes	Año	Cód	Años	Cód	Cód	especif	Cód	Año	Mes
1	el jefe del hogar (mismo)												
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

Hoja de Respuestas: Sub-módulo C--Emigrantes

	1a-b Lista C Emigrantes desde 1977	2 Sexo	3 Edad Partió	4 Tiempo Pasado		5 Estado Civil		6a-b Educativo	
	Relación con el Jefe	Cód.	Años	Meses	Años	Cód	Especif.	A Cód	B Años
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

	6c Ocupación		7a-b Razón			8a-b Donde			9 Edad	10 Donde Nacío
			A		B	A	B			
	Cód	Especi-ficación	Cód	Especificación	Cód	Nombre	Cód	Especificación	Años Total	Nombre o Descripción
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

Hoja de Respuestas: Sub-módulo D--Inmigrantes

	2	3	4		5	6a-b			7a-b		
	Lista D	Nació	Mudó		Edad	Vivía			Razón		
	Inmigrantes 1977-87	Nombre o	Meses	Años	Años	A	B		A		B
	Relación con Jefe	Descripción				Nombre	Cód	Especific.	Cód	Especific.	Cód
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

	7c		8		9a-b		9c		10a-d					
	Decisión		Estado Civil		Educación		Ocupación		Información					
	Cód	Especific.			A	B	Cód	Especific.	A	B		C	D	
			Cód	Espec.	Cód	Años			Cód	Cód	Especific.	Cód	Cód	Especific.
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														

Hoja de Respuestas: Sub-Módulo E--Re-migrantes

	1c	2		3		4		5a-b		
	Lista E Re-Migrantes 1977-87	Ocupación Primero		Vuelta		Fuera		Sitio		
								A	B	
	Relación con Jefe	Cód	Especificación	Meses	Años	Meses	Años	Nombre	Cód	Especificación
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

	6a-b			7a-b		8		9a-b		10		11a-b		
	Razones			Edad		Estado		Educa.		Ocupación		Razones		
	A		B	Años		Civil		A	B	Secundo		A		B
	Cód	Especificación	Cód	A	B	Cód	Espec.	Cód	Años	Cód	Especific.	Cód	Especificación	Cód
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														

Hoja de Respuestas: Sub-Módulo F--Migrantes Potenciales

	1a	1b	1c		2a-b		3a-b		
	Lista F	Intent.	Razón--No Ir		Tiempo		Razones--Ir		
	Migrantes Potenciales	Cód			A	B	A		B
	Relación con Jefe		Cód	Especificación	Cód	Cód	Cód	Especificación	Cód
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

	4		5a-c				5d-f				6	
	Actividad		Lugar				Razones--Venir				Quedarse	
	Cód	Especific.	A	B	C		D	E	F		Cód	Especificación
			Cód	Nombre	Cód	Especific.	Cód	Cód	Cód	Especificación		
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												

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