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UNIVERSITY OF MICHIGAN
SCHOOL OF NATURAL RESOURCES AND ENVIRONMENT
POPULATION-ENVIRONMENT DYNAMICS: TRANSITION THEORY.
School of Natural Resources and Environment 545,
School of Public Health EIH 575
MONOGRAPH, FALL TERM 1997.

POPULATION-ENVIRONMENT DYNAMICS: ISSUES AND POLICY



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PREFACE

This monograph, is a compendium of the individual works of eight students enrolled in a cross-listed course NR 545 (EIH 575). The focus of this course, like prior years, is captured in its title "*Population-Environment Dynamics: Toward Building a Theory*". The course began with an examination of alternative theoretical constructs useful in studying the interaction between human populations and the environment. Also, at the beginning of the course, each participant was asked to select a topic of inquiry and a geographical setting for their study. This selection then became their major focus for the entire semester.

Students participating formally in the course this fall had a delightful mixture of backgrounds and interests. Schools and colleges represented included the School of Natural Resources and Environment, School of Public Health, College of Architecture and Urban Planning, and College of Literature Sciences and Arts. In addition to the formally enrolled students, others sat in from time to time, including participants from previous year's seminars. Disciplines and areas of interest represented included area studies, economics, sociology, architecture, urban planning, public health, and natural resources. Participants in this year's seminar included colleagues from the Continents of North America, Europe, and Asia.

A very important element in the seminar was the use of data sources that recently have become available in machine-readable form. These data sources permitted the students to quickly gain experience in handling longitudinal datasets, especially those that were not amenable to modeling with linear functions. The most useful and user-friendly dataset provided participants was The World Resources Institute Data System (1996-97). Another tool used in the course was state-of-the-art PC-based Geographic Information Systems. The GIS package selected as most helpful this year, was Atlas GIS version 3.03. Extensive use also was made of information from the Digital Chart of the World. Another device used this semester for the second time was the simulation software, Stella 5. A doctoral student, Rhonda Ryznar, provided a brief and concise introduction to this tool that included examples. Two students then chose to include its use in their individual papers. This year's seminar also saw a heightened use of data and documents coming directly from the World Wide Web. In one instance, the student's project could not have been carried out without this new source of readily available data. Prior to the publication of the monograph outside reviewers provide feedback on several of the chapters. Papers included in this monograph all had completed this review process by the time of publication. Remaining papers will be published at a later date. Dr. Sandra Lach Arlinghaus, Adjunct Professor in The School of Natural Resources and Environment, co-taught the course, as she has in previous years.

The success of the course resulted largely from the enthusiasm of the participants. As in previous years, extra sessions were held near the end of the semester, which often extended beyond scheduled meeting times. Feedback from fellow participants was provided in these sessions. In addition, each student was asked to develop a brief synopsis of how their study related to the other participants in the class. These thoughtful remarks are presented as the main body of the concluding chapter. This monograph was

published during the winter term in the academic year 1997-98.

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POPULATION-ENVIRONMENT DYNAMICS: TOWARD BUILDING A THEORY

INTRODUCTION

This volume is a collection of separate but related studies focusing on the relationship between human populations and the environment. The effort consists of this introduction followed by seventeen chapters each written by a seminar participant which investigates a different aspect and geographic setting of the population-environment dynamic. A concluding chapter provides comments written by each participant relating their work to those of the others.

In this introduction we present a synopsis of the common framework, which we call a family of transitions. In addition to the common framework, this introductory chapter presents the abstracts for each ensuing chapter. Readers of the monograph reporting work from prior years should note that the material in the following section on a family of transitions is repeated here for background and therefore can be skipped.

1. A FAMILY OF TRANSITIONS

One way of viewing the complex dynamic relationships between population and the environment is to visualize them as a family of transitions. That is, not only is there a demographic and epidemiologic transition but also a deforestation, toxicity, agricultural, energy and urbanization transition as well as many others. In this chapter it is argued that for each transition there is a critical period when society is especially vulnerable. During that period, rates of change are high, societal adaptive capacity is limited, in part, due to this rapid change, and there is a greater likelihood that key relationships in the dynamic become severely imbalanced. The trajectory society takes through a transition varies, depending upon many factors operating at local and national levels. Transitions not only are occurring in many different sectors but also at different scales, both temporal and spatial. At times, a society experiences several transitions simultaneously, which can raise social vulnerability because of how they amplify each other.

1.1 TYPES OF TRANSITIONS

The Demographic Transition

Let us begin with a review of the ideas behind the widely accepted demographic transition. At the onset of this transition, births and deaths are both high and are in relative equilibrium with each other. Historically, births exceed deaths by small amounts so total population rises only very gradually. Occasionally, famine or an epidemic causes a

downturn in total population but in general, changes in rates are low. During the transition, however, death rates drop dramatically, usually due to a change in the health condition of the population. This change in health is caused by many, often interrelating factors. After some time lag, the birth rate begins to drop and generally declines until it is in approximate balance with the death rate again.

The Epidemiological Transition

The term epidemiologic transition was coined to describe the changing source of mortality and morbidity from infectious diseases occurring primarily in the younger age groups to degenerative diseases in older age groups. As with the demographic transition, there is considerable volatility during the transition. At the onset, infectious diseases begin their decline usually due to extensions of health care and sanitation by the national or local government. Single vector programs such as malaria control and immunization programs are often the first implemented because they are capable of ready extension and do not require as heavy a commitment to education and other sustained infrastructure - especially in rural areas. These single vector programs are then followed by broader-based health care which demand heavier investment in infrastructure. But an entirely successful move through this transition does not always happen. At times, other sectors in transition overpower the health care delivery system.

The Agricultural Transition

For several hundred years, worldwide agricultural production has been rising in relative harmony with population. Overall, increases in production have kept up with and even outpaced growth in population. The two factors that have been responsible for these increases are 1) extensions of land under cultivation and 2) improvements in productivity. At times changes have been dramatic. Formulating an agricultural transition reflects the condition that, in general, sources of increase in production shift from extending land to intensifying production on land already under cultivation.

The Forestry Transition

At the onset of the forestry transition generally a large percentage of a region is under forest cover. Rapid deforestation occurs during the transition and finally forest cover stabilizes at a lower level determined by many factors such as the local region's needs, the state of the local and national economy, climate and soil characteristics. In most settings this transition will end in a steady state equilibrium balancing growth and harvest. Again, how society handles the vulnerable transition period often determines in a profound way the quality of life for the region.

The Toxicity Transition

The toxicity transition can be considered a composite of many transitions: global atmospheric, local air pollution, surface water, ground water and solid waste to name a few. Again, there are at least two sets of factors operating in tandem. The transition begins with low levels of industrial or agricultural production and correspondingly low levels of toxins. As production and population increase, toxic byproducts increase to levels which eventually become unacceptable to the general public. This in turn, causes a public demand for pollution abatement. After an environmentally costly time lag, remediation steps are taken which helps to bring pollution under control.

The Urbanization Transition

The urbanization transition is driven by the dual forces of rural to urban migration and central city population growth. The early stages of the transition are characterized by rapid growth of urban population; however, in later stages, growth declines and may reverse. Rural to urban migration is a product of many forces - both "pull" and "push". In terms of the population-environment dynamic, the urbanization transition often acts as an amplifier as it interacts with other transitions.

The Fossil Fuel Transition

The fossil fuel transition is a special case of the energy transition. Historically, many energy transitions have already occurred in different regions and time periods. Significant transformations began in the sixteenth century brought about by sail and later, by steam power. Today, we are now in the most universal and perhaps critical energy transition: fossil fuels. Studying this transition is especially instructive because the record on different societies' passage through the vulnerable period is varied and appears to be heavily influenced by public policy.

1.2 GENERAL CHARACTERISTICS OF TRANSITIONS

Similarity of Trajectory Across Sectors

We have attempted to show in the seven example sectors discussed earlier that the notion of transitions apply across all sectors of investigation. Each class of transition, whether it be demographic, toxicity, forestry, agriculture, urbanization, energy or epidemiological have similar patterns. It is this perception that has caused us to posit the existence of a family of transitions possessing some common attributes useful in analysis. The first common attribute of all transitions is their trajectory. They all begin in reasonable stability, then move to the volatile transition period where change is rapid, and finally return again to relative balance. Analytically, these are clearly nonlinear systems but ones which have properties that lend themselves to well-understood

mathematical functions.

Applicability of Transitions Across Scales

The second attribute has to do with scale. One of the most interesting and at the same time vexing aspects of studying population-environment dynamics is that many phenomena manifest themselves at all levels of geographic and temporal scale. For example, data depict one demographic transition for an entire continent, a different one for a country within that continent and still other different transitions at the regional level. Local conditions may delay or advance the onset and or completion of the transition in relation to the larger body. Thus, moving through the demographic transition can take more or less time as the scale changes. This same variation seems to exist in all other population-environment transitions that have been investigated. True, national or regional-level determinants often set the stage for the local dynamic, but in the end it is these local conditions which determine the timing, magnitude and specific trajectory of the overall transition.

One can think of our world, seeming to be chaotic, but instead consisting of a multitude of well defined transitions in many sectors, each with its own local characteristic. Different transitions begin at different times and places, but ebb and flow in an overlapping way, sometimes reinforcing one another and at other times dampening their dynamic. As adjustment occurs, occasionally useful niches are created which are then exploited by stressed elements of the ecosystem. Unfortunately, at other times, different sectors interact with each other in a harmful way to broaden and extend the susceptible period.

Societal Vulnerability

During transitions there seems to be a special vulnerability borne by society. Ample evidence indicates that key relationships are most likely to become out of balance during the transition. A primary cause of this vulnerability is the rapidity of change during the high velocity portion of the transition. Adaptive capacity is impeded because there is little time for systems to adjust and often there are limited feedback mechanisms operating which otherwise could help this process. Another contribution to social vulnerability during a transition is the amplifying effects created by transitions occurring simultaneously in several sectors. Rapid rates of change in several sectors could more easily overpower the available infrastructure which leads us to the next source of vulnerability during transitions: capital availability.

Capital or investment capacity can either amplify or reduce societal vulnerability during a transition. If there are financial resources available to deal with the effects of rapid change, remediation is easier

to implement. Africa which is trying to deal with a difficult demographic transition has almost no capital available for its use and will therefore undergo great hardship. The Soviet Union and Eastern Europe are struggling to find financial resources to deal with their flawed toxicity transition. Another dimension of transitions which affects societal vulnerability is the degree of interconnectedness. How closely is the local village connected to the regional and national economy? How much does what happens in one location determine what happens in another? There is no question that interconnectedness is increasing worldwide. We also know that under some circumstances linkage creates dependencies which in turn, increase vulnerability. However, it can work in the opposite direction as well. These very same links to a larger domain can also act as a safety net. If there are connections, resources can be brought to the stressed area more easily to mitigate the local adversity. The final and perhaps most important dimension of transitions affecting vulnerability is feedback.

Analytic Properties of Transitions

We have seen that many characteristics of transitions are common across all sectors and geographic scales. The question then, is whether there are analytic techniques which might be useful in describing this family of transitions. If so, these techniques may be helpful in portraying transitions in a way that facilitates comparison and thereby increases our understanding. In this quest we are especially interested in techniques and functions which reduce complexity and at the same time provide a reasonably accurate portrayal of reality.

Functions which are candidates for consideration include exponential, exponential to the limit L , logistic, Gompertz, and the power function. Bounded functions which fit data more precisely but cannot be used for predictive purposes may also be helpful in uncovering patterns.

1.3 POLICY IMPLICATIONS OF TRANSITION THEORY

But what does it gain us to fit an exponential or logistic or for that matter any function to transition data? The answer lies in our ability to gain insights by relating different transitions to each other. First, consider the transitions within a given sector and at a given scale. We know there are transitions in a sector which some societies have already experienced while others have yet to endure. If the nature of these experiences can be captured in general form, it is more likely that knowledge can be transferred to other settings where a transition is first starting. Of course, each civilization or local culture has its own unique characteristics but any one emerging transition may be comparable to one or more of those which have occurred before because conditions are similar.

Second, there may be useful comparisons across different scales. We already surmise that a national-level transition, perhaps now in process, is actually comprised of a myriad of local transitions also in process or which have recently occurred. But there may be other locales in the region for which the transition has yet to happened. If similar patterns emerge because of similar local conditions, a useful prediction could be made about the nature of the passage through the transitions yet to appear. Third, there may be insights gained simply by the process of fitting a function to historical data. Different mathematical functions often have very specific underlying characteristics which can provide useful ideas. The next potential use of transition theory is to facilitate analysis across sectors. There is, of course, no good reason to expect the trajectory of, say, a forestry or agricultural transition to mimic an epidemiologic transition. However, for any society at a given time, there may be similarities in the rates of change across sectors. Developed economies have slower rates of change in their agriculture sector than developing economies when conditions are favorable. Rural based cultures may be expected to have urbanization transitions which are steeper than non-rural cultures. In short, it is worth testing to see if patterns can be empirically determined which would be helpful in predicting the shape of future transitions, given a stated level of intervention.

We have already mentioned the special societal vulnerability associated with several sectors being in rapid transition simultaneously. From a modeling perspective this simultaneity a very difficult condition to describe and analyze, which may be why less progress has been made in this area to date. However, being able to portray these multiple transitions with specific functions could be helpful. There is no question that each transition interacts with the other. And to the analyst this means that a reliable model must be structured as a set of simultaneous relationships. Describing transitions as functions facilitates this manipulation.

Another potential benefit of transition theory lies in the identification of lead indicators. If success is achieved in fitting transition data to an appropriate function, then for a given condition and point in time, the future trajectory can be predicted more accurately. Identifying lead indicators is facilitated because with an orderly function, only one, or at most, two parameters need to be determined to define the trajectory. This advantage is even more evident when several functions are considered simultaneously.

Finally and perhaps most importantly, transition theory may permit more informed public and private intervention. At one level we find ourselves believing that the trajectory of a transition is somehow fixed by an

immutable law of nature. But at another level we know that this is not the case. Public and private policy can make a difference as we have seen from some of the cases discussed in this book. Rates of change can be influenced by policy redirection and consequent resource allocation. To the extent that we can link historical rate differentials with historical policy implementation, a better determination can be made about which intervention mix works best in dealing with problems facing society today.

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AUTHOR ABSTRACTS OF PAPERS

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RELATIONSHIPS AMONG PAPERS: AUTHOR VIEWPOINTS

- 1. Callewaert, John.**
 - 2. Chaudhuri, Moushumi**
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Abstract
John Callewaert

Over the past decade, issues of justice, equity and racism have become significant developments in the environmental movement. Research, scholars, community activists and members of the general public are beginning to see that environmental issues are not just about wilderness preservation, pollution prevention, and resource conservation. There has been a growing awareness that environmental hazards are not uniformly distributed. In general, studies have shown that lower income and minority communities experience a disproportionate exposure to environmental hazards. This understanding is known as environmental justice.

Using data for the State of Michigan that has been compiled by Dr. Elaine Hockman of the Research Support Laboratory at Wayne State University, I explore the relationship between race, income and the distribution of environmental hazards. The findings support previous studies from other regions that identify a strong association between income level and the location of environmental hazards and an even stronger association between areas of high minority concentration and the location of environmental hazards. Data are displayed in graphs using *Excel* and are also mapped using *Arcview*. Following an analysis of the data, policy recommendations are made based on the current United States Environmental Protection Agency's (US EPA) environmental justice decision making process for Region V.

Abstract

Moushumi Chaudhuri

West African Sahel is facing several challenges in trying to cope with environmental pressures in relation to population activities. The growth of population and the lack of natural resources have created numerous struggles for food and access to land. It has also created displacement and conflict between herders and the cultivators. In this paper, it is my intention to deconstruct the reasons for this struggle. This will be done through analyzing five transitions: ecological, population, urbanization, economic, and social. The main question is, has the ecological and the social carrying capacity been surpassed?

The question of carrying capacity depends on the state of "vulnerability" within each of these transitions. In terms of the environment, desertification is a barrier to population and ecosystem sustainability. This "vulnerability" will also create tensions among people in search for fertile land. This tension is already occurring in many parts of the urban Sahel where herders and cultivators are fighting over limited pieces of sustainable land. The scramble for land is also strongly effected by economic policies implemented by the governments in this region. The transition to the market economy, structural adjustment policies and profit incentives all contribute to the tensions between people in the Sahel. To a great extent, the market economy deteriorates the social conditions as family structures are being broken down leading to more poverty. The interrelationships between these transitions are very much permeable and interrelated.

These conflicts can nevertheless be appeased. There are several policy suggestions that could lead to long term sustainable development. In terms of direct environmental policy, more importance must be paid to reforestation issues to reduce urbanization. There must also be an emphasis on reducing population growth through education and family planning. Finally, agriculture and herding could be implemented through "double strategy" where products of one benefit the other. Ultimately, the governments of the Sahel need to advocate the improvement of the standard of living in the rural parts of the Sahel that are facing most of these difficulties. There must also be an effort to include herders and cultivators into the development process in order to avoid the "overshoot and collapse" scenario.

Abstract **Shannon England**

This paper is an attempt to explore the relationship between violent conflict and environmental scarcity by focusing on Burundi as a case study. As a former Peace Corps volunteer in Muyinga province in 1993, I had occasion to witness some of the violence in Burundi first hand. This paper provided me an opportunity to explore the conflict from political, demographic, and environmental viewpoints. In the course of study, I determined that there is some evidence to indicate that access to agricultural land played a crucial role in the conflict that continues to engulf Burundi today. While the association does not prove causality, it may point the way to important policy recommendations for solving the problems facing Burundi. These include fostering a greater role of engagement from the international community, improvements in the Burundian judicial system, an expansion of family planning programs in Burundi, and focused research into improving the agricultural yields in the area.

Links are provided below to charts and maps about Burundi. A few photos from Burundi are followed by the complete paper.

[Map of Africa, Population Density by Country, Large](#)

[Map of Africa, Population Density by Country, Small](#)

[General Map of Burundi](#)

[Map of Burundi's Agricultural Regions](#)

[Map, Burundi's Population Density, 1988](#)

[Map, Burundi's Coffee Production, 1988](#)

[Map, Burundi's Population Density, 1991](#)

[Map, Population Density for 1991 and Election Results for Burundi, 1993](#)

[Map, Population Density for 1991 and Violent Conflict for 1993](#)

[Map, Regions of Violent Conflict in Burundi, 1965 and 1972](#)

[Chart One: Population Growth in Burundi 1950 - 1996](#)

[Chart Two: Comparative Statistics on Population Density](#)

[Chart Three: Population Density for Rwanda and Burundi](#)

[Chart Four: Percentage of People Living in Absolute Poverty in Africa](#)

[Chart Five: Average Life Expectancy Around the World](#)

[Chart Six: Burundian Children Suffering From Wasting and Stunting](#)

[Chart Seven: Daily Per Capita Calorie Supply, Percentage of Requirements Being Met for Africa](#)

[Chart Eight: Effects of Ethnic Violence in Burundi Since Independence](#)

[Chart Nine: Effects of Ethnic Violence in Burundi, Deaths and Refugees](#)

[Chart Ten: Population Growth Trends in Burundi](#)

[Chart Eleven: Crude Birth and Death Rates for Burundi](#)

[Chart Twelve: Comparing Total Fertility Rates for Burundi and Rwanda with World Rates](#)

[Chart Thirteen: Food Production Index for Burundi](#)

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[Chart Twenty-Four: Population Growth Plotted Against Ethnic Violence in Burundi](#)

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Photo of Burundian Children



Photo of Burundian Fields



Photo of Burundian House and Fields



Abstract
Seema Iyer

Urban decline is a phenomenon ascribed to both the United States and Russia; however, the disparity in the spatial configuration of that decline renders the consequences of each country's situation as unique. In the US, the process of urbanization nationally has diffused from the traditional coastal cities of Los Angeles and the Boston-Washington, DC corridor into the less monolithic towns of the south and southwestern heartland. Similarly at the local level, suburbanization around metropolitan areas has significantly encroached into the agricultural hinterland of each city due not only to the general population increase but also to an out-migration of households and businesses from the center. This mode of development has been facilitated if not generated by an extensive transportation network accompanied by an increased accumulation of wealth at a national scale. In contrast, urbanization in Russia mainly occurred during the seventy years of Soviet rule which meant that the Marxist philosophy of equality dictated the patterns of settlement and migration. The central planners envisioned a landscape of urban areas dispersed evenly throughout the country that were equally sized and uniformly dense. Cities were created in Central Asia and the Siberian Far East, and households were directly and/or indirectly encouraged to migrate from European Russia located west of the Urals. The allocation of aggregate resources for the purpose of building the necessary physical infrastructure was based on political and bureaucratic power. With the dissolution of the Soviet Union in 1991, the foundation for the sprawling landscape was completely and swiftly abandoned. During Russia's current transition from a planned to a market economy, the superimposition of cost accounting and demand-determined pricing for housing, transportation and employment is creating unprecedented migration patterns. Based on initial post-Soviet data and theories of population-environment dynamics, this paper develops predictions about an eventual spatial stasis of larger, polycentric cities that are regionally dispersed and possess important local economic and political linkages.

Abstract
Daria Kim

The Red River Delta of Vietnam is an area of dense human settlement and intensive land use. In the past, the region's villagers have been able to increase production sufficient to cope with increased population. Whether further increases in population can be supported by the land and whether current high levels of production can be sustained are questions which have yet to be answered. This paper attempts to answer these questions in the specific context of an agricultural village, Nguyen Xa, in the densely settled Red River Delta province of Thai Binh.

Nguyen Xa was selected because it represented the extreme case of population pressures on natural resources in Vietnam. This paper will draw upon fieldwork jointly conducted in 1991 and 1992 by researchers from the Southeast Asian Agroecosystem Network (SUAN), the Program on Environment at the East West Center, the Southeast Asian Agroecosystem Network (SUAN), Center for Natural Resources Management and Environmental Studies at Hanoi University, and Hanoi Agricultural University.

This paper will be comprised of three different sections: the first section will focus on presenting an introduction to the region and providing specific information relevant to the understanding of this paper; the second section will present the village of Nguyen Xa, and briefly discuss certain key issues that might contribute to our analysis of the region's sustainability; the last section will explore the issues of rural development in the Red River Delta, and how Nguyen Xa's specific situation might provide clues to the prospect of the region's long-term development.

Deforestation in Southeast Asia

Thammasack Manokham

I will attempt to find the underlying causes of deforestation, or the loss of forest cover, in eight Southeast Asian countries and to analyze prospects for sustainable forest management. These eight countries are Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam. In order to explain deforestation, I examined the relationship of deforestation to population, agricultural production, slash and burn cultivation, and (over-harvested and illegal) logging. I found that as deforestation increased, agricultural production, slash and burn cultivation, and logging also increased. Increasing population pressure expanded deforestation. After applying one successful program in Thailand to the other seven countries, I proposed several solutions to slow deforestation.

Abstract
Rosalyn Scaff

This paper examines the spatial ramifications of the reunification of East and West Germany. Specifically, the population and environment dynamic are explored through an investigation and analysis of population trends, and the past and present environmental state. This paper proposes to answer the question: has reunification helped or hindered this former eastern bloc country, and more specifically, how has land development and the ecosystem been effected by reuniting the two nations?

East Germany is the only eastern block country to have been united with a western nation. The implications of this union have had a great impact on the country; more money was given to the former German Democratic Republic (GDR) in the first few years after the fall of communism than any of the eastern blocks combined (Albania, Bulgaria, Czechoslovakia, Hungary, Poland, Romania and Yugoslavia). Yet, monetary aid has not brought the country to the economic highs that many had hoped and predicted. Environmental problems coupled with a population emigrating to the west have created slow economic development in the east. Meanwhile, those remaining in the eastern portion of the country demand goods and services attainable in the west. Building and construction are the only industries which have consistently not experienced job losses. While the population of the entire country declines, and more people leave the east, we see a rise land development. Loss of green space, detracting of economic development from the older inner cities, increased traffic patterns and higher rates of environmental pollutants are only some of the repercussions of this type of rapid, unchecked growth. Proposals are made in this paper as to how the newly reunited country can curb and control this type of expansion.

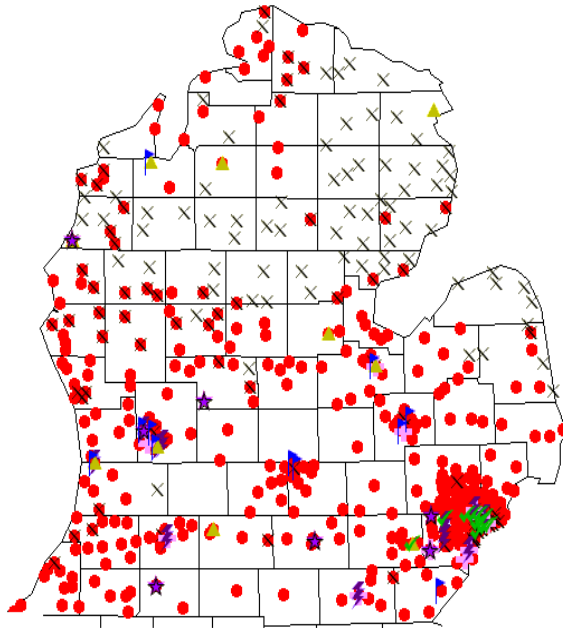
Abstract

Jennifer Wegbreit

Dengue fever incidence rates of are thought to be contingent upon weather variables, namely precipitation and temperature. Because the activity and survival of the primary vector of dengue fever, *Aedes aegypti*, is related to local weather conditions, it is believed that there may be a correlation between weather variables and morbidity rates due to dengue fever. The relationship between weather variables and morbidity rates may incorporate a time lag of up to twelve months. In this retrospective study, the statistical association between monthly morbidity rates and monthly temperature and precipitation records in the islands of Trinidad and Tobago were studied, taking monthly time lags of up to twenty-four months into account. It was determined that a statistically significant relationship between temperature and morbidity exists at time lags of six months. In this model there is a positive correlation between morbidity and temperature. Such a model may prove useful in determining possible effects of global warming or in implementing control strategies.

**Environmental Injustices in Michigan:
A Spatial Analysis of the Interactions between Race, Income, and the Distribution of Environmental Hazards.**

John Callewaert



Introduction

One of the most critical issues confronting the global society today is the understanding of the relationship that humans share with each other and with the environment. As we place greater demands on the environment, we also place increasing demands on the relationships among people. This is not a new issue. Throughout history, humanity has struggled with a fair and equitable distribution of resources and access to resources. More recently, a body of literature has been developing that convincingly documents the idea that the causes of environmental destruction and negative environmental impacts have their origins in social relations, specifically the dynamics of class and race (Bryant & Mohai; Painter & Durham, 1995). This understanding supports an argument that environmental degradation and social injustice go hand in hand (Faber, 1993).

Instead of the popular notions of global environmental collapse, it is more likely that there will be a slow unevenly distributed environmental deterioration that will be confounded by humanity's ability to adapt, deny and forget. While there will be growing pockets of wealth, environmental conservation and protection, there will be many other areas that experience desperate poverty, environmental contamination, and resource depletion. This is not just simply the

familiar North versus South dynamic. Rather there are increasing pockets of the "North" in the South and the "South" in the North where disproportionate environmental dilemmas will play out (Athanasiou, 1996).

Moreover, during the past decade, issues of justice, equity, and racism have become significant developments in the environmental movement, particularly in regards to demographics and the environment. Researchers, scholars, professionals, community activists and members of the general public are beginning to see that environmental issues concern more than wilderness protection, pollution prevention and resource conservation. However, a number of important questions need to be explored further: In what ways do factors such as race and class interact in relation to environmental problems? How have attempts to solve environmental problems generated social problems? What is the link between environmental protection and social justice? How do specific environmental problems and hazards disproportionately affect certain communities over time? How have policy decisions and implementation addressed concerns about disproportionate exposure?

One response to this disparity has been the environmental justice movement that has sought to identify and challenge the disproportionate exposure that minorities or low-income populations have to negative environmental impacts, particularly the siting of hazardous waste facilities. The Region V office of the US EPA Superfund Division offers the following definition for environmental justice:

Environmental justice is generally defined as the fair treatment of people of all races, cultures, and incomes, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment implies that no people should be forced to shoulder a disproportionate share of the negative environmental impacts of pollution or hazards due to a lack of political, economic, or educational strength. EPA is committed to investigate all environmental issues and situations that raise questions of justice and equity (US EPA 1997).

History

One of the first to raise questions about the connection between environmental hazards and social status in the U.S. was Alice Hamilton. Trained in medicine at the University of Michigan, Hamilton is known as the country's first great urban/industrial environmentalist as well as a tenacious reformer, compassionate advocate and cautious careful researcher. Hamilton's investigation of a serious typhoid epidemic in Chicago at the turn of the century, revealed a direct relationship between sewage outflow and outbreaks of disease in poorer neighborhoods (Gottlieb, 1993).

In 1972, A. Myrick Freeman presented a paper for Resources for the Future that addressed the distribution of Environmental Quality. This was one of the earliest reports that was able to show a quantifiable correlation between hazardous air pollution exposure (suspended particulates and sulfation) and income level. In three areas of study (Kansas City, St. Louis, and Washington, D.C.) lower income groups were consistently exposed to higher levels of pollutants. In his summary, Freeman concluded that environmental quality is positively associated with wealth.

Following on Freeman's work, Peter Asch and Joseph J. Seneca carried out a national study that examined the systematic relationship between exposure to air pollution and economic and social characteristics of the population. Their findings showed a stronger correlation between income groups and air pollution than between racial composition and air pollution (1978). This study raises an important methodical concern regarding the unit of analysis for such studies. Asch and Seneca chose census tracts as the unit of analysis for their research while others (as will be shown later) work with zip code level information. Regardless of the unit that is selected or method of data analysis, an important characteristic that drives all of these studies is the principal that environmental policies in the U.S. should provide uniform regulations and ambient standards independent of local conditions and costs (Gianessi, Peskin, and Wolff, 1979).

A major event that helped focus national attention on the question of race, income and environmental hazards occurred in 1982 when state officials decided to locate a poly-chlorinated biphenyl (PCB) landfill near a predominately African American community in Warren County, North Carolina. This led to protests similar to the civil rights movement of the 1960s and inspired further investigation into the link between social indicators and environmental hazards (Mohai and Bryant, 1992).

In 1983 the General Accounting Office (GAO) conducted an analysis of the socioeconomic and racial composition of the communities surrounding the four major hazardous waste landfills in the South. The GAO study found that 3 of the 4 landfills were located in communities that were predominantly black and living below the poverty line.

The GAO report prompted the United Church of Christ's Commission for Racial Justice to conduct a nation wide study (using zip code data) of the distribution of hazardous waste sites to determine if there might be results similar to the GAO report. The Commission found a clear pattern. The study revealed that the proportion of minorities residing in communities that have a commercial hazardous waste facility is about double the proportion of minorities in communities without such a facility. Where two or more facilities are located, the proportion of resident who are minorities is more than triple. Furthermore, the study showed that race is the single best predictor of where commercial hazardous waste facilities are located (United Church of Christ, 1987).

In an analysis of 16 studies which explore this phenomenon, including their own in the Detroit area, Paul Mohai and Bunyan Bryant determined that regardless of the scope of the study, the distribution of pollution has been found to be inequitable by income. Where the distribution of pollution has been analyzed by both income and race, in most cases race has been found to be more strongly related to the incidence of pollution than income (Mohai and Bryant, 1992).

The Data

This study uses data that has been compiled by Dr. Elaine Hockman of the Research Support Laboratory at Wayne State University. Dr. Hockman has gathered information on 907 variables including race, income, environmental hazards and public health for all 873 zip codes in the State of Michigan. Sources for the data include the Michigan Department of Environmental Quality (DEQ), the Michigan Department of Public Health (DPH), US EPA, the 1990 Census, and several others. I will be using eight of the variables to explore the spatial association between race, income and environmental hazards. Six of the variables represent various environmental hazards by zip code and the other two variables provide information on median household income and the ratio of minorities to whites for each zip code.

For this report I am simply looking at the spatial association of race, income and selected environmental hazards. An analysis of the statistical correlation of these variables will be done at a later date. A detailed explanation of each variable that I will be using is given below:

Median Household Income Quartiles (QHHINCOM): This categorizes 1990 Census information household income data in quartiles. Zip codes are classified as "1" (where the median household income is below \$21,391 per year), "2" (\$21,392-\$26,999), "3" (\$27,000-\$35,042) and "4" (greater than \$35,043). Therefore "1's" identify the poorer areas of the state and "4's" identify the wealthier areas.

Ratio of Minorities to Whites (QMIN2WHT): This variable also relies on 1990 Census information and categorizes zip codes based on the ratio of minorities (all minority groups) to whites. This is the total population for a zip code minus the white population divided by the total population. Zip codes identified with a "1" are areas with no minorities and areas identified by a "4" represent those zip codes with the most minorities. Zip codes with a "2" or "3" represent the quartiles between "1" and "4".

Toxic Release Inventory 1989 (TRLN89): In 1988, the US EPA began collecting information releases, transfers, and others waste management practices for certain listed toxic chemicals. The current Toxic Release Inventory (TRI) reporting requirements apply to facilities in the manufacturing sector of the economy with ten or more full-time employees, and that exceed an activity-based threshold limit for one or more for the 650 toxic chemicals and chemical categories on the TRI list. This information is collected annually by EPA. For this data set, this variable represents the total number of chemical records (or number of TRI chemicals) for a particular zip code. It does not quantify the amounts of various TRI chemicals for each zip code.

Leaking Underground Storage Tanks (LUST.N): This variable quantifies the number of Leaking Underground Storage Tanks (LUST) sites identified in Michigan in 1990. Examples of LUST sites are leaking fuel tanks at service stations, deteriorated or abandoned home heating fuel tanks, etc. As with the TRI variable, the LUST variable only quantifies sites, it does not rate the severity of contamination, at a particular site.

Number of Incinerator Emissions (INCIN.N): This data represents the total number of incinerator records for a particular zip code. Like the TRI 1989 variable, the incinerator variable counts the number of types of emissions such as carbon dioxide.

Number of Hazardous Waste Management Facility Sites (HAZFAC.N): This is the total number of hazardous waste facilities located in each zip code.

Number of Landfills (D.NDUMP): The number of landfills located in each zip code.

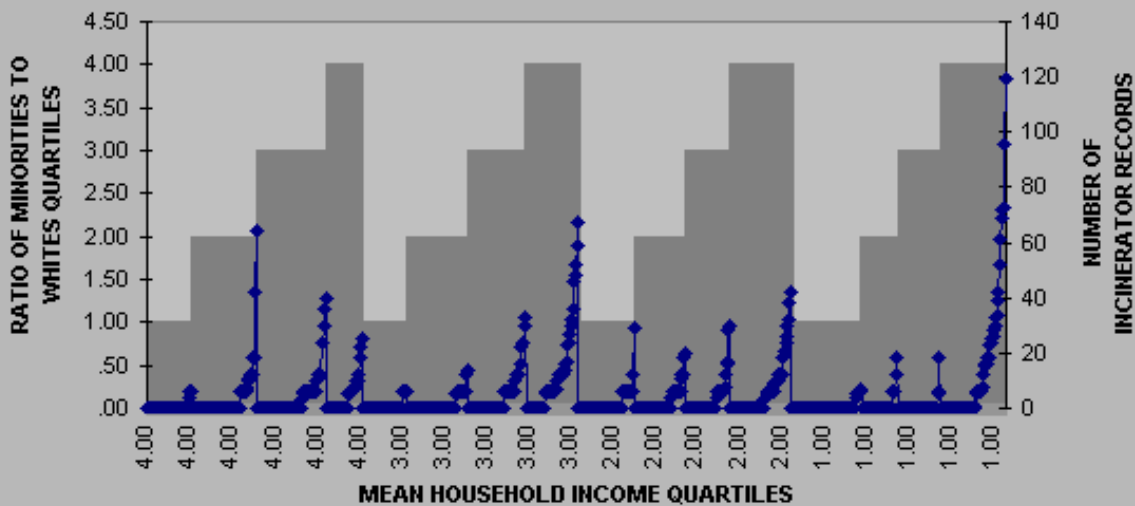
Number of Chemicals at Act 307 Sites in 1990 (ACT.90NC): Act 307 is the Michigan Environmental Response Act of 1982. It provides for the identification, risk assessment, and priority evaluation of environmental contamination at certain sites in the state. This variable represents the total number of chemicals identified under Act 307 in a particular zip code in 1990.

Working with these variables, I have used *Excel* to sort out the top (or worst) ten (there was often a natural break here) zip codes for each of the six environmental hazard variables (1989 TRI, LUST sites, number of incinerator emissions, number of hazard waste facilities, number of landfills and number of Act 307 chemicals). The relationship of these top ten zip codes is then graphed to compare the race and income information for that zip code with one of the environmental hazard variables. I then display GIS images created in *Arcview* to show the spatial association of these data sets.

While the data cover zip codes for the entire state, the maps that I have created only reflect the Lower Peninsula of Michigan as the interactions between the variables I have selected only occurs in this portion of the state.

Analysis

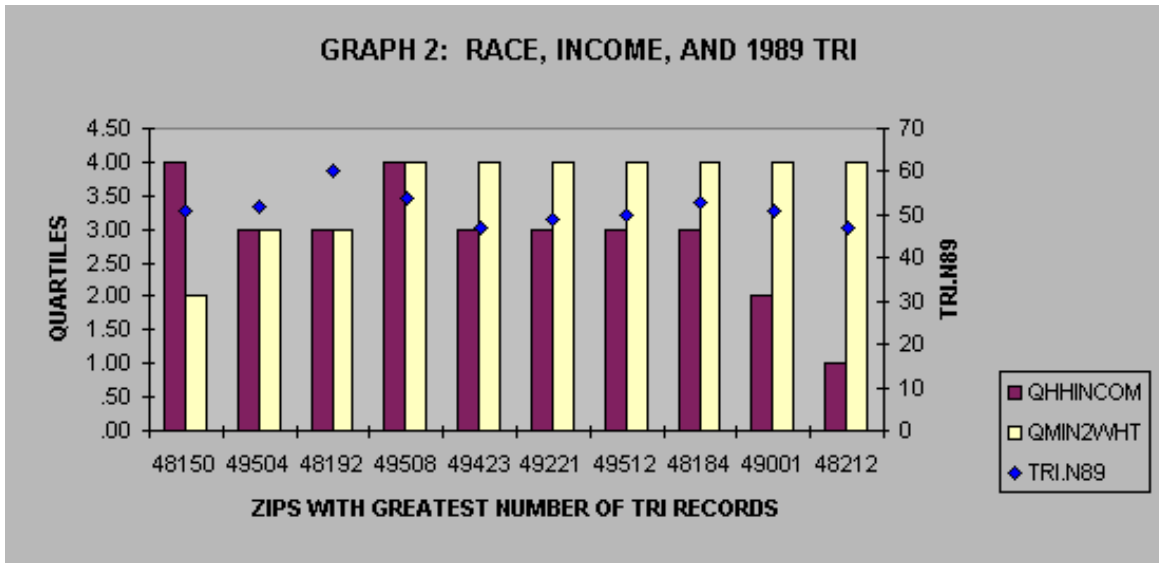
Graph 1: RACE, INCOME, AND INCINERATOR RECORDS FOR ALL MICHIGAN ZIP CODES



Graph 1 bears some resemblance to a standard demographic transition map. There are periods of low growth, periodic peaks and valleys and finally exponential growth resulting in a steep climb. While this graph does not represent population figures it does represent one of the most disturbing facts of the population-environment dynamic: the disproportionate exposure to environmental hazards that certain groups experience because of their social class or their race. In the dark gray bars, graph 1 displays mean household income values (QHINCOM) in descending order on the x-axis, the ratio minorities to whites (QMIN2WHT) in ascending order on the y¹-axis. The blue line represents the number of incinerator records (INCIN.N) on the y²-axis. All of the data are based on zip code level information. The graph dramatically displays the relationship between race, income and incinerator records. The exponential rise in the

number of incinerator records on the right hand side of the graph is associated exclusively with zip codes that represent low-income area and areas with high minority populations.

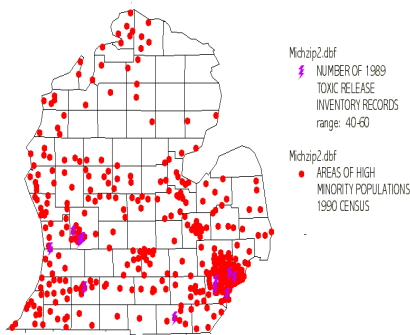
1989 TRI (TRI.N89)



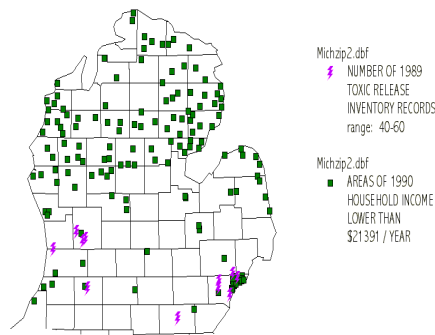
This graph shows that for the 10 zip codes with the highest number of TRI records in 1989 were also zip codes with primarily minority populations. Only one zip code had a QMIN2WHIT value of 2. On the other hand there is a wider range of representation in the QHHINCOM values. While there is a clear link between the zip codes of high TRI records and minority populations, there is not a clear link between zip codes of high TRI records and poorer areas. In fact many of the zip codes (8 out of 10) fall into the higher quartiles for household income. The GIS images display a clear connection between

QMIN2WHT and TRI.N89 (map 1) while the connection between QHHINCOM and

MAP 1



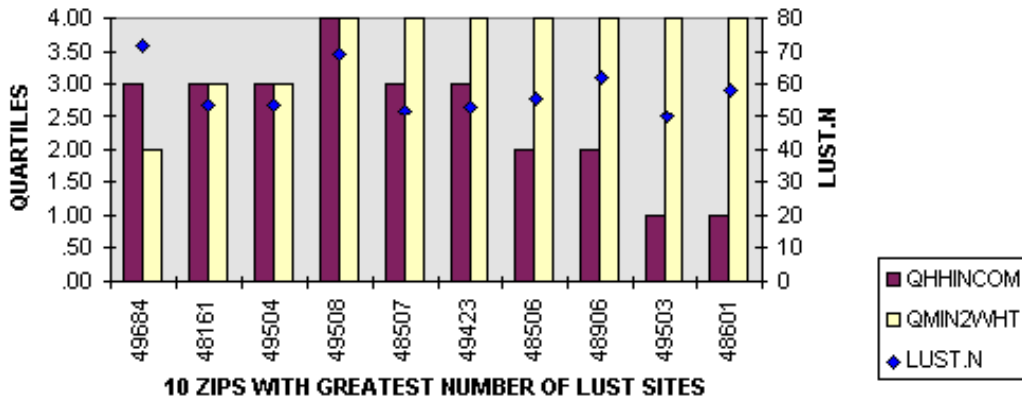
MAP 2



TRI.N89 (map 2 is not as direct).

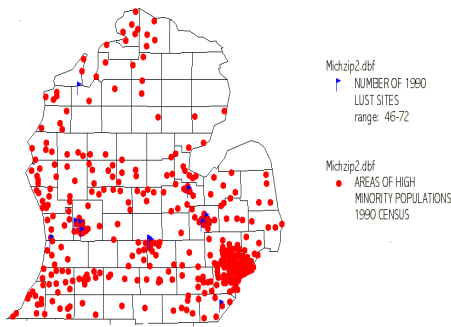
LUST Sites (LUST.N)

GRAPH 3: RACE, INCOME, AND NUMBER OF LIST SITES

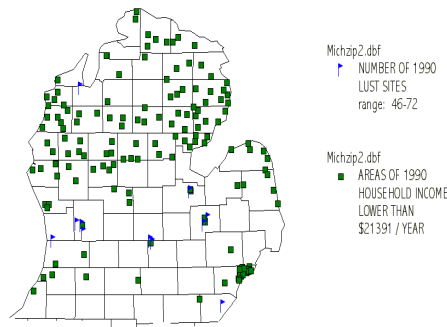


As with TRI.N89, there is a strong connection between QMIN2WHT and the location of the zip codes with the highest number of LUST sites (map 3) and unclear connection between LUST sites and QHHINCOM (map 4).

MAP 3

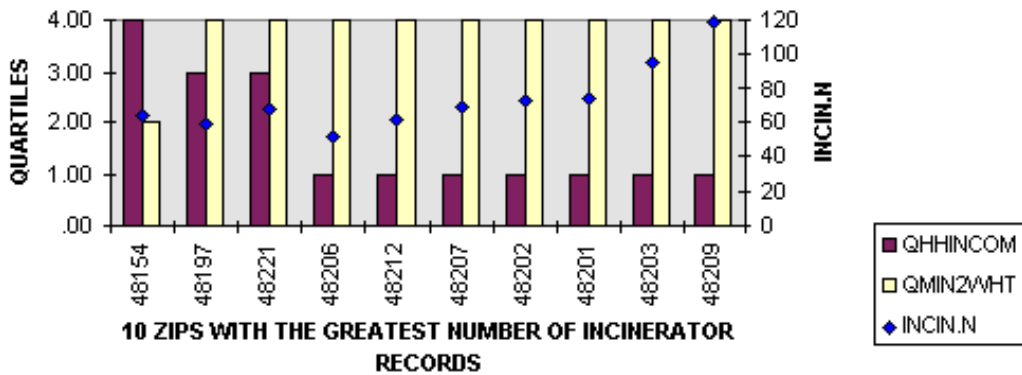


MAP 4

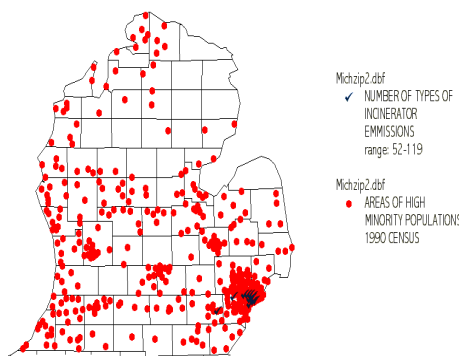


Incinerator Emissions (INCIN.N)

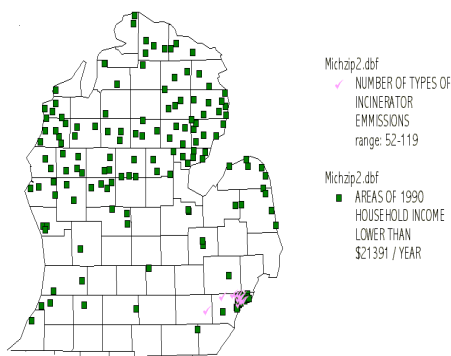
GRAPH 4: RACE, INCOME, AND NUMBER OF INCINERATOR RECORDS



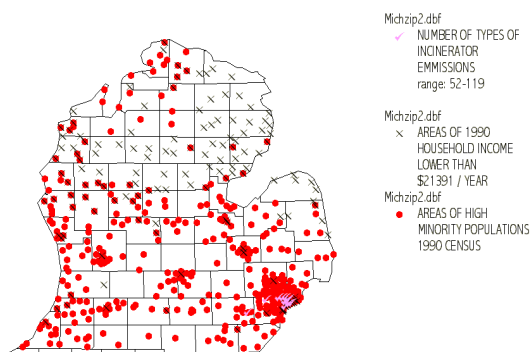
MAP 5



MAP 6



MAP 7

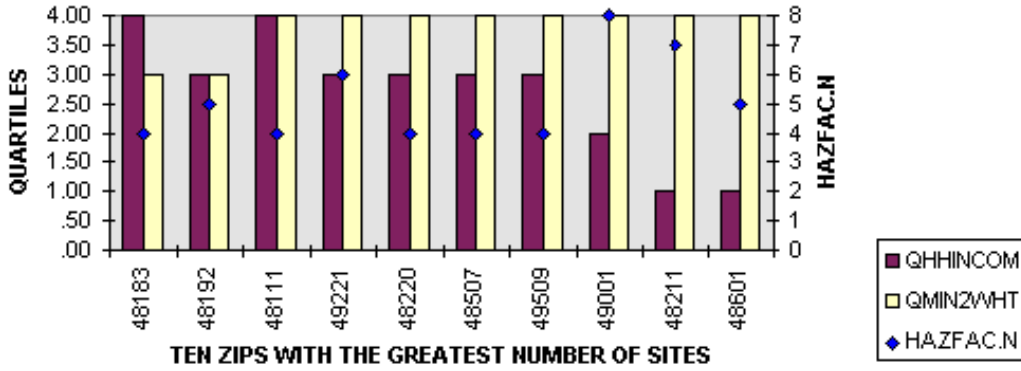


More than any of the other comparisons, the zip codes with the greatest number of incinerator records (INCIN.N) show a close connection between areas of low income and areas with the high minority populations. Seven of the ten zip code areas have QHHINCOM values of 1 and QMIN2WHT values of 4. A clear relationship between race, income and exposure to pollutants. Map 7 below displays the combination of both data sets.

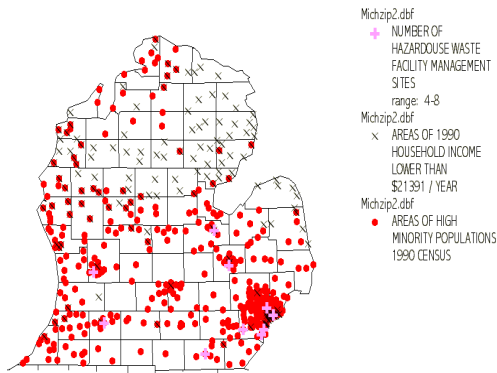
The graphs and maps that follow provide similar comparisons for HAZFAC.N, D.NDUMP, and ACT90.NC

Hazardous Waste Management Facilities (HAZFAC.N)

GRAPH 5: RACE, INCOME, AND NUMBER OF HAZARDOUS WASTE MANAGEMENT FACILITY SITES

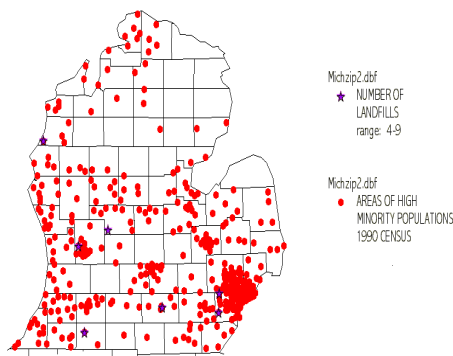


MAP 8

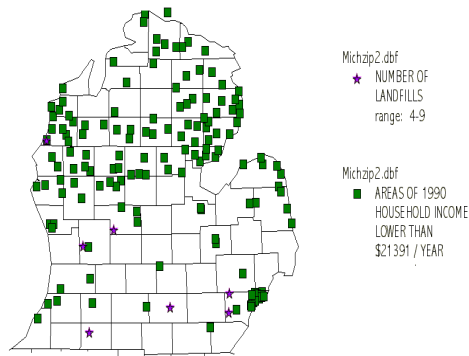


Landfills (D.NDUMP)

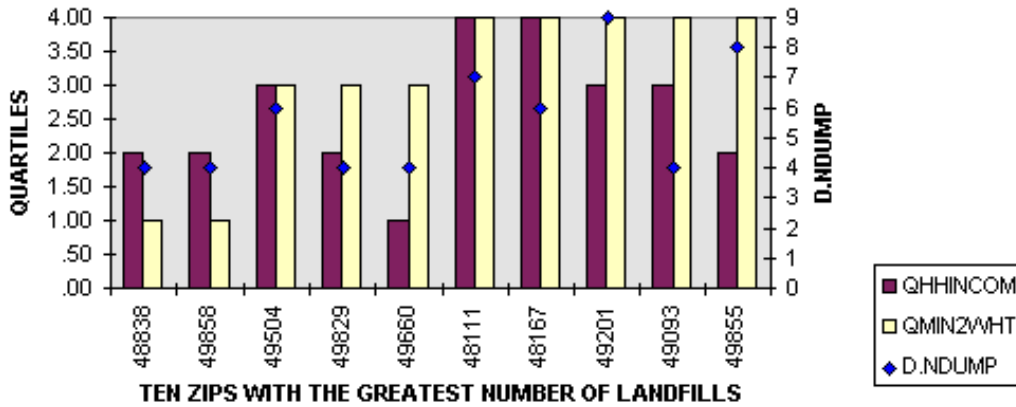
MAP 9



MAP 10

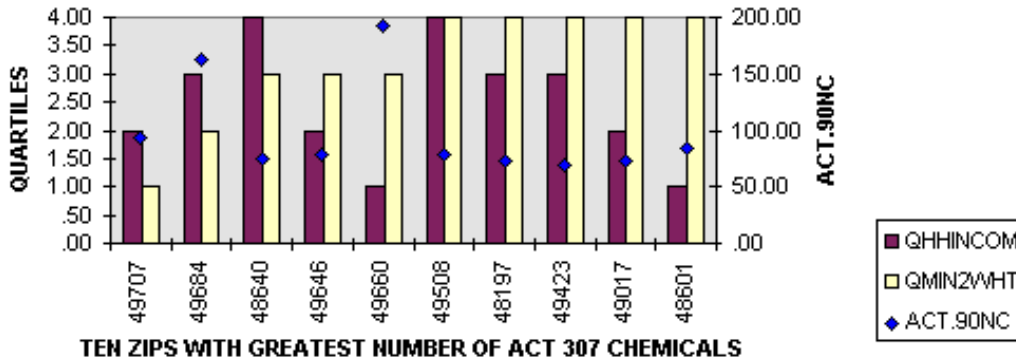


GRAPH 6: RACE, INCOME, AND NUMBER OF LANDFILLS

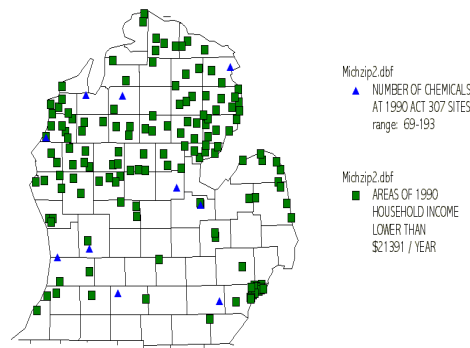


Act 307 Chemicals (ACT90.NC)

GRAPH 7: RACE, INCOME, AND NUMBER OF ACT 307 CHEMICALS



MAP 12



Reviewing all six of the environmental hazard variables reveals that, in general, there is a strong association between the location of the ten worst zip codes and zip codes with high zip codes having high minority populations. Only zip codes that reflected high numbers of incinerator emissions corresponded with both low income and minority populations. This pattern is similar to the findings of Mohai and Bryant (1992) who concluded that when the distribution of environmental hazards is analyzed by both income and race, in most cases race is more strongly related to the incidence of environmental hazards than income.

Questions

Even with these results, there still remain many questions and policy concerns. Given the strong relationship between environmental hazards and areas of high minority populations, is there a justifiable claim of environmental racism? Some claim that environmental racism probably does not apply as many of the communities reflected in the data only became minority communities after the area was industrialized or the polluting facilities had been sited, (Been, 1994; Been and Gupta, 1997).

These claims against environmental racism, however, do not sufficiently incorporate broader societal dynamics that force or encourage minority populations into undesirable or polluted areas. Why is it that many of the zip codes with the highest rates of environmental hazards are not only associated with high minority populations, but also with medium to high levels of income? If racism were not a factor in these areas, why would not wealthier minorities simply move out of the contaminated areas? Putting this debate aside, there still is a valid complaint that as present conditions stand, minorities bear a disproportionate burden in regards to environmental hazards.

Further Analysis

More work is clearly needed to explain and prove the association between environmental hazards, race, and income. This study has only looked at a simple graphical and spatial association of the variables. To strengthen the findings of this study, statistical analysis of the data needs to be done along with a comparative study using a different unit of analysis such as census tracts or a geographical region (one mile radius, 3 mile radius) around an environmentally hazardous site.

The data for this study has been limited to zip codes, as that was the basic unit for most of the combined data. The limitations of such a unit is that it is large and may not appropriately represent a particular area or community. For example the QHHINCOM variable (median household income) could be skewed by a combination of low and high-income households in one zip code. Another limitation of the data that I have used is that it does not address the severity of a particular hazard. For example, the D.NDUMP variable only counts the number of landfills per zip code. It does not account for the size or condition of the landfill. Despite the limitation of this study, some important policy considerations can still be suggested.

Policy

As a result of the growing awareness and interest in environmental justice, President Clinton issued Executive Order 12898 on February 11, 1994, to establish environmental justice as a national priority. This was the first presidential effort to direct all federal agencies with a public health or environmental mission to make environmental justice an integral part of their policies and activities. The Order, entitled "Federal Actions to Address Environmental Justice in Minority Populations and Low-income Populations," focuses federal attention on the environmental and human health conditions of minority populations and low-income populations with the goal of achieving environmental protections for all communities (U.S. Environmental Protection Agency, 1995). The result has been the establishment of several U.S. Environmental Protection Agency environmental justice programs across the country and many community groups that have begun to use the idea of environmental justice to challenge local environmental threats.

Furthermore, numerous environmental justice bills have also been introduced in Congress and various state legislatures have attempted to create a statutory basis for environmental justice claims. To date, though, none have been enacted. Essentially all of the legal or policy developments to date in the environmental justice field have concerned procedures, disclosure and general policies (Gerrard and Bose, 1997). A recent ruling in Flint, Michigan, however, may have significant implications for future environmental justice policy and legislation.

In October of 1995, the Flint chapter of the National Association for the Advancement of Colored People (NAACP), and several Genesee Township residents sued Governor Engler, the Michigan Department of Natural Resources and Genesee Township (collectively, the state) alleging that the state violated Michigan's Elliott-Larsen civil Rights Act by authorizing the siting of a wood waste incinerator in a predominantly African-American neighborhood in Genesee County without considering the incinerator's impact on a community that is "forced to bear a disproportionate burden

of exposure to environmental harm." African Americans comprise only 13.9 percent of the population of the State of Michigan, and 19.6 percent of Genesee County, but they are a majority of the residents within a three-mile radius of the proposed plant. In addition, the NAACP claimed that the incinerator siting violated the Michigan Constitution and the former Michigan Environmental Protection Act. The state requested that the case be dismissed because the NAACP could not prove that the alleged discrimination was intentional. The court held that the NAACP was not required to demonstrate that the discrimination was intentional, only that it occurred, and allowed the case to proceed, (Smith, 1996).

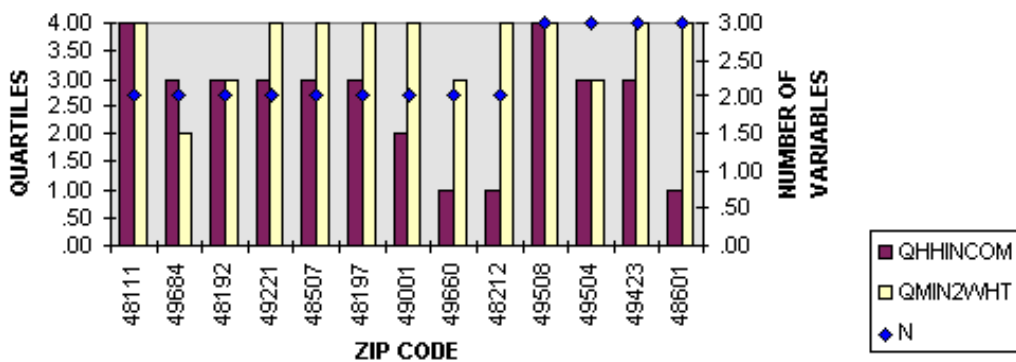
Judge Archie L. Hayman of the Circuit Court for Genesee County presided over the case. While noting people of color bear a disproportionate and unfair burden of society's pollution he rejected the plaintiff's claim that the case constituted a civil rights violation, because "most, if not all, of the major polluters in Genesee County and especially in Flint were located prior to any significant African American population being located there," and there was no evidence that the state's policy of not considering race in its permit review process had caused the disparate impact.

This was not the end of the case, however. Judge Hayman focused on a provision of the Michigan Constitution, which provides for the public health and general welfare of the people of the State. Thus, under both the state constitution and the Michigan Clean Air Act, Judge Hayman found that the state must, before issuing permits for any major polluting facilities, prepare comprehensive risk assessments that take into consideration the cumulative effect of all existing conditions. While Judge Hayman rejected the plaintiff's disparate impact theory, he directly endorsed the examination of the cumulative effects of different kinds of chemical exposure on vulnerable populations. (Gerrard and Bose, 1997).

The impact of Judge Hayman's decision is still be analyzed. It has caused a major upheaval in the Michigan Department of Environmental Quality (DEQ). DEQ is currently appealing the decision, which could affect more than 480 air emissions permits pending before the DEQ Air Quality Division (McBrien, 1997).

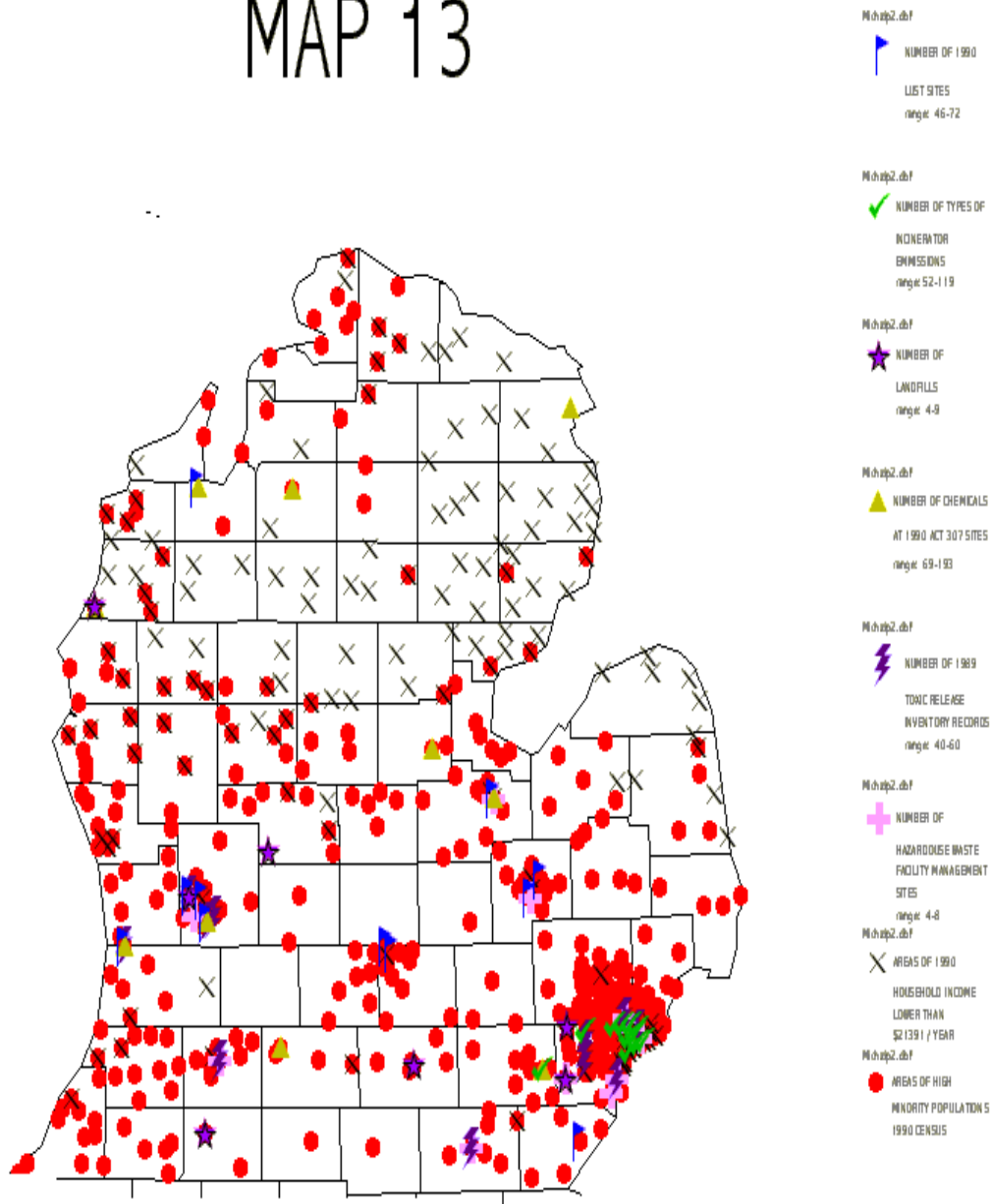
The issue of cumulative effect is pertinent to the findings of the data review above. Not only were most of the zip codes that were experiencing the burden of environmental hazards in zip codes reflecting minority communities, but in several cases they were the same community. As the graph below shows, nine of the zip codes show up on two of the top ten lists and four show up on three of the top ten lists of environmental hazard variables. (See appendix A for a complete listing of all six variables with the corresponding zip code, race and income information.)

Graph 8: RACE, INCOME AND NUMBER OF TOP 10 ENVIRONMENTAL HAZARD VARIABLES



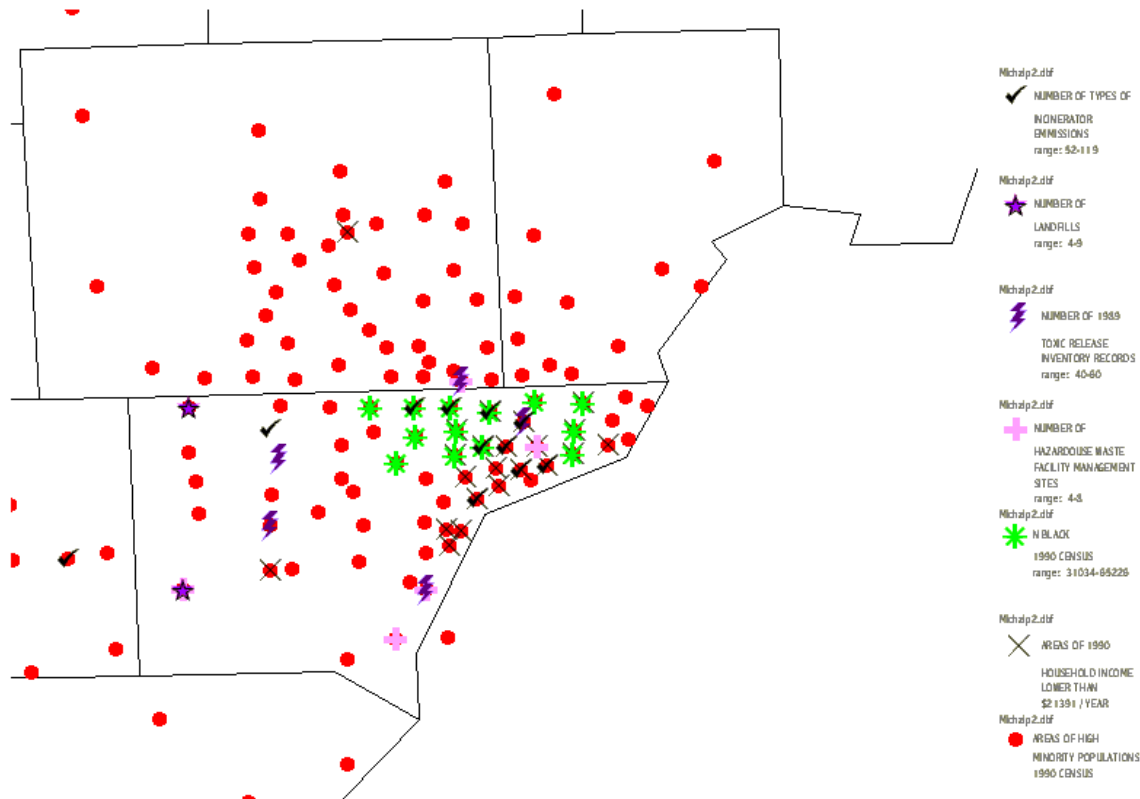
The cumulative impact of the data can also be clearly seen in the map below, both for individual zip codes with multiple hazards and regional cumulative impact from multiple hazards in the surrounding area.

MAP 13



Similar cumulative impacts can be seen in a close-up map of the Detroit area.

MAP 14



Conclusion

The disproportionate burden of environmental hazards that minorities and some low-income communities experience is obvious. Arguments and legal challenges regarding environmental racism and the intentional or unintentional siting of environmentally hazardous facilities in minority communities will undoubtedly continue. These are cases that need to be determined on the merits of each individual case. However, there needs to be a mechanism established to prevent future cumulative impacts or disproportionate impacts from new or relicensed facilities.

The Region V US EPA Superfund Division currently uses the following decision matrix to determine priorities cleanups in situations with environmental justice criteria (US EPA, 1997).

ENVIRONMENTAL JUSTICE DECISION MATRIX

	High Minority Population	Low Minority Population
Low Income	<p>Category 1</p> <p><i>Highest Level of Action or Priority</i></p>	<p>Category 3</p> <p><i>High Level of Action or Priority</i></p>

High Income	Category 2 <i>High Level of Action or Priority</i>	Category 4 <i>No Extra Action Taken</i>
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While the data used in this study would not support decisions based on low income or high income (except in the case of incinerator records) a similar decision matrix or decision process could be developed to incorporate the information on based on levels of minority population and cumulative amounts of environmental hazard variables. For example, the DEQ could develop and follow a decision making process for new permits or renewals at environmentally hazardous facilities by zip code as outlined below:

BY ZIP CODE	3 or more top environmental hazards	2 top environmental hazards	1 top environmental hazard	no top environmental hazards
High Minority Population	<i>moratorium on new permits or renewals for hazardous waste management facilities</i>	<i>5 year moratorium on new permits and renewals only for facilities with an approved pollution reduction plan</i>	<i>2 year moratorium on new permits and renewals only for facilities with an approved pollution reduction plan</i>	<i>new permits only for facilities with an approved low emissions application</i>
Low Minority Population	<i>5 year moratorium on new permits and renewals only for facilities with an approved pollution reduction plan</i>	<i>2 year moratorium on new permits and renewals only for facilities with an approved pollution reduction plan</i>	<i>new permits only for facilities with an approved low emissions application</i>	<i>standard permitting process</i>

This decision matrix could be supported by an ongoing GSI analysis of the disproportionate distribution of environmental hazards. An argument could be made that based on the findings of this study neither race nor income need be incorporated into this matrix. The reason for this is that if the cumulative impact is addressed, then race would automatically be addressed and income has not shown to be strongly associated with environmental hazards. However, these two variables, race and income, have been too historically significant to ignore or to leave to implicit inclusion. Left on its own, society has repeatedly shown its ability to disproportionately burden low-income and minority communities with a variety of social and environmental problems. To appropriately address this history, these two variables should be explicitly included in such a decision-making process.

Currently US EPA has begun to use GSI in identifying and prioritizing environmental justice concerns. Only in one region, however, is any attempt being made to address the cumulative impact of multiple environmental hazards. Region VII of US EPA has completed the GIS mapping for the city and county of St. Louis and has identified and located all industrial facilities subject to RCRA, CERCLA, UST, LUST, the Clean Air Act, and TRI on a series of GSI maps. The Region has also included blood lead information and plotted this information on a map. The Region overlaid this information with socio-economic data on poverty levels and racial makeup obtained from the Census Bureau in an effort to identify potential areas of environmental justice concern (US EPA, GIS, 1997). At present, though, this information is not yet being applied in any type of permitting or review processes.

There are clearly limitations with such a decision matrix presented above and US EPA efforts, yet they represent a

beginning. There will no doubt be economic challenges to such processes given the limitations that they set. Yet, something must be done to restructure the environmental injustice burdens that minority communities face. New protocols must be established that are in line with the uniform regulations and environmental standards that exist in federal and state law.

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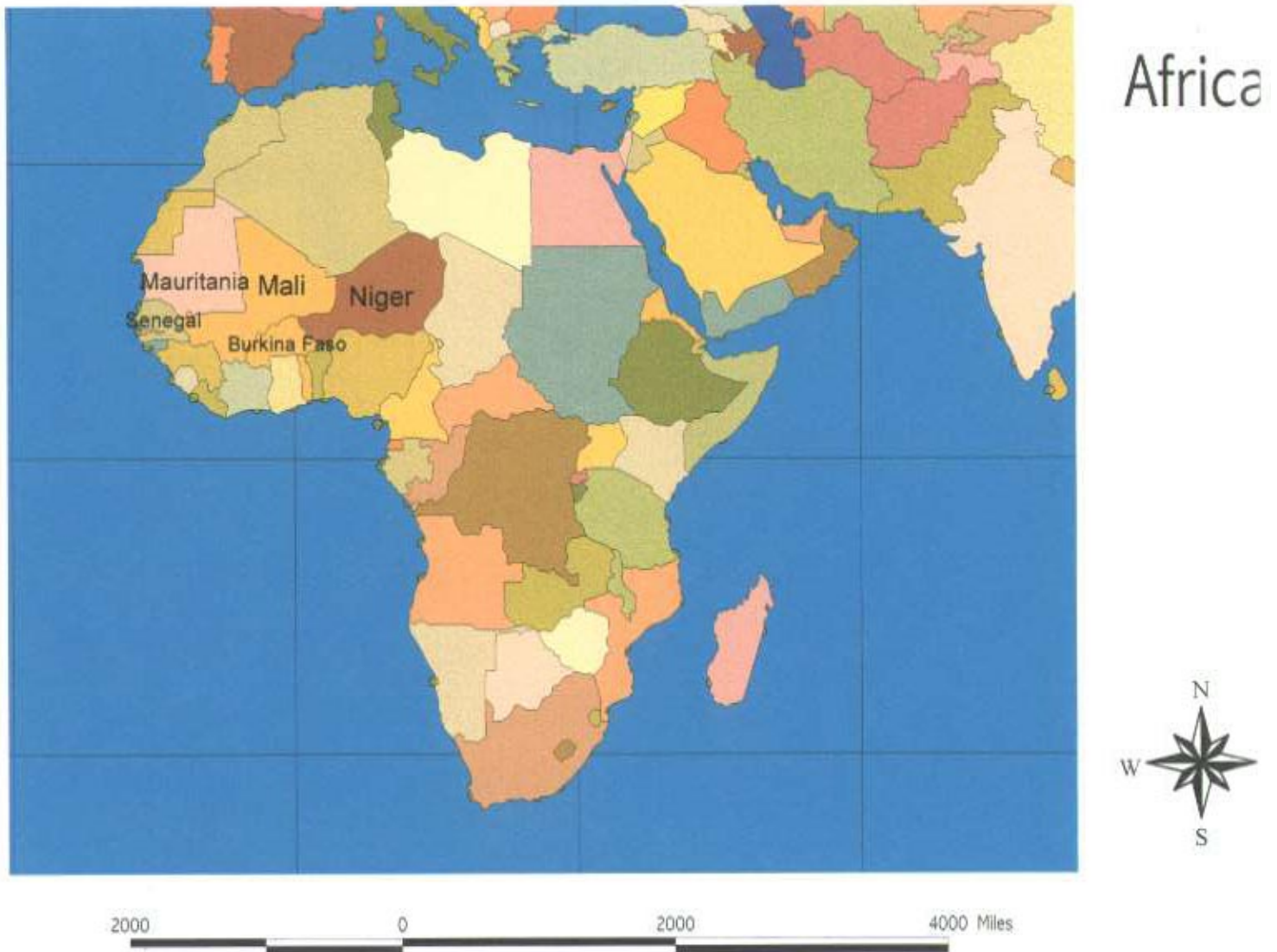
The Sahel

Moushumi Chaudhuri

Introduction

The Sahel, a region between the Sahara Desert and sub-Saharan Africa, is one of the most naturally arid places in the world. Habitation has always been a struggle because the people of the Sahel have been constantly challenged by series of droughts and land degradation. Due to the harsh environment, there has been an intensification of conflict over natural resources. This conflict has displaced many people, such as herders and poor farmers, from their homeland or territory. Displacement has caused homelessness, loss of livelihood, and cultural dislocation. Such a situation has led to the questioning of whether the ecological and social carrying capacity has been surpassed. Can droughts and land degradation ever be combated in this region to prevent further displacement? In order to answer this question, it is essential to understand the relationship between environmental change and population activities.

In this paper, the state of the Sahelian region and the reasons behind displacement and conflict will be analyzed through four different aspects that make up a "family of transitions." The first goal will be to assess the environmental situation of the region by understanding the reasons for desertification. I will demonstrate the ecological patterns and changes in this region, and how they relate to growing aridity. Although natural environmental alterations are an important aspect, I will primarily demonstrate the correlation between the population growth rate of this region and its environmental state. Within the umbrella of the population transition, I will also include the effects of population pressure that lead to the third transition, urbanization. The fourth transition that I would like to focus on is that of the economic changes. I will explore the reasons behind certain economic policies implemented by the governments of this region and the effect of the market economy on the rural sector. Finally, the last transition I will focus on is that of social change, especially in the lives of the herders. During the analysis, it is important to keep in mind that these transitions do not necessarily occur independently of one another. They are permeable and interconnected. Furthermore, it is essential to note that the Sahel is not a homogenous region. Each country is unique in terms of their environment, policy practices, and culture. It is only the overarching problem of desertification and displacement that is common in the five western Sahelian countries of Mali, Mauritania, Burkina Faso, Niger, and Senegal that I will be concentrating on.



Africa



2000 0 2000 4000 Miles

The four transitions that I have chosen to examine are all in a "vulnerable" state. Vulnerability, which mainly occurs in the early stages of transition, is determined when "rates of change are high, social adaptive capacity is limited...and the relationships in the dynamic are imbalanced" (Drake 1993: 303). It is the "vulnerability" occurring within environmental, population, urban, economic, and social transitions that are causing displacement and conflict between herders and cultivators. Although the Sahel is at a "vulnerable" state, there are policies that can be implemented to create a better future. However, first of all, it is essential to establish the environmental state of the Sahel.

The Environmental Transition

The Sahel is 500-1,000 km wide and stretches for 7,000 km from the west to the east coast of Africa. In the distant past, the Sahel was a "well-watered savanna" where forests, rivers, and grassland plains used to thrive. However, since 2000 BC the region has been drying up. The Sahel now mostly consists of a semi-arid ecosystem that fluctuates between grassland and shrubland thicket, where the rainfall is only between 150-600 mm/year. There are four different ecological zones in the Sahel: the sub-desert margin mainly located in Niger is sensitive to wind erosion since it is barely covered by vegetation; Sudano-Sahelian

zone which falls in Mali, Mauritania, and Senegal has an annual rainfall between 350-650 mm; edapho-climatic zone in Burkina Faso which contains very poor soil quality and is susceptible to extreme climatic events; and the humid zone in Niger and Senegal which is affected by salinity and seasonal floods (Raynaut 1997: 31-35). Considering such a variety in terms of harsh climatic and ecosystemic zones, what have been the reasons for climatic change and degradation of the ecosystem?

One of the main causes of climatic change has been series of droughts that have affected this region. In this century, there have been at least six recorded droughts. One of these droughts recorded between 1968 and 1973, was declared an international disaster because rains failed for six consecutive years (Bennett 1991: 13). Droughts could be caused by several reasons. One reason could be the temperature change in the Atlantic Ocean changing patterns of rainfall in West Africa. Another reason might be the greenhouse effect in relation to the global concentration of greenhouse gases (Hume 1993: 44). In addition to droughts, desertification has also contributed to environmental degradation.

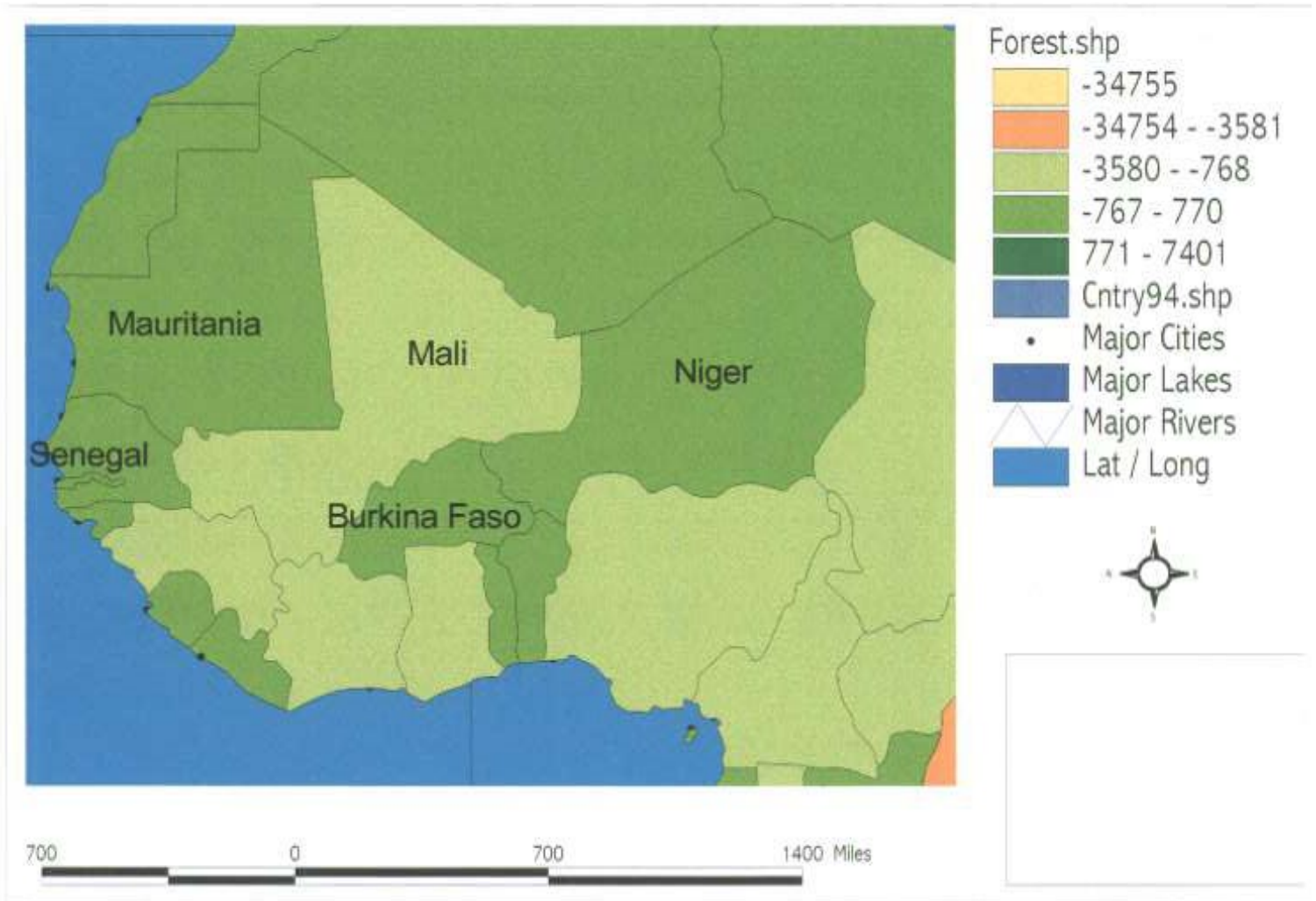
Desertification is growing at a very fast pace. Although it is understandable that deforestation is occurring for commercial and subsistence usage, there has been no encouragement for reforestation. Reforestation as a policy should be enforced because it is crucial for maintaining a viable ecosystem.

	Mauritania	Senegal	Burkina Faso	Mali	Niger
Deforestation (1,000 ha/year) 1980-89	13	50	80	36	67
Reforestation (1,000 ha/year) 1980-89	(.)	3	2	1	2

Table 1; See map on Deforestation for further data; Source: Human Development Report 1995

However, it is important to keep in mind that the popular image of the desert "spreading like a plague" is inaccurate. Instead, "the spread of the desert is more like a bad skin disease...individual patches then join together, until eventually a whole area is affected" (Bennett 1991: 14). Nevertheless, desertification is also caused by the increase of population growth. In order for people to feed a growing population, land use has been extensive in terms of, repeated cropping, salinisation, and land encroachment (IUCN 1986: 21). This has lead the land to be vulnerable to the loss of top soil and subjected to "nutrient mining."

Deforestation 1980-90 (Hectares)



The Population Transition

The population growth rate in Africa is considered "over-exponential." It has been predicted that by the year 2020, Africa will have 20% of the world's population compared to the 12% it has now (Raynault 1997: 37). In the Sahel, there are 38.6 million people and the population is growing at an average rate of 2.88% (Human Development Report 1995: 179).

Birth Rate

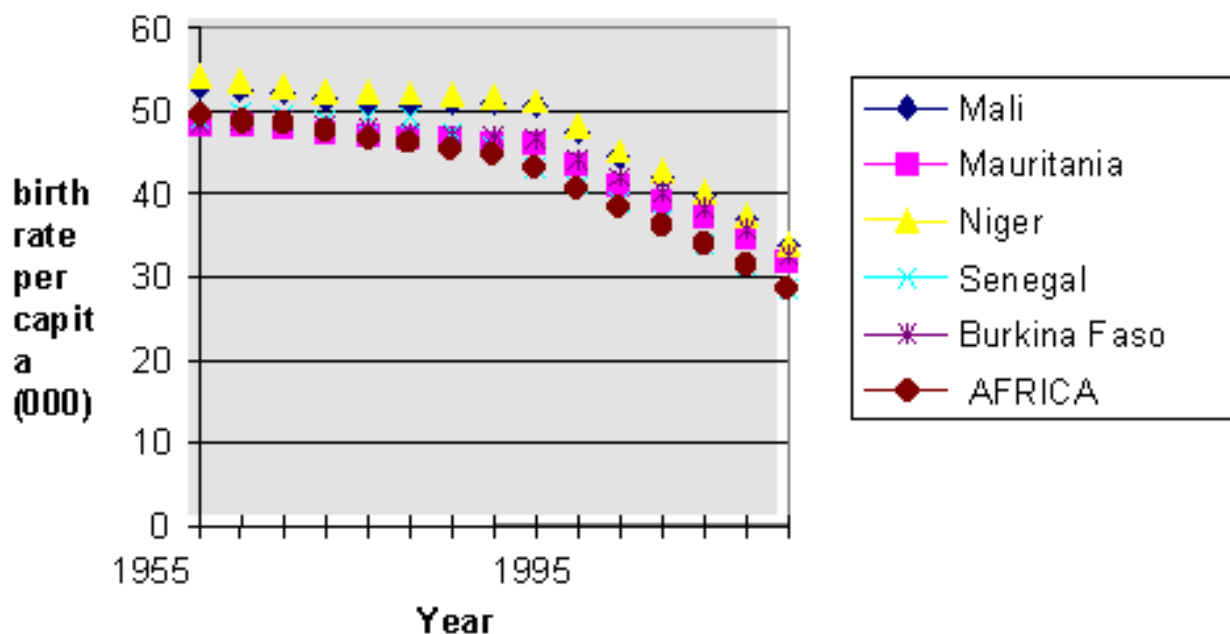


Figure 1; Actual data till 1994; Source: World Resources Institute (WRD)

By looking at Figure 1, it may seem as if population is decreasing. However, it is important to notice the time lag between birth and death rates (Figure 2). The average crude birth rate for the Sahel is 46.5 compared to the 17.22 as the death rate (Human Development Report 1995: 179). The birth rate is still greater than the death rate suggesting that the Sahel is still in the early stages of the population transition. The Sahel is clearly an example of a neo-Malthusian prediction where overpopulation and this will lead to land fragmentation, over utilization of land and a degraded environment (Mobugunje 1995: 6). Because fertility is almost three times greater than mortality, population still increases at an exponential rate. This makes the Sahel "vulnerable" in terms of the environment being incapable of supporting more population growth.

Death Rate

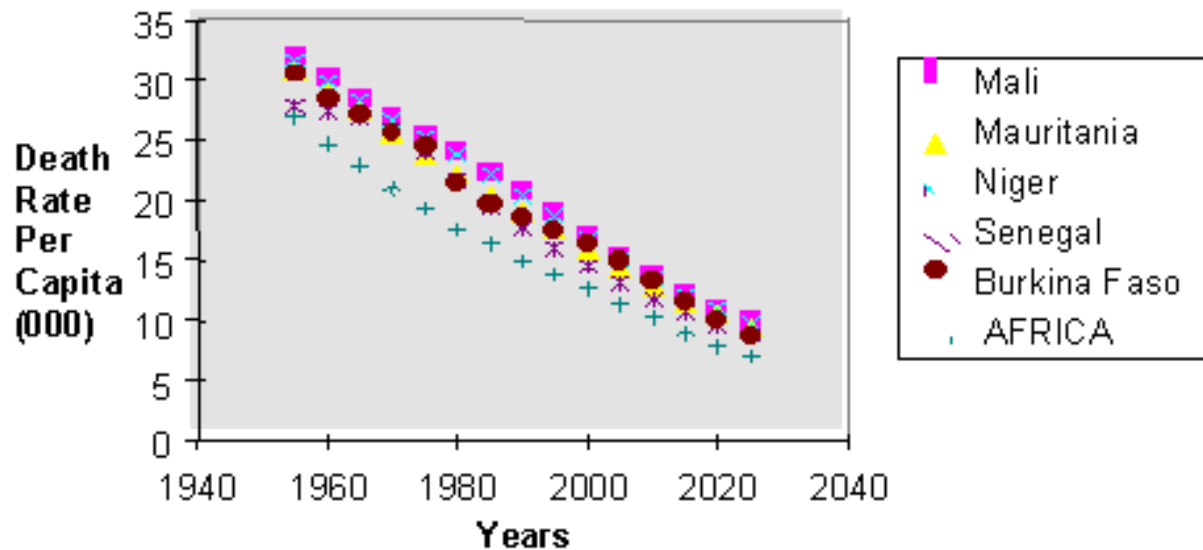


Figure 2; Actual data till 1994; Source WRD

[click here to see country-wise population projections](#)

The "vulnerability" allows us to induce that there is an imbalance between the timing of environmental transition and that of population growth. What is important to note is the extent of vulnerability. So far, the analysis has been based on exponential projection. However, looking at the linear and especially the logarithmic projections on Chart 1, the extent of vulnerability is not as great as the exponential projection. Therefore, it could be debated that the Sahel should not be alarmed about the depletion of its natural resources or the neo-Malthusian predicament. Instead, sustainability or even entering the middle stage of the demographic transition, where births and deaths are coming close to bring equal, is closer than expected. This could imply that the Sahel is not at a fully "vulnerable" state. However, it is still important to keep in mind that at the present, all of these projections to some extent, demonstrate an increase in population and is susceptible to "vulnerability." The extent of "vulnerability" may differ in the future but it is the high probability of vulnerability now that we should be cautious of when making policies.

Even though the connection between population and environment can be debatable, there is evidence that there is a need to be weary. The increase in the mouths to feed, which is leading to the depletion of natural resources, will have future repercussions in terms of decreasing food production. As Figure 3 shows, with the exception of Burkina Faso, food production is already considerably fall. This could have detrimental affects on the health of the population. Therefore, not only is the ecological carrying capacity at stake now, but it will be in a worse condition by the year 2020 at the current rate of population growth when population will double (Human Development Report 1995: 79). This is a situation of positive feedback where an increase in population results in increase in environmental degradation. This positive feedback can be slowed down by through family planning measures within the societies of the Sahel as well as

education. Population policies must also take into account geographical location of population density.

Food Production

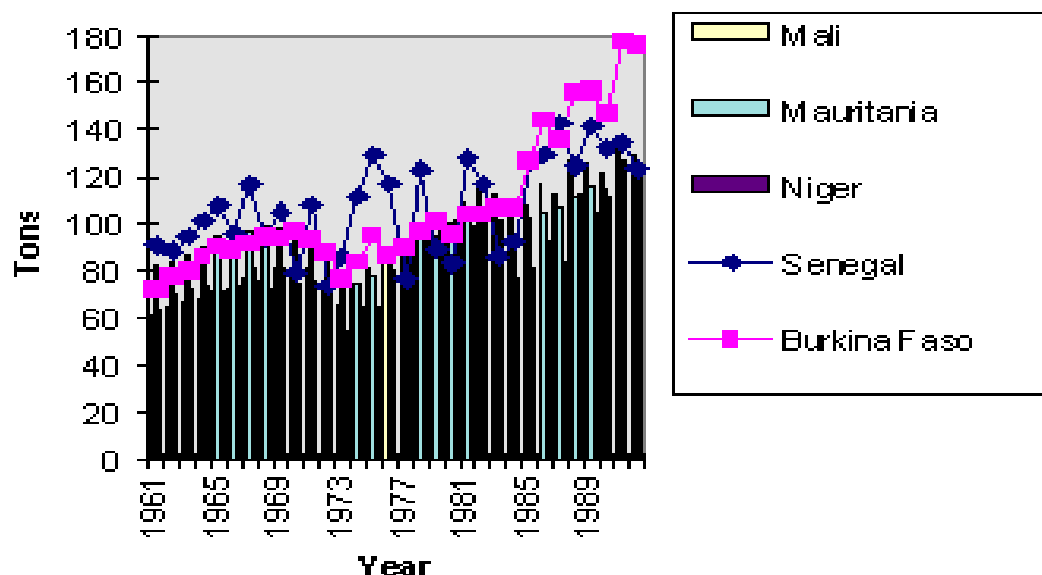


Figure 3; Source: WRD

The distribution of population in the Sahel is "discontinuous." In other words, in some areas, the population density is large and in others, hardly anyone inhabits the area. The most crucial indication of population density and carrying capacity is the climatic zones. With the worsening climatic conditions in the last twenty years and land degradation due to population growth, there has been a considerable amount of demographic decline in the northern areas. More people have been immigrating to the south because of higher precipitation and land fertility (Raynaut 1997: 47). In addition to natural population growth, migration to the urban southern areas is mainly responsible for conflict over fertile lands.

Urbanization Transition

Throughout history, internal migration has always occurred in the Sahel. Capital cities are especially "centers of attraction" because of employment opportunities. On the one hand, internal migration has created a considerable loss of population in the north and nation-wide, especially in the modern Sahel. For example, in Senegal, not only have people in the north immigrated to Dakar in the south, but many of those already living in Dakar have immigrated to Europe. Senegal represents a general trend in the Sahel. However, urbanization is not as prevalent in Burkina Faso, Mali, and Niger as it is in Senegal and Mauritania. In Mauritania alone, the rate of urbanization is 42%, a very high rate for most developing countries (Raynaut 1997: 75). Nevertheless, these "centers of attraction" have created an immense growth in urbanization.

There are four zones of urbanization in the Sahel. The first is in the extreme west of the Sahel, which is

characterized by "an area of urban polarization." This area is very fertile and densely populated. The second region is the Upper Senegal Basin where labor is exported to other coastal countries, Bamako, or to Europe. The third region is between the Niger River and western Burkina Faso. This area has a high population mobility due to the search for favorable levels of rainfall. The last region is located in the Nigero-Nigerian border. Although this region acts as "pole of attraction," it shows no sign of "saturation" yet (Raynaut 1997: 85). It has been predicted that "spatial

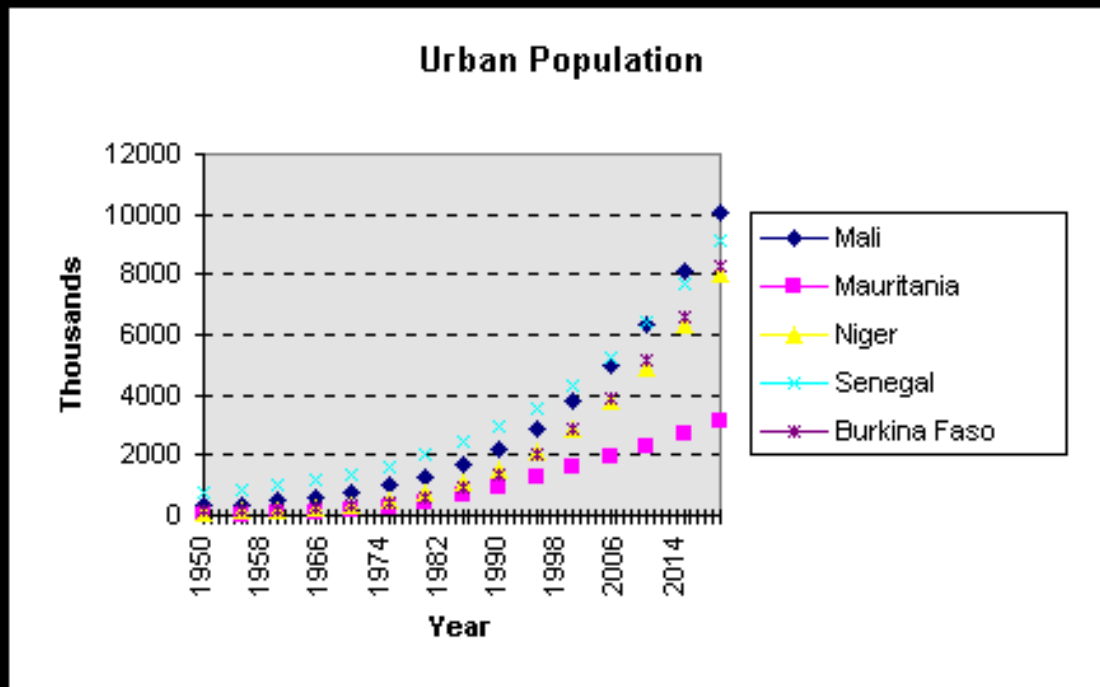


Figure 4; Actual data till 1994; Source: WRD

Distribution of population...will depend primarily on the balance established between two opposing forces: on the one hand, the capacity of rural regions to retain their inhabitants, and, on the other hand, the level of attraction exercised by the urban world." (Raynaut 1997: 83).

The rate at which urbanization is occurring suggests that there is an imbalance in the population flow between the urban and the rural areas. The imbalance is based on the timing of environmental and population transitions. The people of the north are vulnerable not only because of the high rate of environmental deterioration and population growth, but also because of dislocation. Dislocation is mainly occurring among herders being pushed into "foreign territory," threatening their traditional mode of livelihood and cultural life. Furthermore, the urbanization transition also jeopardizes the standard of living for those who were already settled in the "center of attraction." Playing more attention to the needs of the rural sector can dim the intensification of urbanization. For example, if reforestation took place, more people in the rural areas would have access to natural resources and they would not be forced to go to urban areas where the situation may be worse. Because such measures are not taken into account, regional conflict exists within the Sahel between herders immigrating from the north and cultivators in the south. The rate at which urbanization is occurring creates a scramble for the limited natural resources and is accentuated by the environment and population dynamics already in play.

The Herders' Plight

Over half of the 40 million "livestock dependent" people in the world live in Africa (IUCN 1986: 28). Herding in the Sahel has been a very important way of surviving for centuries, especially in the northern parts of the region. Pastoralists are known as the "Bedouins" made up of ethnic groups such as the Moors, Tuareg, and Toubou. In the past, there was a great balance between the number of herds, herders, cultivators, and the ecosystem. For example, the animals would convert sparse vegetation into milk and meat while providing manure for farmers (Bennett 1991: 18). Among many ethnic groups in the Sahel, such as the Fulani in Mauritania, cattle are considered a form of wealth. Meat is not consumed but traded for agricultural products. If tension between herders and cultivators was minimal, what then set off the trigger between these two groups of people?

One answer is again the issue of drought, which reduces the resources for humans and livestock. The search for fertile land, especially in times of droughts, leads to permanent land degradation. This forces pastoralists to roam within smaller or marginal areas leading to overgrazing, preventing future regeneration of vegetation, and a significantly reducing productivity of the pasture. The primary erosion loop is the erosion of grass. When the grass is eaten down by the herds there is less vegetation, lower topsoil, and moisture, making erosion permanent (Meadows 1992: 128). Ironically, the drilling of more wells in order to ensure that there is at least some availability of water during droughts and the dry seasons, have also lead to more over-exploitation of land by the herders. The increase of livestock and wells, "blur the map of social control over the pasture lands" (Raynault 1997: 123). Wells create their own "center of attraction" while degrading land that they are on. Additionally, it is also the increase of livestock that eliminate fertile land in addition to human resource use, leading people and their cattle to the south.

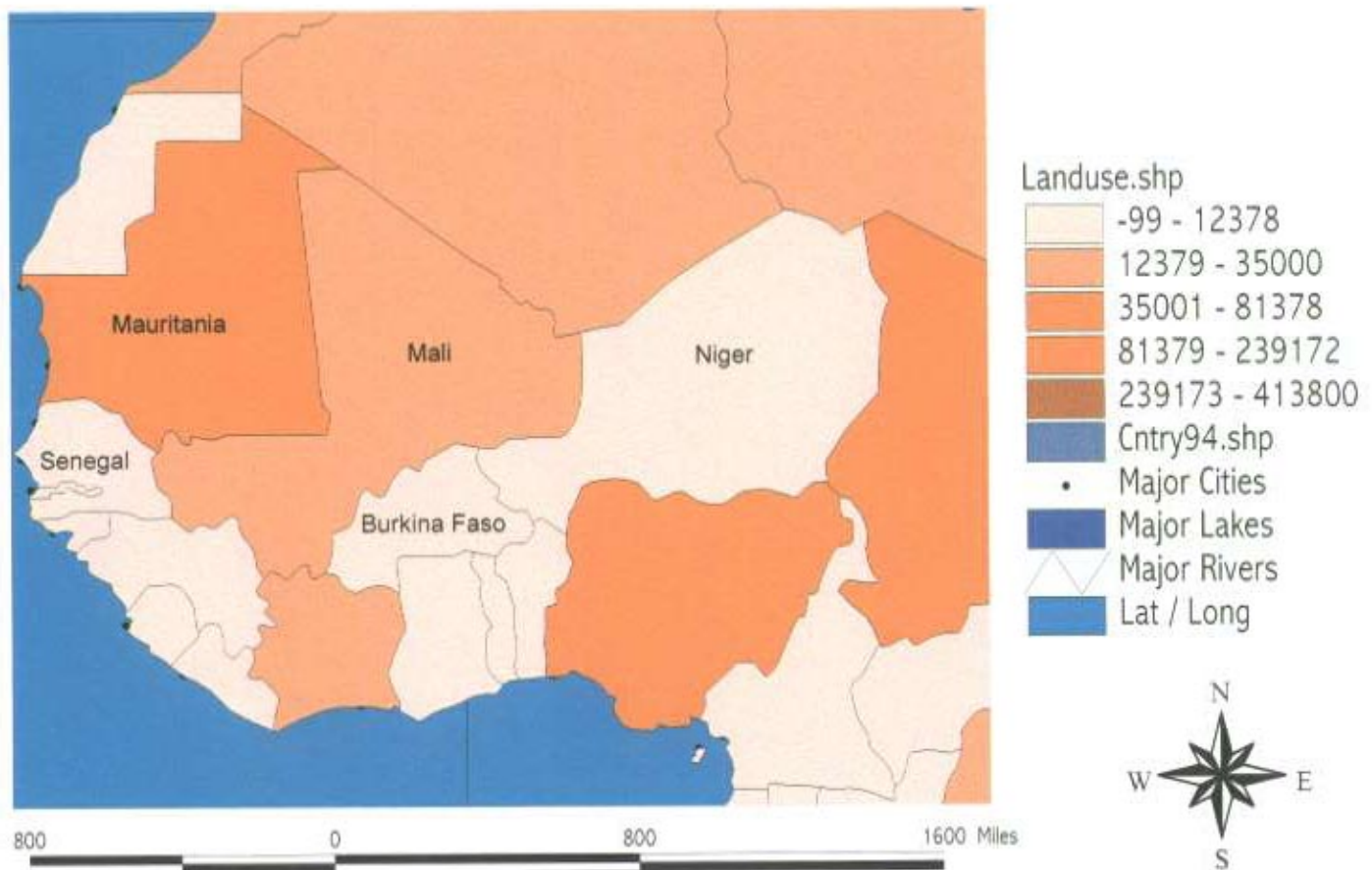
Total Number of Cattle (1,000)	Mali	Mauritania	Niger	Senegal	Burkina Faso
1990	4996	1350	1711	2740	3937
1991	5198	1400	1790	2770	4015
1992	5373	1400	1800	2800	4096

Table 2; See map on Pasture for further data; Source: Human Development Report 1995

In the south, herders are threatened by the growth of agricultural land and land privatization. Many governments in this region since independence have implemented private property laws. This automatically becomes problematic for nomadic herders because they do not believe in "artificial borders." The prejudice, especially against nomadic pastoralists, has been in existence since the colonial days where the goal was to have better control over people to secure taxes from populations with "unused

wealth." More specifically, since the 1990's the Taureg, a nomadic pastoral ethnic group in this region, have suffered rebel attacks by cultivators and air raids by the Nigerian government because they refuse to pay taxes. This conflict has spread to the Malian borders (Bennett 1991: 53-56). This example illustrates that there is no "rational" contact between the governments and nomadic populations, such as the Taureg. Not only do the people like the Taureg have little participation in the decision-making processes of the country, but the only form of contact comes through tax collection. The contact between pastoralists at the grassroots and administrative levels are as if it is through "the republican guard, who mostly behave as if they were on conquered territory, and because of this they [herders] symbolize pure violence in the eyes of the population (Bennett 1991: 57). The governments fail to recognize the limits of the environment, and the population transitions of the humans and the herds. This, thereby, marginalizes and further displaces herders. The governments' place more emphasis on cultivation.

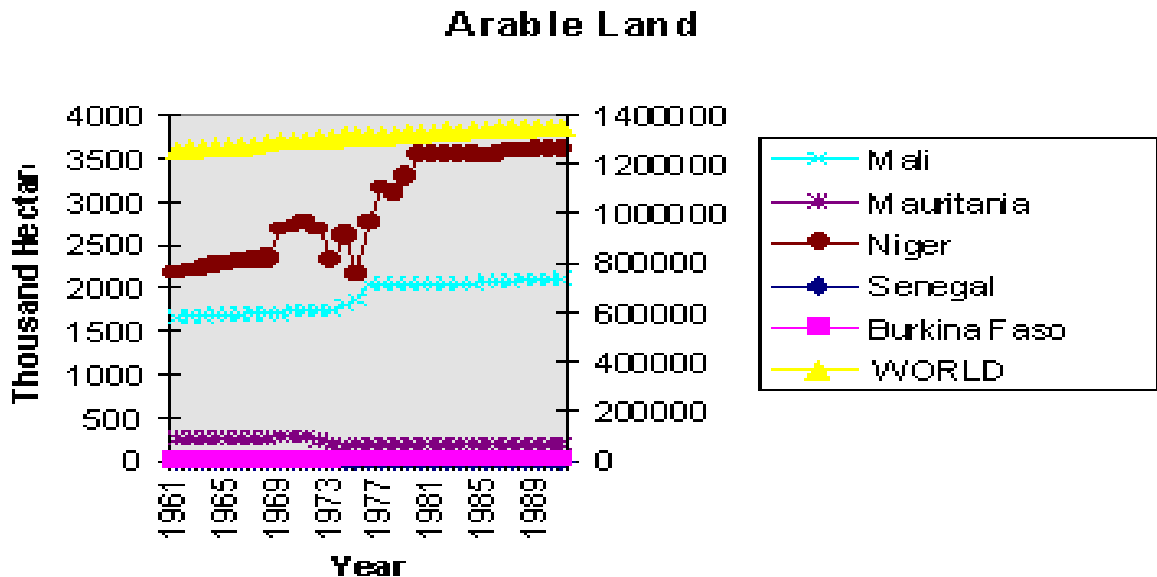
Pasture 1993 Total Hectares (000)



Agriculture

The other component of this vicious cycle is the extensification of agriculture. For instance, since 1985 in Senegal, the implementation of "structural adjustment" policies and cash cropping has increased the

quantity of farmers who arbitrarily clear land in order to be coerced into the greater national economy. Once the land has been used, farmers move on to more cultivable land. This practice not only hurts herders who may come to the same piece of land for their animals to graze only find it infertile, but it is only based on short term gains (Bennett 1991: 42). This is mainly the case because most of the farming in this region is extensive and based on shifting cultivation. Slash and burn methods are also used where lands lay fallow, reducing the amount of land available for use. When land is in short supply, the fallow period is shortened and the land no longer has sufficient amount of time to regain its production



capabilities.

Arable land is increasing majority of the areas because a greater emphasis is placed on agriculture.

Figure 5; See map on cropland for more data; Source: WRD

Nutrient mining pushes both farmers and herders to more fragile areas. Although cultivators may seem to be in a better position than herders, especially by having government support and property, there is a great disparity between rich and poor farmers. The social vulnerability between herders and farmers and among farmers themselves can be explained through the economic transitions.

The Transitions to Market Economy and Government Intervention

In conjunction with environmental and population transitions is the economic transition. The market economy and integration of agriculture into national economies influence economic transition. After independence, the goal for these Sahelian countries was not only to become "developed" but also to finance growing foreign debts. The only way to fulfill these objectives is to rely on agriculture. Agricultural production can not only feed the nationals of a country, but can also be used as export crops to receive hard currency for further development and financing debts. Governments support agriculture for sustained economic growth because it is lucrative and has the potential to alleviate poverty. Unfortunately, these theories about agriculture were not implemented efficiently. International donor agencies such as the World Bank advocated structural adjustment policies where aid would be tied to

economic stabilization. Structural adjustment policies were also highly coercive. In order to receive aid, a country had to engage in privatization and liberalization of its economy. This is not necessarily a negative policy but it has been enforced without understanding the socio-economic situation already in existence in the Sahel. Such a policy failed to take into account the costs of privatization among herders, and especially, poor farmers. This negligence has caused serious environmental deterioration and conflict.

Privatization of land through the market economy is a new phenomenon that has resulted in inequality financial as well as access to land (Raynaut 1997: 258). Traditional land entitlements laws still exists but has been nullified to a great extent with establishment of nation states. The extent of nullification varies from state to state - in Niger land belongs to those who "develop" it and in Senegal, traditional land rules are nullified. Overall, access to land is determined by who has more financial resources. Not only does this exclude herders and poor farmers who lack finances, but it is completely foreign for herders. Such a situation gives the rich farmers the option to use land unsustainably by buying more and more land without any concern for future repercussions. Additionally, due to the lack of "economic assets," the poor have no rights. They also do not have any access to credit they need to invest in the new technologies or infrastructure (Mobuguje 1995: 32). Because of this, they too encroach on marginal lands and making the future more vulnerable in terms of feeding a growing population.

The key to a successful future in the Sahel is to invest in agriculture because it has the potential of feeding more people and producing more money. However, it is not being practiced in a sustainable manner nor is the greater economy including herders in the process of economic growth and eradication of poverty. The concept of profit and the "get rich quick" phenomenon that results form privatization and liberation of the economy can lead to the "race for land" and conflict. This form of social and economic vulnerability can be reduced if governments advocate a more equality for both herders and poor farmers in terms of access to land or subsidize the poor farmers by providing them fertilizers, securing tenure rights, and educating them about soil conversation methods. In other words, emphasis must be placed on intensification of land use rather than extensification. Agricultural economists such as Ester Boserup states that population growth where "intensive agricultural practices...induce[s] more favorable attitudes toward technological and organizational innovation that will not only increase productivity, but improve environmental quality" (Mobagunje 1995: 6). It is then possible to redistribute the wealth from agriculture into other economic sectors such as herding to alleviate the herders' level of poverty and create better sustainable grazing rights. In addition to redistribution of wealth, there can be a greater initiative placed on a "double strategy" where agricultural practices can be combined with herding. Like in the past, the increase of fertilizer use, for instance, can come from herding practices. For example, there are societies in the Sahel such as the Haalpulaar of the Senegal River where the results of cultivation and herding create a cyclical pattern. In this "double strategy," the residues of the flood plain agriculture create a common grazing land, the excrement from herds provide nutrition for the fish, and the organic waste helps produce more vegetation (Raynaut 1997: 115). However, with the current means of economic growth, social conditions are "vulnerable" leading to more hardships.

Social Dimensions of the Sahel

Such traditional methods of social and land control systems are now under serious threat from both the

agriculturist and pastoral perspectives. The economic transition and the introduction of the use of money can explain the social transition. The process of integrating the local economy or those living in the rural areas into the greater world economy has put an emphasis on individualization and monetary profit. This has caused disintegration of social structures such as the family. For instance, young people and women are now investing in their own plot of land. Ironically, to a great extent, the disintegration of the lineage and family structure is reducing economic productivity because small, individual production units are unable to mobilize work force at crucial times (Raynaut 1997: 280). If family units become smaller, they may fall behind in sowing or weeding, resulting in lower productivity and extensification. The loss of one family member, especially in agricultural societies, is greatly felt because it affects future population sustainability (Raynaut 1997: 280). Additionally, those who migrate to the urban areas also pose vulnerability as family ties become disconnected. The migration for profit (although essential) can lead to anomie or alienation from the new atmosphere resulting in cultural deterioration. However, it is important to note that such reasoning is not advocating that people should remain in one place just to prevent social disruption while going hungry. The evidence of social vulnerability should be used as a sign that a significant portion of the policies made in the Sahel should emphasize the need to improve rural areas. If reforestation and better infrastructure were provided as an incentive to stay in rural areas, then social or familial disruption would be minimized.

[click here for a "theoretical diagram"](#)

Policy Proposals and Conclusion

Governments need to invest more in the rural areas and place less emphasis on maintaining the political support of urban populations, especially the civil servants, army, and the police (Grainger 1982: 61). Although urban needs are no less important, majority of the population in the Sahelian countries still live in the rural areas where effort to encourage sustainable growth should be emphasized. Initiatives should be taken to increase reforestation as a direct solution to desertification. Reforestation as a policy also has the potential to decrease the rate of urbanization and perhaps social deterioration. Maintaining a sustainable ecosystem can also come with an early population stabilization no matter what projection is used. Reducing population, through education and family planning can significantly reduce the detrimental effects on the environment (Meadows 1992: 29). However, it is important to keep in mind that population pressure is not necessarily a problem. Taking into consideration Boserup's theory on the increase of agricultural production through intensification of land use, population can be "put to work." Boserup's theory has been practiced in Machakos, Kenya and it could work for the Sahel as well. The conditions in this region improved due to initial accumulation of capital and skill (Tiffen 1994). The accumulation of capital could lead to communal investment in other sectors of the economy, alleviating poverty and improving the state of the environment. The initial capital could come from investing in agriculture.

Investing in agriculture will not only be able to feed the growing number of people, but it will also help the Sahelian governments finance foreign debts. However, agriculture will only be beneficial if it is practiced sustainably and equitably through better access to land and infrastructure. Herding communities will also be able to receive benefits through redistribution of wealth. It is evident that the importance of

herding is decreasing because it is not as lucrative and is a livelihood much harder to monitor due to its nomadic nature when considering integration into the world economy. Nevertheless, it is crucial for governments of the Sahel to integrate herders, a significant part of the population, into development. If all of these policies just suggested are practiced effectively, the Sahel should see fewer tensions between herders and farmers over scarce resources.

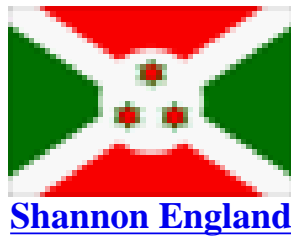
All the transitions presented in this paper have positive feedback loops where the increase in environmental degradation increases population vulnerability and urbanization. The current haphazard economic transition, increases inequality and social vulnerability. Because the conglomeration of these four transitions that are out of sync with each other, they foretell the future of overshoot and collapse. With the data and the analysis provided, it is highly likely that the carrying capacity of the Sahel will collapse because the "signal from the limit is delayed" and the environment is "overstressed" (Meadows 1992: 128). The rate at which the population is growing, the environment is being used, the economic and social pressures are forcing people to use the land extensively, will lead to the collapse of the resource base leading to an ever-present state of vulnerability. Interpreting these signals correctly and making policies for long-term sustainability is essential in order for the Sahelian people to live sustainably and without violence.

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[Link to Relationships](#)

Exploring the Relationship Between Environmental Scarcity and Violent Conflict: A Case Study of Burundi



I. Introduction

Since the overthrow of President Melchior Ndadaye in October of 1993, Burundi has been locked in a gruesome civil war. Although estimates vary considerably, it is acknowledged that, at a minimum at least 160,000 Burundians, mainly civilians, have been killed in the massacres. A brief literature search using 'Burundi' and 'Violence' as key words turned up over a thousand news articles over the past two years. A glance at some of the more recent headlines about Burundi from the past year illuminates the magnitude of violence continuing to affect Burundians today:

November 6, 1997, *"54,000 Burundians returned from Tanzania to the Eastern and Southern Provinces of Burundi. Violence has forced a standoff in the government's move to dismantle 43 'regroupement' sites holding over 250,000 people. Many more refugees in Tanzania and the Democratic Republic of Congo are unwilling to return to their homes."*(Africa News)

September 2, 1997 *"OAU chairman Robert Mugabe warned that sanctions imposed on war torn Burundi will stay because the ruling junta appears not to have moved toward the return of democracy. 'they haven't done anything . . . and there is still the military regime.' stated Mugabe"* (Agence France Presse).

July 24, 1997, *"We visited [regroupement] camps in about five of the sixteen provinces. And the conditions in many of these camps is really quite shocking. We saw extensive malnutrition. There were a number of adults starving to death . . . and also we found it virtually impossible to speak with anyone who had not had members of their direct family killed by the armed forces of Burundi during the rounding up period , which took place from March-September of 1996."*

(All Thing's Considered)

July 16, 1997, *"The wife of the National Assembly was wounded when her car ran over an anti-tank mine in Bujumbura on June 30 . . . In Cibitoke province, armed men killed 26 civilians between July 2nd and 6th according to eyewitnesses. . In Bubanza province Burundi civilians reported that they were afraid to leave their regroupement camps because it was not safe for them to return home. They added that they were unable to work in their fields because of fighting . .In Maramvya outside of Bujumbura, a nutritional survey*

conducted by Action Contre la Faim in February found rates of severe malnutrition at 18% and global acute malnutrition rates of nearly 24%." (Africa News)

May 2, 1997, "The army announced this week that it had killed at least 300 Hutu rebels in Bururi since April 6th . . . in another incident, the military claimed that suspected rebels killed 38 high school students and seven teachers in an attack on a school at Buta near Bururi. At least another 40 students were wounded in the attack"
(Reuters World Service)

April 2, 1997 "Fighting killed 147 people last Thursday in Tumonge, Southwestern Burundi, during engagements between the Tutsi-led Burundian army and Hutu rebels." (The Xinhua News Agency)

March 13, 1997 "Residents in Burundi's capital city were caught unawares by anti-tank mines that killed at least six people yesterday . . . the mine attacks follow a foiled assassination attempt earlier in the week on President Pierre Buyoya." (Inter Press Service)

January 30, 1997 "The nation's mainly Tutsi army, which grabbed power in a coup last year, has killed at least 1000 people since the beginning of December, said the United Nations human rights office in Geneva . . .the Hutu rebels are also accused of massacres of civilians and are responsible for killing at least 58 people in the same time period."
(Los Angeles Times)

The natural question for anyone reading these articles or for anyone affected by the tragedy of war is always 'Why?' Attempting to understand the causes of any particular violent conflict is not an easy undertaking and there is never a simple explanation for violence. Attempts to clarify will almost inevitably lead to oversimplifications, nonetheless, the effort to understand - and hopefully to prevent - violent conflict is important. An interesting question about violence was once posed to public health practitioners in the United States by the Surgeon General, and it changed the way we think about violence in our own society. The reality is that the question applies equally well to any society plagued by violence: *"If violence is not a public health issue, then why is it killing so many people? It is a good question and the issue deserves serious attention by scholars.*

Recent scholarship on international conflict has focused on the interaction between environmental scarcity and violence. Thomas Homer-Dixon is a professor of Political Science at the University of Toronto and co-director of the Project on Environmental Change and Acute Conflict. To date the project has researched several different countries and regions as case studies for the many hypotheses generated about the relationship between environmental scarcity and violent conflict. These have included studies of Bangladesh, Egypt, Senegal, El Salvador, Honduras, China, and Haiti. More recent work has focused on the Gaza strip, Mexico, Pakistan, South Africa, and Rwanda.

I propose to examine Burundi as a case study for applying these models of environmental scarcity. I will also incorporate ideas of transition theory as explained by William Drake, Professor of Public Health at

the University of Michigan, to develop an understanding of the complex relationships evident in Burundi's current and past crises.

II. Overview of Burundi

Geography

Burundi is a small nation in Eastern Africa surrounded by Rwanda, the Democratic Republic of Congo, and Tanzania. (See [Map 1](#).) The total area of Burundi is 27,830 square kilometers with 25,650 square kilometers of land, approximately equal in size to the state of Maryland. The country's climate is temperate with a hilly and mountainous terrain. There is a plateau in the east and plains along the coast of Lake Tanganyika. Arable farmland accounts for only 43% of the total land. Approximately 35% of the land is used for pasture and raising cattle. Soil erosion is growing problem in Burundi due to both overgrazing of cattle and expansion of agriculture into marginal areas. Soil exhaustion is also becoming a concern in some areas. Deforestation of Burundi's land is almost complete with less than 2% of the country currently covered by forests, primarily in designated national parks. Trees are cut down mainly for firewood fuel.

Population

The most recent estimates for Burundi's population place it at 6,088,000 as of mid-1996. This represents an almost 250% increase in population since 1950. The population growth rate for 1996 is estimated at 2.9%. (See [Chart 1](#).)

Burundi's extreme population density of 237 people per square kilometer places it fifth in Africa just behind Rwanda and the island nations of Comoros, Reunion, and Mauritius in terms of population density. If only arable land is taken into account, Burundi's population density approaches 551 people per square kilometer. Comparative statistics with some other countries noted for high population densities highlight the magnitude of current population pressures in Burundi. (See [Charts 2, 3](#), [Map 2](#)) ([Click here for a larger version of Map 2](#).) Population pressures are also not evenly divided in Burundi, some areas are much more densely crowded than others. (See [Map 3](#).)

Ethnicity

Burundi's population is very similar ethnically and culturally to its neighbor Rwanda to the north. There are three main ethnic groups in Burundi: the Hutu, who comprise approximately 85% of the population, the Tutsi, about 14% of the population, and the remaining 1% consisting of Pygmy Twa, South Asians and Europeans.

Burundi's ethnic divisions, like Rwanda's, are often depicted as representing centuries old animosities, originating with distinct tribal divisions that inevitably must lead to war. In reality, however, the divisions between the Hutu and Tutsi are not nearly so simple to explain and any reference to "tribalism" as a

explanation for conflict in Burundi is essentially meaningless. Burundi is an anomaly in a continent of states with artificially constructed borders in that it was a 'kingdom' long before colonization and has been a "national entity" for centuries. Moreover, both Tutsi and Hutu speak the same language in both Rwanda and Burundi- in Burundi the language is known as Kirundi. Hutu and Tutsi also share the same social organizations and have never been separated geographically. In fact, Hutu and Tutsi have lived literally side-by-side, and mostly peacefully, for centuries. The issue is further complicated in Burundi due to the fact that Burundi's kingdom was ruled, not by the Tutsi as in Rwanda, but by a ruling class of royalty known as the Ganwa, considered neither Tutsi nor Hutu, but rather seen as having origins and legitimacy with both groups.

The distinction between Tutsi and Hutu, historically, was based much more on socio-economic divisions than upon ethnic lines. Considerable intermarriage between "Hutu" and "Tutsi" was common, as was movement between groups. The term "Hutu" originally had more to do with social status and hierarchical relationships than with ethnic identity. In Kirundi the word was traditionally used to connote one who was in a subordinate position to another.

Because of the importance of ethnic distinctions in Burundian society today, much discussion by both Tutsi and Hutu centers around perceived physical differences between the groups. Tutsi are often described in the media as 'tall, thin, beautiful people, descendants of a Northern Hamitic population of pastoralists' and the Hutu as 'darker, shorter, Bantu stock, traditionally agriculturalists.' The fact of the matter is that it is not always possible for Burundians to distinguish a 'Hutu' from a 'Tutsi' on physical characteristics alone. Many Burundians do not fit the stereotypes of their ethnicity and many are killed for it when violence erupts. The historical distinction of the Hutu as agriculturalist and the Tutsi as pastoralist probably has a bit more truth to it, but the reciprocal nature of cattle tending in traditional Burundian society was more of a *uniting* factor for Hutu and Tutsi than a divisive one.

A full discussion of the pre-colonial relationships between Hutu and Tutsi is beyond the scope of this paper, but the important point is that ethnic conflict in the region is not the historical reality that many assume. For more information about pre-colonial society in Burundi, interested readers should refer to Rene Lemarchand's book Burundi: Ethnocide as Discourse and Practice, Woodrow Wilson Press, (1994).

Economy

Burundi is a resource poor country, described by some as being in an early stage of economic development. The economy is dominated by the agricultural sector and 90% of Burundians depend upon subsistence level farming. The main crops for farmers are coffee, tea, sorghum, sweet potatoes, bananas, manioc (cassava), meat (cattle and goats), and milk.

Burundi's per capita income is one of the lowest in the world at \$210. The UNDP 1994 Human Development Report lists Burundi as second only to Rwanda for having the highest percentage of people living in poverty: eighty four percent of Burundians are estimated to live in absolute poverty. (See [Chart 4.](#))

Foreign exchange for the government is dependent upon the nation's coffee crop which accounts for 80% of the country's foreign exchange earnings. This dependence on one crop leaves Burundi's economy extremely vulnerable to both climate change and to market changes in world coffee prices. (See [Map 4](#) for a depiction of Burundi's main agricultural zones.)

Health Indicators

The overall poverty rate in Burundi is reflected in several health status measures: the most notable of them being average life expectancy. A Burundian's average life expectancy is only 50.2 years, compared with 76.2 for North Americans and 64.7 for the world wide average. (See [Chart 5](#).) Many Burundian children are subject to malnutrition resulting in growth problems. According to the UNICEF report on the State of the World's Children, almost half of the children in Burundi are suffering from malnutrition induced wasting and stunting.

(See [Chart 6](#).) Burundi is, in fact, among the worst fed countries in Africa: only about 84% of the country's daily per capita food supplies are currently being met. (See [Chart 7](#).) Maternal mortality in Burundi is also very high, estimated at about 1,300 deaths per 100,000 live births. Contraceptive prevalence is extremely low with less than 1% of married women reporting the use of any contraceptives at all.

III. Theories of Environmental Scarcity and Violent Conflict

The central questions posed by scholars interested in the link between the environment and conflict began first and foremost with speculations about population growth. Given past growth rates, within the next fifty years or so, the total population of the earth will probably surpass nine billion people. Unless radical changes are implemented, global economic output is expected to grow exponentially alongside of total population. If we accept the notion that the earth has finite resources, the next question becomes this: what happens to human populations when resources become scarce?

In his article "On the Threshold: Environmental Changes as Causes of Acute Conflict" Thomas Homer-Dixon poses the question of what happens when renewable resources of agricultural land, forests, water resources, and fisheries become scarce: In his words: "*If such 'environmental scarcities' become severe, could they precipitate violent civil or international conflict?*" Based on research of specific cases, he presents his own answer to the question in his follow-up article, "Environmental Scarcities and Violent Conflict: Evidence from Cases."

"In brief, our research showed that environmental scarcities are already contributing to violent conflicts in many parts of the developing world. These conflicts are probably the early signs of an upsurge of violence in the coming decades that will be induced or aggravated by scarcity. The violence will usually be sub-national, persistent and diffuse. Poor societies will be particularly affected since they are less able to buffer themselves from environmental scarcities and the social crises they cause. These societies are, in fact, already suffering acute hardship from shortages of

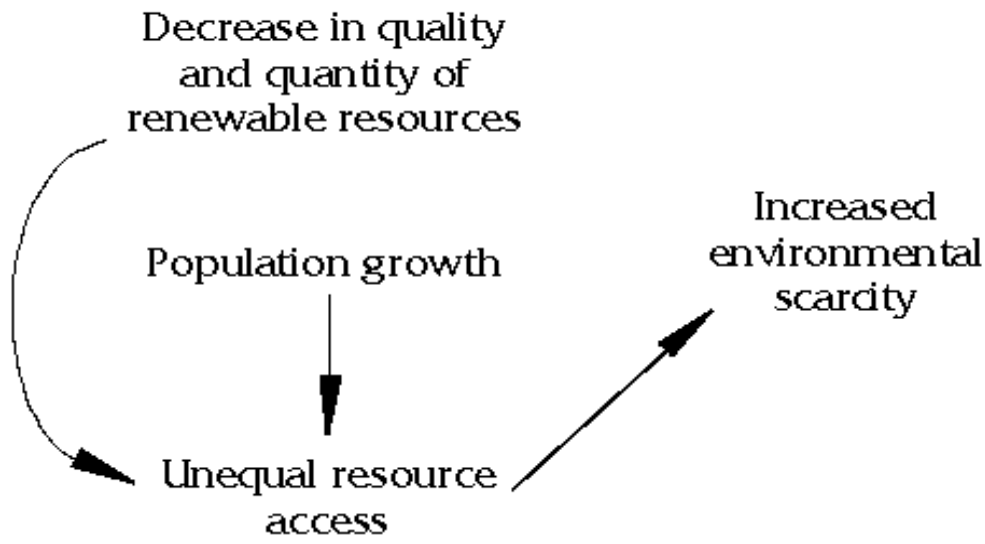
water, forest, and especially fertile land.

Social conflict is not always a bad thing: mass mobilization and civil strife can produce opportunities for beneficial change in the distribution of land and wealth and in the processes of governance. But fast-moving, unpredictable, and complex environmental problems can overwhelm efforts at constructive social reform. Moreover, scarcity can sharply increase demands on key institutions, such as the state, while it simultaneously reduces their capacities to meet those demands. These pressures increase the chance that the state will either fragment or become more authoritarian. The negative effects of severe environmental scarcity are therefore likely to outweigh the positive."

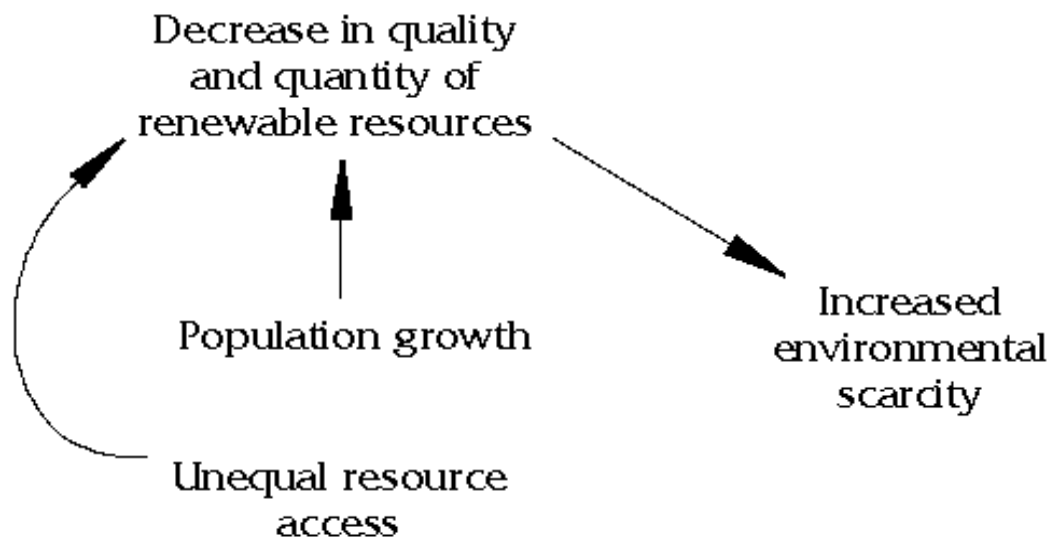
The concept of environmental scarcity defined by Homer-Dixon refers to three main sources of scarcity of renewable resources: environmental change, population growth, and unequal social distribution of resources. Environmental change occurs when human induced activity produces a decline in the quantity or quality of natural resources at a rate faster than it can be renewed by natural processes. Population growth creates a situation where *per capita* availability declines as resources are split amongst a growing number of people. Unequal resource distribution causes environmental scarcity by concentrating resources in the hands of a few at the expense of the many.

These three causes of environmental scarcity can and do interact to produce even more extreme results. Two such patterns of interaction, "Resource Capture" and "Ecological Marginalization," are described in Figure 1. "Resource Capture" is described as a situation where environmental changes resulting in a reduction in available renewable resources combine with population growth to encourage elites within a society to shift resource distribution in their favor. Severe environmental scarcity is the result for the majority. "Ecological Marginalization" describes a situation where unequal access to resources combines with increased population growth to force migrations to regions that are ecologically unstable. High population densities and a lack of capital or knowledge necessary to protect natural resources, in turn, results in increasingly more severe environmental changes leading to greater environmental scarcity for all.

Figure 1: Resource Capture and Ecological Marginalization



Resource Capture: Resource depletion and population growth cause unequal resource access.

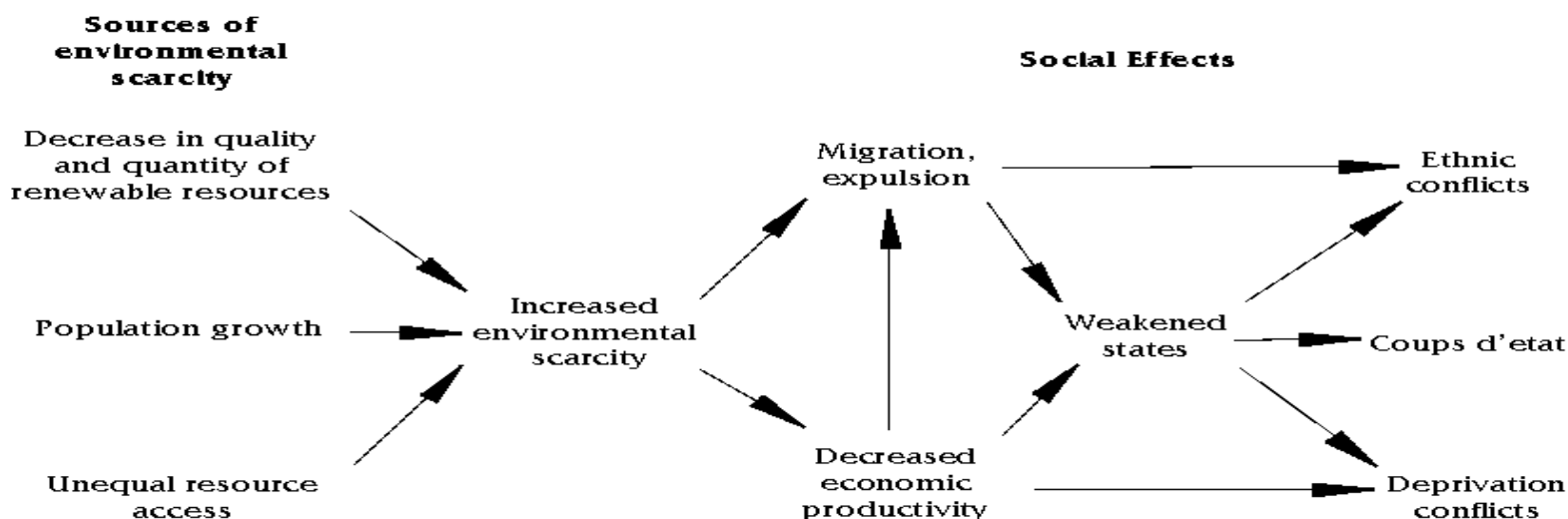


Ecological Marginalization: Unequal resource access and population growth cause resource degradation and depletion.

How does environmental scarcity cause violent conflict? A model of the sources of and possible consequences of environmental scarcity is presented in Figure 2. First, environmental scarcity may cause population movement which can lead to "group-identify conflicts" conceivably leading to violence. Migrations of newcomers may also place new demands upon states and decrease their legitimacy.

Environmental scarcity can also lead to violence by contributing to increased economic deprivation, resulting in a decreased legitimacy of the state.

Figure 2: Some Sources and Consequences of Environmental Scarcity



Homer-Dixon is careful to note that economic deprivation *in and of itself* does not lead directly to violence. Notions of 'deprivation' are subjective and poor people do not necessarily revolt. First, they must believe that they have a right to economic well being. Societies with fatalistic attitudes about deprivation are unlikely to be as prone to violence as are those where the poor believe they have a right to economic and social justice. Second, the economic deprivation must be severe and persistent enough to erode the moral authority of the state. The probability of civil violence is also increased when groups centered around social cleavages (class, ethnicity, religion) are already in existence and can mobilize aggrieved individuals to action.

The theory further speculates that conflict induced in this manner is likely to be sub-national, diffuse and persistent. Environmental scarcity has cumulative impacts as it can lead a society into a continuous spiral of decline by encouraging widespread population movements and increased economic despair. Violence is also likely to increase in intensity as environmental scarcities increase. For states affected by environmental scarcity, Homer-Dixon predicts one of two outcomes: fragmentation and a decreased ability to control their regional territories or, alternatively, the state may become authoritarian and militarized in an attempt to control internal challenges to authority.

It should be noted that Homer-Dixon and his colleagues are not without their critics. The critics argue that simply because environmental scarcity and violent conflict may happen to coincide in a particular region this *does not* imply that you can prove causality. Many possible causes of conflict can usually be identified and focusing on one particular cause (environmental scarcity) is unlikely to explain very much. Moreover, even if causality could be proved, by only studying cases where conflict and environmental scarcity are both in evidence, scholars in the field have left themselves open to the charge that the research does little to add to the overall body of knowledge. After all, ideally research would be directed at finding *solutions* to the problem of violence and conflict engendered by environmental scarcity- and not simply at proving that such a connection exists. By not examining a "control group" of countries or

regions that have avoided conflict despite severe environmental scarcity, potentially useful "model cases" are overlooked.

Thomas Homer-Dixon addresses some of these issues in a rebuttal specifically addressing both methodological techniques and the problems inherent in studying environment and population dynamics. He points out that all too often those analyzing violent conflict have focused on politics and have simply failed to consider the independent limits inherent in some environmental systems, as well as the resulting effect of those limits upon rational actors responses. In addition, "threshold" effects evident in many systems may lead to a situation whereby environments pass a point of irreversibility. Environmental scarcity in these systems will have long reaching effects upon human systems regardless of economic or political responses to the problem. He argues that ignoring such an important variable when analyzing violent conflict is not the answer.

Homer-Dixon also argues that identifying "control countries" to match up to specific "experimental countries" would be virtually impossible given the highly complex nature of environmental and political interactions. His argument is that case studies focusing on areas where clear relationships between violence and environmental scarcity exist may help scholars identify potential relationships that can then be used to study conflict in other areas, and that case studies are a necessary first step to understanding those relationships.

IV. Is Environmental Scarcity Related to Violence in Burundi?

Introduction

A brief introduction to Burundi's current political crisis will perhaps help to clarify a very complex situation of ethnic tension. An understanding of the historical situation is also crucial to interpreting any of the relevant data on environmental scarcity to be presented. The question remains, however, "*Is environmental scarcity related to ethnic violence in Burundi? And if so, how?*" In attempting to answer these questions in light of Homer Dixon's theories, it is perhaps best to focus on the availability of different renewable resources in Burundi over time. Water resources are not scarce in Burundi. For the most part, people have access to enough water to meet all of their personal and agricultural needs. Renewable resource sectors to examine then become the following: agriculture, fisheries, and forests. Because population growth is also necessarily related to environmental scarcity, it will additionally be useful to look at trends in Burundi's population growth over time. Transition theory, as described by William Blake in his article, "Towards Building a Theory of Population-Environmental Dynamics: A Theory of Transitions," will be used to speculate on Burundi's stage in these four different sectors over time. Finally, the history of recent violence in Burundi will be analyzed in light of this data and its relationship to current theory about environmental scarcity and conflict.

Historical Overview of Recent Violence in Burundi

Patterns of Recent Violence

Since independence from the Belgian administration in 1961, Burundi has experienced several major periods of ethnic turmoil and violence. As mentioned previously in the introduction, Burundi's most recent period of conflict began in October of 1993 with the assassination of the first democratically elected Hutu President in Burundi's history. During this most recent period of conflict, there have been upwards of 160,000 deaths with perhaps as many as 1,600,000 people dislocated from their homes.

In 1991, a period of violence claimed between 4,000-6000 lives. There were over 5,000 Burundians killed by ethnic violence in 1988, and in 1972 over 100,000 Burundians were killed by their fellow countrymen in one of the most gruesome massacres in African history. In 1965 a wave of killing took the lives of approximately 5,000 Burundians. Charts [8](#) and [9](#) depict very conservative estimates of the number of those killed and the number of those forced from the country due to violence since 1961.

The conflict in Burundi today is explained as a simple conflict for power between Hutu and Tutsi, but it cannot be understood completely without also considering intra-group rivalry between the ruling Tutsi elite. Each of the aforementioned outbreaks of violence involved to some degree a grappling for power of the state amongst different factions of the ruling Tutsi classes. Each wave of violence, too, is necessarily connected intimately with the ones preceding it. Indeed, violence and the memory of violence permeates the political consciousness and the meaning of ethnicity for all Burundians. One must also consider the history of Rwanda to understand Burundi. Due to cultural and historical similarities, the political situation and crises in Rwanda have always had a profound effect on subsequent events in neighboring Burundi.

The political and historical events leading up to each of Burundi's massacres have been duly noted elsewhere and the story is not a pleasant one. A brief summary in this paper cannot do justice to the subject, but the story perhaps begins with the assassination of Burundi's first ever Prime Minister designate the Prince Louis Rwagasore on October 13th, 1961.

Post-Independence Burundi

Prince Rwagasore, a member of the UPRONA party was assassinated in a plot by the rival PDC party (perhaps in conjunction with the departing Belgian regime) only one month after winning the election on the eve of Independence in 1961. The tragic death of Prince Rwagasore sent Burundi down a path of violence that some believe could have been avoided. Rwagasore's popularity, charm, and perhaps more importantly, his legitimate claim of descent from the Ganwa royalty may have served as a unifying factor in a country that was destined to become very ethnically divided.

Rwagasore's death marked the beginning of a crystallization of ethnic identity among Burundian elites. The Rwandan revolution and the establishment of a ruling Hutu government in Kigali also served, for both Hutu and Tutsi elites, as a demonstration of what could potentially happen in Burundi. Majority rule with a distinctly Hutu government in place was a prospect looked upon favorably by Burundian Hutus and decidedly not so by Tutsis. An influx of Rwandan Tutsi refugees escaping from violent conflict poured into the Northern provinces of Burundi. These refugees, as many as 50,000 in number, directly spread ideas of ethnic hatred in Burundi that could not help to fan the flames of a rising sense of an identification based upon ethnicity in Burundian elites.

In 1963 and 1964, soon after independence, the Tutsi and Hutu elite were jockeying with the monarchy (made up of the 'Ganwa') for control of both the government and the UPRONA party. (Burundi was created as a constitutional monarchy at the time of independence from Belgium in 1961. UPRONA was the dominant political party.) The intrusion of external cold war factors tipped the balance of power to the Tutsi with the "Congo Rebellion" in Eastern Zaire. The Chinese wished to use Burundi as a base to transfer ammunitions into Zaire. In exchange, they agreed to provide financial support to the Tutsi elite in Bujumbura. Tutsi refugees from Rwanda also entered into the equation because they wanted to use Burundi as a "safe-haven" from which to wage a war against the Hutu government in Rwanda. Rwandan Tutsi thus had a vested interest in helping the Tutsi in Burundi to gain power over both the Hutu and the Royal Crown and they soon became pivotal in the events that would unfold.

On January 18th, 1965 a Rwanadan Tutsi shot Burundi's Hutu Prime Minister Pierre Ngendandumwe. The event sparked outrage amongst the Hutu elite. The monarchy, sensing its legitimacy quickly slipping away, called for general elections to be held for both a new Prime Minister and National Assembly. The Hutu emerged from a legislative victory in May of 1965, capturing 23 out of a total of 33 seats in the National Assembly. Hutu elites naturally expected that a new Hutu Prime Minister would be placed into power. Instead, the monarchy selected a famous "Ganwa," Leopold Biha, to the position. Meanwhile the government, increasingly controlled by the monarchy, decreed that the number of communes (subsets of provinces) would decrease from 181 to 78 and that the elected leaders of the communes (most of whom were Hutu) would be replaced by functionaries appointed by and responsible to the court. This blatant attempt to concentrate and increase power into the hands of the ruling monarchy was not well received by either the Hutu or Tutsi elites.

Hutu elites responded in anger with an attempted coup against the ruling monarchy in October of 1965, a response that was to prove disastrous for them later. The coup attempt failed and troops loyal to the Crown regained control as the King and his courtiers fled to Zaire in panic. Hutu elites were then accused by the Tutsi of being disloyal to the government and attempting to establish a Hutu revolution similar to what had unfolded in Rwanda. Thousands of Hutus were killed in the purges of the army and the government that followed. All Hutus with any political standing were killed, and with the monarchy in exile, power came to rest exclusively with the Tusti elite.

The repression was brutal, resulting in at least 5,000 Hutu civilians being killed, mostly in the provinces of Bujumbura and in neighboring Muramvya. Surprising though it seems now, most of the rest of the country remained relatively calm, and relations between Hutu and Tutsi were fairly peaceful. The fighting among the "elite" for power seemed to have little impact on the day to day lives of Burundi's rural population. In the urban areas, by contrast, polarization around ethnic identity was fairly complete.

Besides the complete elimination of the first generation of Hutu leaders, one other notable effect resulting from the failed coup was the extreme weakening of the monarchy. The Court and most "Ganwa" were still in exile and it was not until March of 1966 that the King decided to entrust power to his son the Prince Charles Ndizeye. The reign of the new king, crowned Ntare, was to be a short lived five months. The Tutsi led government and military moved against the new king while he was away in Zaire celebrating the

first anniversary of President Mobutu Sese Seko's rise to power.

The abolition of the monarchy following the Tutsi led coup in 1966 probably sent the final blow to national unity in Burundi. In Burundi, in contrast to Rwanda, the ruling monarchy class or "Ganwa" had always served as a unifying factor for Hutus and Tutsis. Both groups, although occasionally in direct conflict with the monarchy, generally acknowledged the perceived legitimacy of Ganwa rule. The Crown had thus served as an intervening factor in diminishing Hutu and Tutsi perceived ethnic differences.

The First Republic

The new Tutsi led government, known as the First Republic, was led by President Michel Micombero. President Micombero was a Tutsi of the Hima clan from the south of the country, Bururi. He filled his government with his fellow clansmen. Of the seventeen military officers in his newly formed National Revolutionary Council (NRC), 8 were from Bururi and only 3 were of Hutu origin. The National Assembly was abolished and a military rule established. The UPRONA party was called upon to be the "unifying force" for an increasingly divided Burundian society.

The new government, despite its rhetoric, was hardly democratic and far from a "unifying" force. The struggles that were to follow stemmed from a conflict between Tutsi and Hutu, but also between Tutsi and Tutsi. Different Tutsi clans, based both on regional and historical kinship lines, struggled for control of the state. The threat of Hutu insurrection, with the example of Rwanda ever present in their minds, was often used as a tool by the ruling government to bring any potential Tutsi competitors for power back into line. Specifically, reference to the 'Hutu peril' as used by those from the South to accuse competitors from the North as being too 'soft' on the Tutsi-Hutu 'problem.' As Muramvanya was the site of the deposed King, Tutsi from this region were also accused of seeking to re-establish the monarchy, which supposedly could not happen without Hutu support. Purges of the army and government of 'Hutu elements' continued. A particularly harsh repression began after an accused Hutu rebellion plot was "uncovered" in 1969. Whether or not there was any basis for the charge is unclear, as there was no documentation, but the state sanctioned killings that resulted certainly were clear. What few Hutu remained in the government were clearly "tokens" and the remaining Hutu elite began to feel increasingly insecure.

In the same way that the Hutu "problem" was related to intra-group conflict among the Tutsi, similarly, Hutu insurrection in Burundi was always preceded by perceived weaknesses in the ruling government. Hutus sought to exploit the opportunities they saw in the deepening rift between Tutsi elites from the North (Muramvanya) and those from the South (Bururi). Violence erupted full force in Burundi in 1972 after just such an attempt by Hutus to wrest power from the increasingly brutal Tutsi regime. The Hutu insurrection occurred in April of 1972 after the well publicized and much discussed trials of several Muramvanya Tutsi and Ganwa by their Southern Tutsi rivals from Bururi. The Hutu uprising began in the south of the country in Nyanza-Lac when Burundian Hutus invaded from across the border of Tanzania. Assisted by Zairean troops, Hutu insurgents attacked the military outposts in Nyanza-Lac and Rumonge. Simultaneous attacks also occurred in Cankuzo and Bujumbura. In Rumonge and Nyanza-Lac, Hutu began to slaughter every Tutsi in sight. Most of the victims were civilians and estimates are that as many as 3,000 Tutsi were killed. Also killed were any Hutu that attempted to resist the slaughter.

The official interpretation of the insurrection varied widely. Some claimed that it was a plot by the former ex-king Ntare, who had returned to Burundi from Zaire, and, it was claimed, had plotted with foreign mercenaries to reinstate the monarchy. Others claimed that official high-ranking Hutus had collaborated to finance a rebellion. The historical facts hardly matter, as the repression that followed the insurrection made enemies both of the suspected 'monarchists' and the Hutu officials. They were, in fact, accused of plotting together. In the slaughter that followed, Hutus throughout the country were executed in large numbers. The ex-king Ntare also was summarily executed. The bloodbath was carried out over several months in a chilling and systematic manner. In an effort to wipe out the Hutu elite entirely, every Hutu male with any education at all was accused of conspiracy against the government. In a call to "rise up against the python in the grass" Tutsi were advised to slaughter all Hutu males down to even the grade school level.

"Army units commandeered merchants' lorries and mission vehicles, and drove up to schools, removing whole batches of children at a time. Tutsi pupils prepared lists of their Hutu classmates to make identification by officials more straight forward."

In many areas of the country, Hutus fought the rebels alongside of the Tutsi, only to be later slaughtered in turn. If anything served to cement the hatred of Hutu for Tutsi, it was this systematic execution that took place throughout the country. Never again would the political struggles of the elites be seen by the rural population as irrelevant to their lives. The scale of the killings varies. Some conservative estimates say 100,000 people, others claim the number is closer to 200,000. In addition, at least 150,000 Hutu fled Burundi to neighboring Tanzania and Zaire to live in exile.

The systematic nature of the killings can probably only be understood by noting the cycle of fear by now implicit in the relationship between Hutu and Tutsi. Many Tutsi saw the elimination of the Hutu as the 'final solution' necessary to protect their well-being. As had happened in the South, they feared a slaughter of every man, woman, and child of Tutsi origins. This fear was compounded by the anti-Tutsi violence that shaped Rwanda's history from 1959-1962. The Tutsi elite hoped to not only eliminate the perceived immediate threat to their well being, but also to inspire fear and terror that would be remembered for generations to come. It should also be noted that, although most of the victims were Hutus, many Tutsi were killed as well. Particularly targeted were any of the remaining Muramvanya Tutsi accused of monarchism. Many Tutsi also died attempting to protect their Hutu friends and neighbors.

While not all Tutsi were involved in the genocide, many clearly benefited from the deaths. Transfer of property to Tusti seems to have been a major inducement to violence in some areas. Those killed were robbed of their money, personal belongings, lands, and livestock.

After this ethnic cleansing, the only 'elites' in Burundian society were of Tutsi origin. A strict rule of 'Kirundization' of the schools was instituted whereby it was against the law to teach French in all government schools. This effectively served to prevent Hutu children from learning the language of governance, restricting it to the realm of the wealthier and ruling Tutsi. Because admission to higher levels of education was predicated upon a knowledge of French, Hutus were effectively blocked from

rising to positions of prominence in society. The army became even more Tutsi dominated, to the extent that nearly 100% of the recruits and officers were Tutsi.

The Second Republic

On November 1, 1976, Burundi's state structure underwent another profound change with the coup d'etat placing into power Lt. Col. Jean-Baptiste Bagaza. The Second Republic was a time of consolidation of Tutsi rule and an attempt to codify into the national law and discourse an official view of 'National Unity,' meant to restore the moral legitimacy of the state. The official view of history propagated by the government at this time was mostly an attempt to legitimize Tutsi rule through the ruling UPRONA party. Hutu were almost entirely excluded from political participation. By late 1987 only 2 seats out of 65 in the Central Committee of Uprona's party were held by Hutus. To prevent claims of ethnic favoritism or discrimination in educational or public life, the Second Republic simply banned the public discussion of ethnicity. Anyone publicly referring to Hutu or Tutsi ethnic identities was charged with inciting 'racial hatreds' and arrested. Individuals were issued identity cards that had to be carried with them at all times. Rural Hutu were, for a time, organized into "villages" in a nationwide campaign of "villagization." Ostensibly to increase agricultural yields in a "development scheme," the move was, in reality, an attempt to exert greater control over the Hutu communes. The project ultimately failed, but it is an example of the lengths to which the Tutsi dominated regime went to officially denying the real motives for its actions.

Divisions and cleavages within the ruling Tutsi hegemony would once again lead to a renewed cycle of violence in Burundi. This time the church played somewhat of a role in the ensuing violence that was to come. The Catholic Church, as well as several Protestant denominations, had been establishing schools and organizing community-based projects for rural Hutu. These activities threatened to undermine the carefully constructed power structures that the Tutsi rulers had created. In addition, the UPRONA party leaders remembered the crucial role of the Catholic Church in the "emancipation" of the Hutu masses in Rwanda in the 1950s. Several Church affiliated leaders also began to speak up for Hutu labor groups and (illegal) political parties.

The state responded by severely restricting the activities of churches in the country. New rules were made restricting the appropriate days for worship and meetings. Religious broadcasts were banned and foreign missionaries were expelled. Religious primary schools were closed in 1977 and all religious secondary schools were closed in 1986. Informal 'catechism schools' organized for Hutu school children by the Catholic Church were also forbidden. Some 220,000 children were denied basic schooling in this manner. By 1987 the government had expelled approximately 550 foreign missionaries from the country.

Increasing levels of church-state antagonism, including arbitrary arrests of several Catholic clerics, aroused the attention of the international community. Belgium reviewed its technical assistance program to Burundi in light of the human rights abuses surrounding the Church. The French also began to take notice. Suddenly the antagonism of church and state began to threaten a large amount of foreign exchange currency. In addition, several high ranking Tutsi were affiliated with the Catholic Church. The usual and continued nepotism and corruption of the regime also made it vulnerable to challenges of its authority by other Tutsi elites. The 'trigger event' of the coup of 1987 appears to have been the early 'retirement' of

several officers in the military due to economic austerity. One batch was dismissed in 1986, with another to follow in 1987. The members of this group, who saw no other options for employment in the civilian sector, orchestrated the bloodless coup d'etat of September 3, 1987.

The Third Republic

The Third Republic was established with Major Pierre Buyoya as the new President of Burundi. Like his predecessors, President Buyoya was a Tutsi from Bururi and so much of the state's apparatus remained in place. Important changes were beginning, however, first with the repeal of restrictions on the Church, and second, with the release of several hundred Hutu political prisoners. Hopes were raised among the Hutu population that real change and political liberalization was in order. Student strikes were held and mainly Hutu students participated. Hutu were said to be engaging in clandestine meetings in the North with Hutu from Rwanda. Ethnic tensions increased and minor conflicts between Hutu and Tutsi began to occur throughout the country. The growing tension and anxiety on the part of Hutus was based in part on fears of a repeat of the 1972 massacres.

Tensions were highest in the North in Ntega, Ngozi Kirundo. Proximity to Rwanda also played a role as there were many Tusti refugees living in the two provinces. Coffee was the main economic support for the region and the drop in world coffee prices in the mid 1980's heavily impacted this region. Many Hutu producers reaped large losses. Competition for scarce social service resources (schools, health care, etc.) in the region also heightened tensions. When a confidential document was discovered that showed that the central government in Bujumbura had requested Kirundo primary schools to report their ethnic breakdown of students, tensions flaired. In a climate where any mention of ethnicity was officially banned, the document seemed to support Hutu suspicions of admission requirements based on ethnicity designed to keep their children out of schools. Finally, local elections where the Hutus won 84% of the vote were seen to be meaningless in a context where the communal level administrator was appointed by the central Tutsi government. These so-called "sham elections" played a large role in exacerbating Hutu frustrations. As tensions began to mount the gendarmes were called in to patrol Ngozi, causing widespread panic among the Hutu peasants who remembered 1972 all too well. In Ntega, Reverien Harushingoro, a known Tutsi collaborator in the 1972 massacres, was seen showing groups of army men the way from hill to hill. This was the spark that set the killings in motion.

On the night of August 14, 1988, a group of Hutu surrounded Harushingoro's house, clearly intending him harm. Harushingoro opened fire on the crowd, killing six people. Violence erupted and the Hutu killed Harushingoro and his family before fanning through the area killing Tutsi and burning their homes. Ethnic hatred caused a massacre of every Tutsi in sight and hundreds of civilian Tutsi lost their lives over the next few day. The army, of course, moved in to restore 'peace and order' and upwards of 15,000 Hutus were killed in retaliation. More than 50,000 Hutus fled to Rwanda to escape. Analysts agree that the fear of an apocalypse reminiscent of 1972 probably played a large role in the initial Hutu killings of Tutsi. The feelings of fear, related to earlier killings of Hutus, were sparked when troops began arriving in the area. Rumors, combined with the collaboration of Habushingoro in speaking with the army, led to the preemptive violence by Hutus.

Response to Massacres of 1988

The future of ethnic relations in Burundi was eerily predicted in the letter written by Hutu protesters to President Buyoya following the massacres:

*"Social injustices and inequalities are a reality which has been legitimized by the authorities . . . Power in Burundi remains regional, clanic, and above all tribal, but in the meantime, unfortunately, **the pie is getting smaller and smaller every day.** . . . Someday history will tell us how the events of Ntega and Maranga have deteriorated into a bloody conflict that spread to other communes. Although the story is now shoved under the rug by the media, the future will tell . . .'" - Open letter to President Buyoya by 27 leading Hutu intellectuals, 1988*

The predicted violence did not happen right away, however. Compared to 1972, the difference in the regime's response to the massacre of 1988 was quite positive and dramatic. The difference was due in large part to international pressures. Unlike in 1972, when the U.S. and the world turned a blind eye to violence in Burundi, changes in international perspectives on human rights meant that the killings in 1988 generated outrage on the part of the international community. The World Bank and the U.S. threatened to cut off financial assistance unless "national reconciliation" was achieved. International pressure did what it was supposed to do. On October 12, 1988 Buyoya agreed to a major reshuffling of his cabinet with the number of Hutu cabinet members increasing from 6 to 12. He also selected a Hutu to become Prime Minister.

Under President Buyoya, Burundi was to undergo a period of increasing liberalization and integration of Hutu members within the government. These efforts culminated with the election in August of 1993 of the first ever Hutu President in Burundi's history, President Melchoir Ndadaye. This did not happen without struggle. The army continued to be dominated by Tutsi 'hard-liners' who wanted no part of democratization. Additionally, revolts by Hutu in November of 1991 in selected parts of the north of Burundi (Cancuzo and Cibitoke) were systematically repressed and several thousand Hutu were once again killed. President Buyoya also survived an abortive coup by Tutsi hardliners in March of 1992.

The election held in August of 1993 pitted President Buyoya, a member of the traditional UPRONA party (primarily the party of Tutsi- but also claiming some Hutu who were encouraged by the liberalizing changes in the party) against the Hutu Melchoir Ndadaye, part of the FRODEBU party (Front de Democraties du Burundi) which came to represent the majority of Hutu in the country. The election was a landslide victory with FRODEBU clearly gathering the majority of votes. ([See Map 4](#)) President Buyoya stepped down gracefully and the Hutu people rejoiced at the fact that one of their own was in power. The rejoicing was to be short lived. In October of 1993 Burundi was once again thrown into the by now all too familiar downward spiral of ethnic violence and killing.

Ethnic Violence Begins Again

The violence started when several units of the Tutsi dominated army stormed the Presidential Palace on the night of October 21, 1993, and abducted, and subsequently killed, President Ndadaye. They also killed

the President and Vice President of the National Assembly and three cabinet ministers. When news of the assassinations got to the communes, Hutu supporters of the FRODEBU party reacted with rage. Every Tutsi in sight, as well as Hutu UPRONA supporters, were seen as legitimate targets for attack. Tens of thousands of innocent Tutsi civilians lost their lives in fighting that was originally contained in the Northeast and Central parts of the country. Men, women, and children were hacked to death with machetes and Tutsi houses and fields were burned. The subsequent retaliation by Tutsi soldiers was equally horrific: entire Hutu communities were attacked by soldiers with machine guns. The coup of October 1993 ultimately failed but the damage had been done. An interim government ruled for a while and another military coup eventually displaced the ineffective 'transition government' in July of 1997.

Burundi is now locked in civil war and has been since 1993. Burundi is ruled by a military-controlled dictatorship lead by former President Buyoya, who came once again to power in the coup of July, 1997. Recently, the government has taken to requiring Hutu to live in 'regroupement' camps in the interior of the country. This aids in solving the problem the army had faced in controlling the rural population over the past few years. "Hutu rebels" had continued to prevail in the communes and fight against the military, which controlled most of the towns. Conditions in the rural camps are said to be "horrific" in the words of one aid worker. The prevalence of disease and malnutrition is high. Sporadic violence continues throughout the country and several hundred people are killed every day. Very conservative estimates place the number who have been killed in the range of 160,000- 200,000 people. The conflicts in neighboring Rwanda and Zaire have also affected the situation in Burundi. Rwandan Hutus' systematic massacre of over 500,000 Tutsi has made many Burundian Tutsi reluctant to ever reconsider liberalization or democracy. They literally define the "problem" as a matter of Tutsi ethnic survival. The possibilities for a solution to the current crisis between Hutu and Tutsi seem limited at best and bleak at worst.

The reasons that the Tutsi military ended Burundi's experiment with democracy in 1993 originate with two facts: 1.) Buyoya was planning to reduce the Tutsi presence in the military and to allow a more equitable representation of the population prevail, and 2.) Buyoya planned to return land to Burundian refugees who had fled Burundi in past years. The Tutsi hard-liners realized full well that the lands would come from current Tutsi occupiers and they felt that this was unacceptable. The actions of two units of the military were unfortunately enough to spark the violence that has consumed the country to this day.

Hypotheses Linking Environmental Scarcity & Conflict in Burundi

It is clear that a multitude of factors were evident in the pattern of violence that has dominated Burundi since independence. A look at several trends over time in Burundian society, with the political situation as a backdrop, can perhaps shed some light on the situation. Several hypotheses of how conflict might interact with environmental scarcity in Burundi should be presented at this time. They include the following:

Hypothesis #1: Hutu eruptions against Tutsi control were the result, at least in part, of increasing environmental scarcity due to both population growth and environmental degradation. Competition for these scarce resources forced Hutus to revolt against increasingly repressive Tutsi control. Revolts were "triggered" in part due to Tutsi

appropriation, through the mechanisms of the state, of those same scarce resources.

Hypothesis # 2: Conflict between Tutsi factions was a result of decreasing economic viability of the country's resource base due to environmental scarcity. Tutsi competitors viewed the state as a mechanism for gaining access to increasingly scarce resources, with the end result being violent conflict.

Hypothesis # 3: Because resources were becoming increasingly scarce, episodes of killing by the Tutsi against the Hutu population were motivated in part by the Tutsis' desire to obtain access to Hutu resources.

The evidence in support of these possible hypotheses will be examined in the sections to follow.

Population

Burundi is in the early stages of the demographic transition. While death rates from disease have fallen over the past 50 years or so, birth rates have not slowed enough to prevent the population from growing exponentially. This increase in population has contributed greatly to the pressures on the land. As mentioned earlier, Burundi is one of the densest nations in Africa at 230 people per square kilometer. If only arable land is considered, Burundi's population density approaches 551 people per kilometer squared. The trends in crude birth and death rates over the past fifty years in Burundi are presented in [Chart 10](#). This has resulted in the exponential growth noted previously in [Chart 1](#). Burundi's population growth trend best fits an exponential curve. If current growth continues, Burundi's population will approach 12,000,000 by the year 2030. (See [Chart 11](#)). If this happens, Burundi will have a total population density approaching 470 people per square kilometer. Clearly Burundi must find a way to maintain a sustainable population by lowering its birth rate before this happens. To date, this has not been the case. Burundi's total fertility rate is very high at 6.8 children on average per woman. Both Burundi and Rwanda have had little success in lowering their fertility rates. As is evident in [Chart 12](#), there has been little change in this rate since 1950. Today less than 1% of Burundian women say they use birth control at all. Changing this fact is crucial to Burundi being able to maintain a healthy population. The population is not divided evenly in Burundi. [Map 3](#) shows population densities in Burundi by province.

Agricultural Sector: Food

Burundi has been able to maintain increases in food production since 1961. [Chart 13](#) shows the food production index for Burundi between 1961 and 1995. The index is based on 1979-1980 crop production. As is evident from the chart, production in 1994 was 30% higher than in 1979. Burundi also compared favorably with both the World and with Africa in terms of raising production levels. This growth was obtained primarily through improvements in agricultural practices, such as increased use of fertilizers. [Chart 14](#) depicts the growth in total fertilizer consumption in Burundi.

The growth in production is misleading, however, when you consider Burundi's population growth and its

relationship to total available land. [Chart 15](#) illustrates the fact that almost all of Burundi's arable land that is currently being used for farming. As is evident in the graph, there has been almost no increase in arable or permanent cropland since 1969. [Chart 16](#) shows the decreasing farmland available per person. The decline began in 1970 and has been dropping ever since. The net result is that per capita food production has also been steadily declining since 1979. (See [Chart 17](#).) The precipitous drop in 1995 probably reflects disruptions in the agricultural season due to ethnic conflict. Burundi, although historically self-sufficient in food, is becoming increasingly unable to feed its people. It is interesting to note also that although the world on a whole has been producing more food per person since 1979, Africa has done worse during that same time period.

Agricultural Sector: Coffee

As noted earlier, coffee makes up 80-85% of Burundi's foreign exchange currency. The crop is also the main source of income for the majority of Burundians. Fluxuations in price or climate quality for growing coffee beans can seriously threaten Burundi's economy. The world price of coffee dropped in the 1980's. The effect of this drop is clearly apparent in [Chart 18](#) which shows a steady but very slow growth in the GNP from 1980 through to the present. [Charts 19](#) and [20](#), Gross Domestic Product Per Capita and Gross National Product Per Capita, both illustrate that the economy as well, did not keep up with the country's population growth. Since the early 1980's, the average Burundian has been getting poorer and poorer over time. There is little evidence to suggest, however, that environmental degradation led to decreased coffee production. [Chart 21](#) shows the production of coffee from 1971 to 1989. Although coffee production has fluctuated over time, in response primarily to changes in world coffee prices, there is no evidence to suggest a trend of decreasing coffee production over time.

Agricultural Sector: Cattle

Cattle production is important culturally to many Burundians. Cattle in Burundi generally are not exported, they are stored as wealth or they are eaten at festivals, weddings, and parties. [Chart 22](#) examines cattle stocks in Burundi since 1961. In 1980, total stocks of Burundian cattle started to decline rapidly. The reason for the precipitous decline in cattle production is unclear. The government of Burundi states only that "counts are inaccurate" and that "people seemed to be slaughtering more of their animals for cash." One possible explanation might be the decrease in available land as more marginal grazing land was converted to food production. Another possible theory might be that as coffee incomes dropped, rural farmers began relying on their cattle as a "saving account" to support them in hard times. The data could, however, simply reflect a change in reporting or data collection methods. The data are somewhat interesting but it should be noted that 98% of Burundi's total food supply comes from crop foods, and only 2% from cattle. Although cattle are culturally important to Burundians, the issue of cattle production is unlikely to have affected the majority of Burundian in the same manner that crop food production would have

Fisheries

Fish are taken from Lake Tanganyika by Burundian fishermen at a fairly low rate considering the size of the population in Burundi. The data in [Chart 23](#) shows a somewhat cyclic pattern to annual fisheries catches from the lake. There appears to be no evidence, however, that overall stocks have declined. Data from two separate sources show very disparate findings, an illustration, perhaps, of the variability and inconsistency of the data. Fish are also not likely to play a large role in ethnic conflict in Burundi as they account for less than 1% of Burundian's food production or diet.

Forests

The final data I proposed examining showed that despite the fact that deforestation may be a problem in Burundi, it is one that happened well before independence. Forest cover is currently less than 2% of Burundi's land and it has stayed at that level for approximately the past 30 years. FAO data report that Burundi has approximately only 85,000 hectares of forest cover left, mostly in national parks that are poorly maintained and at risk for people seeking firewood. Changes in access to forest resources, however, are unlikely to have had much effect on ethnic violence in Burundi, as they have been low and relatively constant until quite recently.

Conclusions

The initial analysis showed that, if any renewable resources are likely to have played a part in Burundi's ethnic violence, that resource was access to land. The data also highlight the fact that population growth has played a tremendous role in environmental scarcity in Burundi.

Conservative estimates for ethnic violence, when plotted against population growth as in [Chart 24](#), and cropland per person, [Chart 25](#), do appear to show a somewhat positive correlation between violence and scarcity of land. The sharp increase in population that began in 1970 corresponds with the sharp increase in violence noted in 1972. Additionally, there was a marked decrease in available cropland that immediately preceded the violence of 1972.

What about the spatial data? Did violence occur in Burundi in areas where scarcity of land was a problem, or was there no association at all? Results from studying maps of outbreaks of violence in Burundi ([See Map 5.](#)) shows that in the earlier periods of violence, 1965 and 1972, there appears to be little correlation between where the violence began and where population densities were highest. In 1965, violence did erupt in the two most densely populated provinces, Bujumbura and Muramvya, but politics probably played a much greater role in this than environmental scarcity. Bujumbura was the capital city and Muramvya was the site of the deposed monarchy. In 1972, violence began when Hutus in exile from the repression of the late sixties attacked from across the border of Tanzania. The outbreaks of violence were initially focused, therefore, in the South and East of the country, areas with relatively low population densities. It should be noted, however, that the violence in 1972, although it began in the South and East, quickly spread to encompass all of Burundi. Some historical evidence indicates, moreover, that Tutsi were in fact appropriating land from Hutus during the massacres that occurred at this time.

In the more recent outbreak of violence, there appears to be a higher degree of correlation between violence and population densities. ([See Map 6.](#)) This higher degree of correlation in 1993 would be appropriate, given that over time land has become increasingly more scarce (as per capita land availability has decreased). In 1991, violence erupted to a smaller degree in Cankuzo and Cibitoke, areas with medium population densities. One more interesting correlation may be noted in [Map 7](#), which shows the results of the Presidential elections of 1993. There appears to be a loose association between population density and discontent with the ruling UPRONA party. Those provinces with the highest population densities were also the ones most likely to register discontent with the status quo and to vote for the opposition party of FRODEBU. [Map 8](#) displays population density, election results and violence on one map.

I also studied a map of coffee production by province, as it has been suggested that in 1988 it was not, in fact, access to agricultural land which caused distress in Burundi's Northern regions, but in fact, declines in world coffee prices in the Eighties. The map presented shows that Burundi's two largest producers of coffee in 1988 were Karuzi and Kayanza, neither of which were the location of the outbreaks of violence in 1988. ([See Map 9.](#)) Violence was most serious in 1988 in Kirundo and Ngozi provinces. It *does* seem probable to suppose, however, that decline in coffee prices in the Eighties, which led to governmental financial difficulties, was the cause of the Tutsi elites fight for power and the Coup d'Etat of 1987 that placed President Buyoya in power. It was the "forced retirement" of several Tutsi military elites that sparked the coup. The uncertain period which followed probably contributed to the likelihood of violence and tension that resulted. Violence was highest, however, in areas where there was the most pressure for land.

Based upon the small amount of evidence presented, therefore, I believe there is support for Hypothesis # 1 and Hypothesis # 3, but not Hypothesis # 2. Most Tutsi were dependent upon the state for their income and resources. The financial viability of the state was and is dependent upon coffee production. Total production of coffee did not appear to be declining throughout the 1960 - 1993 time period. On the contrary, coffee production ([See Chart 21](#)), continued to rise throughout the 70s and 80s, although in a sporadic manner. The stagnation of income by the government, and hence the Tutsi, therefore, probably had less to do with environmental limits and much more to do with international market forces.

Hypothesis # 1 and Hypothesis # 3 may also have both been salient possibilities for explaining the violence in 1988, 1991, and in 1993. In 1993 this is especially the case because the violence began when the government was in the process of handing both land and positions within the military to long neglected Hutus. As Homer-Dixon's theory correctly predicts, Burundi has experienced an increase in the amount of violence as environmental scarcity has grown. The theory also predicts the nature of the violence that plagues Burundi today. Violence in Burundi is diffuse and sub-national. It also resulted in first a decline in the ability of the government to control its territory and now an even greater militarization of political and social life in Burundi.

V. Discussion

Policy Implications

The results of this analysis highlight, I believe, a number of important issues in attempting to break the cycle of escalating violence in Burundi. The first notes the role that the international community can play in Burundi. The fact that democratization and liberalization happened in response to international pressure must not be forgotten. The international community has disassociated itself from Burundi since the coup d'etat placing President Buyoya in power once again. Imports and exports from Burundi have been stopped. I believe that this strategy is misguided in light of evidence that economic deprivation is only likely to heighten tensions in Burundi. Coffee exports in particular should be resumed.

The international community also, I believe, has a responsibility to actively prevent further tragedy in Burundi. It is not unrealistic to suppose that a similar level of violence to that of Rwanda in 1994, where over half a million people were killed, might also happen in Burundi. An international peace-keeping force could prove invaluable in stopping the immediate violence from escalating. If Burundi's army continues to be controlled by the Tutsi, any future prospects for peace seem unlikely. Indeed, the prospects for peace decline with each new death. Violence and human rights abuses continue daily in Burundi and must be stopped by the international community if massive and large scale massacres are to be avoided. The fact that many Hutu males have been placed in "regroupement" camps by the army is ominous, especially in light of the 1972 massacres in Burundi.

Long term solutions to Burundi's problems include an increased focus on holding those responsible for the killings accountable. An effort to improve the judicial system in Burundi is essential, and a public and honest accounting for past crimes is the only way to ensure future security and to build trust in the political system.

An increased focus on population issues must also be incorporated to help solve Burundi's long term problems. Access to agricultural land is only likely to decrease, and ignoring the reality of demographic pressures is irresponsible. Efforts should be made to improve access to contraceptives as well as to improve the education of women in an effort to lower the very high fertility rates of Burundian women.

Finally, improvements in agricultural productivity are essential for Burundi's long term stability. It is clear that Burundi will be forced to improve the productivity of the land if the country is to survive. Although some improvements, such as fertilizer use, have occurred, there is tremendous potential to be explored. Research is urgently needed to develop integrated, sustainable systems capable of producing greater yields from the land. This research should take into account the physical limits inherent in Burundi's climate and geographical location.

Problems with the Analysis and Directions for Future Research

The most serious problems with the analysis in this paper stems from the fact that accurate information about violence in Burundi is difficult to obtain. There have been very strong incentives for the government of Burundi to hide evidence of massacres and deaths. The international community has been unable to document adequately even past abuses from 1972. More recent violence, because it is still

continuing today, poses its own problems in terms of locating accurate information.

Information about ethnicity and access to property or land would also be invaluable in an expanded analysis of this topic. For political reasons, discussion of ethnicity was banned for many years in Burundi. It is only recently that the Tutsi elite have begun to speak about ethnic differences, usually in an attempt to defend the need for a Tutsi dominated army to "protect" them as a minority in a majority Hutu country. Further research would look at issues of land ownership in Burundi and specifically at transfers of land titles from Hutu to Tutsi or vice versa.

Finally, although there does appear to be a correlation between environmental scarcity and the more recent violence in Burundi, it is difficult to prove causality. This problem was mentioned earlier in connection with Thomas Homer-Dixon's analysis of violence and environmental scarcity. Case studies of the correlation between environmental scarcity and violence are only the first step towards proving the possible links.

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The Urbanization Transition in Russia

Seema Iyer

Urbanization Transition Theory

At the center of urbanization is the city, which is an ancient manifestation of cultural, political, and economic activity. Cities grow due to the positive feedback cycle of an increasing population requiring a variety of employment, social centers, and physical amenities, which in turn require a minimum population for sustainability. In western countries, relatively recent interjectors into this cycle of growth were mass production and the Industrial Revolution which transformed the city from an agricultural outpost to an economic entity in its own right. Classical, monocentric cities arose out of industrial necessity in the 19th century when proximity to both markets and raw materials were essential due to high transportation costs. Today in the developed nations, urbanization is no longer fueled by industrialization and no longer requires the concentration of households with employment centers. Yet, the phenomenon continues in industrialized countries and throughout the world, albeit with resoundingly diverse consequences. As one in a family of transitions, the urbanization transition behaves as a metaphorical petri dish by providing the physical space for the other transitions to grow and mature. Unlike its biological counterpart, however, the space itself is in transition, thereby altering the nature of the other transitions' progression. Thus, in an effort to build upon the theory of population-environment dynamics, the urbanization transition must be dissected further into the transition of its spatial configuration. To clarify these distinctions, urbanization can be conceptually defined as the conversion of agricultural land for commercial, industrial, or settlement purposes. The spatial configuration of the urbanization can be either centralized, having a well-defined focal point, or decentralized, having multiple focal points or an even distribution of activity. The purpose of this study is to identify a possible temporal hierarchy between the spatial patterns of urban areas and the conditions under which one configuration may transition to another.

The existence of concentrated or diffused urban areas is primarily dependent on population movement. Migration patterns within a country are influenced by mobility via transportation networks and employment opportunities within the economic system, both of which are intricately related to the political infrastructure. Since the US has been politically constant for the past two centuries, the spatial transition among and within urban areas can be used as a barometer for countries experiencing political upheaval. The general trend nationally is of the spread of urban areas from the coastal metropolises of Los Angeles and the Boston-Washington, DC corridor into the less monolithic towns of the south and southwestern heartland. Locally, suburbanization around metropolitan areas has significantly encroached into the agricultural hinterland of each city not only due to the general population increase but also due to an out-migration of households and businesses from the center. This mode of development was facilitated by an extensive transportation network of railways and roadways, which has rendered the cost of mobility negligible. Slightly less obviously, an increased accumulation of national wealth has brought urban amenities such as electricity, communications, and even cultural variety to the rural areas so that differences between the two lifestyles have become more subjective. The decentralization of urban areas in the US, however, is dependent on the

historical precedent of the centralized cities. This means that diffusion has not sprouted spontaneously but has occurred because of spatial adjacency to other urban areas.

From Czarist Russia to the Russian Federation

Urbanization in Russia lies in stark contrast to the transitions in the US and the remaining western world. The fundamental difference in the nature of the population movement dictated by the ideological agenda was translated into a different spatial path. In order to understand how such extreme political and economic experimentation could have occurred in Russia, at least a cursory overview of the nation's history is necessary to provide insights regarding the Russian people and their relationship with their government. Russia's predecessor citystate, Muscovy, came into existence in the 14th century and was ruled by the despotic Romanov dynasty until 1917. The fact that one family ruled the country for more than 500 years differentiates Russia from most other countries around the world. Unlike its European neighbors who had emerged from the Middle Ages by the 15th century, Russia existed as a feudal state until 1863. Population movement was severely restricted as serfs were indentured to the land for life. Contemporaneous with the abolition of slavery in the US in 1861, the reigning Czar's decree to eradicate serfdom was not instigated by an uprising of the peasantry but instead was in response to international pressure. Unfortunately, many policies were implemented, similarly to the antebellum Jim Crow laws in the US, to insure that the serfs had very little *de facto* freedom. Since the peasants were not granted the right to own the land they had been cultivating, many began to flee to the cities due to the lack of opportunities in the rural areas. In order to appease the grumbling landowners, an internal passport system was quickly developed to curb migration. In fact, railroad development was not a national priority during this time specifically to hinder population movement. Russia remained an agrarian society throughout this time, but the inequality between the rural and urban regions became extremely acute.

While the intricate factors that lead to the "Red" Revolution in 1917 are beyond the scope of this paper, the fact that the Marxist-Leninist movement was distinctly urban-oriented is relevant to understanding the nature of the subsequent urbanization that occurred within the newly-formed Soviet Union. The government that eventually usurped power from the Romanovs had a philosophy regarding the 19th century capitalist city that was heavily influenced by the *Communist Manifesto*, written by Marx and Engels in 1848 decrying the degradation of the proletariat in large, industrial cities. The irony of the situation lay in the fact that Russia was an agrarian society at the time of the Revolution, and urban squalor was not nearly at the level of other European metropolises. Yet, the new leaders believed that industrialization was the wave of the future and would legitimize the new communist state to the rest of the world. The aggressive pursuance of economic development via industrialization was largely responsible for an explosion of urban growth (see Figure 1).

Levels of Urbanization, 1920-1970

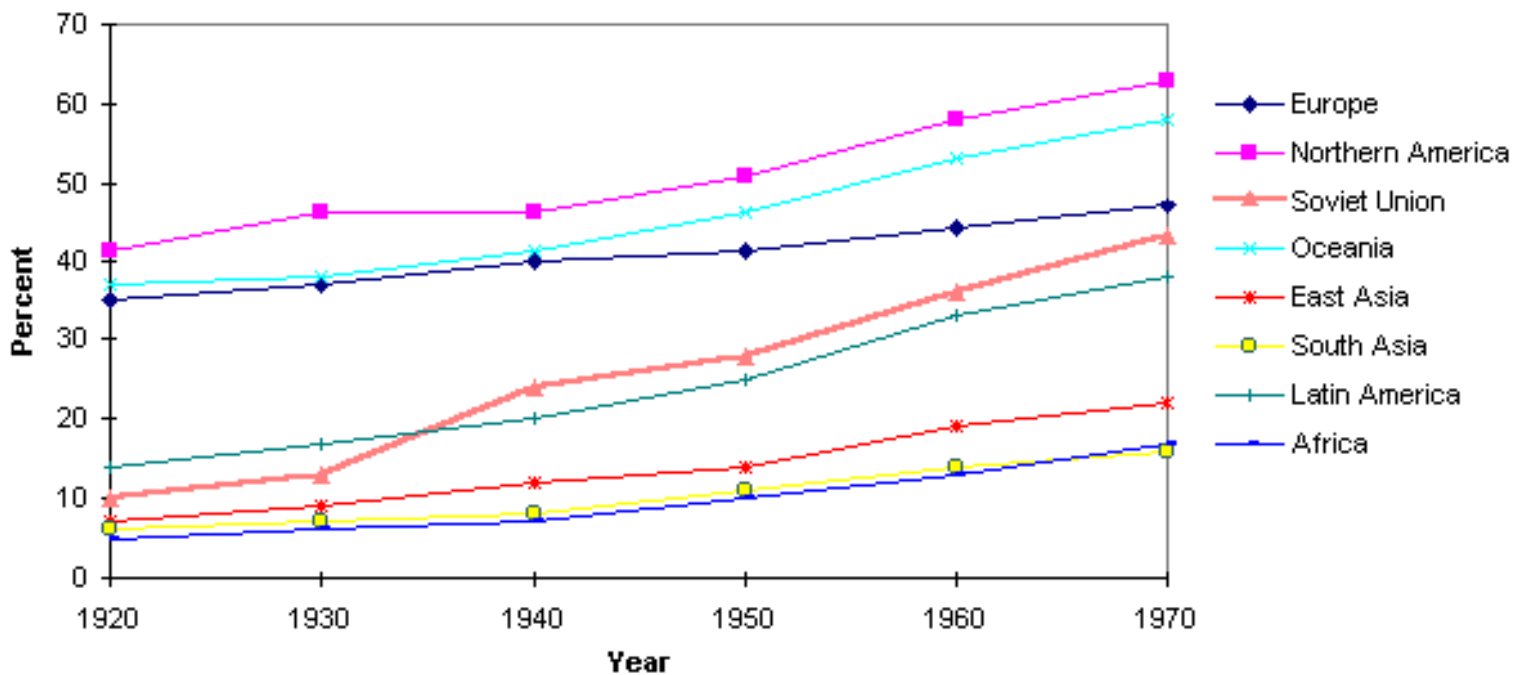


Figure 1: Level of urbanization by major world regions based on an urban definition of 20,000 or over. The level of urbanization at the time of the 1917 Revolution was much less than in the rest of Europe but the subsequent rate of increase for the Soviet Union was significantly faster than in any other region.

(Source of data: Lewis, Rowland p. 171)

With the desire to circumvent the urban degradation suffered by European cities, Soviet leaders incorporated the Marxist doctrine of equality into the distribution of urban life and urban land. Policies were designed to promote regional equality by eliminating the distinction between "town and country". As almost all of the urban growth occurred under socialism, the spatial manifestation of Marxist-Leninist ideals created a fundamentally new social geography based on an evenly dispersed population and the development of small- to medium-sized cities. With a centrally planned economy, it was theoretically possible to manipulate populations in accordance with state objectives. In order to redistribute the population, migration from the largest urban areas to under-populated areas was directly or indirectly encouraged through the creation of industrial cities in remote and/or rural areas. Borrowing a tool from economics, the degree to which Soviet policies achieved population dispersal can be determined. The Lorenz curve and the Gini concentration ratio are used in combination to measure the state of inequality using the cumulative percentage of population and the cumulative percentage of some economic indicator (see Figure 2). In a study done by Demko and Fuchs (5, p. 56), a demographic indicator was used over time to determine trends in urban concentration or deconcentration. The Gini index was calculated for the economic regions of the Soviet Union (see Figure 3) using the formula

$$G = \frac{1}{2M} n^{-2} \sum_{i=1}^n \sum_{j=1}^n |C_i - C_j|$$

where M is the mean size of all urban centers C . If $G = 0$, this implies total dispersion of the urban population in equal-sized cities; if $G = 1$, this implies total concentration of the urban population into one city.

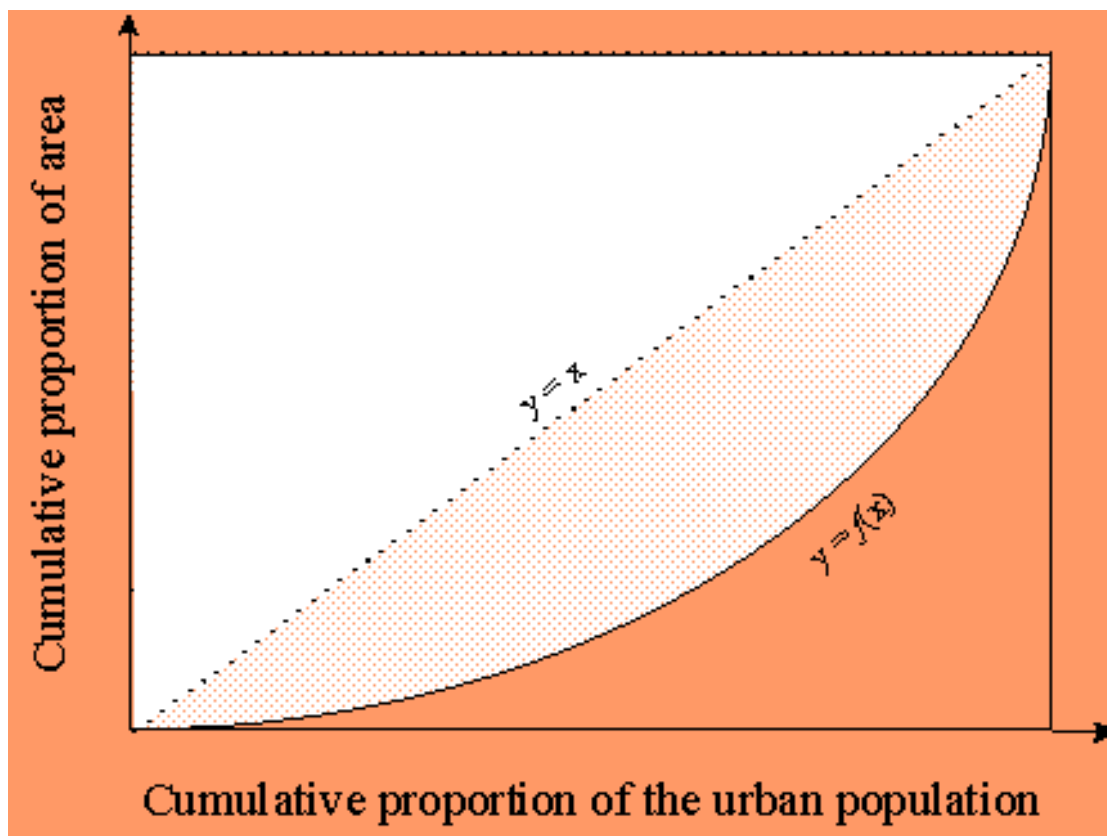


Figure 2: The Lorenz curve plotted in relation to the line of "equality". Typically, the curve is a discrete function as opposed to continuous, since data is collected as a series of points.

Gini Indices of Concentration for Cities of 15,000 or more (population) for Economic Regions of the USSR, 1897-1970

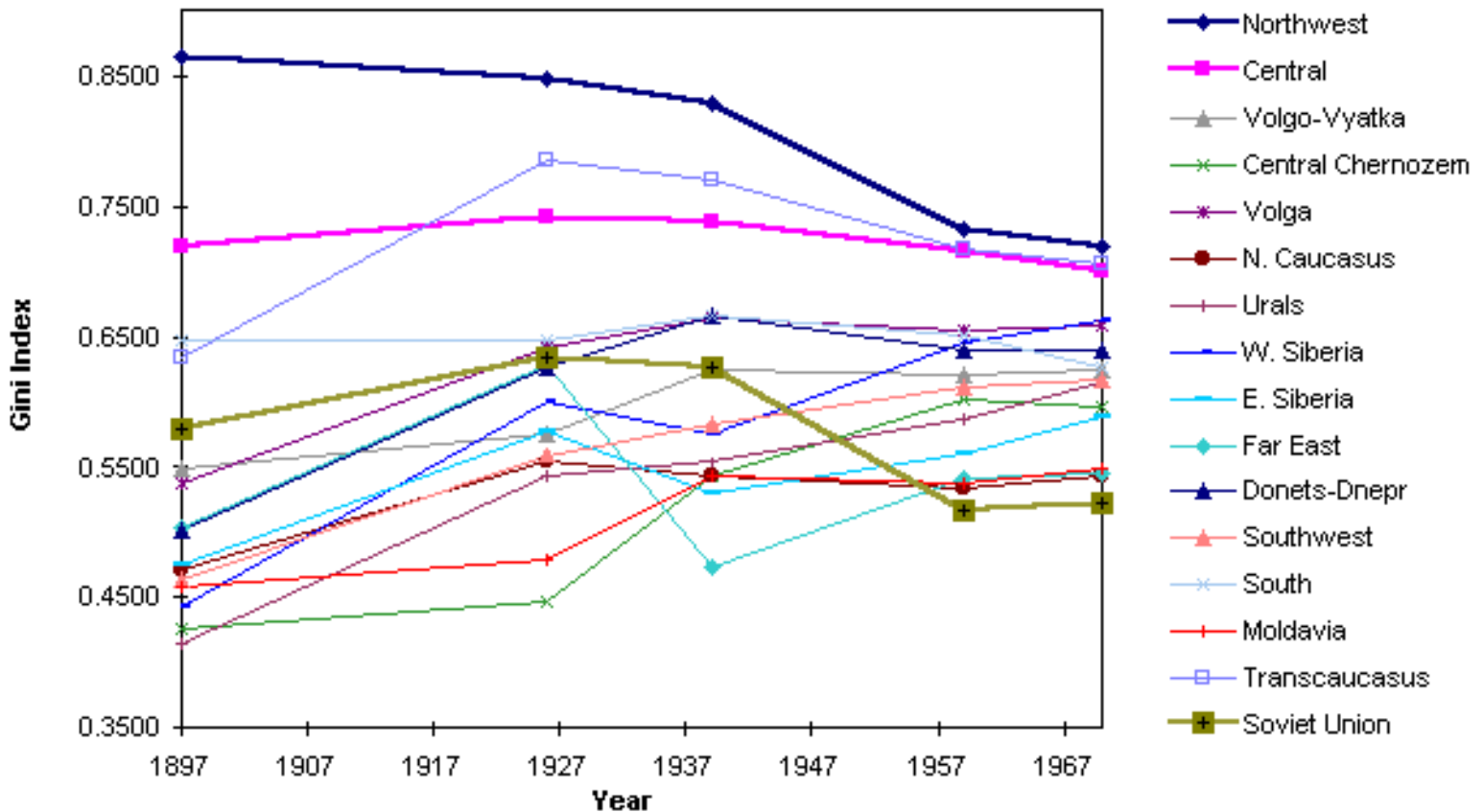


Figure 3: Gini indices of the concentration of urban areas by economic region and total of the Soviet Union.

Source of data: Demko/Fuchs p. 63

The figure shows that in spite of an initial increase in the urban concentration due to industrialization, intervention efforts to diffuse the urban population regionally did affect the index nationally. Urban concentration west of the Urals and specifically in the Northwest (St. Petersburg) dramatically declined, whereas in West and East Siberia the urban concentration increased.

The notion of an optimal city size was widely accepted in the Soviet Union as an essential element of urban policy. Beginning in the 1920s, cities with 50,000-60,000 people were considered ideal because large enough for economic sustainability yet small enough for the fostering of communal allegiances. However, as resources were solely being funneled to the urban areas, people in the rural areas were attracted to them by the mere expectation of better opportunities. In order to hold the cumulative processes of urban growth and high rates of labor turnover in check, Stalin introduced the *propiska* system in the 1930s, reminiscent of the internal passport issued during the Czarist era, which remained in effect until 1992. As the population continued to grow, redistribution became more and more difficult, and so the urban planners simply increased the acceptable population for a city. By the mid-50s the figures ranged from 150,000-200,000, and by the mid-60s, the figures moved to the 200,000-300,000 range. The only two cities with over a million population in 1917 were Moscow and St. Petersburg, and despite planners' visions and efforts, the

proportion of urban dwellers in cities with more than a million increased greater than in any other city size group (see Figure 4). By 1991, over two dozen cities existed with more than one million inhabitants.

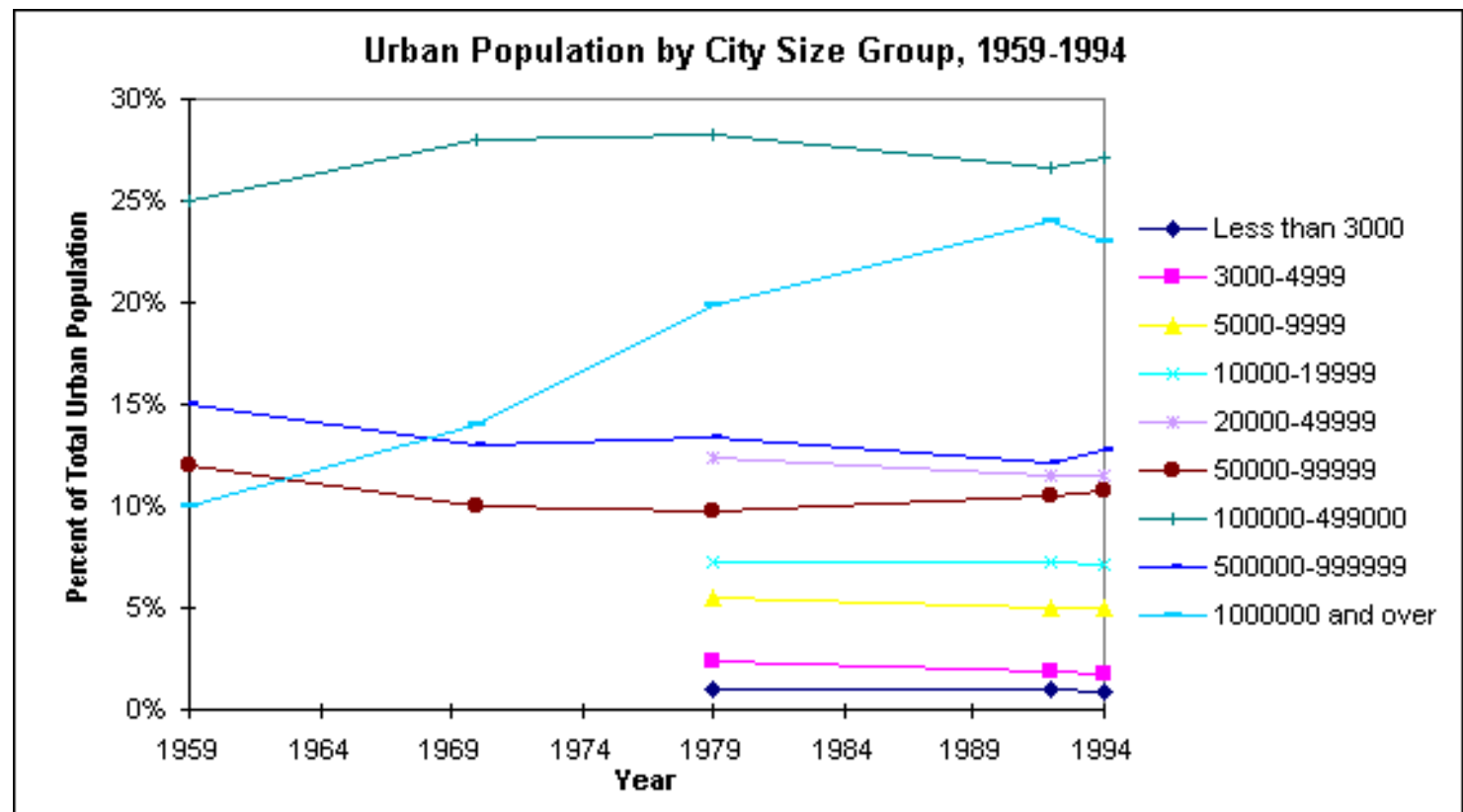


Figure 4: Percent of urban population living in each city size group. Although contrary to the central planners intention, the percentage living in cities of one million or more grew dramatically.

Source of data: Bater, p. 139

As mentioned previously, conversion to an industrialized society was effected by the creation of cities that were locationally in accordance with the precepts of Marxist geography. The employment opportunities within the urban areas were generated by the central government based on their logistical relevance to the national socialist economy, which was practically synonymous with the military economy. The war economy was propagandized for the "unobjectionable" pursuit of the union of the world's workers but furtively sought to establish the Soviet hegemony in Eastern Europe and beyond. The rationale for locating military towns in the remote, hidden areas of the Urals served the dual purpose of promoting national security and dispersing the population. But, paradoxically, many towns within European Russia itself were militarized as well. The distinction between militarization and industrialization is vague due to interconnectedness of the military and civilian economies. For example, in 1990, 100% of all sewing machines, television sets, radios, videocassette recorders, cameras, and chain saws in the country were produced in a defense complex (Gaddy, p. 20). The non-defense [single-enterprise](#) town, defined as a city with population 100,000 or more where 30% of the population are employed in one enterprise, became prevalent in the Soviet Union. The economy of scope is a concept that describes the conditions under which one firm will produce two outputs at a lower cost than would two separate firms. Soviet planners employed this concept to the process of planning itself; the agglomerate allocation of publicly owned resources within

each city possessed an economy of scope over more discrete allocations. Many towns were placed in areas without regard to the location of factor inputs or potential markets for outputs so that an efficient [transportation system](#) was essential for successful economic integration. While a concerted effort was implemented to create extensive road, rail, and waterway networks, the extreme weather conditions east of the Urals rendered large expanses of land accessible only by air. The network for the various modes of transport was developed in series, as opposed to in parallel, which meant that if one link along a travel path broke down, there was no alternative route to continue towards a destination.

The human topography inherited by the Russian Federation after the dissolution of the Soviet Union in 1992 was a piecemeal dispersal of isolated urban areas. The economic foundation that united the areas and supported their existence has swiftly collapsed. During the first few years of the transition from a planned to market economy, urban areas have declined due to a net natural decrease of the urban population compounded by a net urban out-migration (Rowland). Disaggregating the data, however, reveals that while some towns are declining or disappearing altogether, others are increasing in population. The decline of cities within 50 miles of Moscow has been referred to as *Viennaization*, the decline of a city that no longer serves as the capital of an "empire". The majority of declining towns are very small urban centers, particularly noticeable in the string of towns created along the Trans-Siberian Railroad and Baikal-Amur Mainline, which are both in terrible states of disrepair. Disappearing towns are both small in size and relatively newly-formed, which means, relating back to the positive feedback cycle for urban growth, that a sufficient stock of people had not yet accumulated in these cities to overcome the negative feedback of out-migration. As Figure 4 shows, the percentage of urban population has increased since 1992 in cities with populations between 100,000 and 999,999. Within this category are the secret [military towns](#), located primarily in the Urals, which were previously closed to the general public. These cities had a higher standard of living and higher wages both regionally and nationally and employed an extremely educated workforce. Due to the sensitive nature of the missile and nuclear bases around which these cities were built, international funds have been invested into these towns thereby building an economic base and attracting people from the rural areas.

Moscow

The spatial configuration of urbanization within the city boundary is dependent upon the micro-level interaction over space of housing, employment opportunities, and transportation networks. Prior to 1992, central planners controlled the construction of housing and transit systems and created the jobs, thereby actively configuring the socialist city. A marked difference between capitalistic and socialistic cities lies in the nature and intensity of land use. In the Soviet system, political and bureaucratic power governed the use and quantity of land consumed. As cities expanded, new rings of development were added to the periphery of the existing city. Within each concentric ring, land use reflected the demography, technology, and resources at the time when the ring was developed. For example, except for [Moscow's](#) historic city center, the Kremlin, all urban growth occurred after 1917. A ring of industrial development approximately 5-7 kilometers from the center was built in the 1920s (see Figure 7c). Housing was assigned based on availability, and as the population continued to grow, land for the construction of new settlements was allotted beyond the industrial ring and successive residential rings. In a market city, changing land prices exert pressure simultaneously in all area of the city, which can provide powerful incentives to recycle already developed land in the inner rings when the existing use is not economically optimal. For households,

the cost of housing was uniformly low in proportion to household income (2%), and transportation costs were constant regardless of the distance from the urban center. One of the preliminary steps along Russia's road to a market economy is the privatization of stated-owned goods and services. Of all the economic resources switching over to private ownership, the one acutely altering the landscape within cities is the land market itself. In a market economy, housing prices and transportation costs vary over distance and therefore, constitute the most important factors determining quantity and location of land consumed for housing. In order to anticipate the consequences of introducing demand-driven housing prices into Moscow, the following model of basic residential choice in a city with land markets isolates the effect that distance has on the rent and quantity of housing.

Assumptions for the model (Fujita):

1. The city is monocentric; it has a single pre-specified center of fixed size called the central business district (CBD). All job opportunities are located in the CBD.
2. There is a dense, radial transport system. It is free of congestion. Furthermore, the only travel is that of workers commuting between residences and work places.
3. The land is a featureless plain. All land parcels are identical and ready for residential use.

Let: z = composite consumer good (numeraire)

H = housing quantity (floor space)

Y = income per unit time

r = distance from CBD

$R(r)$ = unit price of floor area at r

$T(r)$ = transport (commuting) cost at r

Then the residential choice of the household can be expressed as the following utility function:

$$\max_{z, H} U(z, H), \text{ subject to } z + R(r)H = Y - T(r)$$

where $r \geq 0$, $z > 0$, $H > 0$ (i.e. both z and H are essential).

Further assumptions on the utility function:

1. well-behaved utility function in terms of strict convexity
2. increasing transport cost

3. differentiable where

$$\frac{\partial U(z,H)}{\partial z} > 0, \quad \frac{\partial U(z,H)}{\partial H} > 0, \text{ and } T'(r) > 0$$

Housing bid-rent function

Bid rent is a theoretical concept that describes a household's ability to pay for land under a fixed utility level. The market rent structure of a city arises from the interaction of many households.

Define *bid rent* as the maximum rent per unit of land that the household can pay for residing at distance r while enjoying a fixed utility level u . Then, mathematically

$$\Psi(r,u) = \max_{z,H} \left\{ \frac{Y - T(r) - z}{H} \mid U(z,H) = u \right\}$$

where $\frac{Y - T(r) - z}{H}$ represents the rent per unit of land at r . Solving for z using the equation for the indifference curve yields: $U(z,H) = u$, solve for $z \Rightarrow z = Z(H, u)$.

Thus, the unconstrained maximization problem becomes:

$$\Psi(r,u) = \max_H \left\{ \frac{Y - T(r) - Z(H,u)}{H} \right\}$$

The solution to this problem yields the optimal floor space $H(r, u)$ which is called the *bid-max lot size*. Through an application of the *envelope theorem*, the rate of change of bid rent with respect to r

can be calculated as $\frac{\partial \Psi(r,u)}{\partial r} = \frac{-T'(r)}{H(r,u)} < 0$ (see Figure 5).

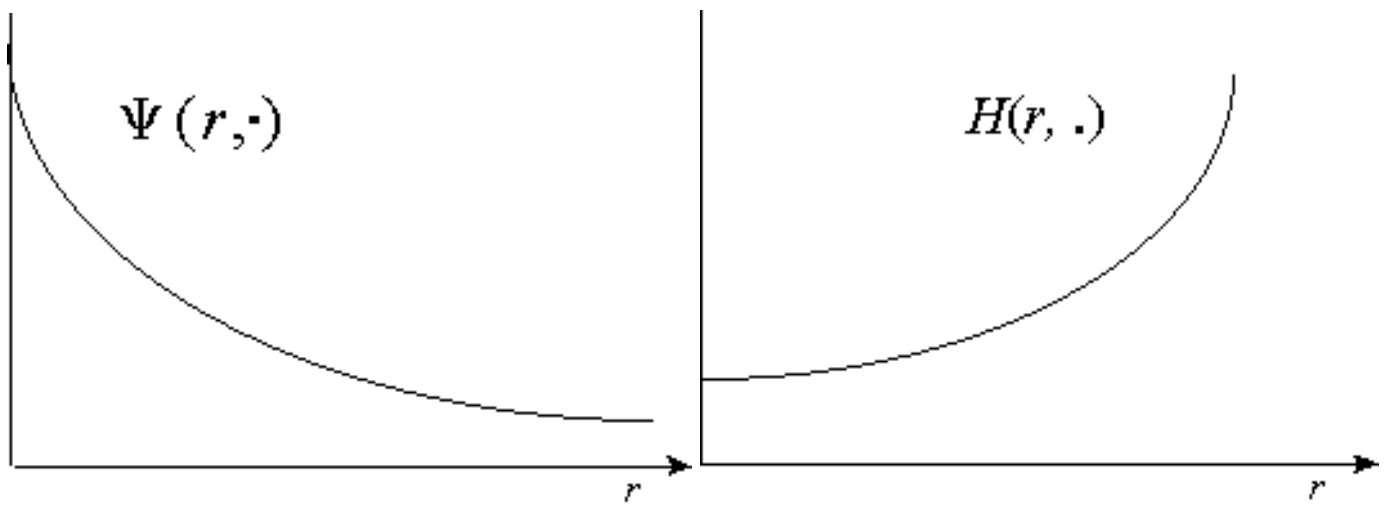


Figure 5: Bid rent decreases with distance Figure 6: Floor space increases with distance

Using economic concepts regarding the nature of the demand for housing, the rate of change of the

$$\frac{\partial H(r, u)}{\partial r} > 0$$

bid-max lot size with respect to r becomes (see Figure 6). Roughly, population density is the inverse of the bid-max lot size function, therefore, the population density curve decreases in r similarly to the bid rent function.

For a household to attain a particular utility level, both of the conditions for bid rent and bid-max lot size must be hold true; a household will be equally happy choosing commuting a farther distance to the employment center as long as the rent is cheaper and the living space is greater. The eventual equilibrium for this model occurs when the utility among all residents is equal throughout the city. This means that there is not incentive to move within the city because of the tradeoffs between commuting costs and rent for housing closer or farther from the center. While the initial assumptions may appear too hypothetical for the model to apply to a real life situation, the conditions in Moscow, a representative socialist city, are not too far removed. Since job density continually increases with proximity to the center, Moscow can be characterized as being monocentric (see Figure 7b). The metro system, which is the primary mode used for commuting, can be characterized as a dense, radial transport system. Located in the heartland of European Russia, Moscow's growth is unencumbered by political or natural boundaries, so that for land use purposes, it can be considered a featureless plain.

The actual situation in Moscow as of 1992 shows that housing space is greatest in the center, and while a rent gradient does not exist, the population density increases with distance from the center (see Figure 7a). So the spatial configuration transition in Moscow began as a centralized urban area in 1917 but transformed into a decentralized megalopolis by 1992. The key difference between Moscow and decentralized cities in the US (Detroit for example) is the centrally located employment.

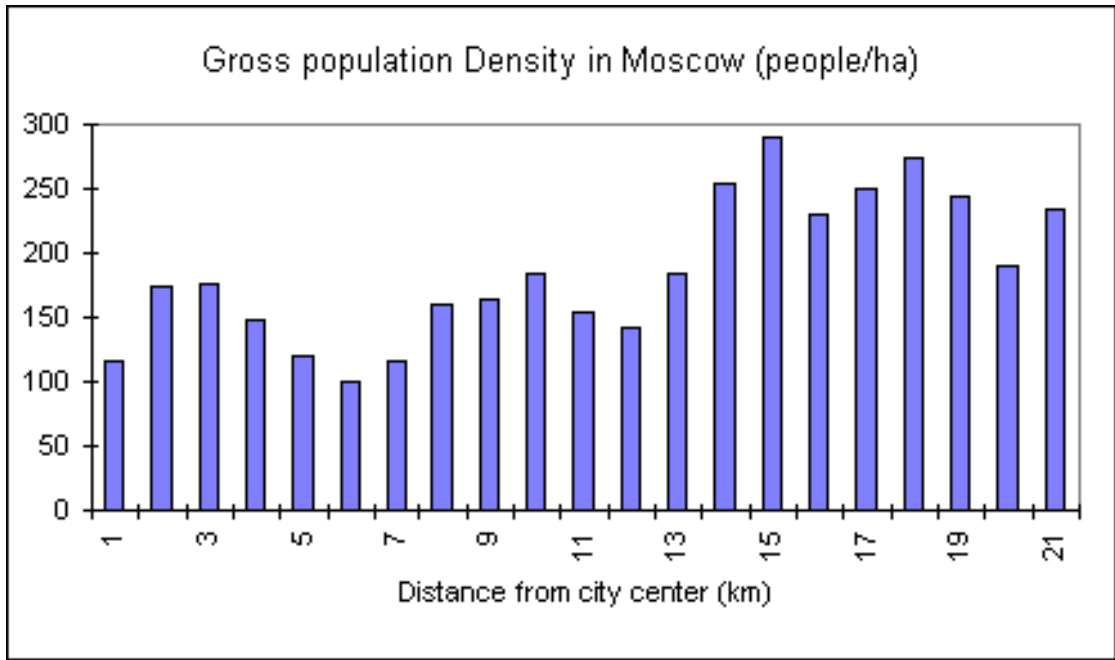


Figure 7a: Gross population density in Moscow (1992).

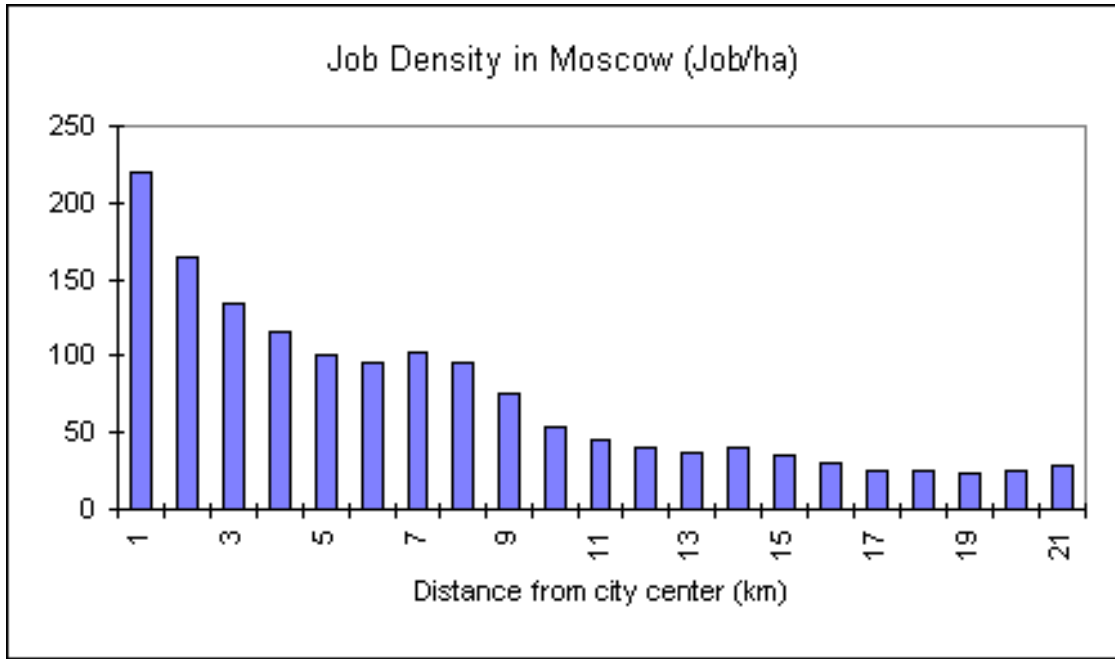
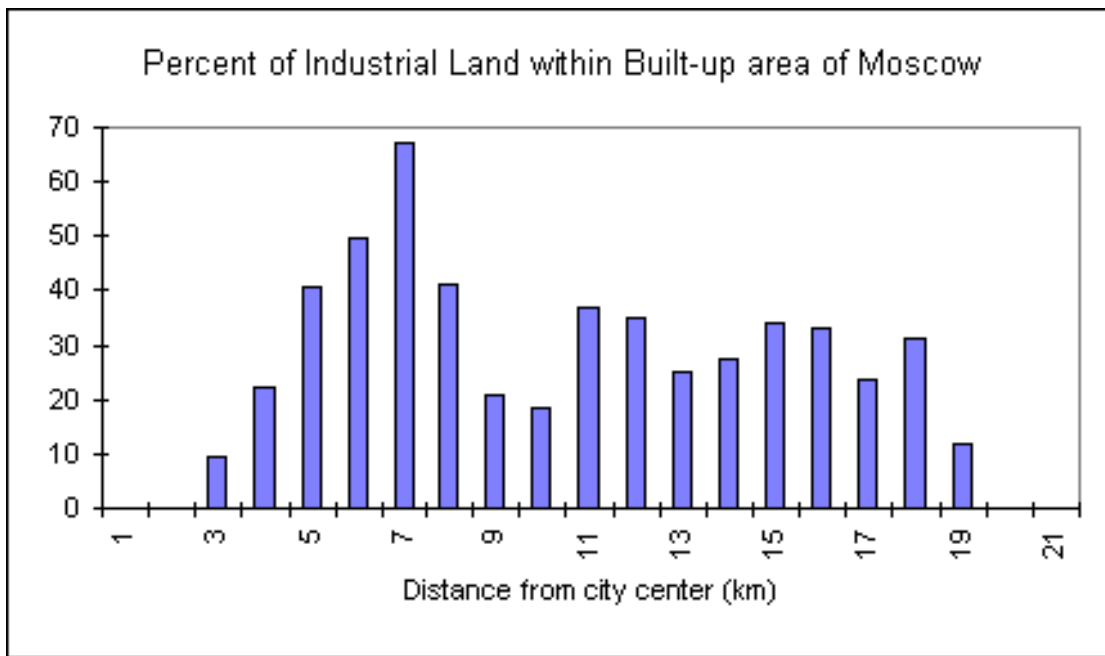


Figure 7b: Job density in Moscow (1992).



[Figure 7c](#): Job density in Moscow (1992).

Source of data (a-c): Bertaud/Renaud, p. 141-145

Other transitions

Certainly many other transitions have generally affected the urbanization transition in Russia, but the demographic and bureaucratic transitions specifically influenced population movement, which is at the root of determining the spatial configuration within and among urban areas. Demographically, the urban population has risen at nearly the same rate as the total population since 1950 (see Figure 8). Trends in Urban and Rural Population in Russia

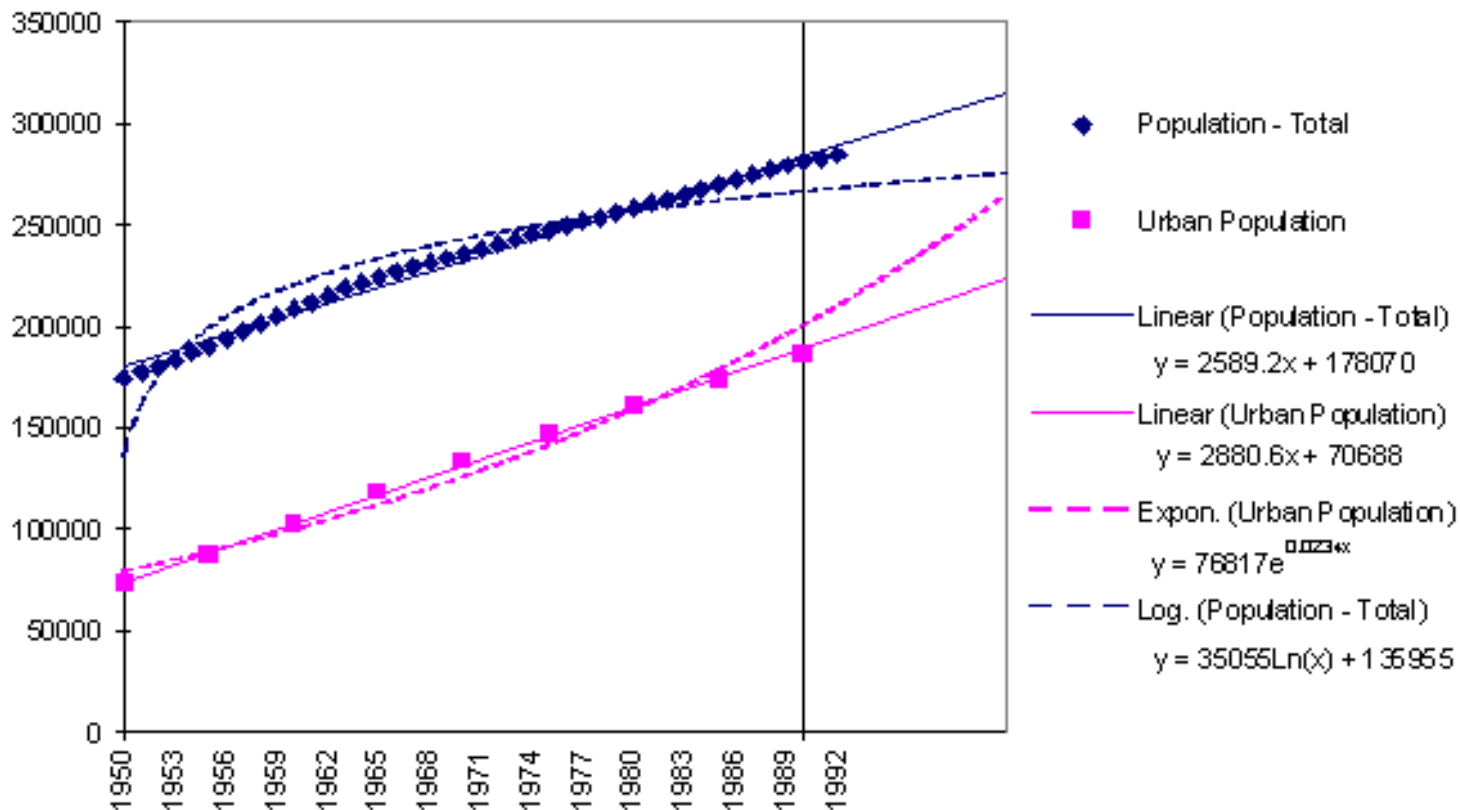


Figure 8: Possible trends of urban and total population in Russia projected to 2002. The rate of total population increase has been projected to slow down (log. Total population) because of the current negative rate of annual increase. The low rate of birth seems to be temporal, however, while Russia progresses through its economic transition. The rate of population increase is more likely to continue relatively linearly.

Source of data: WRD

The population movement appears to be shifting both nationally and locally. Aside from the large-scale emigration beyond Russia's borders, the remaining population seems hesitant to migrate internally due to the physical and psychological dislocation between the different regions within Russia. Additionally, the lack of free-flowing information regarding potential employment opportunities hinders people from risking a long-distance migration for fear of the unknown. As of 1992, the only regions experiencing net in-migration (1-2%) were the southern European Russia and the northern Caucasus. The advantages readily apparent to these areas are the existence of undeveloped land already equipped with a physical infrastructure, access to the Black and Caspian Seas, and a warmer climate. Population shifts in and around the larger cities are also occurring. Since the emergence of property markets in 1992, the price gradient for housing seems to be downward sloping from the center of the city, based on the analysis of initial sales of apartments in Moscow [Bertaud/Renaud]. The trend seems to be conforming to the model, which could imply that the population density curve is rotating, i.e. sloping downward from a peak in the center.

The communist government's regulatory policies over population movement were directly responsible for creating the vast, decentralized settlements in Russia. Seen in a broader historical context, the control imposed by the Soviet era bureaucracy was very similar to level possessed by the Czarist regime it

overthrew. The Russian society has historically passed from one totalitarian leader to another. In fact, the cycle for the bureaucratic transition has passed through extreme peaks and troughs in intensity during this century alone (see Figure 9).

Hypothetical Bureaucratic Trends

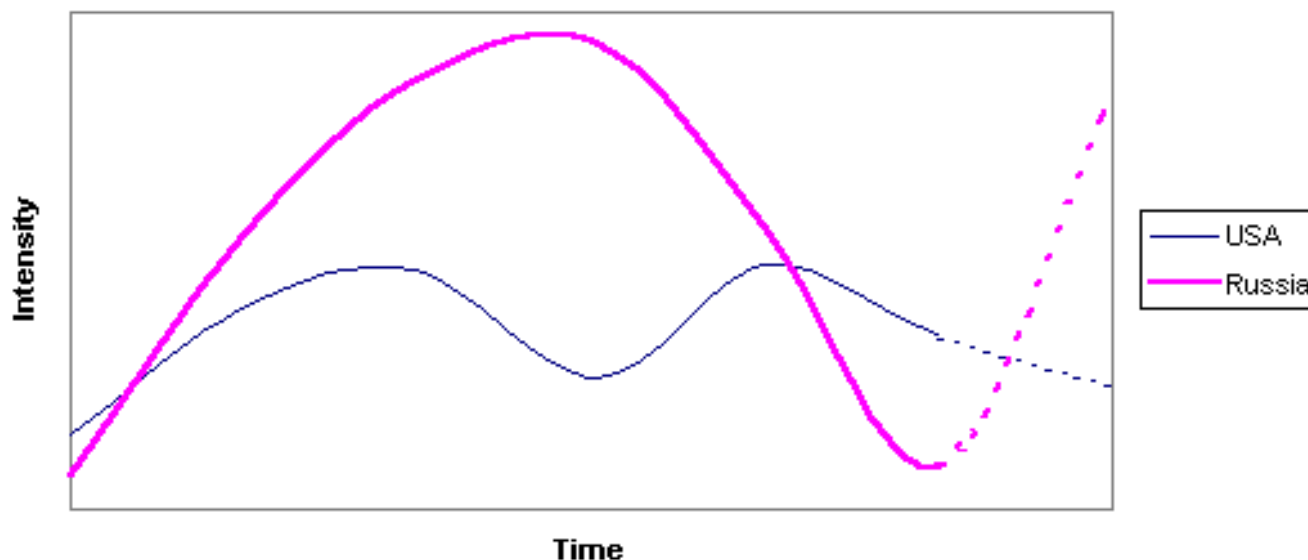


Figure 9: Hypothetical comparison of the bureaucratic transition in Russia and the US. For example, the two low points in Russia's trend might correspond to the anarchy after the 1917 Revolution and the general lawlessness since 1992. US peaks might correspond to the eras of the New Deal and Great Society.

However, reversion to a authoritarian government would not be surprising even today. Long periods of time of democratic rule in Russia simply do not exist. Even further back into Russia's history, the Romanov era was preceded by the occupation of Ghengis Khan's Golden Horde, two centuries of notorious subjugation of the Slavic people.

Implications and recommendations

Returning to transition theory, the trajectories of several, fundamental transitions are simultaneously undergoing rapid changes in Russia. Predictions about the changing spatial configuration of urban areas during this critical stage of the broader transition may help pinpoint policies for stabilizing the other transitions. While a definite conclusion about eventual stasis is naïve at best, some features of the current pattern may suggest characteristics of future urbanization. Firstly, Russia population will remain predominantly urban not only because the built environment already exists but also because they have moved sufficiently far away from their agricultural roots. Also, while out-migration from some areas east of the Urals will exceed any other part of the country, the Siberian region as a whole will remain populated because of the vast amounts of untapped, natural resources that are much sought after by the international world.

A comparison of Russia's transition to the barometer transition in the US also identifies distinguishing characteristics of possible outcomes. Via two divergent paths, the urban areas in both the US and Russia have decentralized spatially, however, the key difference between the configurations lies in the implementation of Marxist social geography in Russia. Equality based on the concentration of urban areas should have been normalized in some way by the physical geography, which is inherently unequal. Today, agglomerations of artificially created urban areas are not locationally continuous in Russia, and they are even more disconnected due to the insufficient physical infrastructure. Transportation costs are now an enormous factor in determining location for industry, retail, and housing. When this was true in the developing countries, urban areas developed centrally. The pattern of migration over short distances suggests that smaller towns may be collapsing into adjacent or proximate larger towns. Larger does not necessarily imply more populated. Migration will occur to areas with employment opportunities, and the lands west and east of the Urals provide different economic possibilities. European Russia has the geographic advantage over Asian Russia in terms of proximity to potential international trade markets and a well-networked transportation system, but the eastern frontier possesses unfathomable resources for the creative mind. Within the cities experiencing in-migration, housing, employment and commercialization should be intertwined instead of developed into separate rings around the center. For example, the industrial rings around the Kremlin should incorporate more housing so that people can have access to residences closer to the center. Of course, the environmental realities of the area might make the site inappropriate for housing. Therefore, new businesses should be encouraged to locate where the population is densest—the periphery. For cities experiencing out-migration, the "white elephants" of development will not be maintained unless there is an economic incentive to do so.

In order to institutionalize the current democratic and economic reforms, true political authority should be regionalized throughout Russia so that people are enfranchised to create their own destiny. In terms of future research, it would be interesting to watch as regions politically break free from the center and start developing their own vision.

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Prospects for Agricultural Sustainability in the Red River Delta of Vietnam

Daria Kim

Preface

The Red River Delta of Vietnam is an area of dense human settlement and intensive land use. In the past, the region's villagers have been able to increase production sufficient to cope with increased population. Whether further increases in population can be supported by the land and whether current high levels of production can be sustained are questions which have yet to be answered. This paper attempts to answer these questions in the specific context of an agricultural village, Nguyen Xa, in the densely settled Red River Delta province of Thai Binh.

Nguyen Xa was selected because it represented the extreme case of population pressures on natural resources in Vietnam. This paper will draw upon fieldwork jointly conducted in 1991 and 1992 by researchers from the Southeast Asian Agroecosystem Network (SUAN), the Program on Environment at the East West Center, the Southeast Asian Agroecosystem Network (SUAN), Center for Natural Resources Management and Environmental Studies at Hanoi University, and Hanoi Agricultural University.

This paper will be comprised of three different sections: the first section will focus on presenting an introduction to the region and providing specific information relevant to the understanding of this paper; the second section will present the village of Nguyen Xa, and briefly discuss certain key issues that might contribute to our analysis of the region's sustainability; the last section will explore the issues of rural development in the Red River Delta, and how Nguyen Xa's specific situation might provide clues to the prospect of the region's long-term development.

I. Introduction



The country of Vietnam is located in the southeastern region of the Indochina peninsula, bordered by the South China Sea. It occupies a space of 331,668 square kilometers, and has a north-south distance of 1,650 kilometers. Vietnam is composed of hills and densely forested mountains, with mountains occupying 40 percent of the country, hills 40 percent, and forests 70 percent. The north consists of the highlands and the Red River Delta; the south is divided into coastal lowlands, the central mountains, and the Mekong River Delta.

Vietnam has a tropical monsoon climate, with humidity averaging 84 percent throughout the year. However, because of differences in latitude and the marked variety of topographical relief, the climate tends to vary considerably from place to place. During the winter or dry season, extending roughly from November to April, the monsoon winds usually blow from the northeast along the China coast and across the Gulf of Tonkin, picking up considerable moisture; consequently the winter season in most parts of the country is dry only by comparison with the rainy or summer season. During the southwesterly summer monsoon, occurring from May to October, the heated air of the Gobi Desert rises, far to the north, inducing moist air to flow inland from the sea and deposit heavy rainfall. (Library of Congress Web Site, 1985)

Annual rainfall ranges from 120 centimeters to 300 centimeters. Nearly 90 percent of the precipitation occurs during the summer. Temperatures range from a low of 5°C in December and January, the coolest months, to more than 37°C in April, the hottest month. Seasonal divisions are more clearly marked in the northern half than in the southern half of the country seasonal temperatures vary only a few degrees, usually in the 21°C-28°C range. (Rambo, 1993)

Figure 1.1 Country of Vietnam

Vietnam's current population is 78.4 million with an average population density of 220 persons/km². The life expectancy rate is about 67 years, the literacy rate is 87 percent, and the per capita GNP is US \$230. Vietnam provides elementary education for 9 million children and basic family planning services to about 15 million women. There is a 54 percent use rate of contraceptives by married women which is a remarkable drop in fertility rate in the last 2 years. (See Figure 1.2) Despite the fertility drop, the annual growth rate is still 2.1 percent. According to conservative estimates, there will be approximately 80 million Vietnamese citizens by the year 2000, with the World Resources Database estimating the population to be 82 million. (Xenos, 1993)

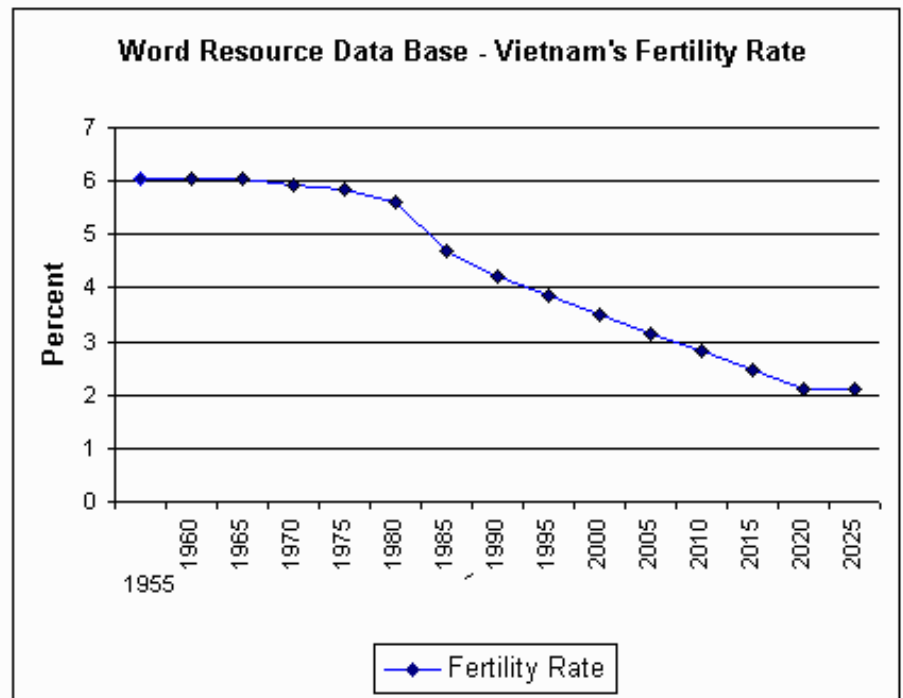


Figure 1.2 Vietnam's Fertility Rate 1955 – 2025
 Source: World Resource Data Base

Family planning has been actively pursued as a national policy since the early 1960s, and the province of Thai Binh especially has pursued this with enthusiasm. Contraceptive information is available in health clinics which are open to both men and women, and there are also media campaigns offered through various organizations in the village. Table 1.1 shows that province wide, 66% of the current female population in 1990 were acceptors of various planning methods, versus 43.9 percent of the national level. Thi Xa is the provincial capital and it has the highest percentage of acceptors. And Dong Hung, where Nguyen Xa is located is slightly below the provincial average. (Xenos, 1993)

Table 1.1 *Family Planning in Thai Binh*

District	Population	Cumulative Acceptors	Cumulative Acceptors		Birth Rate (%)
			As % of Population	As % of Currently Married Females	
Thi Xa	125,000	27,084	21.6	NA	18.2
Quynh Phu	225,000	29,741	13.2	64.9	23.5
Nung Ha	226,000	26,635	11.7	57.5	23.9
Dong Hung	230,000	27,758	12.1	59.5	21.5
Vu Thu	221,000	28,201	12.8	62.9	23.3
Kien Xuong	216,000	25,265	11.7	57.5	21.6
Tien Hai	191,000	29,430	15.4	75.7	23.1
Thai Thuy	249,000	29,259	11.7	57.5	23.5
Province, 1988-1990	1,674,000	227,030	13.5	66.4	22.6
Province, 1976-1990	1,674,000	866,451	51.7	NA	22.6

Source: Committee on Population and Family Planning.

NA = not applicable, exceeds 100%

The Red River Delta, a flat, triangular region of 3,000 square kilometers, is smaller but more intensely developed and more densely populated than the Mekong River Delta. (See Figure 1.3) This region was once an inlet of the Gulf of Tonkin, but since has been filled in by the alluvial deposits of the river system over a period of a millenium, and it continues to advance one hundred meters into the gulf annually. (Neher, 1995)

The Red River Delta climate is tropical monsoon, and has two distinct seasons: rainy and dry. The rainy season lasts from April to October with 80 – 100 days providing around 1450 – 1650 mm of rainfall during the season. The dry season is from November to March with 40 days providing almost 150 mm of rainfall during the season. Average humidity is 82 – 88 percent and the potential evaporation is between 900 and 1000 mm/yr. The total average radiation is 120 kcall/cm²/yr with the yearly average temperature registering around 23 degrees C.



Figure 1.3 North Vietnam and The Red River Delta Region

Source: Library of Congress Web Site, 1985

The Red River Delta is comprised of six provinces: Hanoi, Hai Phong, Ha Nam Ninh, Ha Son Binh, Hai Hung, and Thai Binh. These six provinces can be further subdivided into three topographic regions as follows:

1. The Midlands – a region of low hills and mountains which make up the land borders of the delta. The soils of these regions are fertile but the land is seriously eroded because of high rates of deforestation.
2. The Delta Plains – the flat plains made up of alluvial depositions from the Red River and its tributaries. These soils are also highly fertile, but alluvial deposit rates are lowering because of the limiting influences of the dyke system. Nguyen Xa in the Province of Thai Binh is located in this area.
3. The Coastal Regions – has the youngest alluvial soils, but is currently experiencing alluvial depositions and sea encroachment. (Le Trong Cuc, 1990)

The Red River Delta region of North Vietnam, which encompasses the Midlands to the north of the delta has a total area of 17,321 square kilometers. Although the delta makes up only 5 percent of the total area of Vietnam, its population makes up 21 percent of the country's total. Currently, 83 percent of its 13.6 million inhabitants live in rural areas with the average density in the low lands of the delta at about 923 persons/km². The average growth rate in the entire delta region is 1.7 percent with Thai Binh registering the lowest growth rate at 1.4 percent. (Xenos, 1993)

The hydrology of the Red River Delta is dominated by the Red River system and the Thai Binh River System. The Red River's flow is high and carries with it rich alluvium. The Thai Binh River's capacity on the other hand is not as rich, with a lower amount of potassium than that of the Red River, with higher acidity. Flooding is still the most frequent hazard in the area but the extensive dyke system used to control water flow has created a control mechanism for this. Years of

continued alluvial deposits along the walls of the dykes has raised the water level during the rainy seasons several meters higher than surrounding delta plains. Thus flooding remains a very real threat. (Patanothai, 1996)

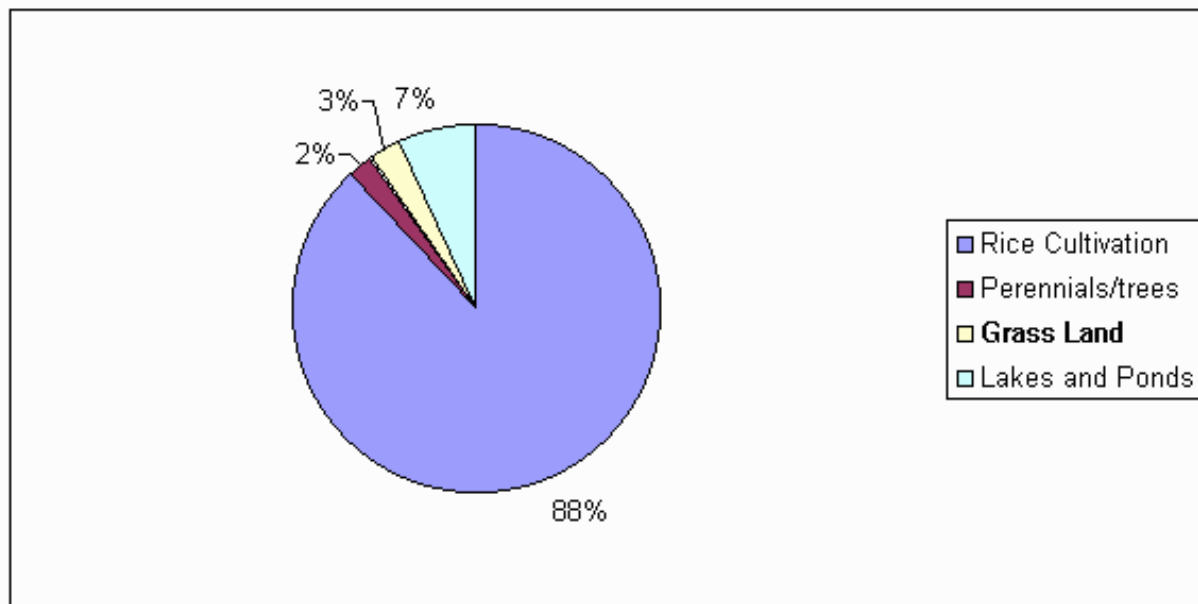


Figure 1.4 Cultivated Land use in the Red River Delta Region

Almost all of the cultivated land in the Red River Delta is used to grow rice with a small proportion of the land used to grow cash or other crops. (see Figure 1.4) There are two distinct rice crop seasons in North Vietnam: Winter/Spring and Summer/Autumn. In addition to the rice crops, farmers have also used periods between the seasons to grow a variety of additional crops, winter tropical-derived crops (maize, soybean, garlic) and late winter temperate zone-derived crops (potato, cabbage, wheat). Thus, farmers have been able to take advantage of all the possible agricultural niches and conditions to create a tight schedule of agriculture production. (Patanothai, 1996)

II. Nguyen Xa

Nguyen Xa farmers have been involved in intensive rice cultivation for hundreds of years. Because of a variety of factors, including location, elevation, and soil composition, Nguyen Xa has a history of consistently producing some of the highest yields in the Red River Delta. Over the past 50 years, Nguyen Xa farmers have been able to keep ahead of growing population pressures by achieving a nearly fivefold increase in annual rice yields whereas population had tripled. In order to understand how farmers were able to attain this achievement, we must look at the chronology and evolution of agriculture and how it contributed to current production in this region. (Patanothai, 1996)

Historical development of agricultural production in Nguyen Xa can be divided into four periods: The French Period (1935 – 1954), The Land Reform Period (1956-1957), The Cooperative Period (1958 – 1982), and the Contract Period (1982 – present). The French Period was marked with a high degree of tension. Thai Binh Province was the site of a French military camp, and Nguyen Xa became a battleground between the French and the Viet Minh forces. The French marched against the farmers of Nguyen Xa three times, once on February 17th, 1950, and two additional times that same year, on August 19th, and the 29th. In all about 92 Nguyen Xa villagers gave their lives defending their community from the French. (Patanothai, 1996)

During the French Period, double cropping of rice was possible in certain fields in Nguyen Xa, although the second crop was usually lost to flooding. Traditional varieties of rice were grown with little use of fertilizer. This period is marked with a high degree of tenancy: 70% of the village farmers either rented their lands from village lords or worked on them as hired

hands. Yields from this period range from 1.7 to 1.8 t/ha. (Patanothai, 1996)

The Land Reform Period followed the Viet Minh victory over the French at Dien Bien Phu in 1954, and Ho Chi Minh initiated land reforms in the northern part of the country including the Thai Binh Province of the Red River Delta. All land was confiscated by the government and redistributed to the residents of the village, the former tenants and landless workers. Manure use increased during this period, fields were better managed, and the yields increased to 1.9 to 2.2 t/ha.

The first Cooperatives were formed in 1958, and all farmers of the newly redistributed land had to turn them over to Cooperative control. During the Cooperative Period, members were placed in local production teams which managed specific activities. In addition to the rice production teams, Cooperatives also formed pest and disease teams, irrigation teams, and animal husbandry teams.

Several key things happened during the Cooperative Period which resulted in substantial increases in rice yields. New varieties were introduced by the government, along with fertilizers, and management practices. In addition, canals and dams were completed and equipped with electric pumps, which greatly increased water control and resulted in yields of 2.8 to 3.6 t/ha by 1960. These new varieties were shorter in duration, and therefore opened up the possibility of a third crop for the Nguyen Xa villagers. (Patanothai, 1996)

By 1982, Nguyen Xa began to decentralize agricultural production by offering short term (one to two year) contracts to specific families within the Cooperatives. These households were given an allocated parcel of land, and a yield/production quota based on the analysis of the soil potential. The tax was based on this quota, and not on the actual yield, which gave villagers an incentive to exceed the quota assigned to them. Eventually the contracts were extended to five years (1986), and then up to fifteen years (1992) which gave farmers an even greater vested interest in not only increasing current yields, but in the long term sustainability of these yields. In addition, farmers began to recognize that the key to balancing agricultural production was population growth. (Xenos, 1993)

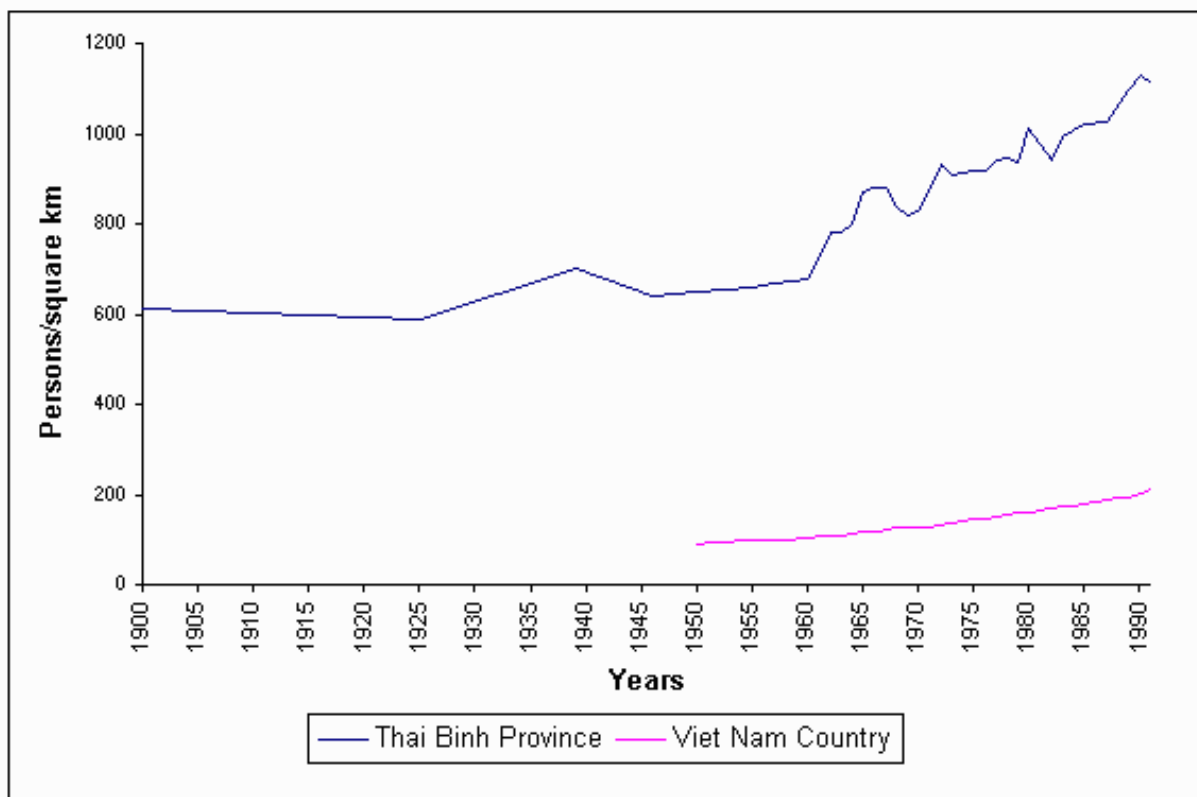


Figure 2.1 Population Density in Vietnam and Thai Binh (person/km²)¹

Nguyen Xa is a village of the Dong Hung District which is a part of the Thai Binh Province. Thai Binh's density is the highest of the predominantly agricultural provinces, nearly matching the levels of urban Hanoi and Ho Chi Minh City, and nearly quadrupling the national levels. (see Figure 2.1) The province also registers one of the lowest growth rates, birth rates and death rates, and its growth rate is lower than the

¹ Population dips in Thai Binh's density graph shows population decline during war, famine or large scale migration. The period towards the end of World War II (1940–1946) there was a great famine in North Vietnam resulting in an estimated 2,000,000 deaths. The dip in density in 1968 to 1973 was due in large part to the Vietnam War, and the smaller decline in population density in the early 1980s could have been a

Vietnam resulting in an estimated 2,000,000 deaths. The dip in density in 1968 to 1973 was due in large part to the Vietnam War, and the smaller decline in population density in the early 1980s could have been a result of the NEZ policies put into place in the late 1970s.

national intercensal rate of 2.1 percent.

Thai Binh's steady decline in birthrate and death rate is due, in large measures to government policies and actions on demographic change, including the following important policies:

1. Very effective public health and mortality control, including control over episodic mortality.
2. A recent effort to advance the ongoing fertility decline by vigorously linking childbearing to land allocation and various state services.
3. Attention to permanent out-migration to the south or New Economic Zones (NEZs) to improve the population/resources balance. (Xenos, 1993)

Dong Hung District is near the geographic center of Thai Binh Province, and its population density of 1122 persons/km² is similar to the provincial average. Nguyen Xa, with 1620 persons/km² has the highest population density of all the Dong Hung villages with one of the region's lowest birth and death rate. (Xenos, 1993)

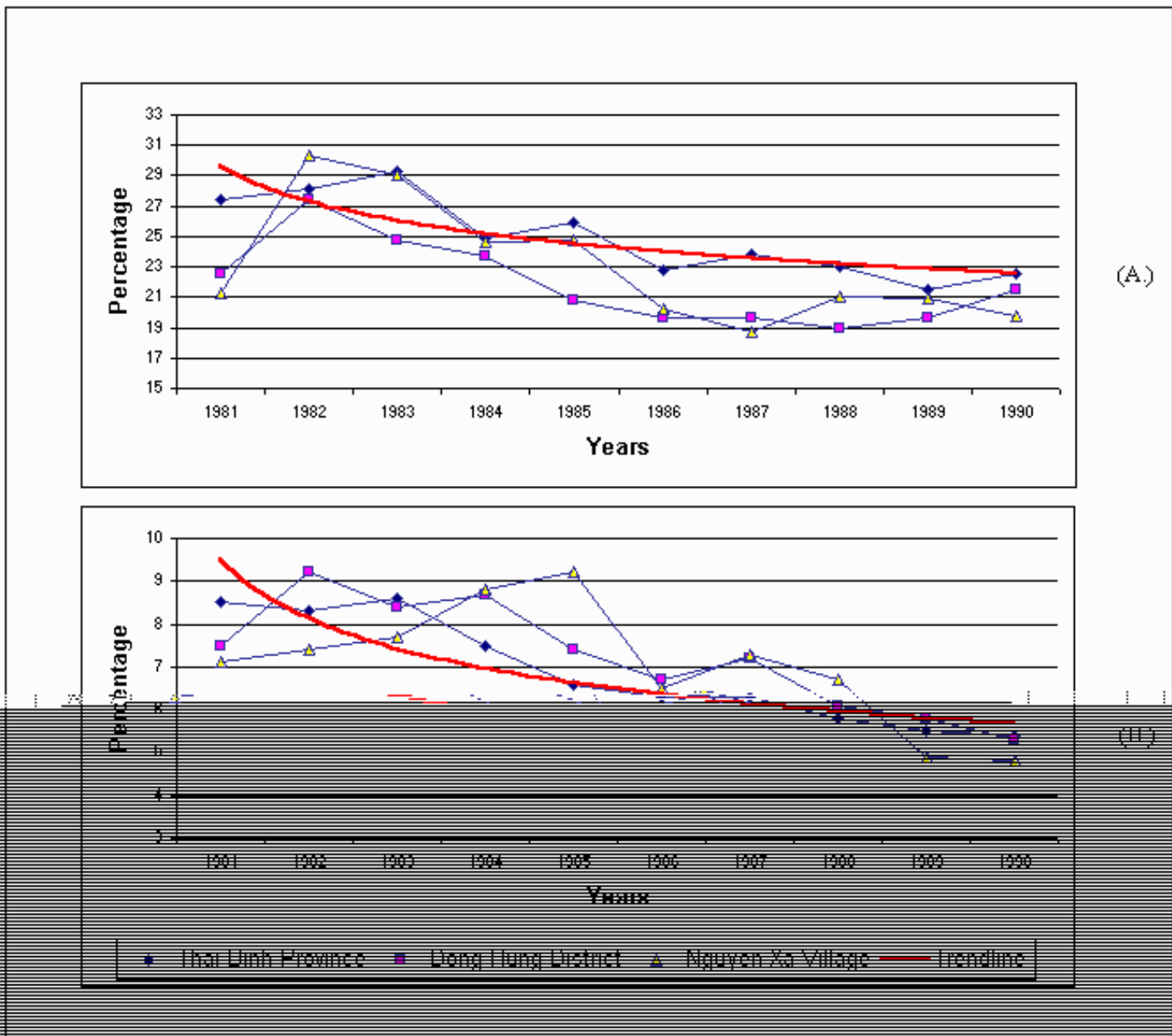


Figure 2.2 Birth (A) and Death (B) Rate

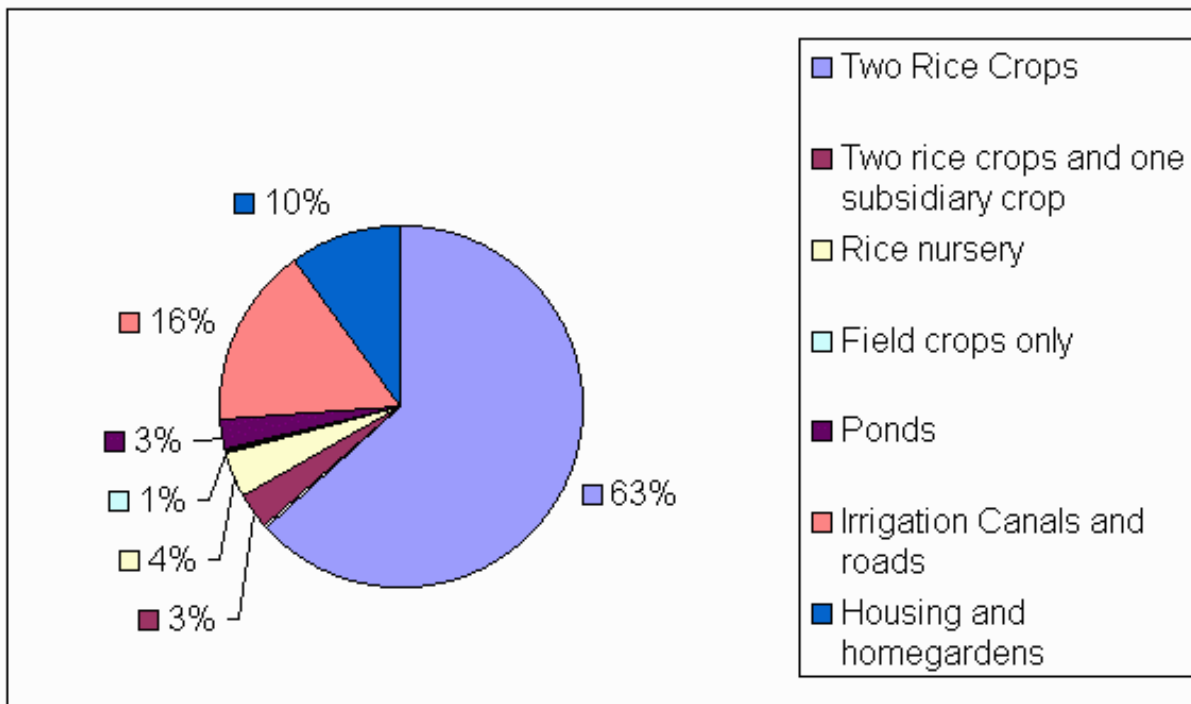


Figure 2.2 *Nguyen Xa Land Uses*

Nguyen Xa has a population of 6,512, which includes teachers, and officers who are assigned to the region, but who are currently not registered as residents. The village has a total surface area of 430 ha, which places the population density of the village to be over 1600 person/km². This is higher than the provincial average of 1065 persons/km², and higher than the district average of 1,122 persons/km². Of the total surface, more than 25 percent of the land is used for non-agricultural purposes such as roads, canals, housings, and gardens. Thus the population density of cultivated land is 2030 persons/km², which means that each hectare must support 20.3 people. This represents only 490 m² of cultivated land for each inhabitant. (Patanothai, 1996)

The farmers of Nguyen Xa Village practice a refined and intensive form of rice cultivation and the community exhibits a high quality of life despite the strong population pressure on land resources. Rice production provides employment to the majority of the village population regardless of the economic status a household might hold. The rice crops do not generate income because villagers generally consume a large proportion of the rice they produce and often have little left after agricultural taxes (in the form of rice) have been collected. Thus, in order to cover shortfalls, households generally require an additional source of income to cover expenses during emergencies. (Patanothai, 1996)

Livestock raising is an important component of the livelihood structure of the residents of Nguyen Xa. Even though animal husbandry is not extensive or large scale, the majority of the households in the village raise pigs for the sale of meat, and most importantly, for manure to put on the rice fields. At the present, pig raising is not considered a profitable venture by most households because they are only breaking even. But the value of pigs to agricultural production, however, is high since they provide manure for the rice fields, which not only increases the productivity of crops but also reduces costs in terms of purchased fertilizers. Poor households with fewer pigs also derive less manure for fertilizers, which, in turn, may lead to lower rice productivity. (Bouahom, 1993)

Most households in Nguyen Xa also maintain homegardens, although they are small and not extensively planted.

These families with the homegardens sell fruits and vegetables at the market in Nguyen Xa. Households can also supplement their income with fish grown from shared communal fishponds, although, once again, the income from the fishpond is low. This all means, in general, that the culture in Nguyen Xa is predominantly one of subsistence agriculture, and that the economy is still immature and has room for growth. (Patanothai, 1996)

Therefore rice, the staple food of the Vietnamese is the most important crop in the Red River Delta. The majority of the cultivated area is devoted to rice, and wherever possible, it is given priority over other crops. Historically, because of physical, social, and economic conditions, Thai Binh Province, in general, and Nguyen Xa Village, in particular, have been intensive rice cultivation areas. (Patanothai, 1996)

For the past 10 years, the average rice yields in Nguyen Xa have been increasing, and yields are higher than the average yields for the district and the province as a whole. In 1990, productivity was 6.45 t paddy/ha for the spring crop and 4.68 t paddy/ha for the fall crop (See Figure 2.3). The average yearly production was over 10 t paddy/ha, one of the highest yields of rice in the Red River Delta. There are several factors which accounts for this high productivity:

1. Water - The availability of year-round water and the ability to control water levels are major factors in the high productivity of this system.
2. Fertilizer - The high production is due to widespread use of heavy fertilizer (chemical and manure) and pesticides.
3. Labor - Farmers are well informed about agricultural processes, and there is excess labor in Nguyen Xa. Thus, farmers are able to put more labor into the same amount of fields.
4. Rice varieties - Experimenting and adapting new and different varieties of rice has allowed farmers to keep production of rice high.
5. Government Policies - Policies increasing technological inputs into rice production ensures high and relatively stable productivity. The government was also responsible for an efficient water control system, the promotion of new improved rice varieties, and made chemical fertilizers and pesticides easily available to farmers. (Patanothai, 1996)

What is the possibility of increasing the current production yields? In order to answer that, the CERES – Rice Simulation Model, was brought in to simulate potential yields for the spring and winter rice crops. (Godwin, 1990). These maximum yield experiments found that the current Nguyen Xa rice variety, CR203 was currently producing 80% of the maximum yields simulated in the model. To accomplish four fifths of near optimal production is an incredible feat for the farmers of Nguyen Xa and to increase such a yield would require either new rice varieties or different weather patterns. (Patanothai, 1996)

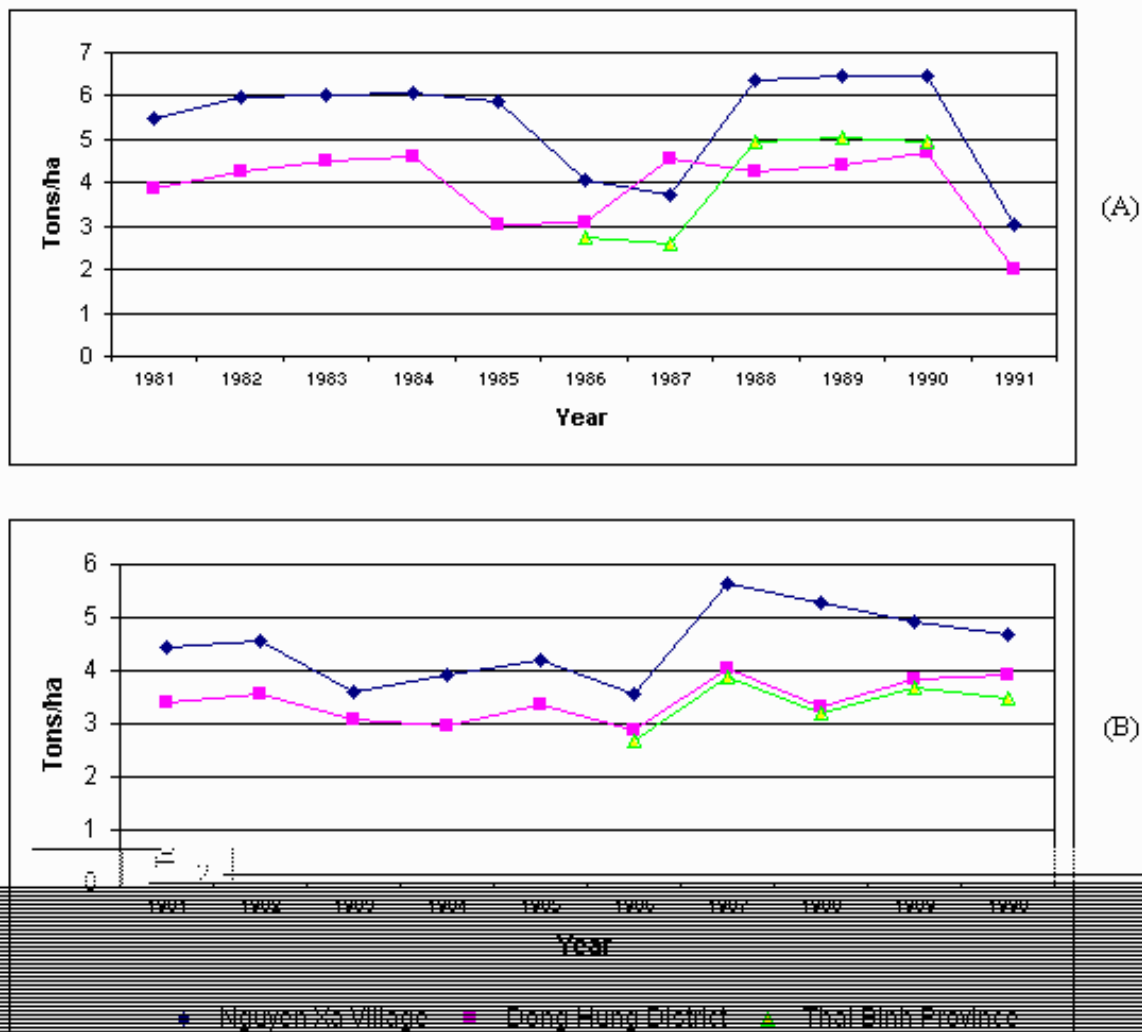


Figure 2.3 *Rice Yields in Thai Binh Province, Dong Hung District, and Nguyen Xa Village*
A.) Spring Crop B.) Winter Crop

This high production is not stable however and as Figure 2.3 attests, yields seem to have reached their plateau and have started to decline, although the time period considered is rather short for any conclusive analysis. There are several reasons that might account for this decline:

1. Pest outbreaks - Contributed to several decreases in potato and rice varieties.
2. Climatic change - Especially temperature decrease in the winter, was responsible for the major reduction of yields in spring 1991.
3. Rice Variety Yield Fluctuations. (Patanothai, 1996)

Flooding was not a factor in the recent decreases in yields, neither was rainfall or sunlight. There was a surplus of wage laborers to cover productions, thus employment or lack of human resources were not the reasons for the poor results. Nutrient recycling (which we will explore in the next section) is still highly efficient. Thus, it would seem that rice varieties, and its resistance to adverse is conditions are the primarily causes for recent poor performances. Still, the instability of these high productions have raised issues of concern about long-term sustainability of existing resources.

Can farmers maintain as high a level of yields in the future as they did in the past? In order to answer this question, it is important to look at the nutrient recycling system of Nguyen Xa, and to identify areas where nutrient depletion might become a problem or current practices might not be sustainable. (Patanothai, 1996)

Nguyen Xa is located in the alluvial soils region of the Red River system with long-term rice cultivation. The latest soil survey, recorded in 1992, had the following soil types:

1. Old alluvial soil inside the dike system with clay horizon
2. Old alluvial soil with spotted or ferralite horizon.
3. Recently deposited alluvial soil with uniform horizon.
4. Alluvial soil with sandy horizon 30 – 40 cm below the surface.
5. Alluvial soil with acid sulphate horizon. (Patanothai, 1996)

The soil texture in Nguyen Xa can be grouped into two main categories: light loam, and moderately heavy loam. The second category is the predominant type and is suited for rice cultivation. Soils in the high spots are generally lighter in texture and are suited for tuber and other winter crops. (Patanothai, 1996)

95% of the soil in Nguyen Xa is acidic, and about 41% have a pH lower than 4.5 (see Table 2.0). Consequently, lime application is a common practice with a lot of farmers. In addition, 84% of the soil is also highly organic due to the heavy use of manure, available phosphorus is low, and exchangeable potassium is low. (Patanothai, 1996)

Table 2.0 *Soil chemical properties of Nguyen Xs and their relationship with land topography and depth of plow pan. (1992)*

Soil Property and Class	No. of fields	%	Topography			Depth of plow pan		
			Low	Medium	High	9 - 10	11 - 13	14 - 16
pH (KCL)								
< 4.5	65	41.1	9	40	16	14	31	20
4.5 – 5.5	86	54.4	8	51	26	18	36	31
> 5.5	7	4.4	1	4	2	3	2	2

Table 2.1 *Changes in chemical properties of Nguyen Xa soils during 1985 – 1992*

Soil property and Class	1992		1985		Difference (1982 – 1985)	
	No. of Fields	%	No. of Fields	%	No. of Fields	%
pH (KCL)						
< 4.5	65	41.1	30	19.1	35	22.0
4.5 – 5.5	86	54.4	100	63.7	-14	-9.3
> 5.5	7	4.4	27	17.2	-20	-12.8

Table 2.1 shows comparisons of the chemical properties of Nguyen Xa soils measured in 1992 and the corresponding values measured in 1985. For pH value, comparison of the 1992 and 1985 data indicates an increase in soil even though lime is commonly used and the high pH of the irrigated water should have neutralized the soil to some extent. This increase in soil acidity might be attributed to the release of acid substances from manure and crop residue, which are used at high rates, and from the application of chemical fertilizers. (Patanothai, 1996)

In addition to the overall increase in soil acidity, there is a trend which shows that fields that were strongly acid in 1985 declined in soil acidity. A possible explanation might be selective application of a high rate of lime only in strongly acid fields but not in fields with less acidity. (Patanothai, 1996)

Despite the fact that Figure 2.4 shows that all the nutrients (except for Potassium) within Nguyen Xa show positive balances, it is not clear that these nutrients will remain in balance. Nitrogen and Sulfur are soluble and are expected to be lost through drainage. Phosphorus, Calcium, and Magnesium are immobile and are expected to stay in the field. The accumulation of Calcium and Magnesium is beneficial because it could lower the pH of the soils in Nguyen Xa, but the loss of Potassium at its current high rate will affect the sustainability Nguyen Xa's current rice production. If farmers in Nguyen Xa are to maintain their current yields, they must address the current loss of Potassium, and the accumulation of the remaining nutrients, which, if left unchecked, may reach toxic levels. (Patanothai, 1996)

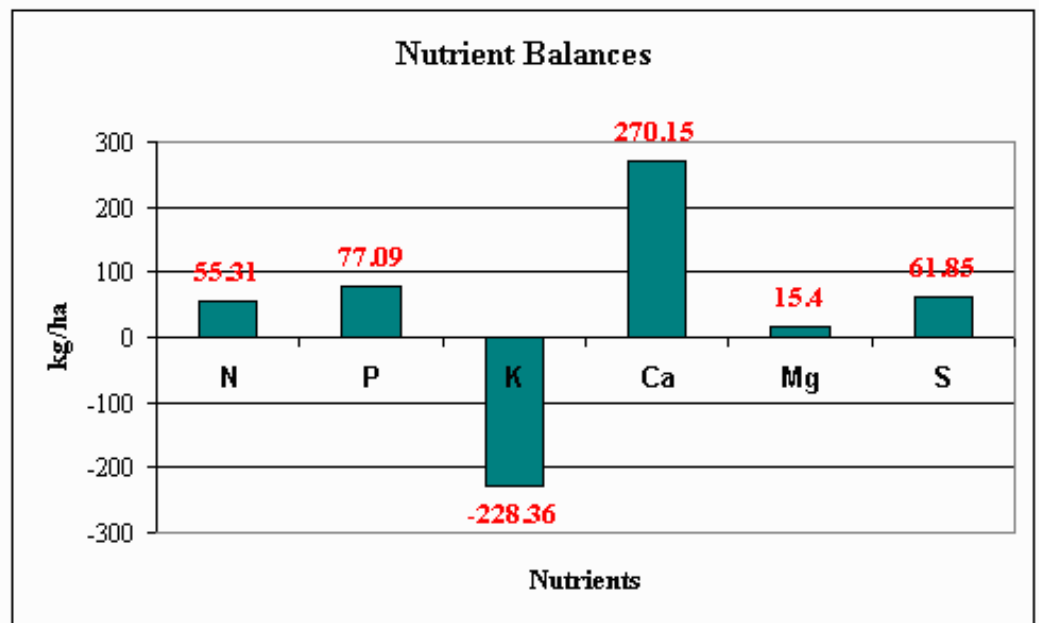


Figure 2.4 *Nutrient Balance Depletion and Accumulation*

Sediment is a source of nutrients that enter the Nguyen Xa Village Agroecosystem through flooding and irrigation water. Once, villages had been subjected to annual flooding which was probably a source of incoming nutrients. Now, with the dyke system of the Red River Delta, flooding is largely no longer a threat, and the source of nutrients is also lost. Currently, the only source of sediment is irrigation water, which loses a lot of its sediment load before it even reaches the fields.

The sediment of the Red River is very rich and its pH varies between 7.0 and 7.4. The following is the breakdown of the available nutrients in the sediment load from the Red River:

1. Available Nitrogen 0.5 mg/100 g solid
2. Phosphorus 1.17 mg/100 g
3. Potassium 1.06 mg/100 g

The sediment deposition rate is 80kg/ha/yr, which means that the amount of nutrients added to the fields are estimated to be:

1. Available Nitrogen 0.04 kg/ha/yr
2. Phosphorus 0.09 kg/ha/yr

3. Potassium 0.08 kg/ha/yr

In other words, the current nutrient flow into the Nguyen Xa system is negligible with the bulk of new nutrient deposits coming from fertilizers (chemical or manure). However the irrigation water to Nguyen Xa does play a very important role in maintaining the pH levels of the fields which are highly acidic from heavy fertilizer application. (Patanothai, 1996)

Although Nguyen Xa is not a completely closed system in terms of nutrient flows, it has a high degree of internal recycling. The principle nutrient inflows are atmospheric nitrogen carried in by rainwater, or fixed by nitrogen fixing plants (like Azolla), sediments from flood waters or irrigation, and fertilizers. The amount of nutrients that come in from rain, the river, or green manure is negligible and chemical fertilizers are probably the major sources of nutrient inflows into the village systems. (Patanothai, 1996)

The major outflows is through rice grain, and pigs sold out of the village. Other outflows are considered small. Under the situation of limited land and intensive cropping, Nguyen Xa has created a very elaborate plan of nutrient recycling and just about everything is recycled back to the field in one way or another (See Figure 2.5). With these practices, farmers have been getting high crop yields. The question though is whether these high yields can be maintained over time especially with its current rate of growth. (Patanothai, 1996)

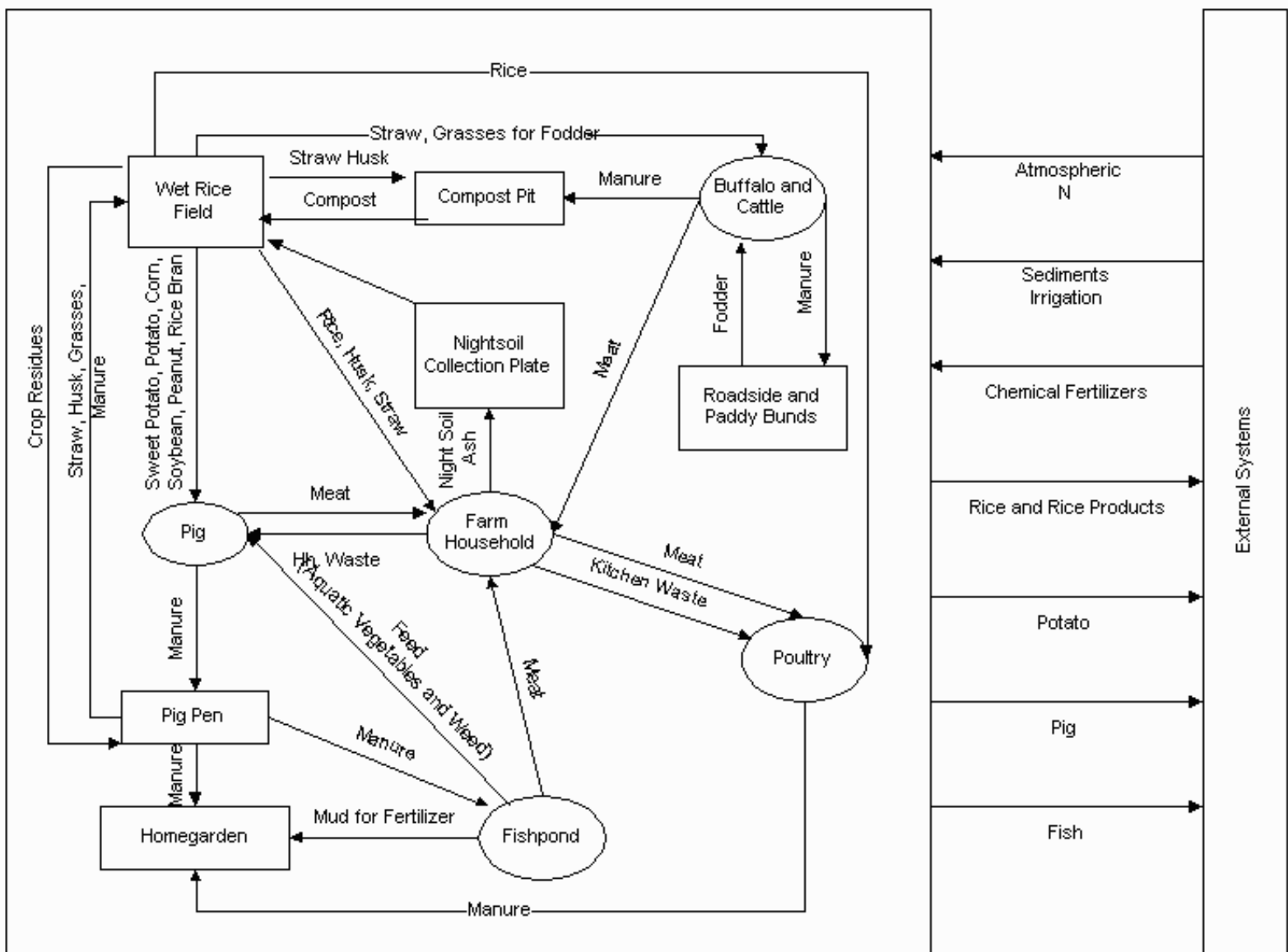


Figure 2.5 Nutrient Recycling in Nguyen Xa¹

¹ Some interesting points to note: The flow chart does not show that *Azolla* is the principle source of green manure used for the fields. In addition, farmers also use weeds, potato plants, and wild aquatic vegetables and wood to supplement their fertilization. This practice is only practiced for the winter crop and not for the spring, because the pre-winter season is favorable for plant decomposition.

~~and used to supplement their fertilization. This process is only practical for the winter crop and not for the spring, because the pre-winter season is favorable for plant decomposition.~~

III. Conclusion

This study found that the villagers of Nguyen Xa were producing enough food to meet their subsistence requirement, and even a small surplus to sell, despite the fact that they had only 490 m² of cultivated land per person. The villagers were able to accomplish this by focussing on producing consistently high yields that would more than meet their subsistence needs. On average the farmers yield over 10 tons of paddy per hectare per year, and this production rate has remained consistent for the last 10 years. Because the farmers are producing 80% of the maximum yield as currently defined by the CERES Rice Simulation Model, to increase the yield rate would be a difficult feat.

The farmers have been able to meet their subsistence requirements by taking steps to ensure minimal population stress on natural resources:

1. They've enthusiastically followed family planning policies which lowered the villages overall population growth.
2. Used locally adaptive rice varieties.
3. Created a carefully controlled irrigation system.
4. Maintained a highly efficient nutrient recycling system.

Despite the best efforts of farmers to maintain soil fertility, the studies show that soils in Nguyen Xa are becoming increasingly acidic, and that Potassium loss is incredibly high. These changes will result in declining yields in the long term. At the same time that the sustainability of the soil is threatened, continued population growth threatens to outstrip the ability of even the best-managed system to provide subsistence needs. As the CERES Rice Simulation Model shows, there is very little room for increased performance, even though the population is growing at over 1.5 percent a year. (Rambo, 1996)

Population Control is certainly an important factor in the management of population stress on natural resources but the government programs currently in operation have already brought the population growth down to a very impressive rates. Encouraging out migration is an alternative but will not provide a complete solution. Newly relocated residences moving to marginal agricultural regions do not have the agricultural experience or community and governmental support to eke out a subsistence in a different agroecological niche. Thus, current government efforts to relocate residences to New Economic Zones (NEZs) have met with only limited success and the program experiences a high degree of return rate. (Le Trong Cuc, 1990)

Then what are the alternative solutions to the current situation in Nguyen Xa? Besides population control, and increasing rice yields, diversifying sources of employment and income will result in less reliance on the wet rice culture of North Vietnam.

Traditionally, agriculture has remained the main occupation for many households in Nguyen Xa , but in more recent times villagers have supplemented their rice income with employment from subsidiary enterprises. engaged in subsidiary enterprises ranging from making sweets, liquors, pressed ham, and tofu; dealing junk and scraps, working in construction, carpentry, rice mills, glass manufacturing. These activities have been increasing and have generated income to the villagers. In fact, income from these activities has become the major part of family income many households. They have both positive and negative affects on agricultural production:

- Positive – There would be more investment in pig raising, which increases manure, provides less stress on land and less emphasis on growing a third crop. This will slow down nutrient depletion and allow the land to replete itself. In addition, subsidiary enterprises provide more generic market oriented skills which would encourage out-migration and less reliance on wet rice cultivation.
- Negative – Less time is spent on crop production and declining interest in maintaining good agricultural land management.

Agricultural Diversification is another alternative to wet rice cultivation practices. Encouragement to diversify products has come in the form of a resolution from the 7th National Congress of the Communist Party of Vietnam. They want the policy of local food self-sufficiency to gradually shift toward utilizing the comparative advantage of each agroecological region. In other words, farmers who take advantage of the agroecological diversity of each region will be able to optimize production of the region's suitable agriculture. (Jamieson, 1992)

If the agricultural potential of the country is realized then this will create favorable conditions for specialization, and facilitate a market-oriented approach. There will be less reliance on rice as subsistence agriculture, and the exchange of goods among different regions will encourage more rapid economic growth and can result in more efficient production of each region's products.

Unfortunately, such an approach will take time and considerable momentum. Because the villagers in Nguyen Xa are traditionally rice cultivators, there is a general resistance to diversifying their agricultural potential. In addition, because the rich alluvial soils of the Red River Delta is a region that is conducive to rice production, Nguyen Xa might very well become a center of specialized rice production for Vietnam. If this is the case, and the population stress continues to grow, then in order to support themselves, the villagers of Nguyen Xa must find alternatives to their current reliance on wet rice cultivation.

There is an additional alternative to solving this population stress, and that is to reduce dependency on rice production by encouraging alternative sources of income as a supplement. The problem with this approach is that in order to be successful at transitioning over to a market economy from subsistence agriculture, villagers must once again be willing to train for new practices. We see that some farmers are already supplementing their incomes through animal husbandry, fishing, and food processing, although income from these activities are very minimal. Traditionally villagers have been resistant to market adoptions of small scale non-farm activities, but the villagers in Nguyen Xa do not seem to be reluctant to engage in off-farm occupations to earn cash.

The most likely approach to the current situation in Nguyen Xa is that a combination of different solutions and policies is needed to address the growing population stress on the village's natural resources. Population control must remain a high priority, with an eye out to possibly increasing current rice yields through the introduction of new rice varieties or practices. But villages must address the growing soil acidity and loss of important nutrients from the region. In order to provide less stress on natural resources, diversification of agriculture and increased participation in subsidiary activities seem to be the only solutions which will not only help keep population in check (by providing incentives for out migration) but allow for long-term land use sustainability. Thus, only a combination of policies and approaches will help Nguyen Xa cope with long term population pressures, and allow for a successful transition into a less dependent wet rice society.

Because the future welfare of the Red River Delta's Population so depends on the functioning of agroecosystems like that of Nguyen Xa, the solutions we create may be useful and portable enough to apply to the Red River Delta region as a whole. Thus, the study of Nguyen Xa is important in determining regional policies, and moving the culture towards less reliance on wet rice cultivation and subsistence agriculture, in addition to providing less stress on current natural resources. Nguyen Xa is a classic case of intensive land management to meet population stress. The insight we gain with Nguyen Xa is important in our ongoing analysis of the region's long term sustainability.

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Deforestation in Eight Southeast Asian Countries: Indonesia, Malaysia, Myanmar, Philippines, Thailand, Vietnam, Laos, and Cambodia. Thammasack Manokham

Introduction.

Environmental destruction is not new to the developing Southeast Asian communities. Deforestation, or the loss of forest cover, is happening at an alarming rate in these countries as the population increases rapidly. The increasing population is accompanied by an increasing need for agricultural land. As a result, much land is deforested by slash and burn cultivators. In these developing countries, the nature preserves drawn on map are overrun by local communities whose need for subsistence overwhelms attempts to protect wildlife or the native forest. In addition to loss of forest land due to conversion to agriculture, many forest trees are over-harvested or illegally cut, resulting in less stock and inadequate reproduction. Since forest products are an important export commodity for many of these countries, loss of forests results in decreases in revenue for the country. Consequently, some countries such as Thailand and the Philippines have become importers rather than exporters of forest products.

My paper will have four sections. Section one will discuss the extent of deforestation in these eight countries and its effects. The second section will explain national policies adopted by these countries to limit deforestation and its effectiveness. A model of sustainable deforestation in Thailand will be discussed in the third section and then, applied to the other seven countries. Finally, in section four sustainable environmental polices will be recommended.

1. Extent of Deforestation.

Population and deforestation

In 1995, Asia has 60.5% of the world's population. Although Asia has the highest recorded population (3,458,000, 000) in 1995, it does not have the greatest annual rate of increase. Africa's annual rate of increase (2.8% between 1990 and 1995) is higher than Asia's annual rate of increase (1.6%). However, Asia faces many environmental problems such as deforestation because of its high population.

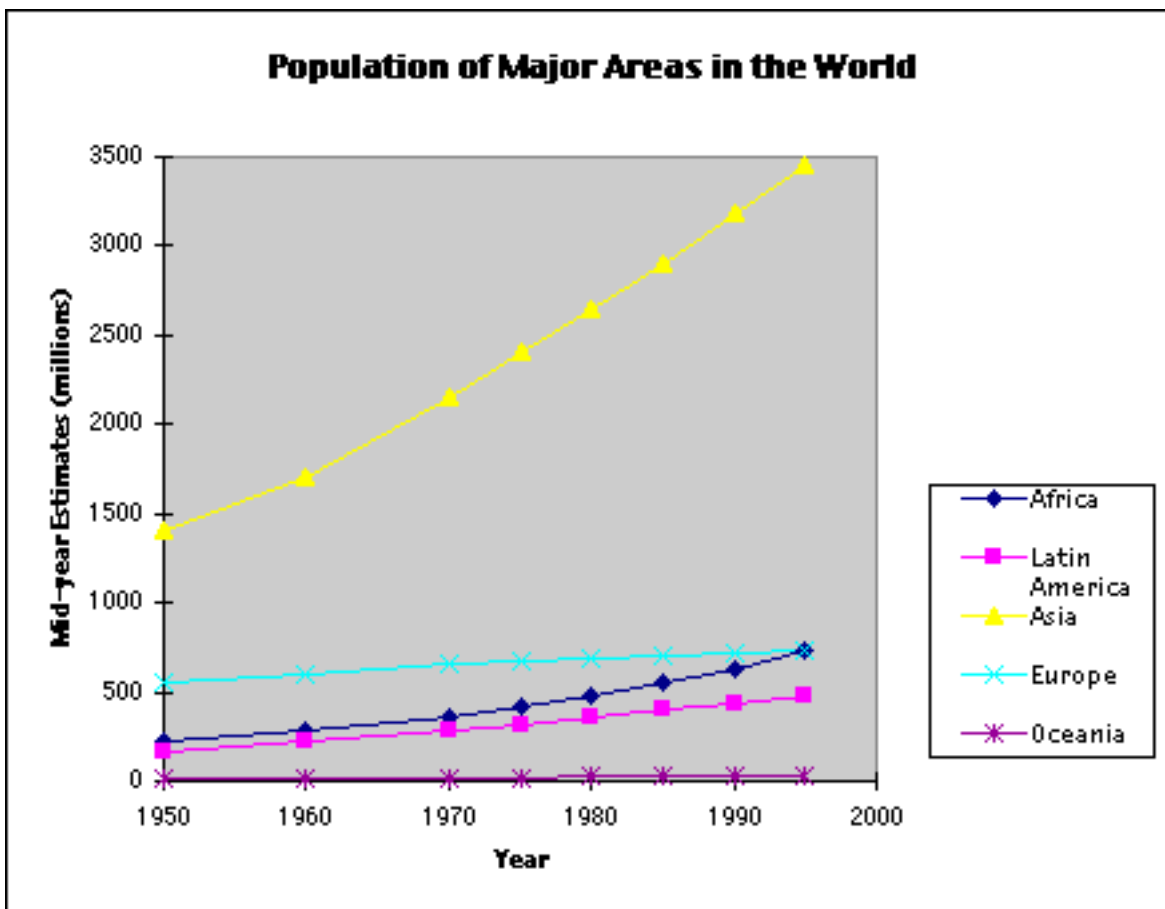


Figure 1. Population of major areas and regions. Source: 1995 United Nations Demographic Yearbook.

Of the eight countries that were examined in this paper, Indonesia has the greatest rate of population increase (figure 2). Indonesia is home to more than half of that region's population. Although the rate of population increase is not as high as Indonesia, the other seven countries are also increasing steadily.

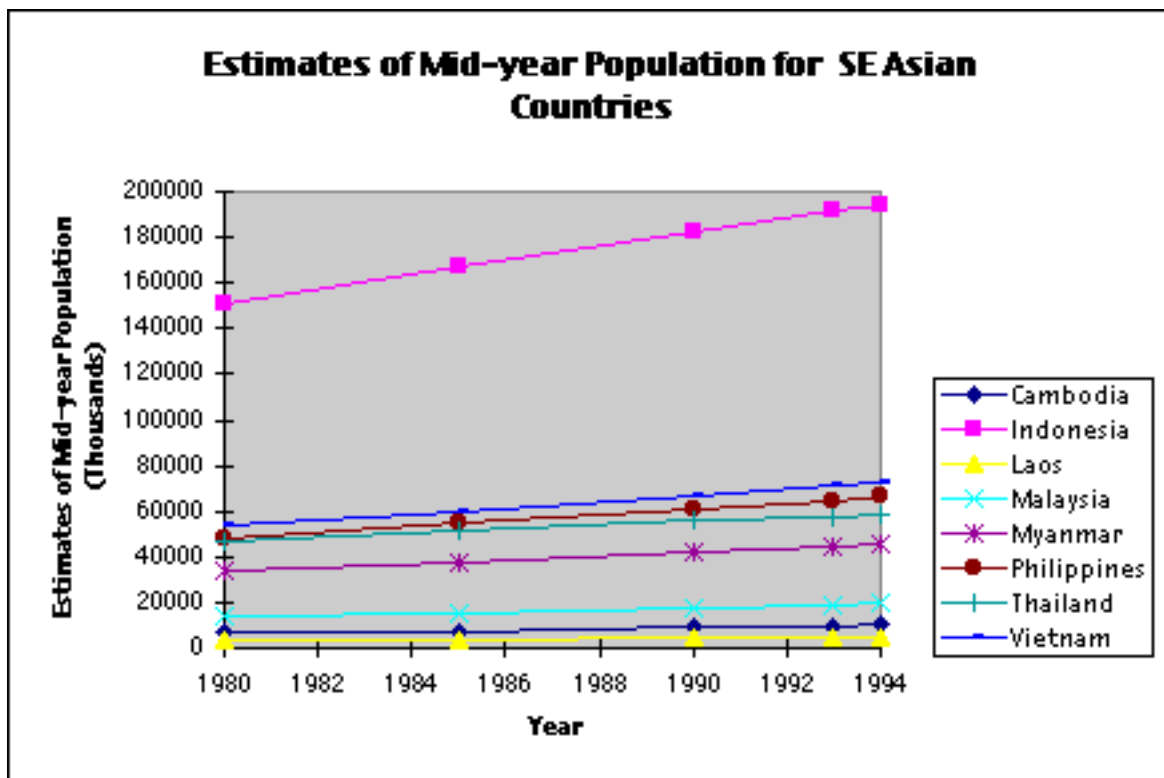


Figure 2. Estimates of Midyear Population (in Thousands) for Eight Southeast Asian Countries. Source: 1996 UNESCO Statistical Yearbook.

One way to measure a country's development is by its GDP. Generally, the higher the GDP, the more developed the country. With this in mind, the eight countries show signs of development because their gross domestic products have increased (figure 3). Malaysia has the greatest GDP. Thailand has the next greatest. The remaining six countries, Cambodia, Indonesia, Laos, Vietnam, Philippines and Myanmar, also have growth in GDP.

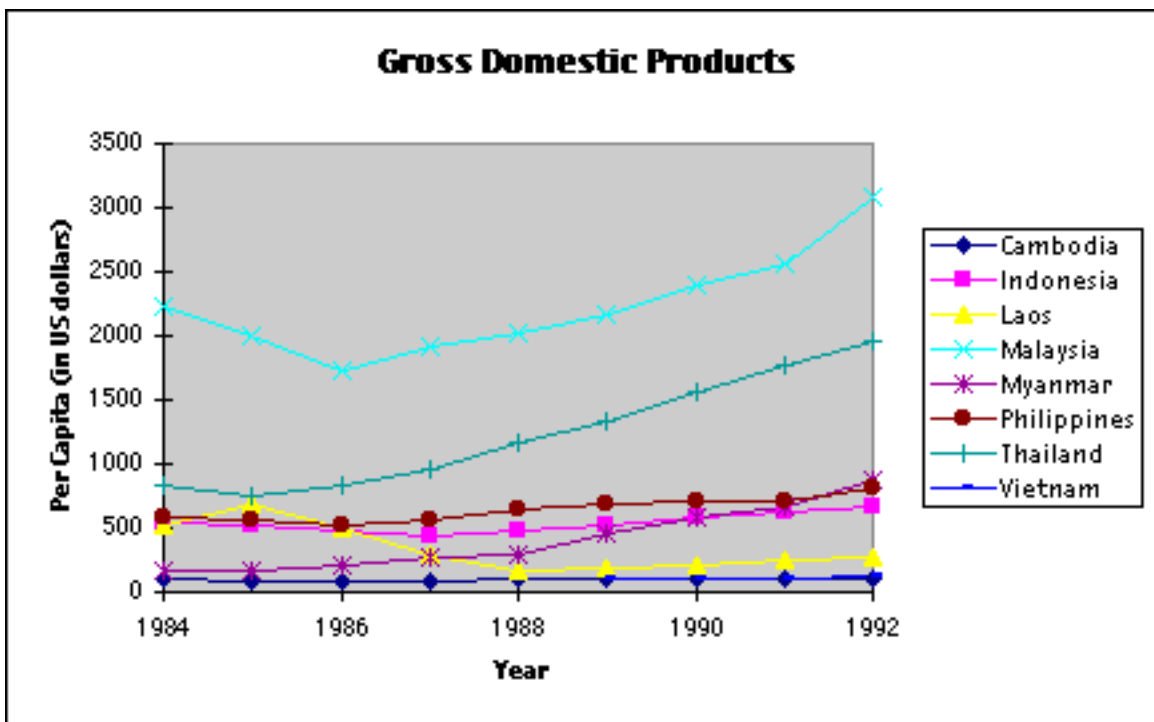


Figure 3. Gross domestic product: per capita for eight Southeast Asian Countries. Source: National Accounts Database of the Statistical Division of the United Nations Secretariat.

GDP is the result of many kinds of economic activities, such as agriculture production, mining and quarrying industries, manufacturing, electricity, and construction. If the agricultural sector (which includes agriculture, hunting, forestry, and fishing) contributes most to the country's GDP, then a growth in GDP could reflect an increase in deforestation.

In two countries Myanmar and Vietnam, the agricultural sector contributes more than half of total GDP (figure 4). This large percentage for Myanmar and Vietnam indicates that the economies of Myanmar and Vietnam are dependent on agricultural production for success. The percentage that the agricultural sector has contributed to the total GDP has increased for Myanmar during the period of 1985 and 1992, whereas for Indonesia, Malaysia, the Philippines, Thailand and Vietnam this percentage has remained stable. Although the percentage has not changed significantly for these latter countries, the percentage of agricultural contribution to total GDP is high. For Indonesia and the Philippines the percentage has been 25, and for Thailand it has stabilized to about 15. The large percentage indicates that agricultural production is important for both domestic consumption and export.

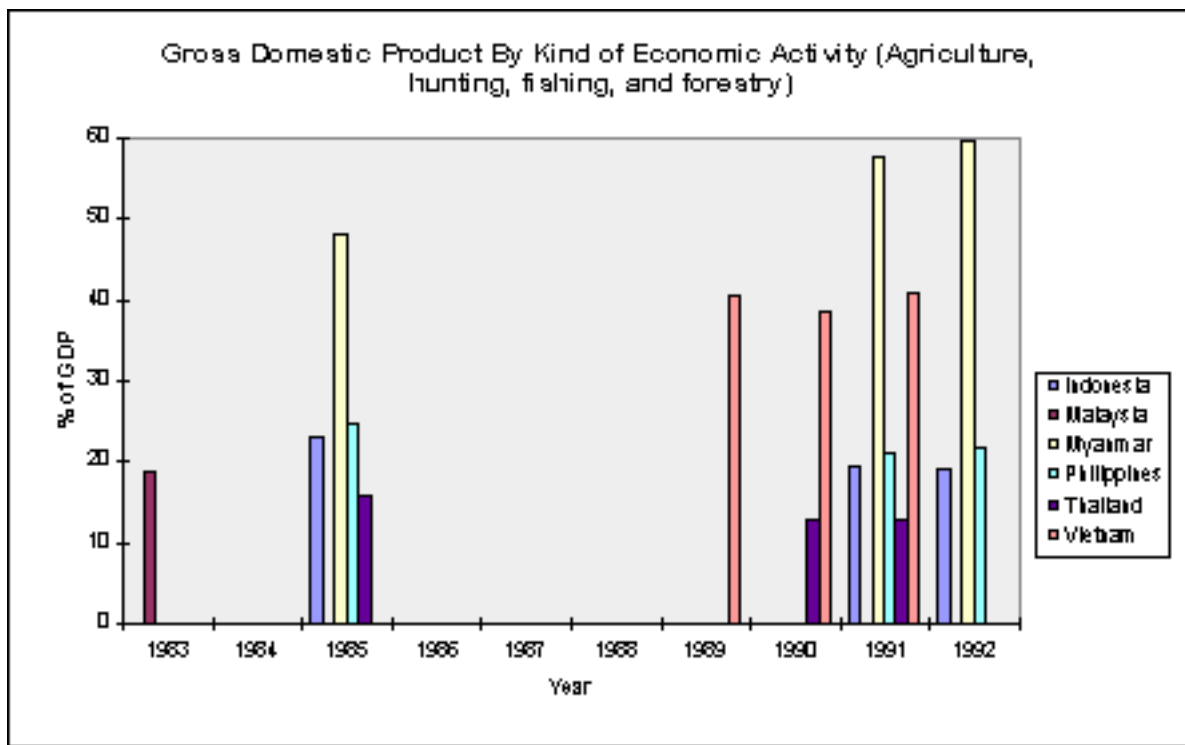
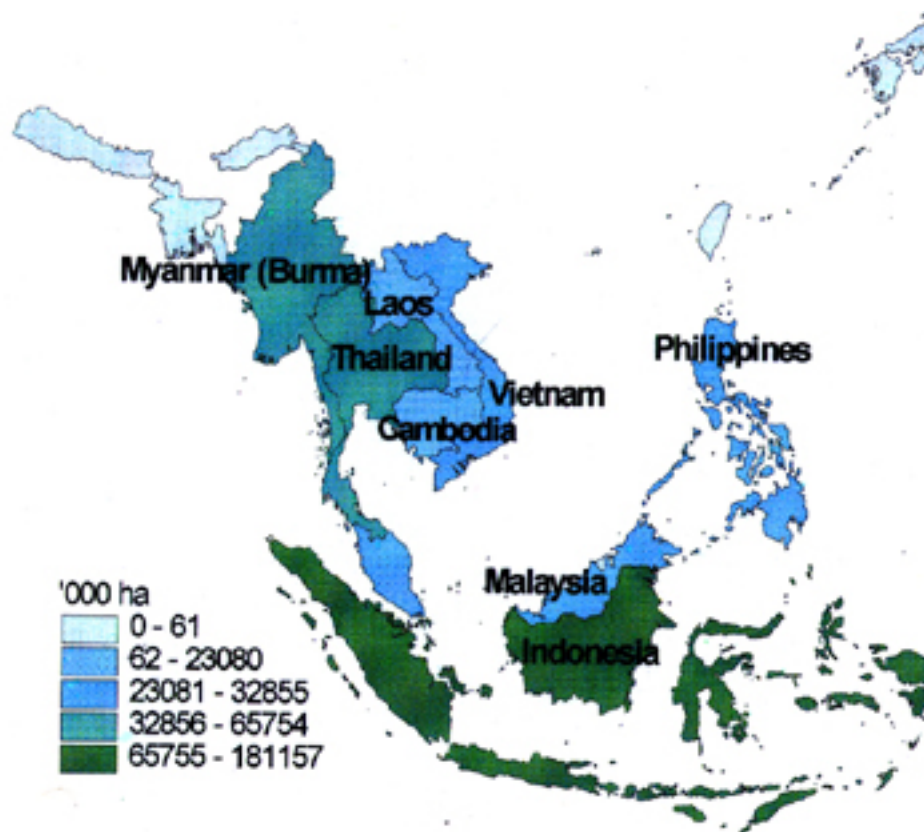


Figure 4. Gross domestic product by kind of economic activity (agriculture, hunting, fishing, and forestry) at current prices. Source: National Accounts Database of the Statistical Division of the United States Secretariat.

There could be a correlation between the increase in gross national product and the decrease in forest cover. To validate this assumption, there must be an increase in the agricultural sector in GDP and the increase must be extensive rather than intensive. In other words, the increase in the agricultural sector must be the result of land expansion instead of increasing the net yield per land.

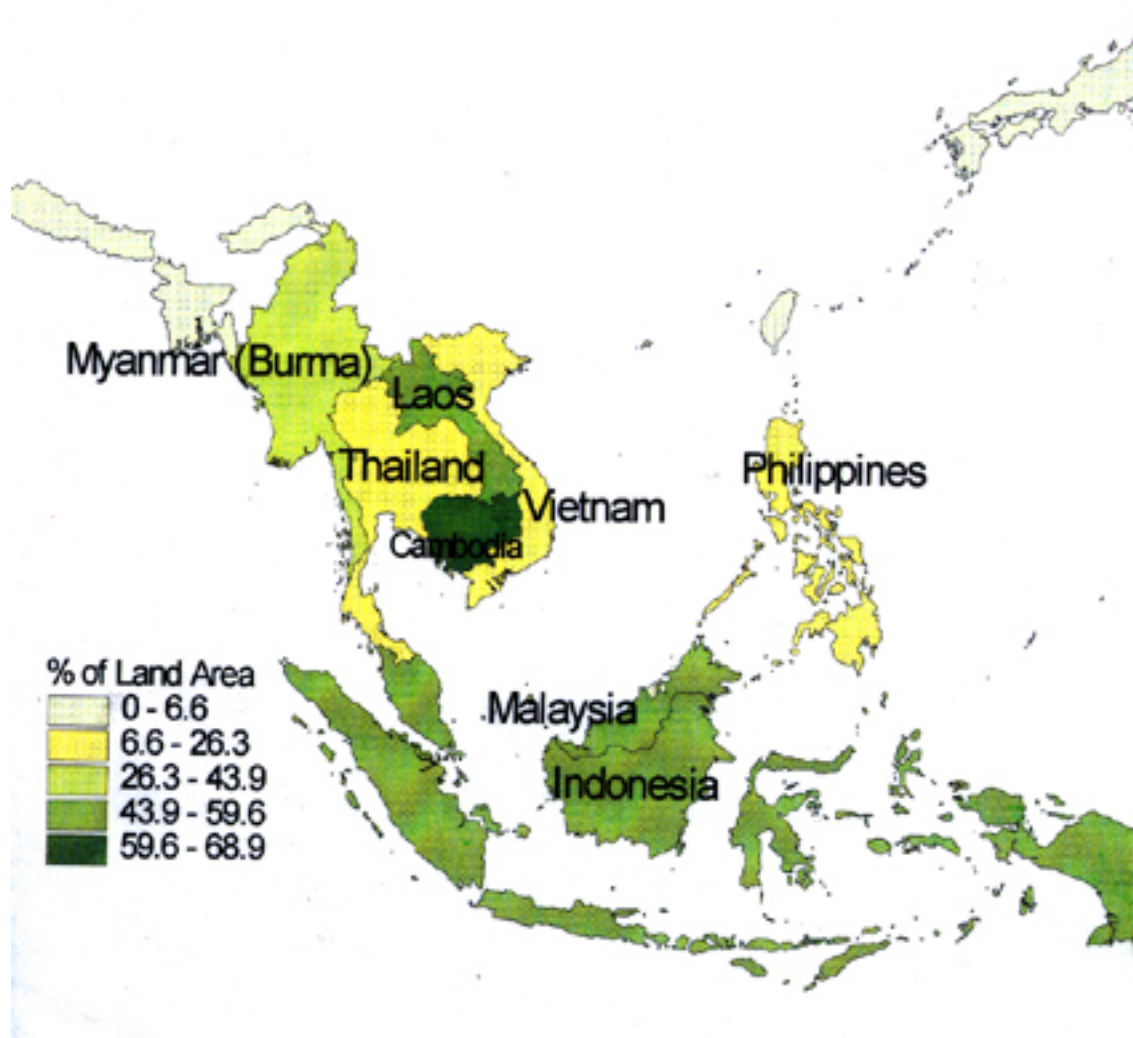
Deforestation Patterns

Indonesia has the greatest total land area (Map 1). Thailand and Burma come next in scale of land forest area. Vietnam and the Philippines follow behind these two countries.



Map 1. Total land area for Eight Southeast Asian Countries. Source: Summary of the Final Report of the Forest Reserves Assessment 1990 for the Tropical World, Food and Agriculture Organization, March 1993.

In the eight Southeast Asian countries, a large percentage of their total land area is covered by forests. In four Southeast countries, Cambodia, Lao PDR, Indonesia and Malaysia, more than 50 percent of their total land area is covered by forests (Map 2). The other four, Myanmar, Philippines, Vietnam and Thailand have greater than 25 percent of their land area covered by forests. The high percentage of forest cover indicates that the potential for agricultural production, commercial logging, land clearings for cultivation and settlement, and uncontrolled fuelwood collection in these countries is also high. There is a great amount of forest land to be depleted.



Map 2. Forest Cover (1990) (% of land area). Source: Summary of the Final Report of the Forest Reserves Assessment 1990 for the Tropical World, Food and Agriculture Organization, March 1993.

Deforestation is high in countries with large total land area. Because Indonesia has the greatest total land area, it plays a key role concerning the future of forests in Asia. While Indonesia has the largest forests, it also poses the largest deforestation (Map 3).



Map 3. Annual Deforestation for Eight Southeast Asian Countries. Source: Summary of the Final Report of the Forest Reserves Assessment 1990 for the Tropical World, Food and Agriculture Organization, March 1993.

Although Indonesia has the highest annual deforestation of all eight countries, the rate of deforestation is much lower than Thailand's and the Philippines'. To determine which countries have the greatest amount of forest loss over the years, the change in deforestation over a ten year period was calculated. Four countries that have lost a considerable amount of land loss from 1980 to 1990 are Myanmar, Thailand, Malaysia and the Philippines. The percentage in forest area decrease over the ten year period is high in these four countries (map 4). This is especially true for countries with large-scale domestic forest-based industries, such as Malaysia and Indonesia.



Map 4. Percentage of Forest Area Decrease in Eight Southeast Asian Countries Between 1980 and 1990.
Source: Summary of the Final Report of the Forest Reserves Assessment 1990 for the Tropical World, Food and Agriculture Organization, March 1993.

Over the ten year period, forest area has been reduced in Thailand by 28.9% and in the Philippine by 28.8%. The rate of deforestation for Thailand and the Philippines are both 4.0×10^{-2} . Malaysia follows behind with its forest area reduction at 18.4%. Vietnam and Myanmar are also close behind, with forest area reduction at 14.2% and 12.2% respectively.

Reasons for Deforestation

The biggest threat to the forests is commercial logging, land clearings for cultivation and settlement, and uncontrolled fuelwood collection. High population density has contributed not only to destructions of forests by land clearings for cultivation but also overharvestings of forests for fuelwood.

In countries where a majority of the total population lives in rural areas and still earns a living principally on agriculture, such as in Thailand, agricultural products have been the major export earners for the past two decades (Phantumvanit, 10-15). Agricultural productions have increased significantly in other Southeast Asian countries as well (figure 5), such as Cambodia, Indonesia, Malaysia, Indonesia, and Vietnam. There is a projected increase for all eight countries. As the demand for land to grow cash crops increases, deforestation will increase.

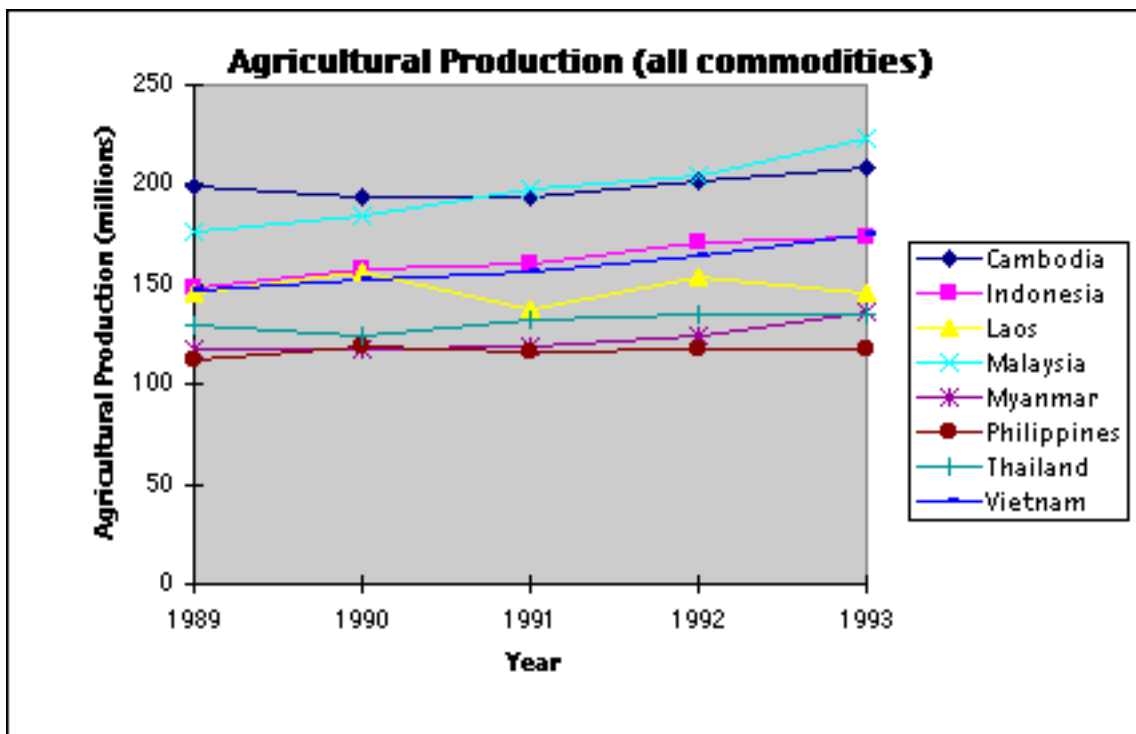


Figure 5. Agricultural Production (all commodities). Source: Food and Agriculture Organization of the United Nations (Rome) in Statistical Yearbook, fortieth issue.

In order to increase agricultural output, there is expansion of cultivated areas rather than increase in the net yield per unit area of land area. As stated earlier, the increase in agricultural production is the result of extensive cultivation rather than intensive cultivation. This encroachment upon forest areas for cultivation is a major cause of deforestation. The situation is made worse by the decline in land quality. Consequently, some crop yields have shown a downward trend over the past five years in both irrigated and rain-fed areas because of soil degradation and poor management (Phantumvanit, 14).

Another cause of deforestation is the increased demand for fuel wood. In the three years since 1991, when the prices of most agricultural commodities have been stable or have fallen, the price of tropical timber has risen by more than half (Lumpur, 38). As the demand for fuel wood increases, deforestation will worsen. Annual fuel wood demand is estimated to be 15.1 million cubic meters, in comparison with the total sustainable supply of 6.3 million cubic meters (Phantumvanit, 14). If the economies of Southeast Asia continue to grow at their fast rate, the rates of consumption of forest products and services will also increase. This will be a problem for fuelwood production in plantations in maintaining a natural forest cover in the region. Consequently, deforestation will cause the Southeast Asian countries

to be importers rather than exporters of forest products. Latin America will become the new exporters (figure 6) as the region's dominance in the world trade of tropical hardwoods decline by the end of the century because of the depletion of timber resources.

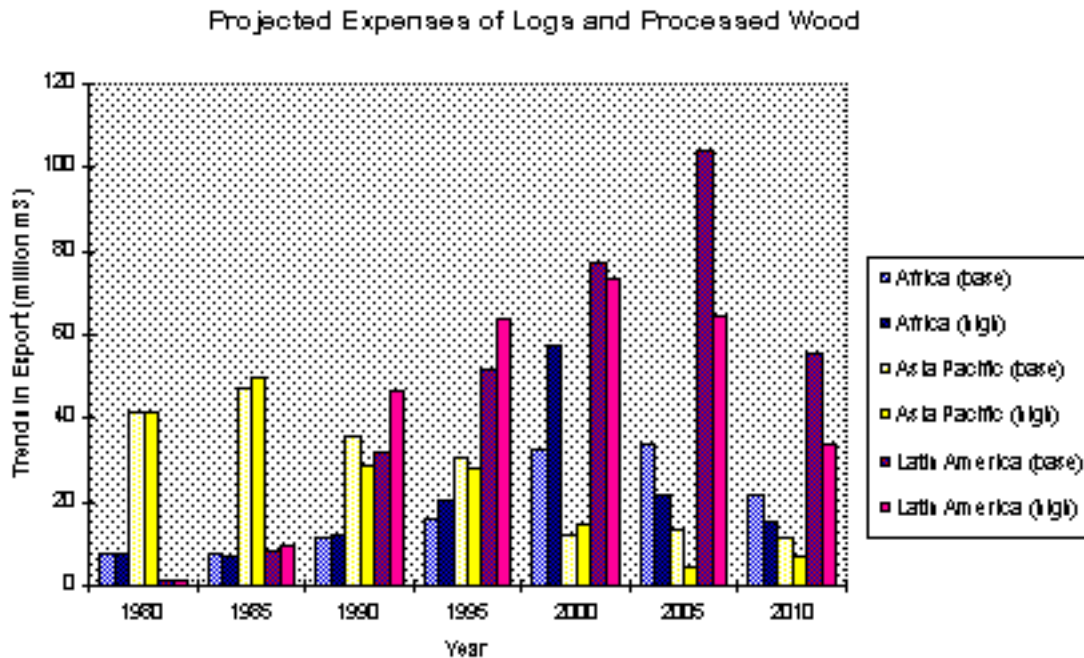


Figure 6. Projected Exports of Logs and Processed Wood. Source: Granger 1987.

Other causes of deforestation include illegal logging by both loggers and farmers. When logging, although it is generally called "selective logging," is conducted with destructive methods involving heavy machinery, damage occurs to the logged area. The logged areas are not regenerated and soon abandoned by settlers, who entered the logged areas and burn down the remaining forests for farmlands, plantations, and building sites, because they have poor soil and cannot be used for long-term farming. Logging reduces the productivity of agriculture and fisheries over wide areas, robbing the environment of its capacity to sustain future generations ("Wasteful Japan," 43). In many cases of excessive and destructive logging, governments have allowed unsustainable logging in order to encourage the timber trade, support industry or earn foreign exchange for economic developing.

Effects of Deforestation

Although deforestation is the result of small scale decisions such as subsistence farming, ranching or lumbering for profit, consequences of deforestation are on the large scale such as alteration of hydrological patterns, effects on global climate, or reduction of biodiversity (Katzman,827).

Soil erosion, frequent floods, droughts, and forest fires are the local results of this loss of tropical forest. Without the protection of trees, exposed topsoil is easily eroded away by wind and rain. The erosion sparks floods and mud slides and the silting of rivers.

Secondly, tropical rain forests are home to over 80,000 different species of plants and 20 million species

of animals. The loss of species is accompanied by the diminishing of the genetic pool. In addition, forests are a source of valuable products such as rattan, bamboo, natural rubber, and medicinal plants. Its disappearance also translates into the loss of cure.

Lastly, deforestation can lead to global warming. The increase in carbon dioxide and other gases from industries causes global warming through the greenhouse effect. Trees, as the biggest plants, play a crucial role in maintaining the earth's oxygen/carbon balance. They take in carbon dioxide and give off oxygen. Burning trees contribute to the greenhouse effect by emitting carbon dioxide. These burned-out forests can no longer remove the carbon dioxide ("Saving the Rain Forests," 11).

National Policies Adopted by Countries and Its Effectiveness.

Malaysia and Indonesia

When the international communities have placed a limit on imports of tropical hardwood, Malaysia and Indonesia have led a counterattack. In Malaysia, lobbyists who were hired by the timber trade argued that limits were another form of protectionism designed to keep the poor countries poor. They argued that when rich countries want to negotiate agreements to limit deforestation, they express no interest in how temperate timber is grown. In other words, rich countries did not want to help pay for the expenses of reforestation.

The Malaysian government has allowed the police and army to round up illegal loggers and to impose much higher fines. In Indonesia, the government requires those who are granted logging concessions to replant where they fell. Both countries have also imposed a ban on log exports. Although these actions may suggest that the government is trying to curb illegal logging, this is really not the case. These actions disguise their economic interest. Both governments want to create an industry that uses the wood on the spot rather than one that simply sells the unprocessed logs. By processing the timber on the spot, they squeeze Japan's wood processing industries and attract Japanese investments for themselves.

These two countries also used certification, a process which cuts out middlemen and puts timber importers in close touch with producers. By certifying that logs have been produced by sustainable methods of forestry, these two countries are taking a short-cut to moral high ground because certification might improve forest management and ensure that the government gets its proper share of logging revenues. Without certification, there is a risk of losing market share in Europe and America, which are the main markets for the high-value timber products. Although some may be reluctant to pay extra, timber producers could still gain, according to rough sums by World Bank economists. They reckon that this, plus regaining those lost green markets, might eventually bring producers an extra \$100m-120m a year in revenues. The Indonesian forestry ministry has already established a group to study the possibilities of eco-labeling and Malaysia is also beginning to investigate certification.(The Economist, 39)

Since the government of Malaysia and Indonesia own the forests, they are able to increase their own political power by distributing concessions to certain groups. When concessions to exploit the forests are

issued to the holder, they are usually too short and this gives them no incentive to conserve resources. To avoid this, the government might auction concessions with a reserve price that reflects the cost of replacement. The chance of this actually happening is rare because concessions are important for political alliances. It is reported that timber magnates pay small sums to the officers and evade quotas, levies, and rules ("Trees Not Timber," 36).

Philippines

Philippines have banned the export of logs (at the start of the Aquino administration in 1986) and sawed lumber. Extensive illegal logging and exports, nevertheless, systematically undermine these measures. Price-fixing schemes, which prevent the producer countries from gaining the proper economic benefit from timber exports, also undermine these measures ("Wasteful Japan," 43).

Laos

To address the rapid destruction of Laos' forests, the Lao government held Laos' first National Conference on Forestry where they issued a resolution that sets forth strategic directives to manage Laos' forests and identified urgent measures to protect these forests. Subsequently, they issued a decree which entrusted the Ministry of Agriculture and Forestry with protecting the forests and discussed land use by villagers, as well as conversion for development in the form of roads, mining and construction for hydroelectricity. A national logging ban was subsequently issued in 1991 that prohibited tree felling for the sale of wood as raw material or as construction material, and only allowed processed wood to be exported.

Thailand

Thailand in the 1950s had adopted a national policy which stipulated that 50%, later changed to 40%, of the national area was to remain under forest (Hirsch, 171). It halted legal logging since the decision in 1989 to cancel all concessions.

It has also mounted a national campaign in response to illegal logging. Log poachers include innumerable subsistence farmers who find illegal logging more economically rewarding than other alternative means of employment (Phantumvanit, 15).

Although farmers occupy and work this previously forested land or forest reserve land, they are in a marginal position economically, ecologically, and politically because they have no legal title to it. Without proper land titles, they do not have incentives to invest in their farms. They also face obstacles in applying for loan credits from any formal financial institutions. Lack of access to credit as a result of inability to provide collateral in the form of land title means that farmers do not have the means to make improvements. Consequently, they have abandoned their older cultivated land for new land because they cannot get money for fertilizers and other items. The latter reason is the more important factor inhibiting sustainable management of land in forest reserve areas because most farmers working the land, despite the insecurity of forest reserve status, regard it as their own in much the same way as do those with legal title (Hirsch, 171). Problems of tenancy and landlessness will increase as the population and ensuing intensification of agriculture increase (Phantumvanit, 14).

Although all such land is state land, policy practices lead to ambiguity over legal status of forest reserve land. The Lands Department of the Ministry of the Interior collects agricultural land taxes on this land, and these tax receipts are used in place of land titles between farmers and in negotiations with state authorities when prior occupancy needs to be established. The government has been in the past reluctant to move settlers off the land in fear of alienating those who are among the poorest of Thailand's rural poor. In addition, forest settlement has been the principal means of agricultural expansion at a national level and of peasant household strategy at a local level. The Public Welfare Department, Agricultural Land Reform Office, and a host of other agencies has granted legal tenures to many of those who in the past illegally occupied forest reserves. Thus, many expect that "sitting tight" will be enough to eventually achieve such legal status (Hirsch, 171).

The government has attempted to rehabilitate the forest itself by implementing programmes that reforest encroached forest reserve land, mainly with fast-growing species. These programmes include 'forest villages,' where farmers are moved off their land and hired full time to plant trees and social forestry, where agriculture is supplemented by reforestation on private and community woodlots. The emphasis is on privatizing reforestation, which involves the granting of 30-year leases to concessionaires on forest reserve land. The state land under lease to concessionaires is often alienated from poor farmers who have been working the land for a number of years. As a result, many reforestation schemes have led to confrontation between local people, state officials, and private concessionaires.

To solve the problem of land tenure in forest reserve area and to stabilize forest reserve areas so that poor farmers do not encroach on forested land, the Thai government implemented the sor tor kor, or usufructory license in 1982. It grants limited land rights (such as the right to occupy and farm up to 2.4 hectares of forest reserve land for an initial period of five years) to the more than one million families occupying forest reserve land illegally. This length can be extended if certain rules are adhered to. However, these farmers are called squatters and have had few rights under law. They can be subject to arrest for oppositions to various government schemes, nominally on the charge of forest encroachment. They are also required to give up some land because their average farm size is about 5 hectares. The strict plot limit is inadequate to make a livelihood under existing practices. Surplus land is then reforested with the participation of usufructory license holders. The license is passed on to descendants but is not sold or used as collateral with commercial banks. Other problems include that ambitious targets have not been met. By 1985, only 1 million hectares had been licensed, which represents approximately one-tenth of denuded land. Lastly, the assumption that land will not be brought and sold is false. Tax receipts are used instead of title deed because there is little perceived risk for large landowners who purchase land from small landowners, and for creditors who wish to foreclose on informal loans (Hirsch, 171).

Model of Sustainable Deforestation in Thailand and Its Applications.

One successful project of sustainable deforestation that was established by the Forest Industry Organization in Thailand in 1967 was the Forest Village System. The program promoted commercialization of timber harvest, reforestation, and forest research. It attempted to solve the

problems of land degradation, lack of land for peasants, and the need for reforestation of valuable timber species. By combining subsistence and commercial agriculture with reforestation, the program created new forest villages for the growing rural population with limited income opportunities. It achieved its objective of settling landless people and assuring a source of labour for plantation work.

By implementing the Forest Village System, the seven countries would stop the migration of the landless who have encroached on forest lands and intensified shifting cultivation. This program will not only prevent them from degrading their forests, but will also prevent them from crowding out forest-dependent communities from their traditional forest farming land. This will prevent violence between the two groups in the long run because the forest-dependent communities will not feel that their rights, identity and culture have been endangered by the landless farmers.

The participants of this Forest Village System will now have incentives to harness and manage the renewable and reproductive capacities of forest resources because they are resettled on a permanent basis. They are working on their own land. Supplied with facilities such as health clinics, schools, and agricultural credits and other forms of economic and social assistance, they will be content with the system and will want to give up their nomadic existence. While rehabilitating degraded forest reserves and increasing the timber production in these areas, they also improve their standard of living.

Recommended Environmental Policies.

If the current rates of deforestation continue, WRI predicts that by the year 2000, the 33 net exporter countries will drop to below 10, and export earnings will shrink to about US \$2 billion at current prices. This prediction is being manifested in two countries: Thailand, who has gone from an exporter to an importer, and the Philippines, whose timber trade is down to a trickle.

In response, the international community's has responded by creating two global initiatives: the International Tropical Timber Organisation (ITTO), which attacks the problem through the logging industry, and the Tropical Forestry Action Plan (TFAP), a task force made up of the United Nations Development Programme, the World Bank, the Food and Agriculture Organisation and the World Resource Institute. Funds to these initiatives and investments designed to slow the rate of deforestation have doubled in the past three years to US \$1 billion, but the rate of deforestation has never been greater.

Tropical deforestation is closely related to the development policies of tropical nations and the weak legal restrictions in developed countries such as Japan and Thailand. Japan, the greatest importer of world tropical timber, imports most of the wood in the form of raw logs, not processed wood products ("Wasteful Japan, 43). Developed and developing countries, whose excessive demand for tropical timber, must help solve the problem of tropical deforestation. For instance, the Japanese government recently had a basic policy regarding the conservation of tropical rain forests, and the Japanese timber industry has expressed no support for these changes. So far, for example, the Japanese industry has taken a negative position on the European Industry's proposal to impose a levy on imports of tropical timber and to use the proceeds to promote sustainable forestry projects through the International Tropical

Timber Organization ("Wasteful Japan, 43).

My proposals require participation from both developed and developing countries. They are as follow:

1. Governments of both developing and developed countries must conduct a wide ranging reform of its basic policies on trade, investment, corporation conduct, the domestic consumption of timber products, and foreign aid instead of settling with a handful of small-scale tree-plantation projects such as those it has been promoting.
2. Developed countries should reform its foreign aid policies, which has been directly and indirectly linked to tropical forest destruction, such as construction roads, dams, port facilities, and large-scale agricultural schemes. a. They should also stop all official and private financing of projects for which the World Bank and other development organizations have canceled loans or grants as a result of the project's potential for environmental destruction. The construction of roads in or through forest lands by legal concessionaires, public highway departments and other public investment programs (dams, railways) provides increasing to forest lands. Instead, they should introduce an environmental-impact assessment system, including alternative proposals, for all foreign-aid projects that could have a negative impact on the environment and on the local societies of the recipient countries.
3. They should also establish a committee of government agencies, the timber industries, and non-governmental organizations to formulate a plan for conserving tropical forests.
4. Lastly, they should establish a domestic and international code of conduct for forestry operations, as well as regulations that restrict the trade and use of tropical timber to supplies obtained, with proper management, from sustainable sources (Wasteful Japan, 43).

The underlying theme is that the developed and developing countries must recognize the economic basis of these decisions and change the incentive structure that generates them (Katzman,). In particular, producer countries should increase the price of timber products to reflect their replacement cost rather than their extraction costs and create financial incentives for conservation. They should should reevaluate land-use decisions (because they have undervalued their forests and thus, must change their policy accordingly, especially those agreements that regulate the timber industry). To meet the demand of forest products on a sustainable basis without destroying forest, more efficient wood extraction and processing techniques can be practices. Increasing the use of wood substitutes should also be encouraged. On the other hand, consumer countries must subsidize forest preservation or revamp the timber trade and increase prices because these tropical countries need timber export earnings, land to plant cash crops and land to settle rising populations. Producer countries do not have the luxury to leave their remaining forests untouched because the land transformed to other uses can provide cash, jobs and a home (Hirsch, 171).

Conclusion

Although Southeast Asia forests are currently able to supply growing demands for both domestic consumption and export, they will not be able to retain this exporting position in the future as their forest reserves get depleted. This region as a whole faces a widening deficit between production and consumption of traditional forest products. In conclusion, these eight countries, Cambodia, Laos, Myanmar, Thailand, Vietnam, Indonesia, Malaysia, and the Philippines, created large-scale forest domestic forest-based industries that promoted economic development but simultaneously decreased their high forest covers. Clearly, deforestation was essential to that country's socio-economic development.

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**Spatial Implications of
the Reunification of East and West Germany
Rosalyn Scaff**

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Introduction

In 1989 the fall of communism marked the end of one of the most dramatic vestiges of World War II. Plans to reunite the democratic government of West Germany and the collapsed communist government of East Germany began immediately and were realized on October 3, 1990. Since that time, programs have been introduced to successfully integrate the radically different approaches to environmental and land use planning taken by both countries. While other eastern bloc countries have split (Czechoslovakia and Yugoslavia) the Germany Democratic Republic (GDR) is the only country to have immediately merged with a western nation. Has this jump-start helped or hindered this former eastern bloc country and, more specifically, how has land development and the ecosystem been effected by reunification?

Estimates show that in the early 1990s more money was given to East Germany for reconstruction than the seven eastern bloc countries combined (Albania, Bulgaria, Czechoslovakia, Hungary, Poland, Romania, and Yugoslavia). Yet, while East Germany has been pumped with money (particularly support from West Germany), economic and environmental recovery has taken much longer than expected. The slow process of reform has been most likely caused by the difficulties of introducing a free market into the region, pressures for economic growth, the cost of environmental cleanup and the psychological change involved in restructuring a country. While the gap between the east and west is not getting smaller, a similar pattern is repeating itself within the former GDR. The new Länder (East German states) differ greatly in the rate in which they are progressing. While some areas are improving slowly, others are heading toward mounting instability. Poor environmental conditions, few jobs and poor housing coupled with a slow reform process have caused migratory patterns which flow solely from east to west.

Reunification increased West Germany's land area by 43 percent and population by more than 16 million. This increase in land and population has put a tremendous stress on West Germany for it inherited a country that had virtually ignored environmental and infrastructure concerns for approximately 40 years. Spatial development in the east has an impact on future economic trends and influences regional labor-markets, patterns of migration and transportation, and environmental sustainability. As stated in a 1996 report by the European Commission:

While spatial policies cannot promote economic development directly, they can lay the grounds for growth and equal living conditions by providing the territory of the new German Länder with the appropriate intra- and interregional links, by increasing the attractiveness of regions or by establishing a balanced spatial distribution of functions.

In order to entice developers and industries to move into the east, the West German government must first rehabilitate the environment and improve the existing infrastructure. This process is not only time consuming but also extremely costly. While the government must boost economic development in the east by attracting diverse markets, they are

also confronted with the problem regulating land use. Rapid, unchecked growth will not only hinder future economic development but also destroy the natural environment. This paper will examine how well and to what extent the government has proposed to solve this mounting problem.

German Planning, 1923-1945

While this report proposes to concentrate on post-WWII German land use planning, it is also important to examine the historical foundation of 20th Century German planning. Planners did not begin their work in 1945 from a blank slate. In fact, reconstruction planning, which began during and before the rise of the Third Reich, still impacts planning today.

Around the turn of the century, German planning focused on controlling the dynamic urban environment. Major themes dominated planning including town extension plans, and the garden cities movement. Latter, during the pre-war period, themes of "Blood and Soil"—the slogan that gave rise to the Nazi party—also infused planning policy. This prevalent sentiment supported urban developments which enabled every German citizen to be in harmony and in contact with the German natural environment. Consequently, antiurban, anti-industrial themes encouraged new developments in previously non-developed areas. Older inner cities were virtually ignored; it was often assumed that in order to change the existing urban fabric a major catastrophe, such as the Hamburg fire of 1824, would first need to take place. It is also important to point out that in many European and American cities public health concerns fueled the antiurban movement. Industrialization brought with it crowded tenement housing in urban areas that were plagued with health and safety problems.

In the 1930s the Nazis rose into power and instituted radical changes in all areas of life. In many design fields, including art and architecture, practitioners were kicked out of positions and replaced with Nazi sympathizers. This was not necessarily the case in urban planning. In this field the planners were given full reign of the urban design process, and asked to create dynamic and grand cities. Many planners did not turn down this offer. Through financial and legal support, and non-democratic means, the Nazi party decreed various planning policies. In 1943 massive Allied air raid attacks put a stop to these elaborate ideas and a new type of planning emerged: reconstruction planning.

Between 1943 and the end of the war, planners became specialists in wartime efforts related to reconstruction planning. For example, a national association of experts on rubble cleanup was created (*Deutsche Studiengesellschaft für Trümmerverwertung*) to give advice on cleanup and potential future uses for rubble. As cities were bombed, damage was assessed by the amount of rubble in cubic meters remaining after the attacks. Leading the charge was the city of Berlin where rubble estimates were approximately 55,000,000 cubic meters. To place this into perspective, the city of Köln had half this amount of rubble and estimates indicate that if the rubble were placed on a field 100 by 40 yards, the pile would be almost 4.5 miles high. These figures show not only the massive devastation to German cities, but indicate the work needed for rubble removal, rebuilding of cities and restoration of destroyed public utilities. Planners became experts in how to turn rubble into urban form and advised city officials to use the rubble to create amenities like new parks or prepare the ground for airports.

German Planning Systems, 1945-present

In 1945 the Allies swept all major Nazi leaders out of office. Ironically, many German planners were allowed to remain in their positions under Allied supervision. There is no question that planners, having gained extensive experience between

1933-1945 in reconstruction planning, were now the experts in the field. As planners began to rebuild the West German cities, plans focused on reducing high density inner-city developments, moving people to carefully planned suburbs, and providing them with green spaces for recreation. Zoning was implemented to clearly separated essential urban functions such as housing, industry and commerce. Only latter did planners realize that reducing urban populations in city centers resulted in areas that were lifeless in the evenings and on weekends; while modern high-rises at the city edge surrounded by green fields were isolated and sterile.

East German cities, on the other hand, did not experience the same growth patterns as West German cities after WWII. East German planning was controlled by communist politics and theories. One central agency made uniform planning decisions for the entire country. Unlike their western neighbors, market forces did not drive development and planning. Western policies attempted to lower housing densities in inner cities, while communist governments tended to concentrate populations in urban areas near industry and jobs. Although large housing high-rises were sometimes built in the GDR on a city's periphery, the development of open space did not occur at the same rate as in the west. Regulated housing markets, low rents in urban areas, and relatively few owner-occupiers in the environs of the towns created a low degree of suburbanization. [Map 1](#) compares open space and settlement structures in the former GDR to those in the Federal Republic of Germany (FRG). East Germany's settlement structure left more open space than in West Germany (although it should be pointed out that the ratio of land to inhabitants is higher in West Germany). Another factor which must be considered in this urbanization pattern is the lack of available automobiles and poor transportation routes in thee. These two items combined made it hard for people to commute from a suburban area to an inner-city job.

Current Land Use Planning Structures

The German constitution distinguishes three tiers of government power: national, the Länder (States), and local. When it comes to German land use planning the federal government's role is to make regulations and guidelines within a legal framework. The federal government cannot influence specific development plans, thus it is up to the Länder to decide on an overall scheme for their state. The municipalities then are allowed to create more specific and detailed land-use plans based on the plan of the Länder. Two strong features dominate German land use planning: a strong legal framework and a decentralized decision-making structure.

Once the federal government has set up the legal parameters, each municipality must create a *Flächennutzungsplan* (regional plan) outlining the intended land uses for the area. It is then up to each locality to establish a more specific plan called the *Bebauungsplan* (master plan) for the area. The master plan cannot deviate from the regional plan and once it is created it is considered law. As a way of ensuring conformity to the plans, permission must be obtained from the municipality for development projects of any kind including renovations, additions, and new construction. It is almost unheard of for building permits to be granted which do not conform to the plans.

This West German planning system has been applied in the new Länder. Because the new Länder were not under the same planning structure, many cities do not have the master or regional plans necessary to control growth. Thus, the West German system is being applied with small modifications to allow for flexibility. For example, developers can be granted the right to build even if there is no local master plan in existence. Under these terms the developer must commit to preparing an overall development plan and must promise to finance the infrastructure needed for the development. The municipality also has the right to accept or reject the plan. While this process was intended for areas in the new Länder, it has now been applied in some western German areas as well providing a new solution to the lengthy process of

development in Germany. It is necessary to allow for flexibility in the former GDR, yet it is arguable whether or not these flexible policies should be extended to the areas of the former FRG where land use plans already exist. Furthermore, while the new Länder need to catch up economically to the western Länder, these flexible policies have allowed for rapid, unchecked growth.

The Environment

Environmental policy closely follows the structure of German land use planning: the federal government defines the legal framework by establishing environmental laws, and the Länder and municipalities are relied upon to implement these regulations. The Länder are also responsible for establishing the objectives for all sectors of land-use and environmental planning.

The Unification Treaty of August 31, 1990 created ambitious conditions for improving environmental health. Article 34 states: the new Länder must protect the natural living conditions of the population in observance of the principle of precautionary action, the Polluter-Pays Principle (PPP), and the principle of cooperation, and to promote the uniformity of the ecological living conditions at a high level, however at least equivalent to that reached by the Federal Republic of Germany.

An interesting component to this treaty is the PPP clause. Under German law whomever contaminates a site is responsible for the cleanup. However, in many cases the Länder, particularly those in the former GDR, have been left with the burden of paying for the proper management and treatment of sites. As the new Länder have not had enough money to cover the cleanup of land, the federal government has stepped in and insisted that the buyer bear a certain proportion of the costs of cleanup. But, in an effort to promote development in the new Länder, laws have been created which release a new owner from liability if damage occurred before July 1, 1990. Consequently, in theory the developer should be paying half the cost of cleanup, but in reality most investors pay 10% and the federal government the remainder.

The Situation of Soil and Water

The environmental damage left in the eastern bloc countries is merely a reminder of the communists' abuse of the physical environment and their failure to approach environmental policy with the same enthusiasm with which they attacked economic growth. While all types of environmental hazards can affect population movements, soil and water contamination are significant indicators for the built environment.

A 1991 survey of the new Länder showed that there were at least 47,000 contaminated sites (CS). Contaminated sites often can not be built upon until the site is cleaned and rid of the environmental hazards. Over 40 percent of eastern Germany's land surface is expected to be contaminated. Under the communist regime environmental regulations were nonexistent thus, industrial sites contributed high loads of heavy metals and other toxic chemicals, while agriculture practices damaged soil and water resources through improper use of liquid manure, fertilizers and pesticides. [Map 2](#) shows a clear north/south divide in the eastern states in terms of land use. Where most of the southern part of eastern Germany was geared to such industries as metal works, mechanical engineering and chemicals, the north was primarily agriculturally oriented. Table 1 provides a breakdown of the labor force in percentages by state for these industries. It is clear that the northern part of the country focused more on agricultural production than the south, yet it is also evident that industry dominated all of East German production. Russian military bases also contributed to high pollutant loads on the land and in the water,

and unlike industry and agriculture, military bases were spread almost evenly throughout the country.

Table 1: Percentage of workforce in the Agriculture and Industrial Sectors in the GDR, by Land

	Agriculture Sector	Industrial Sector
Mecklenberg-Western Pomerania	20%	23%
Brandenburg	15%	33%
Saxony-Anhalt	12%	40%
Saxony	07%	44%
Thüringen	10%	43%

source: Commission of the European Communities. Community Support Framework, 1991-1993 Federal Republic of Germany

In the late 1980s Poland, Czechoslovakia and the GDR were considered the worst polluters in the eastern bloc due to their use of coal-based energy and the concentration of heavy industry in lower Silesia, northern Bohemia and Saxony. Consequently, the area where the three countries meet was coined "the Black Triangle". East Germany also had its own regional industrial triangle which formed around the Halle-Leibzig-Cottbus area. [Map 3](#) shows the type of environmental damage the country is experiencing; East Germany's industrial triangle clearly suffering the most. Ninety-five percent of all industrial discharges received inadequate treatment contributing to high loads of heavy metals and other toxic pollutants in the soil.

Agriculture and industry are not the only areas that contribute to high soil and water pollution. Inefficient waste water treatment plants have been sited as great contaminators in East Germany. Poor infrastructure, such as leaky pipes, contributed to the pollution levels by allowing untreated or poorly treated water to seep into the water table. The new German Länder are said to have the lowest potential water supply in Central Europe due to untreated water: 9.6% of the population is supplied either intermittently or permanently with low quality water.

Eastern Europe represented the extreme end of the environmental scale in terms of environmental controls. Policies were never in place to prohibit environmental damage in these countries. As Alan Berner commented in an article in the Seattle Times, "if East Germany did not exist, environmentalists would have to invent it. It is Brand X, the perfect contrast to demonstrate the dangers of ignoring growing pollution." Yet, the irony is that while western countries complained and pointed their fingers at eastern block contamination and pollution, they too contributed to it. For example, when the city of Hamburg ran out of space to dispose of their sewage, industrial and domestic waste their solution was to import it to East Germany. In their haste to export more than 500,000 tons of waste a year they forgot to mention that it contained dioxins, one of the most deadly substances know. Clearly, West German consumption contributed to East German environmental deterioration.

Russian Military Sites

Along with agricultural and industrial contamination, Russian military sites have proved to be major environmental liabilities for the new Länder. Approximately four percent of the total land in the former GDR was used for Russian military purposes. [Map 4](#) shows the ratio of military installations to total land area by state. While there has been a recent trend to market the land for future development, land brokers have had a hard time selling the areas. Many Russian military personnel pulled out of East Germany as late as 1994. Up until that time westerners were denied access to examine the bases. Thus, three years ago, when Russian troops departed, the ramifications of environmental neglect were seen in full view. Highly contaminated military equipment and ammunition were found in most sites along with dilapidated buildings and infrastructure dating back to the Prussian area. Many buildings used by the Prussian army and then the Nazis, and were also occupied by the Russians.

The implications of these sites for the new Länder are important in terms of land use. The bases contain major environmental hazards, require extensive and costly cleanup and, unless they can be cleaned, represent unusable land. Brandenburg has the highest percentage of military sites. Estimates show that approximately 247,000 acres of military installations exist in this state. Some of the posts have been sold to investors and will be used for future developments, others are being slotted for future German military use. Yet, while many redevelopment plans have been proposed most cases are dropped when cleanup estimates are assessed.

Positive Trends

During the past 20 years many damaged ecosystems have proved they can regenerate if environmentally friendly practices are followed. The Rhine River provides an example of this theory. The Rhine was a highly contaminated river, but West German environmental policies markedly decreased its pollutant levels (Table 2). Pollution levels of East Germany's Elbe river in 1988 match those of West Germany's Rhine river in the 1970s. The linking of East and West Germany will promote a new transition period for eastern Germany. As environmental policies take shape, the ecosystem will likely begin to revive. While the results of this process will not be seen overnight, it is likely that many eastern German ecosystems can be regenerated and stabilized near their original state.

Table 2: Pollution on the Rhine and the Elbe, 1978 and 1988

		Elbe	Rhine	Rhine
		1988	1978	1988
Volume of flow	m ³ /s	874	2,455	2,836
Ammonium	mg/l	1.79	0.88	0.29
Nitrates (NO₃-N)	mg/l	4.92	3.74	3.90
Phosphorus	mg/l	0.56	0.63	0.30
Mercury	mg/l	0.63	0.28	0.21
Cadmium	mg/l	0.37	0.23	0.13

Another positive trend in East Germany is that large parcels of the country are in good environmental condition with a rich diversity of species. This is a result of the relatively sparse and highly concentrated populations, and poor traffic infrastructure that did not allow for easy inner-country travel. The "no mans land " separating East and West Germany, along with state-owned hunting grounds created many natural untouched habitats. After reunification an emphasis was placed on preserving natural spaces, and by 1990 Nature Conservancy land increased in the new Länder from 0.98 percent of the total land to 2.5 percent of the total.

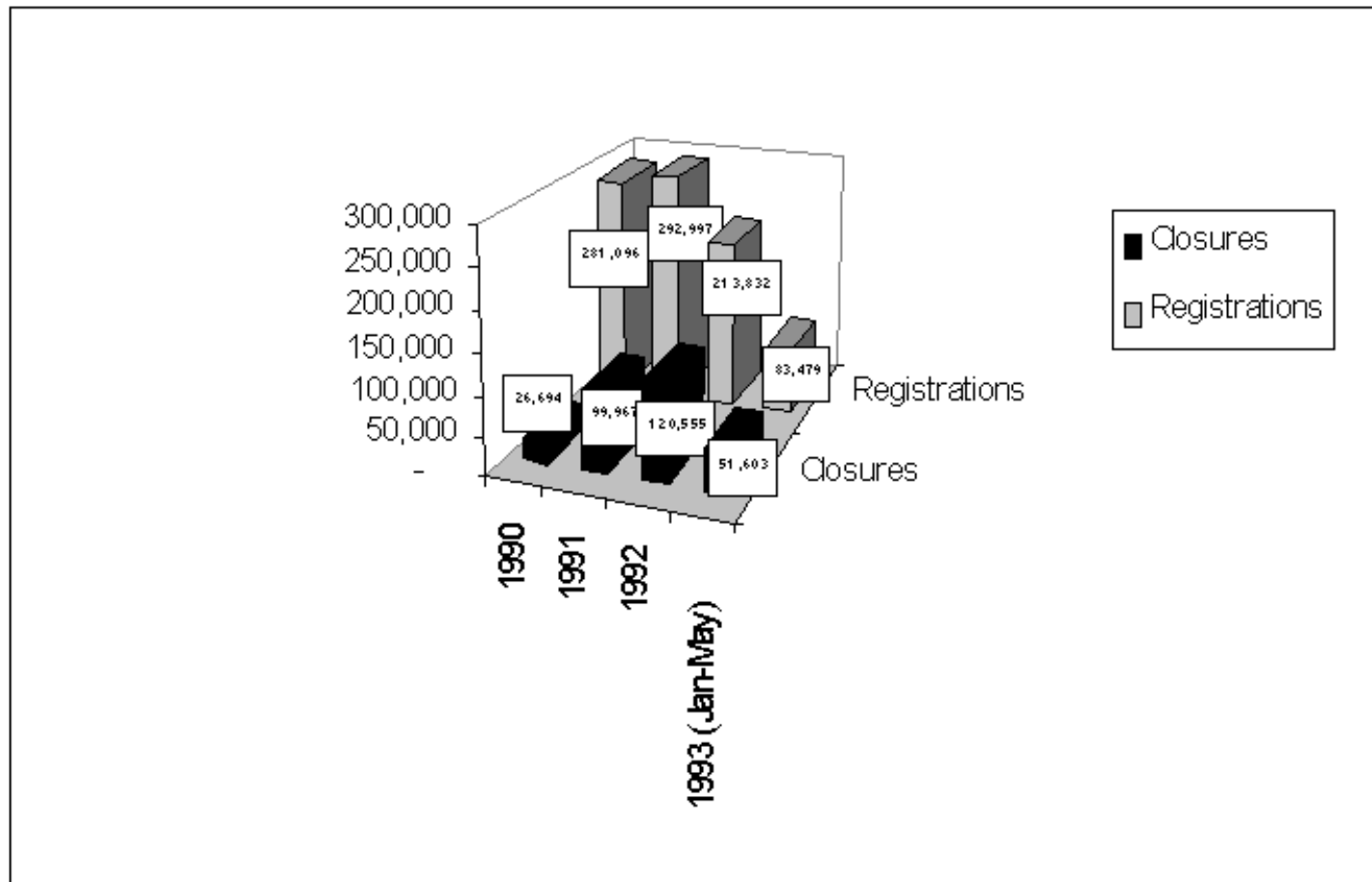
Economics

Communist policies toward housing and all types of business development has implications on present-day land development. While postwar West Germany development took place within the parameters of a market economy, the story of East Germany is different. Soon after WWII market forces in eastern Germany lost their importance as the government took over economic policies. The abolition of private ownership was the main program driving communist policies. Today, privatizing all former GDR companies is a major governmental thrust.

German reunification and the exposure of the East German economy to world has produced a profound adjustment period in the German economy. In terms of business investments which would bring in money for skilled labor, investors increasingly 'go further east' to save on labor costs. East German wages have been raised to the level of wages in the west, thus giving them higher wage rates than their former communist neighbors to the east. At the same time housing stock and infrastructure have not caught up to western standards. These two issues—housing and wages—have been major inhibitors for investors looking to relocate in the eastern part of the country. It is in instances such as these where East Germany has not benefited from unification with the west.

Further exacerbating this problem is the fact that between 1990 and 1993 business registrations decreased and business closures increased. The data available through the first five months of 1993 show that a degenerative ratio gets stronger through time (Figure 1). For example, in 1990 closures represented about 10% of registrations. This figure increases to a approximately 56% in 1992, and 62% between January and May 1993 alone. The breakdown in jobs has resulted in a drastic loss of employment. Unemployment in the new Länder rose to more than 1 million in the end of 1992, representing an unemployment rate of 16.5% where it remained through part of 1993. In fact, all of the economic sectors, except for building and construction, have witnessed job losses.

Figure 1: Registration and closure of businesses in the new German Länder, 1990-1993



source: European Commission study, p. 5

Privatization

In spatial terms, privatization of state-owned enterprises influences investor's willingness to relocate business in the former GRD. In 1989 the State Trust Agency (*Treuhand*) was established to begin privatizing state-owned enterprises in the former GDR. By April 1992, 7,100 of the 11,500 enterprises existing in the new Länder had been privatized. While this accomplishment and many others can be applauded, two items have dimmed the achievements of the *Treuhand*: 1) they have inherited lots of debt; and 2) many of the newly privatized enterprises are not able to fulfill commitments to the Agency in areas such as jobs preservation.

Spatial Change in the new and old Länder

The desire for economic progress plays an important role in German land development. In post-WWII Germany an

economic upswing occurred when the cities experienced growth outside the *Altstadt* (old city). For example, the town council of Hassfurt, West Germany designated the outer regions of the city as commercial zones. Car dealerships were among the first to move to these areas, followed by gas stations and in the 1970s other retailers. Inexpensive land helped to promote this type of greenfield development. Today the outcome of this trend is that large retailers and supermarkets, often discounters, are interspersed between German towns. Germans refer to these commercial type strips and their architectural style as "little Americas". The implications of this type of growth are significant. Not only do these new developments demolish existing land, but funding and land resources are spent on new infrastructure and road construction.

Today the new Länder are mimicking West German growth patterns. When the Wall fell, western chains were convinced they would have an easy time establishing businesses and making a profit in eastern bloc countries. High demand, lax enforcement of building codes and zoning, and little local opposition reinforced these theories. The unstoppable spread of retailers has created developments on what is known as greenfields, which consist of large malls located between communities. Often community governments in the east have bowed to development pressures in order to please voters and raise revenues.

Demand and market forces have continued to lead growth patterns. At the time of reunification the density of retail facilities in a typical East German city was half that of other German cities. In the city of Hildburghausen, a former GDR city, thirty new enterprises were established by August 1991. Even more dramatic was the increase in retail space which doubled in this short time from 5,000 sq. meters, to 10,000 sq. meters. Exacerbating this rapid development are laws created to provide incentives for German investors to write off 50% of their additional investment beyond the purchase price of the land. [Map 5](#) shows how the city of Hildburghausen is being reshaped because of rapid growth on the periphery of the city. Not only will the growth build on existing green space, but the cost to the government and citizens for infrastructure to these areas will be enormous.

Contributing to eastern Germany's spatial change are commuting patterns. According to a survey done by the *Institut für Arbeitsmarkt und Berufsforschung der Bundesanstalt für Arbeit* (IAB) in May 1992, 63% of Germans living in the new Länder commuted to western Länder. More significant are the distances commuters were willing to travel to reach places of work. Along the East German border many of the commuters live and travel from 40 to 60 km one way. As transportation systems are improved and built in the east, more land and autos will be in demand.

The states in the former East Germany are experiencing different rates of progress. The northern most state of Mecklenburg-Western Pomerania is experiencing the most severe structural problems among the new Länder. Its weakness lies in the fact that it had traditionally high shares of farming and low shares of manufacturing compared to other Länder. Uneven regional distribution of industrial locations coupled with poor internal transportation infrastructure has also posed a disadvantage for the state. Job losses in the farming and fishing industries, and collapsed industrial sites have left this state with the highest rate of unemployment in all of Germany. The job sector is not diverse and thus, alternative employment opportunities are not available in this area. On the other hand, Saxony has a diversified economy with an industrial sector characterized by large-scale enterprises and the industrial sector evenly distributed throughout the region. The transportation links in this area have been considerably updated since reunification. The difference in these two states points out some of the internal stress the former GDR Länder are experiencing in terms of economic and spatial growth.

Population

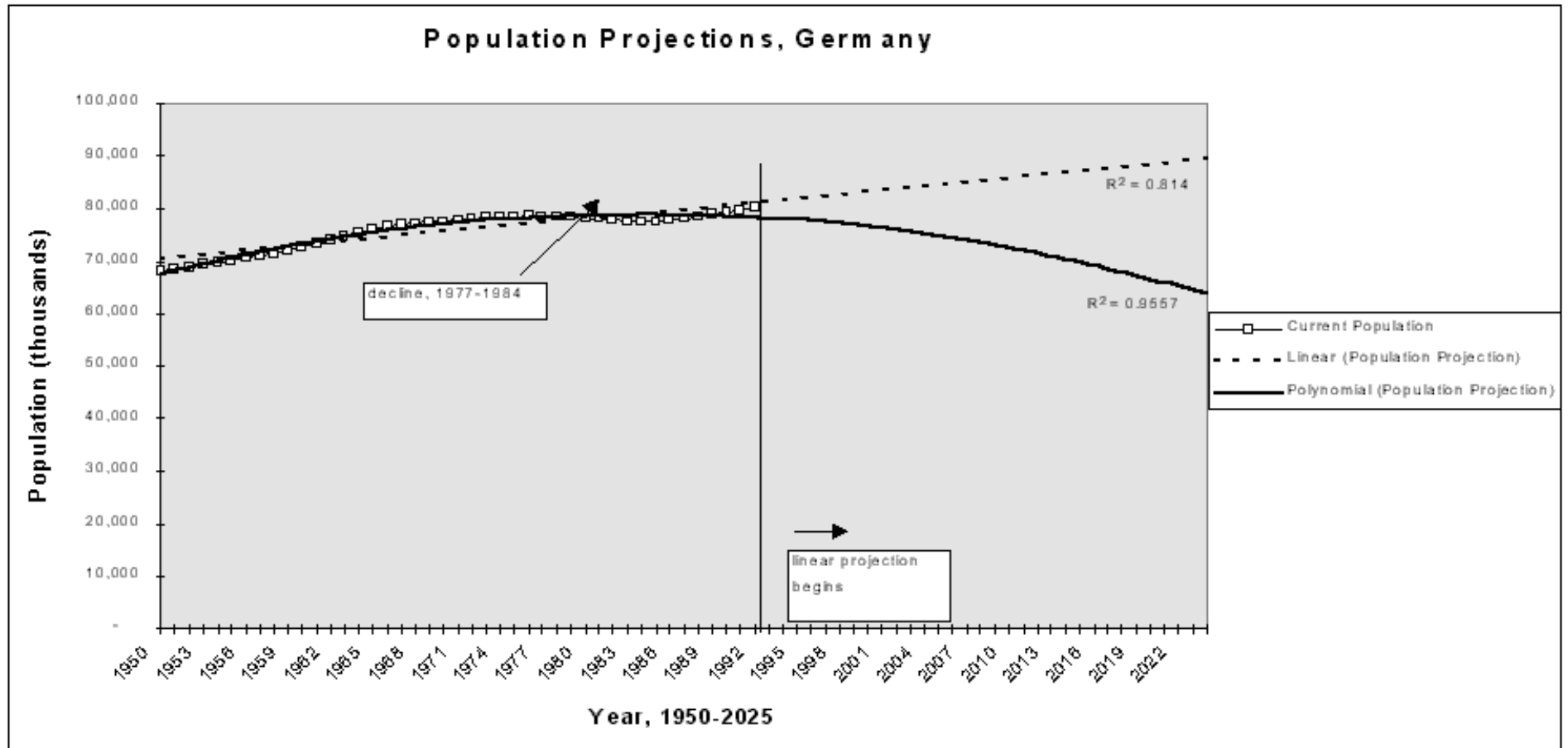
Since the 18th Century, European population has increased primarily as a result of natural population growth, specifically births rapidly exceeding deaths. By the end of the Second World War, birth rates in Europe began to drop below the death rates, signifying what has been described as a "second demographic transition, very different from the first". As Maria Carmen Faus-Pujol states, "rather than an increase in population, this is characterized by stabilization or even a reduction of the population, and the demographic factor responsible for this trend is the fall in the birth rate." The birth rate in Western Europe was the lowest of any major bloc in the world in the beginning of the 1990's.

Germany (both east and west) has been experiencing this post-WWII population decline, particularly in the last thirty years. Significantly, Germany has one of the slowest growth rates in all of Western Europe ([Map 6](#)). While some argue that a transition is occurring where all western, industrialized countries will start to experience negative growth rates, others claim that it can no longer be said that the countries are converging on a common growth rate pattern because of the varying social and economic conditions in each country. If the first hypothesis is true, it can be assumed that Germany is reaching a demographic transition stage sooner than other European countries. Otherwise it can be assumed that German population increases are purely a factor of social, cultural and economic change. Whatever approach is taken, it can not be denied that Germany has a decreasing population trend. The country's slow population growth rate can be explained by industrialization, urbanization, high amounts of educated women in the work force, and low birth and high death rates. Attitudinal changes, such as secularization, egalitarianism and emancipation, are also often cited as contributing to this change.

It is important to note that of all the European countries, including the former east bloc and Russia, the only other countries experiencing a negative or even growth rate are Bulgaria and Hungary ([Map 6](#)). It is interesting to note that Germany's economic and population structures are much different from Hungary and Bulgaria. While the countries are relatively close in proximity and are experiencing the same population trends, their negative feedback indicators may not be similar. Hungary has experienced a transition in the last decade that reflects its population decline. A gradual shift towards older ages coupled with high death and low birth rates has driven this pattern. Contributing to the high death rates in this country is the poor health care system. It is stated that mortality rates for middle-aged men in Hungary are possibly the worst in the world. Bulgaria, on the other hand, has experienced a population change that has favorably more women than men (in 1995 the ratio was 1,041:1,000). Also compounding their population decline is the considerable rate of emigration. Between 1989 and 1994 450,000 people left Bulgaria. Despite a relative lull, estimates show that currently nearly 25,000 continue to emigrate every year. David Coleman also points out that, "in view of the political uncertainty and serious economic disruption these countries have undergone, this (low fertility) is hardly surprising; the least developed areas and those undergoing the most radical change, have shown the greatest decline".

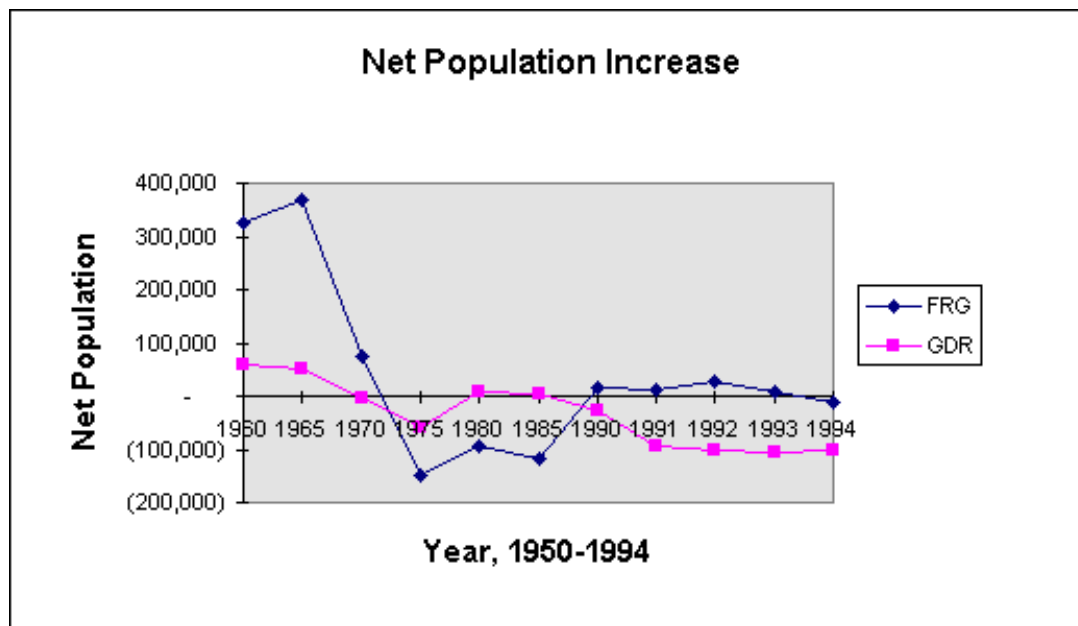
The decline in population growth experienced in the whole of Germany began in the mid 1970s. Starting in 1950, population increased at a rate of less than one percent per year (Appendix 1). Looking at the population growth graphically (Figure 2), one can see that growth has been extremely slow (data in this series is both East and West Germany combined). As previously stated, post-WWI European countries experienced low growth rates. The 1950s and 1960s data relay the short baby-boom in West Germany, but then the population begins to level out again only to drop in the mid-1970s. Figure 2 shows a slight rise in the population after 1984 (perhaps explained by economic boom or immigration patterns) only to increase by approximately .5% every year. While this data shows a minor increase, similar data sets show decline or stabilization in the population structure (Figure 3).

Figure 2



source: WRD, see Appendix 1 for calculations

Figure 3

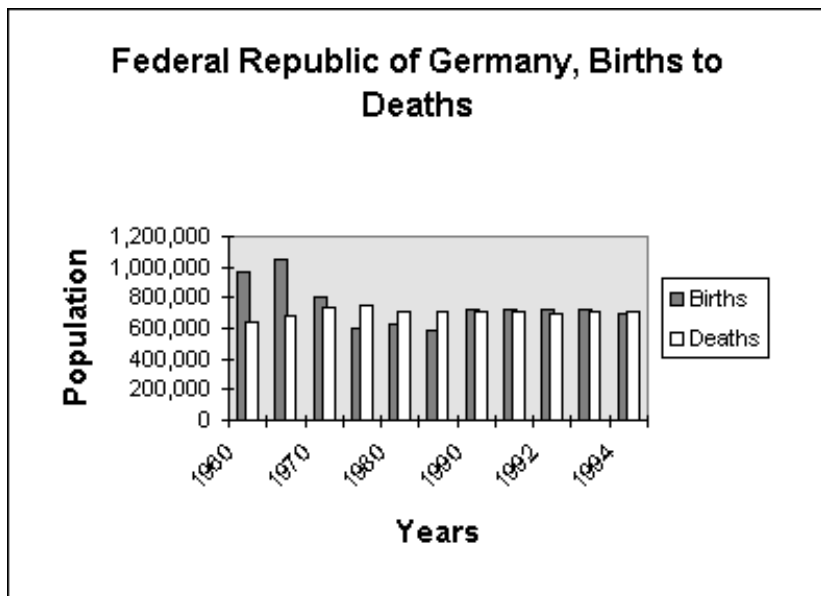
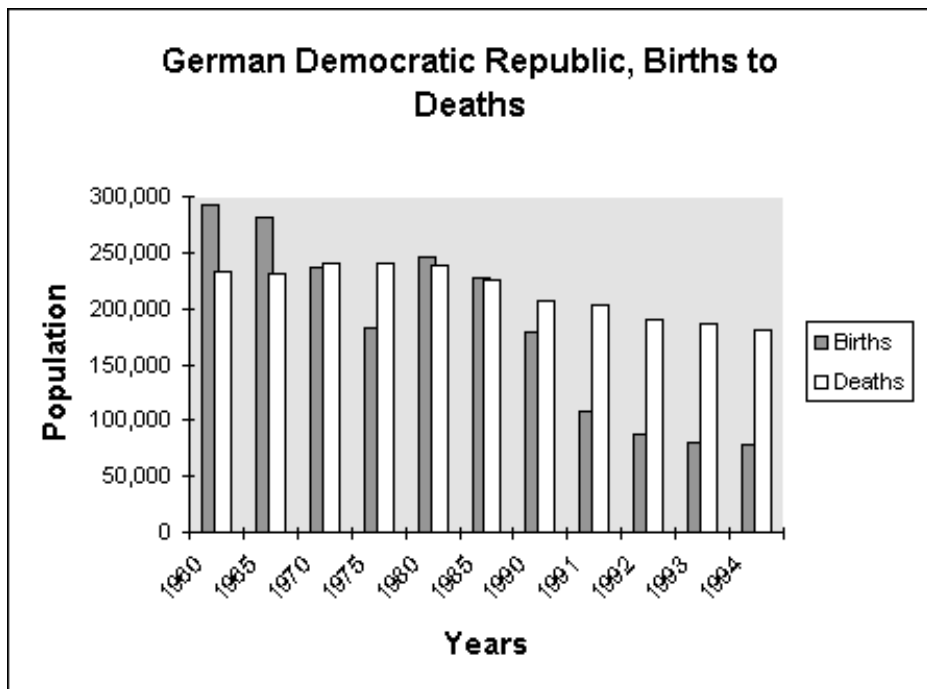


source: Council of Europe, Recent Demographic Developments in Europe, 1996

In Figure 3 a decline and perhaps slight stabilization can be seen. Given this information, Figure 2 also calculates two types of population projections: linear and polynomial. The linear equation accounts for population increases, while the polynomial projection mimics a declining population. It is interesting to note the R^2 factor in both projections, specifically that the polynomial projection has a higher R^2 than the linear (linear, .814; polynomial .9558). If the linear projection is correct, Germany's population will be around 90 million by 2025 while the polynomial projection predicts a population of around 65 million. Interestingly, UN population projections predict German population at a high of 76,566,000, and a low of 66,062,000 by the year 2025.

Another way to examine the population trends in Germany is to divide the data by East and West Germany. Figures 4 and 5 show the birth and death rates compared. In the GDR almost consistently since the 1970s deaths have outweighed or almost matched births. On the other hand, West Germany has experienced an almost even equalization of the populations' birth to death rates. In terms of demographic transitions this data proves that the GDR is still experiencing a transition and perhaps will level out to the population levels of the west. The FRG, on the other hand, has experienced almost consistently even birth to death rates. As the new Germany stabilizes socially and economically their population rates may change. It is my conclusion that population rates will continue to decline slightly or remain constant.

Figures 4 and 5



source: Council of Europe, Recent Demographic Developments in Europe, 1996

Eastern Germany

Since the Second World War fertility patterns in the former eastern bloc countries have developed somewhat differently than those in the west. Specifically, countries in eastern Europe did not experience the same baby boom period in the 1950s and 1960s (see Figure 4). As David Coleman points out, "in these countries the general transition to very low fertility, and major fluctuations such as the 'baby boom', which might have occurred under a post-war free market system, have been retarded or suppressed by various aspects of the communist system." Specifically, limited autonomy and spending, little satisfactions outside the family and limited access to contraception are some the issues cited. Stress on the population, specifically the post war period of the 1950s and the closing of East Germany to the west in 1961 could also account for this dip in population.

Communist regimes depended on high growth rates as a means to support economic prosperity. As a way of promoting higher birth-rates many countries offered positive incentives in the form of financial assistance to families with children, or bonuses such as year long maternity leave for mothers. Nonetheless, in the 1970's deaths outweighed births, and in the 1980s the crude numbers are almost equal. Some of the negative feedback indicators that contributed to this decline were political instability and upheaval, women joining the workforce, urbanization, poor housing stock, poor living conditions and minimal outmigration.

Rapid urbanization is often cited as an indicator for population decline. Table 3 cites how the trend in higher urbanization patterns can be a factor contributing to lower growth rates.

Table 3: Urban Population and Live Births, 1960 and 1985

	1960	1960	1985	1985
	Percent of Population in Urban areas	Live Births per 1000	Percent of Population in Urban areas	Live Births per 1000
GDR	72	17.0	77	13.7
Czechoslovakia	57	15.9	74	14.5
Soviet Union	50	24.9	66	19.4
Poland	48	22.6	60	18.2

source: GDR and Eastern Europe—A Handbook, p. 272

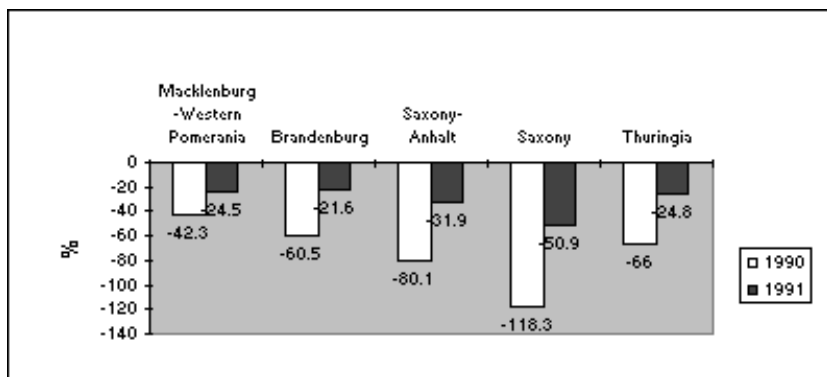
While the GDR has experienced the highest percentage of urbanization, it had the lowest birth rates of all the eastern block countries. These numbers are indicators of how interrelated urbanization and birthrates are for various countries.

After the fall of the Wall, population in eastern Germany experienced large numbers of outmigration caused by labor markets, economic and social factors in the east. Between 1989-1992, each state in the new Länder lost over 1 million people. [Map 7](#) shows the internal migration patterns from 1989-1991. This map clearly depicts the one-way migration patterns from the east to the west. Yet, it should be stated that compared to natural population movements, outmigration plays a diminishing role in eastern Germany's population development, and has continued to decline since the fall of the Wall. A more significant population change factor is the drop in the net population. As stated in a 1996 European Commission study, "since the breakdown of the former regime the number of live births has drastically decreased by almost half and stabilized at this low level." Figures 6 and 7 break down East German population by State, and clearly depict

how outmigration, and birth and death rates of each eastern German state figure in to eastern German population loss/gain.

Figure 6

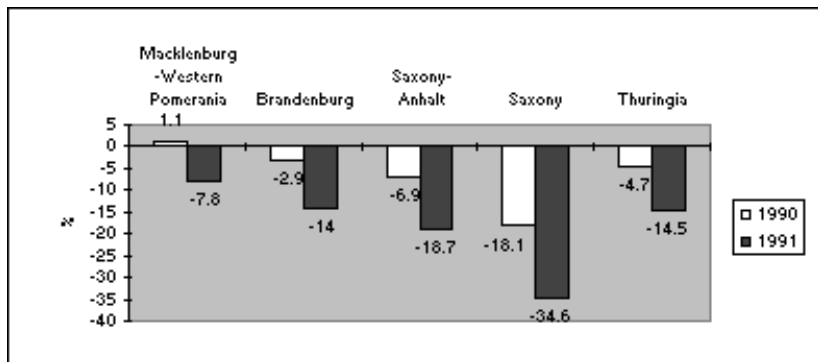
Natural population movements and migration in the new German Länder, 1990 and 1991



source: European Commission Report, pg. 32

Figure 7

Live births in relation to mortality in the new German Länder, 1990 and 1991



source: European Commission Report, pg. 32

This decrease in population growth might be explained by the fact that many people migrating out of the country are younger people looking for work. Older portions of the population, those people that have lived in a city for decades, may not have the means or desire to move away. Thus, an older population is left in the country, which statistically means greater deaths over births.

Case Studies

Berlin

As a future and once former capital, Berlin has always been a center for commerce, government and living. In many ways, East and West Berlin reflect on a micro-scale the events occurring in land use development in other parts of Germany. Investors saw great opportunities in Berlin with the fall of the Wall. Estimates for services demanded in the east, as well as speculations on whether the government would reclaim Berlin as the capital of Germany, became motivating forces for developers. These factors coupled with the fact that the city (both east and west) did not have a comprehensive land use plan encompassing both areas compounded land development plans. Until 1994, when the official post-reunification land use plan was approved, there were no legally binding laws prohibiting building in the area of former East Berlin and in the no man's land which made up the buffer area between the two cities. Thus, the first years after the fall of the Wall Germany's detailed land use planning structure fell apart.

Much of the land interests focused in East Berlin and in the areas around the undeveloped "no mans land" between east and west. Investors jumped at any opportunity available to buy-up and develop these areas, and many pressed their plans to be passed believing it was not politically or economically feasible to wait for a uniform land use plan to be developed. Consequently, before the master plan of 1994 was completed, quick land use decision in the west were made in the Berlin Senate, while in the east a Federal Building Code was created to restrict rapid building by predicting how closely a new development would exist harmoniously within the immediate surroundings. These two mechanisms were able to be kept many projects at bay.

Plans for new and improved retail space in the east became a hot topic among investors and developers. Statistics show that when the Berlin Wall fell, 78 % of all shopping floorspace was in the western sector, thus developers immediately jumped in and added more retail space to the city's eastern side. Today retail outlets have been augmented in the core area of East Berlin, yet current trends show that Berlin city authorities want to plan "polycentral" shopping areas. This trend will speckle shopping centers throughout the city and surrounding areas, rather than reinforcing the traditional single city center structure found in older European cities. The concern with this trend is that it conclusively has pulled economic growth away from the center city.

Another important land use development pattern to consider in Berlin is the tradeoff between office and industrial space expected to occur in the next few years. As the federal government moves to Berlin, industry is expected to leave the city. Between 1961 and 1989 West Berlin was a heavily subsidized city. Industries that located in West Berlin were at a disadvantage because of their distance from markets in the west, thus subsidies provided incentives for these companies to stay in the city. Today subsidies are available to industries that wish to move outside the city and into the territory of the former east. According to a survey carried out by the *Deutsches Institut für Wirtschaftsforschung* in 1992 10% of all companies active in Berlin intend to relocate to out of town areas around Berlin/Postdam. The movement of these companies into the Brandenburg countryside will mean heavier traffic patterns as well as environmental damage as new growth envelopes existing land.

Office space and housing have become another key factor in spatial development. With the seat of the government moving to Berlin, it is estimated that by the end of the decade 108 million square feet of new office space will be added to Berlin alone. Housing shortages, exploding rents and property prices, and poor quality housing stock in the east are expected to

push development further into the periphery of the city.

The problem with trying to control both the industrial and housing growth is that there is no regional oversight board. When it comes to Berlin, the principles of post-war West German land use planning fall apart. Berlin is an island in the middle of the state of Brandenburg. The municipalities in Brandenburg, exercising their new powers, want development in their areas. Enticing developers to come is not hard: planning permissions in these areas of the east are easier to obtain than in Berlin. American style megamarket developments are already appearing in these areas.

Policy Recommendations

When evaluating the present prosperity gap between eastern and western Germany, and in light of recent economic figures, many assume that the new Länder will not match the standards of living of the old Länder any time soon. Some estimates project that this equalization will take place at the earliest by 2005 while others believe that eastern Germany is doomed to have a sluggish economy which will never catch up to the west. Nonetheless, policy trends will surely try to remedy this situation through interventions which seek to: 1) decrease deficits; 2) cleanup and improve the environment; 3) reform administrations; and, 4) invest in infrastructure.

The Case for Regional Planning

Regional planning is a vital tool that can be used to assist in German spatial planning. Regional planning should be established at three levels: 1) within the Länder between the various municipalities; 2) among the Länder; and 3) between Germany and their neighboring countries particularly Poland and the Czech Republic. By establishing economic and environmental goals and objectives, all three areas of regional planning could be used to reduce environmental degradation and increase efficiency in development. The border areas in eastern Germany near Poland and the Czech Republic are of particular importance because of the immediate necessity for environmental cleanup and improved transportation.

It is critical that policy makers and planners focus on the entire country of Germany, both east and west and not isolate certain areas for development and improvement. Much attention has been placed on the growth and development cycles around Berlin and on the border of the former FRG and GDR. Yet, this emphasis ignores other areas in the east. Clearly, while situations in the new German Länder may seem uniform they are "by no means homogeneous." Each state and region differs greatly in terms of locational advantages and development potentials. For example, the border areas between eastern Germany and Poland and the Czech Republic are suffering greatly. German border cities lose jobs to the cheaper labor markets of their eastern neighbors. This pattern further depresses cities in this area. Compounding this problem is the poor transportation infrastructure leading to the western part of the country. Ultimately, further outmigration occurs leaving eastern cities more deserted and depressed.

An emphasis must also be placed on equalizing spending on German cities. While environmental cleanup and economic development in the east is crucial, it is important to recognize that problems of deforestation and growth still exist in the western part of the country. Critical to this concept is the reality that land in both the east and west is being developed at a faster rate than the population is growing. This American pattern of land development has significant implications. Germany must use caution when allowing developments to pop-up in the East. Although economic development is crucial, it would be more progressive and future-oriented for policy makers to insist on redeveloping

existing space. The German government has initiated policies that encourage investors to rehabilitate buildings by giving tax benefits that allow investors to deduct renovations in full from taxable income within 10 years. But as Helmut Fleischhauer, real estate broker for in Hameln Germany pointed out, it is a real problem to get buyers excited about houses that are rundown to begin with. The competition is the greenfields that are considered more scenic, often less costly and easier to develop.

It is likely that policy makers will decide to create stronger transportation routes, which in turn will increase eastern German land value. Major routes will most likely be placed from larger western German cities (München, Hamburg, Düsseldorf, Frankfurt, and Stuttgart) to the main major eastern German cities (Berlin, Rostock, Dresden, Leipzig, Erfurt/Jena). While transportation infrastructure is necessary, it is important to keep in mind how these transit routes might affect eastern German cities. It will be crucial to make sure these cities in-between don't merely become transit routes but instead destination points for commerce and living. One idea would be for the country to create a transportation master plan which would strategically place all future major transportation routes.

Depending on the urban planning policies and strategies of the new German Länder the Russian military bases can be viewed as long-term deficits or locational assets. Planning measures can be initiated to clean sites through a phased plan over time, thus saving on cost. Also, land that is not highly contaminated can be made into regional parks with restored natural ecosystems.

Retail stores has continually led development in the new Länder. While it is important to have solid retail industries, Germany must pay attention to small businesses being shutout by this growth and must promote a diversity of business and industry to move into the areas. While retail is an important aspect to an economy, it is also a "soft" industry that is easily effected by any type of recession or economic slump. Thus, strong industries, which desire a skilled-workforce, should be enticed to move into the areas. Already the development frenzy has left many cities in the East with an over supply of retailers. The German Retail Association estimates one square meter of retail space is needed for every resident of a city. Yet, in many cities in the east the ratio of retail shops to inhabitants is well over 1 square meter per person.

Implications

Since the end of the Second World War, Germany has been a leader in architecture, urban planning and environmental policy, striving to create unique and feasible environmental alternatives and technically innovative ways of living. This tradition has given rise to great experiments in architecture and planning: the Werkbund, the Bauhaus, the Siedlung developments and the post-war international building exhibitions. Strict environmental clean-up policies as well as leading political parties like the Greens have been upheld as examples for countries around the world concerned with their ecosystems. Do current post-reunification trends indicate that this legacy is about to end?

Land use patterns in both the east and west are mimicking American style, suburban growth. While Germany has strict land use regulations, the chaos following the fall of the Wall and the desire for improved economic conditions in the east have led into development patterns which may hurt German cities in the future. Development patterns indicates that land is increasing at a much faster rate than population growth. In a recent article Robert Geddes writes:

American city-regions' population growth is now dramatically outpaced by their geographic growth...While Chicago grew 4 percent in population, its urbanized land increased 46 percent. Even places that were declining in their population

were simultaneously growing in their urban area; Cleveland, for example, had a population decline of 8 percent, while it expanded geographically by 33 percent.

It is evident that this pattern is being duplicated in the eastern part of Germany. While the population declines in that the five East German Länder, construction is cited as the only sector to experience economic growth in the east. It is clear that East Germany seeks to bring economic development into their cities they exponentially increase their land development. Germany, a much more densely populated country than the United States, must consider the growth problems occurring in the US and in other countries and learn from these mistakes. Loss of green space, and detracting of economic development in older inner cities, increased traffic patterns and higher rates of environmental pollutants are only some of the repercussions of this type of rapid land development.

The process of German reunification has reached a critical stage. The regional disparities between eastern and western Germany are still enormous in terms of standard of living, employment, business activity, infrastructure and environmental conditions, with the people in the east undergoing grave social hardship and problems. The transfer of capital to the new German Länder, which is meant to spur their economy and to promote the convergence of living conditions in the two parts of Germany, places a heavy burden on the old Länder. Yet, while Germany is concerned with the rate in which economic conditions in the new Länder are catching up to the old Länder, they are allowing land development to rise at a faster rate than the population is growing. While the country historically has had relatively strict land development guidelines, they have allowed these rules to be flexed for the new Länder. If Germany wants to keep its position as a leader in the field of environmental policy and planning, and if the country is concerned with future growth patterns and the affects on the environment, they need to examine their current policies and create a vision for future land use and environmental planning.

Link to [Appendix](#)

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The main objective of this study was to determine retrospectively, whether there was a temporal pattern of association between weather variables and dengue fever morbidity rates. Because mosquito density, activity, and survival is related to various weather conditions, there may be a correlation between dengue incidence and weather patterns. However, it is uncertain whether temperature or precipitation will be the strongest predictor of dengue incidence, or whether a more predictive relationship exists when both are taken into account. The time lag between weather patterns and possible increases in dengue incidence is also uncertain. The various components of the time lag include the period of embryonic development of the mosquito, hatching time, the adult and sexual development period of the mosquito, the time before the first blood meal, the extrinsic incubation period, the time before the next blood meal in which the mosquito passes the infectious virus, and the time before the appearance of clinical manifestations of dengue fever (Table 1). It has been found that the development of the dengue virus in the mosquito, the extrinsic incubation period (EIP), will range from seven to twelve days depending on ambient temperature (Watts, 1987). It has also been determined that the period between infection and clinical manifestations of disease in humans ranges from four to six days (Pan American Health Organization, 1994). It is therefore assumed that a time lag of at least eleven and perhaps as much as eighteen days will be found. However this may be a very conservative estimate as it does not take into account the life cycle and development of the mosquito which varies according to ambient weather conditions, the availability of food, and larval density in the container in which the mosquito is breeding. Hatching of the mosquito varies dramatically according to precipitation and humidity; a dry period may mean the mosquitoes will delay hatching for more than a year (Pan American Health Organization, 1994). The delayed development could potentially provide a much greater time lag than expected, possibly a time lag of greater than a year. However, because such long dry periods do not occur in Trinidad, a time lag of less than one year is more likely. The goal of this effort was to evaluate whether a temporal association, possibly with a time lag, exists between weather variables and disease incidence.

Table 1: Timing of lag components

Stage	Embryonic Development	Hatching Period	Mosquito Development	First Infectious Blood Meal	Extrinsic Incubation Period	First Blood Meal After EIP	Clinical Manifestation Appearance
Time Period	2 days	Up to 1 year Delay	5 days to several weeks	1-2 days after development (almost simultaneous with mating)	7 to 12 days	??	4 to 6 days

III. Background

Dengue fever is caused by a virus from the family Flaviviridae; four serotypes are distinguished by serological methods, dengue-1, dengue-2, dengue-3, and dengue-4. All four serotypes have been found in the Americas, however only serotypes 1, 2, and 4 circulated in the period focused on for this study (1982-1990). The virus is transmitted primarily by the *Ae. aegypti* mosquito to the human host. *Ae. aegypti* is a highly domesticated mosquito, breeding in freshwater containers stored for drinking and bathing. Because severe frost and cold weather kills adult mosquitoes and eggs, dengue is currently restricted to the region between thirty-five degrees north latitude and thirty-five degrees south latitude. The clinical manifestations of dengue can range from a minor fever, often with flu-like symptoms, to severe Dengue Hemorrhagic Fever (DHF) and Dengue Shock Syndrome (DSS) that may result in death. Between 250,000-500,000 cases of the severe DHF/DSS form occur yearly throughout the world and case fatalities can reach forty to fifty percent if not treated with fluid replacement therapy (Gubler, 1994). The relationship between weather patterns and dengue transmission is multifaceted involving both the mosquito life cycle and viral replication requirements. It has been determined that warmer temperatures reduce larval size of *Ae. aegypti* which results in a smaller adult size (Rueda, 1990). Smaller adult female mosquitoes have been found to feed more frequently to nourish their developing eggs

(Reiter, 1988) which increases the probability of transmission. The positive relationship between biting rates and temperature has been supported in field studies in Bangkok (Pant, 1973). A second consideration in viral transmission is the EIP. A study by Watts et al. (1987) determined that the EIP is heavily contingent upon temperature; the EIP for *Ae. aegypti* decreased from twelve to seven days when mosquitoes were kept at 32-35 degrees instead of 30 degrees Celsius. These results imply temperature induced variations in the vectorial efficiency of *Ae. aegypti* may be a significant determinant of the annual pattern of dengue that Watts et. al. found in Bangkok. Research by Koopman et al. (1991) also supports the theory that dengue transmission frequency relies upon climatic conditions. His study concluded that median temperature during the rainy season was the strongest predictor of infection. High temperature was responsible for greater transmission rates by reducing the period of viral replication in mosquitoes. It has been found that increasing precipitation may either increase or decrease dengue incidence rates. It has been proposed that human vector contact may be enhanced during periods of high rainfall (Gubler, 1994) because mosquitoes may become less active. In this scenario they are more likely to stay indoors where their probability of survival is higher and their contact with humans is greater. However, many scientists have found an inverse relationship between incidence rates and rainfall. In his 1938 study, Soper found that low rainfall in Brazil results in more water storage containers in the home and therefore more *Ae. aegypti* in residential areas. The implications of global warming on dengue transmission has been modeled by Martens et. al. (1997) who found that the transmission potential of dengue may be highly sensitive to climate changes. They predicted that transmission should be particularly sensitive to warming in higher altitudes and in areas which are currently at the periphery of endemic transmission. Jetten and Focks (1996) have also developed a model of the influence of warming on the intensity and distribution of dengue throughout the world. Using a simulation model projection, their results indicate that the current warming prediction of two degrees by 2100 may result in an increase in the latitude and altitude range of dengue. They also concluded that the duration of the transmission season could increase in temperate locations. As yet, there has been no study published of actual case data that seeks a retrospective statistical association between weather variables and dengue incidence. Studies of dengue in the past have not looked at weather factors independently, nor have they looked longitudinally at how these factors may affect morbidity rates. My study is intended to evaluate the relative importance of temperature and precipitation rates to transmission using long-term case data from the islands of Trinidad and Tobago.

IV. Data

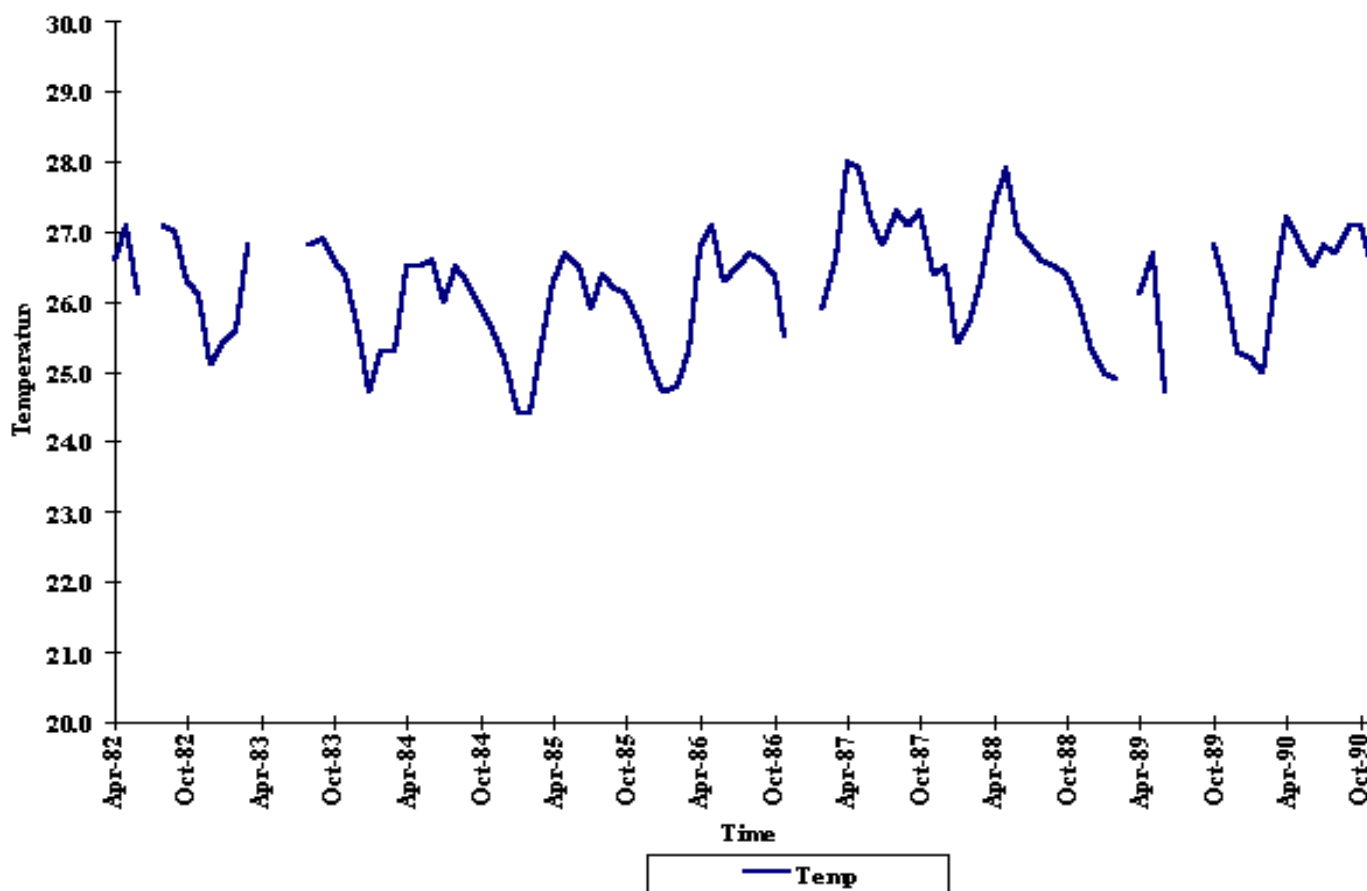
Monthly mean precipitation and temperature data were collected from the Web Page of the National Climatic Data Center (<http://www.ncdc.noaa.gov/ghcn/ghcn.html>). While Tobago did have its own weather station located at Crown Point Airport, this data was unavailable therefore all weather information came from the Piarco International Airport in Trinidad. The mean temperature and precipitation were used, as opposed to either the minimum or maximum temperature, because it has been found that incidence rates of malaria are most closely related to mean temperature at lower altitudes (Loevinsohn, 1994). Because the disease etiology of malaria is somewhat similar to that of dengue (they are both diseases carried by mosquitoes whose living and breeding conditions are contingent upon the ambient environment) and because Trinidad is at an elevation of twelve meters, I chose the mean temperature and precipitation values. However, it is important to note that malaria and dengue are differentiated by difference species of mosquito vectors, entirely different infectious parasites, and different patterns of breeding and development of the vectors. Therefore, it is possible that minimum and maximum temperatures may be useful in predicting a relationship between weather variables and morbidity rates. The weekly incidence rates of dengue in Trinidad and Tobago were obtained from Dr. Wilson of

the University of Michigan Department of Epidemiology. Because data from Trinidad alone was unavailable, I used the coalesced data which included morbidity from both Trinidad and Tobago. The weekly rates were converted to monthly rates, assuming that whatever fraction of the week was ascribed to one of two months, if it was a week split between two months, a similar proportion of incidence was given.

V. Qualitative Description of the data

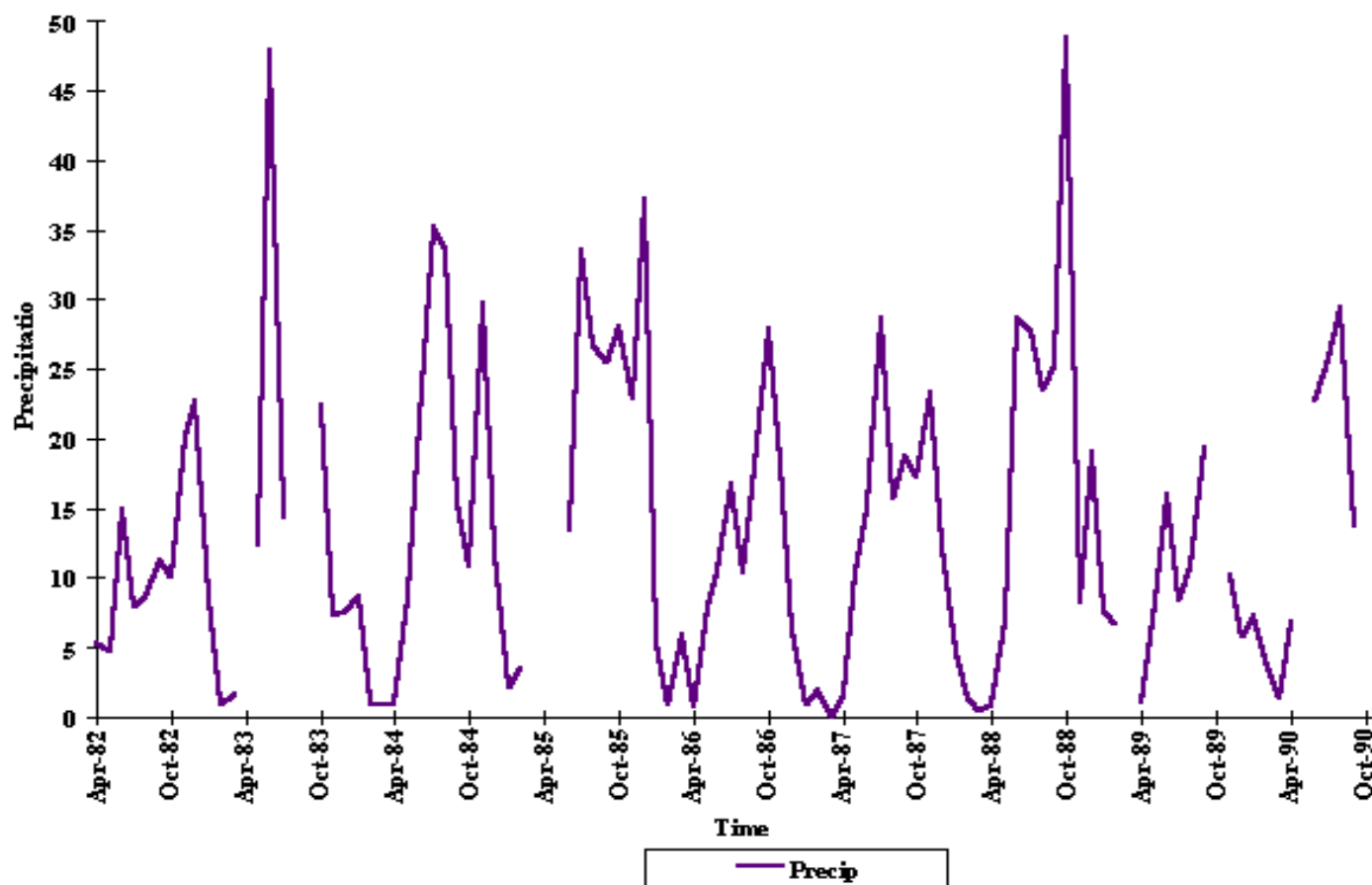
The nine year period of monthly temperature data varied less than 4 degrees Celsius. A seasonal distribution of maximum and minimum temperatures exists; annual maximum temperatures were usually observed in the months of May through September, and annual minimum temperatures were found in either December or January (Graph 1).

Graph 1: The Relationship Between Time and Temperature

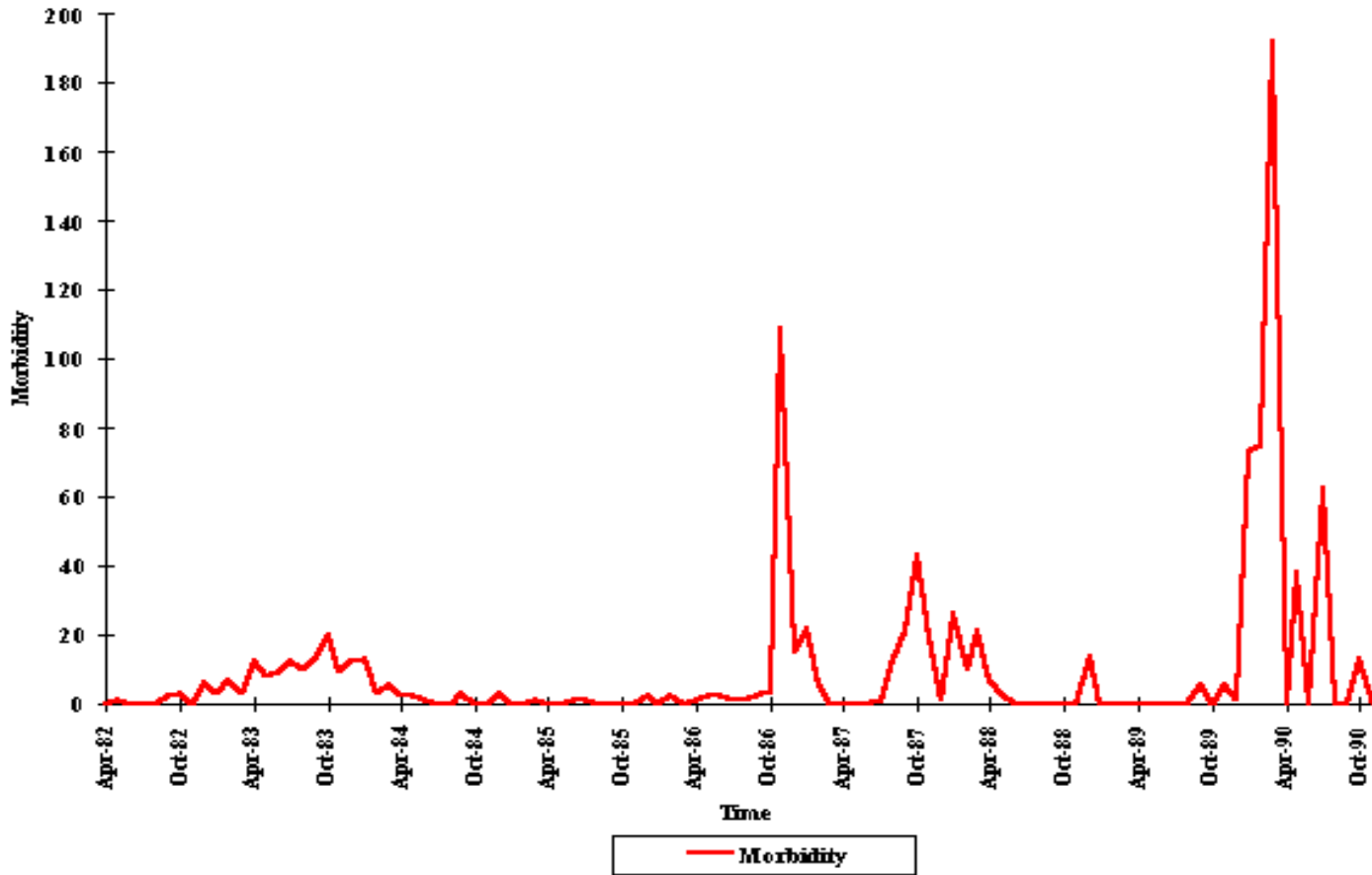


Annual precipitation over the nine years varied considerably (Graph 2). In general, January through April was a period of low precipitation, but the remainder of the year was less consistent with a maximum yearly temperature varying by month each year. Four months had unusually high levels of precipitation, June 1983, July 1984, August 1984, and October 1988, all of which were greater than 30 centimeters, and could be considered outliers.

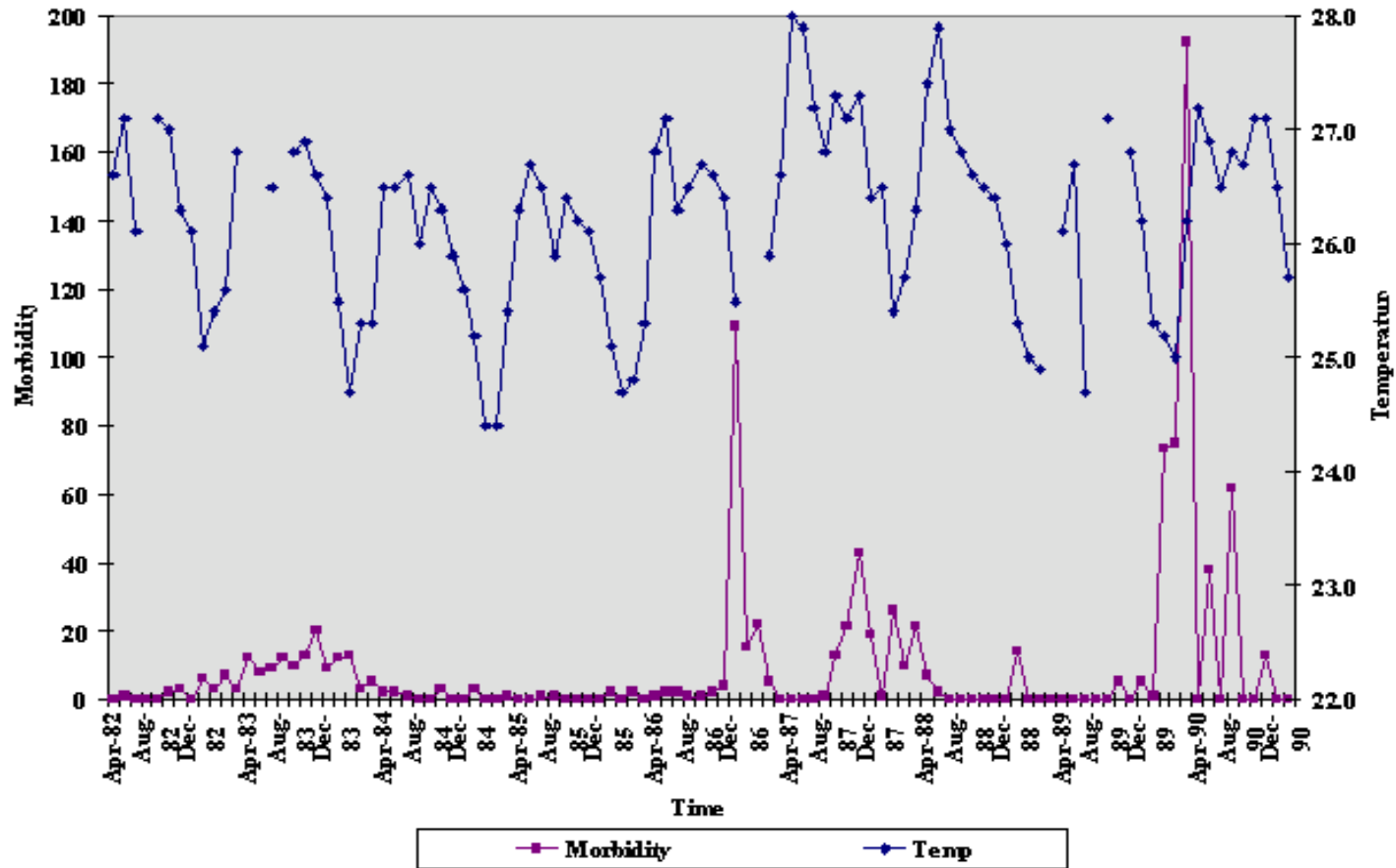
Graph 2: The Relationship Between Precipitation and Time



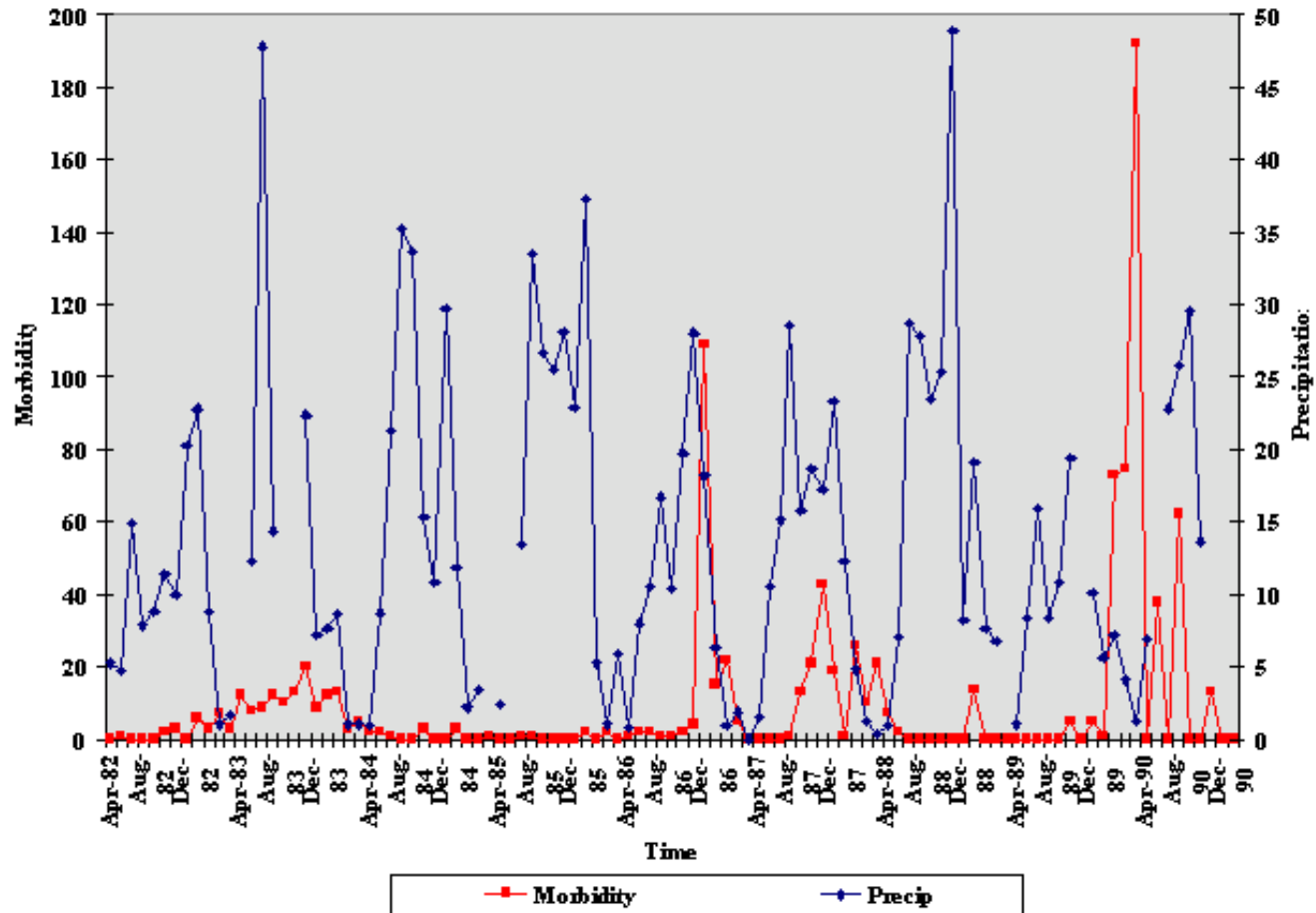
Morbidity data over the nine year period indicated no apparent seasonal distribution (Graph 3) Each year had a different month with a maximum of morbidity cases. Outliers for morbidity are considered months in which the number of cases was greater than 50 and include November 1986, and January, February, March, and July of 1990.

Graph 3: The Between Morbidity and Time

There was no visible relationship between morbidity and temperature over time, nor was a temporal relationship taking time lags into account apparent (Graph 4). The periods of high incidence occurred at any point in the year during the nine-year period and did not appear to be associated with either high or low monthly temperatures.

Graph 4: Morbidity and Temperature Over Time

There appeared to be no visible relationship between morbidity and temperature during the nine-year period, nor did any time lags between precipitation and monthly morbidity seem apparent (Graph 5).

Graph 5: Morbidity and Precipitation Over Time

VI. Methods/Approach

To determine the most appropriate model to demonstrate the possible relationship between morbidity due to dengue fever weather variables, several approaches were undertaken (Thesis1-Thesis 3). Thesis 1: Four separate models were tested to determine the most appropriate one: a linear model, an exponential growth model, an autoregressive model with a time lag of one month, and an exponential growth autoregressive model with a time lag of one month. I conjectured that the relationship between the variables may not be linear and thought it best to try both the linear and exponential models with a time lag of one month. To determine the most appropriate model, a regression was run for each of the situations to find the amount of error explained by each model. Also to determine the robustness of the models, the F statistics were

calculated, as were their corresponding p-value. Because one of the assumptions of multiple regressions is that errors of the variables are not related to one another, the Durbin Watson statistic was calculated to determine possible serial-correlation. To test the null hypothesis that neither precipitation nor temperature were related to morbidity rates, the t-statistic was calculated with its corresponding p-value. Finally, an equation for the line of each model was determined. Results of Thesis 1: The results of the four models showed no statistical significance for each model, nor were any of the variables alone statistically significant. The Durbin Watson statistic indicated that there was serial correlation between the variables as might be expected between temperature and precipitation which often affect one another. Because a linear relationship with time lags is more likely than an exponential relationship, I chose to retain the linear model for the remainder of the tests. Thesis 1a: To determine whether a better model might be achieved if the outliers were removed, the previous four models were tested after removing monthly records in which either the morbidity was greater than 50 or the precipitation was greater than 30. Because there were no outliers for temperature, no temperature records were removed. Results of Thesis 1a: The results of the four models with the outliers excluded showed no statistical significance for each model, nor were any of the variables alone statistically significant. The Durbin Watson statistic indicated that there was serial correlation between temperature and precipitation. Thesis 2: The linear model was retained because although no statistically significant relationship exists without a time lag or a time lag of only one month, a likely relationship may exist with a time lag of up to one year. To determine if such a relationship is a possibility, the dependent variable was lagged against the two weather variables by each month for up to twenty-four months. Results of Thesis 2: Several statistically significant relationships were found during this test. First, the model with a time lag of six months was statistically significant with an F statistic equal to 3.935, corresponding to a p-value of .0234. To reject the null hypothesis that there was no statistically significant relationship between incidence and the weather variables, the p-value had to be .05 or less. The R-squared value was .0889 which indicates that 8.89 percent of the error is explained by the model. Temperature, with a t-value of 2.64 corresponding to a p-value of .0098, was statistically significant, while precipitation was not a statistically significant parameter. To reject the null hypothesis, that there was no statistically significant relationship between temperature or precipitation and incidence, the t-values for either of the weather variables had to be greater than 1.96 with a corresponding p value of .05 or less. The correlation between temperature and precipitation was positive, with a value of .2504, and the correlation between precipitation and temperature was negative with a correlation value of -.0239. The Durbin Watson statistic indicated that serial-correlation between the two independent variables was occurring and had a value of 1.735 (a value of 2 indicates that there is no serial correlation). The equation for this model is $-142.26 = 5.83 \text{ Beta } 1 - .196 \text{ Beta } 2 + \text{error term}$. The other two statistically significant models were at lags of thirteen and seventeen months, which is too long a period to represent an actual relationship and is likely an artifact of lagging the model for too many months. Because long periods of desiccation do not occur in Trinidad, it is most probable that the existing lag is less than one year. Neither of the models were more statistically significant than the model with the six month lag. At the lag of 6 months the F value was 3.211 with a corresponding p-value of .0459. The R-squared value was .0789 indicating that 7.89 percent of the error is explained by the model. Temperature, the only statistically significant variable for this model, had a t-value of -2.52 with a corresponding p-value of .01. In this model, temperature was negatively correlated with morbidity with a correlation of -.279 and precipitation was positively correlated with morbidity with a correlation of .0197. The equation for this model is $261.81 = -9.963 \text{ Beta } 1 + .1098 \text{ Beta } 2 + \text{error term}$. The other model with a statistically significant relationship which is likely an artifact of lagging for too many months is found at 17 months. The F value for this model was 4.059 with a corresponding p-value of .02. The R-squared value was .1001 indicating that 10.01 percent of the error is explained by the model. Precipitation, the only statistically significant variable in this model, had a t-value of 2.77 with a corresponding p-

value of .007. Precipitation was positively correlated with morbidity with a correlation of .319 and temperature was positively correlated with morbidity with a correlation of .065 in this model. The equation for this model is $-39.36 = 1.53 \text{ Beta } 1 + .76 \text{ Beta } 2 + \text{error term}$. Thesis 2a: To test whether temperature as the only independent variable would create a better model, regressions were run of temperature against morbidity lagging the variables up to twenty-four months. Results of Thesis 2a: Two statistically significant relationships were determined. At a lag of six months, the model was statistically significant with an F statistic of 5.887 and a corresponding p-value of .0173. The R-squared value was .0627 which indicates that 6.27 percent of the error is explained by the model. The t-value was 2.426 with a corresponding p-value of .0173, indicating that the variable is statistically significant. A positive correlation between temperature and morbidity was found with a correlation value of .2504. The equation for this model is $-96.67 = 4.05 \text{ Beta } 1 + \text{error term}$. The second statistically significant relationship was found at a time lag of thirteen months which, as explained previously is too long a period to represent an actual relationship and is likely an artifact of lagging the model for too many months. In this regression, the F statistic was 6.84 with a corresponding p-value of .0106. The R-squared was .0779 indicating that 7.79 percent of the error is explained by the model. The t-statistic was -2.616 with a corresponding p-value of .0106. There was a negative correlation between precipitation and morbidity with a correlation value of -.279. The equation for the line is $257.24 = -9.4 \text{ Beta } 1 + \text{error term}$. Thesis 2b: To test whether precipitation as the only independent variable would create a better model, regressions were run of precipitation against morbidity lagging the variables up to twenty-four months. Results of Thesis 2b: There was one statistically significant relationship between precipitation and morbidity at a time lag of seventeen months. However, this is likely an artifact of lagging the variables for too many months. In this regression, the F statistic was 9.047 with a corresponding p-value of .0036. The R-squared was .1016 indicating that 10.16 percent of the error is explained by the model. The t-statistic was 2.008 with a corresponding p-value of .0035. There was a positive correlation between precipitation and morbidity with a correlation value of .318. The equation for the line is $.21 = .778 \text{ Beta } 1 + \text{error term}$. Thesis 3: Because it is possible that precipitation and temperature have different time lags when affecting morbidity, two models were tested using both independent variables at different time lags. Because the time lags for temperature of six and thirteen months and the time lag for precipitation of seventeen months were statistically significant, the models used first a lag of six months for temperature and seventeen months for precipitation, and then a lag of thirteen months for temperature and seventeen months for precipitation. Results of Thesis 3: Neither the model nor the independent variables were statistically significant for both models tested. The Durbin Watson statistic indicated that serial correlation was occurring between the variables. These results suggest that either the variables are interacting with one another or the time lags chosen are too great to indicate a real relationship.

VII. Equations for Each Model

Thesis 1: Full dataset

- linear model

$$\text{MORBID} = \alpha + (\text{Beta}1)(\text{Temp}) + (\text{Beta}2)(\text{Precip}) + \text{error term}$$

- exponential growth

$$\log(\text{MORBID}) = \alpha + (\text{Beta}1)(\text{Temp}) + (\text{Beta}2)(\text{Precip}) + \text{error term}$$

- autoregressive (lag = 1)

$$\text{MORBID}_t = \alpha + (\text{Beta1})(\text{Temp}_{t-1}) + (\text{Beta2})(\text{Precipt}_{t-1}) + \text{error term}$$

- log autoregressive (lag = 1)

$$\log(\text{MORBID}_t) = \alpha + (\text{Beta1})[\log(\text{Temp}_{t-1})] + (\text{Beta2})[\log(\text{Precip } t-1)] + \text{error term}$$

Thesis 1a: Deleting observations where Morbidity > 50 and Precipitation > 30

- linear model

$$\text{MORBID} = \alpha + (\text{Beta1})(\text{Temp}) + (\text{Beta2})(\text{Precip}) + \text{error term}$$

- exponential growth

$$\log(\text{MORBID}) = \alpha + (\text{Beta1})(\text{Temp}) + (\text{Beta2})(\text{Precip}) + \text{error term}$$

- autregressive (lag = 1)

$$\text{MORBID}_t = \alpha + (\text{Beta1})(\text{Temp}_{t-1}) + (\text{Beta2})(\text{Precip } t-1) + \text{error term}$$

- log autoregressive (lag = 1)

$$\log(\text{MORBID}_t) = \alpha + (\text{Beta1})[\log(\text{Temp}_{t-1})] + (\text{Beta2})[\log(\text{Precip } t-1)] + \text{error term}$$

Thesis 2: Full dataset

- Lagging the dependent variable and running a linear model on the lagged dataset.
- Lags ran from 0 thru 24

$$\text{MORBID}_t = \alpha + (\text{Beta1})(\text{Temp}_{t-1}) + (\text{Beta2})(\text{Precip } t-1) + \text{error term}$$

Thesis 2a: Full dataset

- Lagging the dependent variable and running a linear model on the lagged dataset.
- Lags ran from 0 thru 24

$$\text{MORBID}_t = \alpha + (\text{Beta2})(\text{Temp } t-1) + \text{error term}$$

Thesis 2b: Full dataset

- Lagging the dependent variable and running a linear model on the lagged dataset.
- Lags ran from 0 thru 24

$$\text{MORBID}_t = \alpha + (\text{Beta1})(\text{Precipt}_{t-1}) + \text{error term}$$

Thesis 3: Full dataset

- Lagging the dependent variable and running a linear model on the lagged dataset.
- Lags were 6,13 for precip. and 17 for temp

$$\text{MORBID}_t = \alpha + (\text{Beta1})(\text{Temp } t-1) + (\text{Beta2})(\text{Precipt}-1) + \text{error term}$$

VIII. Discussion

There are two models which show the greatest likely relationship between weather variables and morbidity due to dengue fever. Both of the models at a time lag of six months, with temperature alone and with precipitation and temperature together, were statistically significant and appear to be the best models. The model did not greatly improve when temperature was considered alone, therefore both models are considered appropriate in explaining the association between morbidity and weather. Because the time lag is six months, it suggests a seasonal relationship which may be discerned through further research. As yet, my work has some errors which can be overcome with more data and more time. It is possible that although there were one hundred and eight data points and a minimum of twenty data points is necessary for a statistically significant relationship to be found, more data points are needed. Errors could also have been due to the fact that the weather data was from Trinidad alone while the incidence data was from both Trinidad and Tobago. It is possible that the weather in Trinidad is not reflective of that in Tobago. Also, the method of changing weekly incidence data to monthly incidence data may have induced errors. It is likely that although a certain fraction of a week belongs to one month, the corresponding fraction of incidence does not also belong to that month. For example, there may be an outbreak in one month and not the next, which would mean an unequal division of incidence for a week split between those two months. Lastly, the small amount of serial correlation between temperature and precipitation indicate that these two variables are affecting one another which may reduce the robustness of the model. To correct some of these problems a longer period of time should be analyzed, the data should be given in monthly form for all variables, and all data should be given from one locale. Also, using the minimum and maximum temperatures in place of mean temperature may reveal a more predictive relationship.

IX. Conclusions

The statistical procedures suggest that there is a statistically significant relationship between temperature and incidence rates given a six month time lag. The results indicate that it takes six months for environmental conditions, as measured by temperature alone, to affect dengue incidence. This may be due to temperature's influence on the life cycle of a mosquito or viral replication rates. The higher temperatures may reduce the larval size of mosquitoes, which results in smaller adults that need to feed more often. Higher temperatures may also speed up the EIP causing greater rates of transmission. Because the time lag for these to occur is nebulous due to the variable nature to the mosquito life cycle, it difficult to verify how these factors can be ascribed to the six-month time lag found. A small negative correlation of precipitation with incidence was detected, suggesting that precipitation six months prior to reporting dengue may reduce incidence rates. This may be due to a variety of factors. Either high amounts of rain flush out larvae, thereby reducing rates or low amounts of rain requires more water to be stored which will increase incidence rates. In either situation an inverse relationship is observed between precipitation and incidence rates. However, because no statistically significant relationship of precipitation

with incidence was found, precipitation did not actually influence incidence, only a negative correlation between the two variables can be alluded to.

X. Public Health Implications

Because this study indicates that there is a statistically significant relationship between dengue incidence and temperature at a six month time lag, there are both present and future public health implications. The present implications of this study suggest that disease prevention and surveillance measures should focus on the temperature six months prior to determine the risks of increased transmission for the present time. The future implications of this study are more uncertain. Because a positive correlation of temperature with incidence was found, global warming is likely to have an impact on dengue fever, increasing the disease's range and the number of infected individuals. To mitigate future impacts both disease surveillance and control are necessary. Disease surveillance should include both passive and active surveillance. Passive surveillance would require dengue be a mandated reportable disease that would be recorded in all hospitals and clinics. Active surveillance includes providing a laboratory-based surveillance system which would give public health officials precise information about periods of increased dengue activity. One active surveillance measure suggested is the creation of diagnostic centers in sensitive geographic regions bordering endemic zones (Patz et al., 1996). Such centers would provide early warning of changes in incidence and allow for intervention. Control measures should have an integrated approach combining environmental management, chemical control, and biological methods. Environmental management is any change in the environment that prevents or minimizes vector propagation or man-vector-pathogen contact. These include environmental modification (long-term changes to vector habitat such as improved delivery of potable water), environmental manipulation (short-term changes to vector habitat including proper storage of containers), and changes to human habitation or behavior (including the screening of windows). Chemical control should be used in a limited fashion because of the toxic effects most larvicides have had to humans and aquatic organisms in the past. Present use is restricted to containers that cannot otherwise be eliminated or managed. Biological control is based on the introduction of living organisms that will prey upon, parasitize, compete with or otherwise reduce the abundance of *Aedes* or anopheline mosquitoes. These interventions have been largely experimental and have included introduction of fish, bacteria, and cyclopoids ('water fleas') which attempt to reduce mosquito populations. If little is done to prevent global warming, surveillance and control measures will be our last protection against increasing infectious disease transmission. However, preventing warming should be a greater priority to ensure that global dissemination of communicable diseases does not occur.

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Relationships: Integration Paper

John Callewaert

In my paper, I explored the spatial association between environmental hazards, race, and income for zip codes in the state of Michigan. The results of my analysis showed a strong association between zip codes having a high number of environmental hazards and zip codes having the highest minority populations. Only with one environmental hazard variable, the number of incinerator emissions per zip code, was there a strong association between the environmental hazards and both race and income. This type of analysis has come to be understood as environmental justice. The United States Environmental Protection Agency defines environmental justice as

...the fair treatment of people of all races, cultures and incomes, with respect to the development, implementation, and enforcement of environmental laws, regulations and policies. Fair treatment implies that no people should be forced to shoulder a disproportionate share of the negative environmental impacts of pollution or hazards due to a lack of political, economic, or educational strength.

While this is a very useful and helpful definition, environmental justice can be defined much more broadly. In some situations, gender and age may also be important factors in terms of who is experiencing a disproportionate burden of environmental hazards. Furthermore, environmental justice need not only look at the disproportionate burdens of negative environmental impacts, it can also include the disproportionate access to certain environmental amenities or resources. Are particular groups not allowed equal access to the resources needed for production and survival? The framework that I will use to examine the relationship between my topic and the other papers is the framework of environmental justice. My intent is to identify the environmental justice issues that may be present in each study. I hope to work with the broadest possible definition of environmental justice in order to examine the potential for both disproportionate burdens and/or disproportionate access.

Iyer: Urbanization in Moscow

Here I believe the environmental justice concerns might include lower-income groups and the elderly. As land and housing prices increase and with increased capital activity there will be inevitable dumping of undesirables (waste management facilities, polluting industries, etc.) in areas of the city with the least political and economic clout. This has been the case in the U.S., but here the market economy is contained by certain environmental and housing regulations. If such regulations do not exist in Russia, a laissez-faire economic system will inevitably create disproportionate burdens. The elderly on state pensions may be the prime victims as they do not have the financial means to move out of areas that may become the environmental dumping groups of the new Moscow.

Chaudhury: Desertification in the Sahel

An important environmental justice concern with this study involves what is happening to the nomadic peoples as more and more desertification control schemes involve moving people to settled agriculture

lifestyles. What is happening to the nomads as their way of life is curtailed? There may be serious cultural implications as the Sahel transitions through a variety of changes designed to curtail desertification. There are also numerous cases of environmental injustice in the eco-political history of the region. What happened to people and the land due to the colonial forces that demanded a shift to export agriculture.

Kim: The Red River Delta in Viet Nam

Despite centuries of intensive agriculture and a high population density, this region of Viet Nam is surprisingly stable and productive. With the changes from sustainable production to a more market based economy, however, one should be aware of the development of injustices in terms of resource distribution and pollution. In an ethnically homogenous society who are the groups that experience the environmental problems or are left out of the development agenda? Women? Children? The elderly?

Wegbreit: Weather Patterns and Dengue Transmission in Trinidad-Tobago

Even within a small country like Trinidad-Tobago, one should be cautious of looking at “national” data. While more regionally specific data collection is a much more difficult task, there may not be the same correlation between temperature, rainfall and dengue fever for different social groups. Might the elderly or children be more at risk? Or perhaps there might be a difference based on household income? It might seem that lower-income groups might have a greater potential to exposure, but if wealthier groups have a greater ability to store water in the household they might have a greater risk? Expanding the original question to include more socio-economic variables would be very important for establishing public health policies and initiatives.

Manokham: Deforestation in Southeast Asia

Here I think one needs to ask more specific questions about the connection between deforestation, population growth and poverty. Is the reason that deforestation is occurring as such a rapid rate in the region because of population growth and need to raise the standard of living? It seems that in many cases, the deforestation is occurring because of the demand from foreign markets and the desire of national elites to exploit the resources and the market. The plight of the Philippine poor did not improve from the deforestation of that country, but the Marcos regime did grow wealthier and more powerful. In such situations, the poor are often exploited as much as the forestry resources. Attempts at social forestry, which includes the interests of a variety of stakeholders seems a more appropriate effort to overcome some of the injustices associated with deforestation in Southeast Asia.

England: Population Growth, Violence and Environmental Degradation in Burundi

In this study the injustices based on ethnic and class tensions between the Hutu and Tutsi were clearly evident. These injustices have led to severe and violent clashes between the two groups over the last several decades. Recent initiatives such as the regroupment camps in which Hutu men (the ethnic majority) are confined will only exacerbate the tensions between the groups regarding access to land and environmental resources. The government’s mandate that there be no discussion of ethnic differences makes the task of addresses the injustices between groups even more difficult. However, if there are differences between the two groups based on class, perhaps development schemes and environmental programs could use that factor to seek a more equitable distribution of resources. To deny the injustices

that exist and to not seek to address them would seem to only lead to more violence.

Scaff: German Reunification and Consequences to the Environment

As with the Moscow study, it seems that the group that is experiencing the environmental burdens left by the East German political system are those that are not able to move to the West. As noted in the presentation, this is often the elderly. Furthermore, given the rapid and unmanaged growth in the East, what is happening with the inevitable waste generation? Where is it going and how is it being handled? The former political system left severe environmental scars on the land, are the “flexible” regulations of the new political system creating similar scars, and if so, who is bearing the burden?

Lo: Urbanization in Sao Paolo, Brazil

What has been the environmental impact of the dizzying urbanization of Sao Paolo and how has it affected different groups? Along with incredible disparities in wealth, Brazil is also a racially diverse country. Have certain groups bore the impact of urbanization more than others. Do the environmental disamenities affect one group or groups more than others? Or has the rapid growth of the city affected everyone equally despite if they live in a gated household or a favela. It would seem that within a society with great income disparities there are also environmental disparities. What are they? How are they impacting public health, environmental policies, etc.?

These comments are only suggestions for broadening any examination of the population-environment dynamic to include aspects of environmental justice. Including environmental justice would allow for a more complete perspective on the political economy or the political ecology of a particular program, plan, or policy. As human population grows we not only place greater demands on the environment, but we also place greater demands on each other. We can no longer think of environmental regulations and environmental protection without determining the social impact of such programs. Thus, any environmental policy of environmental management system needs to consider how various groups are being impacted by the related decisions and programs. To not do so, I believe, will only lead to greater environmental and social conflict and limit the potential for sustainability.

Relationships to Other Papers

Moushumi Chaudhury

After having listened to very interesting papers presented by my classmates, I realized that the problems of the Sahel are not necessarily unique. Deforestation, consequences of population explosion, growth of urbanization, economic policies that advocate agricultural, and social conflicts between people who share scarce resources are common issues throughout the world. Most interestingly, I have also realized that although the case studies presented were very different from one another, the policies suggested can also be applied to the Sahel or elsewhere to a great extent. The three common themes among the papers that could be comparable are conflict over natural resources, agricultural policies, and urbanization.

The paper presented on the effects of population growth in Burundi was very similar to the conditions of the Sahel. Like the Sahel, Burundi is practicing deforestation at an alarming rate because land needs to be cleared for a very densely populated region that relies on subsistence agriculture. Therefore, there is a striking resemblance between the Sahel and Burundi where the quality and the quantity of natural resources, such as land, is decreasing in order to accommodate for a growing population. The situation then results in conflict or violence. The conditions in Burundi may be slightly different because of the ethnic conflicts involved in relation to access to land, but nevertheless, like the Sahel, unequal access to land depends on who has the upper-hand in the conflict. Furthermore, the poor have the least access to natural resources or are subjected to the worst environmental conditions because they have no economic assets or representation as in the Sahel, Burundi and even Michigan. Environmental injustice is widespread. In order to reduce conflict and poverty, the policy to reduce population growth was commonly suggested.

The correlation between population growth and the use of agriculture as a policy to accommodate for the increase in population density has also been a common theme. The Sahel shares the consequence of poor agricultural policies with the present situation in Southeast Asia. Due to population pressures, deforestation in Southeast Asia is also occurring at a fast pace. After loggers use the forests, the farmers use the land to the extent that they can, and then leave the area to farm elsewhere. This is a case, as in the Sahel, where poor forest resource management exists. There is no incentive for reforestation and intensification of land use. However, agriculture as a policy can also be beneficial if practiced correctly as in the Mekong River region of Vietnam. In this case, agriculture is a means to support an extremely densely populated region. This is also the case in the Sahel where agriculture has the potential for serving more people and integrating the region into the world economy. The success of this policy will only come about in both the Sahel and Vietnam through greater fertilizer use, the products of the Green Revolution, and most importantly, intensification of land use, not extensification.

In relation to population growth and the failure of agricultural policies in rural areas, more people are moving into urban areas for employment opportunities. As in the Sahel, there is also a considerable amount of internal migration from former East Germany to the West and in Russia. This has caused difficulties in terms of availability of living space and work opportunities. Although the process of "decentralization" of living space is different for all three cases, the policies recommended have all

suggested development in the outskirts of the cities or rural areas. For example, in the Sahel, "decentralization" of space may come through reforestation programs in rural areas; the German government may encourage development in the former East Germany; and communist Russia advocated dispersion through mandates that were a part of the centralized planning process.

It is truly amazing to realize that even though conditions of population and environment dynamics may vary around the world, suggested policies relating to population growth, agriculture, and urbanization can be the same to remedy problems. This clearly shows the potential of learning from the mistakes and situations in other countries in order to improve the ecological and social conditions of a particular nation in trouble.

**The Relationship of "Environmental Scarcity and
Violent Conflict: A Case Study of Burundi" to
Class Projects in SNRE 575
Shannon England**

My paper studied the relationship between violent conflict and environmental scarcity in Burundi. Specifically, the paper studies the lack of access to agricultural land that has resulted from exponential population growth and how this may have contributed to Burundi's history of ethnic conflict since Independence in 1961. The paper that was most closely related to this topic was Moushumi Chaudhury's research on the Sahel. This area of the world also seems to be approaching its "limits" in terms of expansion of agricultural land. Many of the problems and the solutions suggested by the research would be applicable to Burundi as well. Further research on Burundi may also be aided by including a similar simulation model from Stella to determine what the actual limits of agricultural production and population growth might be, as well as what the results of possible policy implementations might be.

The most interesting research project in terms of providing solutions for areas experiencing high population densities was Daria Kim's paper about the Red River Delta region of Vietnam. The extremely high population densities (over 2000 people per square kilometer in some places!) in this area have been supported by extremely intensive and integrated agricultural systems. This type of technology is urgently needed in Africa where agricultural production has not been keeping pace with concurrent growth in population, as has been the case in the rest of the world. ([See Chart.](#)) Lessons on agricultural integration and intensive farming methods from this area of the world, while perhaps not directly applicable, may point the way to a solution for countries like Burundi.

John Callewaert's study of environmental justice in Michigan may seem to be very removed from research on violence and agricultural land in Burundi, but I am intrigued by the possibilities for analysis and possible political reform that might be manifested by the type of technology linking geographic information and social data used in this research. It is hard to imagine a more forceful representation or depiction of injustice than a map highlighting discrepancies in such a clear manner. Perhaps reform is a long way off in Burundi, but true change would focus on attempting to undue the wrongs that have occurred in the past. Data on ethnicity and ownership of land mapped over time, could, perhaps, help Burundians to achieve a more equitable distribution of resources.

The research conducted by Jeny Wegbreit on global climate change and Dengue fever raises interesting questions about the global environment and its effect on local populations. Changes in air emissions a continent away now may have dramatic consequences for illness in people in Trinidad and Tobago. For resource poor countries dependent upon agriculture, the implications of global climate change include not only changes in disease transmission rates, but also changes in agricultural systems and the productivity of the land. A net decrease in an agricultural system's productivity due to changes in precipitation, temperature, or the timing of cyclical season changes is not hard to imagine. The implications that naturally follow would be that the world should prepare for possible food shortages in

much of the developing world if global climate change does occur.

All of the research for this class showed that first and foremost, populations and the environment are linked in relationship to each other. We have an impact upon the land as it has an impact upon us: careful monitoring of this relationship is crucial to preventing hardship and harm to ourselves and others. We must recognize now more than ever that we are not separate from the global environment, but rather that we live within it.

Relationships among other semester projects

Seema Iyer

After seeing the results of my colleagues' work at the end of the semester, interdisciplinary collaboration has new meaning for me. Although those of us taking NR&E 545 entered with a range of backgrounds from the natural, physical, and social sciences, none of us had previously been exposed to transition theory, or at least not in the manner in which it had been presented. The concepts of overshoot-and-collapse and "turnings" in time empowered us to view problems in a whole new light as well as united us with a common language. In other words, our independent paths of knowledge intersected with the concepts of population-environment dynamics, but then took off into different directions based on our interests and background. By starting on the same footing, connections and relationships were easier to define and understand.

The geographical areas presented in this monograph not only span the globe but also span the spectrum of political and economic infrastructures. However, the population dynamic is additionally affected by the social, environmental, and spatial characteristics of a region or country. The chapters by Kim and Scaff have an interesting connection to mine because of the communist governments that were (or are) in power. In a centrally-planned economy, particularly as practiced by the Soviet regime, it is theoretically possible to manipulate movement and migration within the country. Clearly in Vietnam, Eastern Germany and Russia, attempts were made to control where and how the population lived. In Russia, the government encouraged or forced people to move from European Russia to Siberia and in Vietnam, the government induced people to move out of the densely-populated Red River Valley. The transition of the population out of the traditionally populated areas was very different in Russia and in Vietnam, however, due to two important aspects of transitions themselves. First, the vastly different sizes of the countries meant that the scale of the transitions were very different, and secondly, the nature of political power meant that the trajectory of the transitions were different.

Since the dissolution of the Soviet Union, migration within Russia is no longer regulated by the government but instead is driven by viable economic opportunities. The geography of the country in terms of the climate and physical infrastructure determine where the economic opportunities will be located. The chapter on the Sahel by Chaudhury presents an area of similar size and similar variations in climate, although opposite in the extremes. The desertification of the Sahel region is the outcome of continuous deforestation, which has precipitated population movement into coastal, urban areas for economic reasons. The population in the former East Germany is moving from the environmentally degraded regions into Berlin and West Germany for similar reasons.

The urbanization transition is characterized throughout the chapters, but perhaps, the chapter by Lo offers a glimpse at our future world. Sao Paulo is a manifestation of ultra-urbanization that is occurring throughout many parts of the world. In Brazil, urbanization has been accompanied by a huge population increase. The disparity between the rural and urban areas also promotes rural-urban migration. Although Russia is not experiencing a population increase, many cities that were created by the socialist government are declining because the current economic structure cannot sustain their existence. Hence,

urban areas that can support a bigger population are attracting people from smaller urban areas.

At the heart of all the chapters, however, are the reasons and circumstances that have led to the current state of transition in each country or region. Past practices offers insights into future outcomes, which is the basis for the curve fitting of data. The chapter by England provides an interesting account of the history of violence in Burundi in order to understand the past and predict the future. This is the premise of *The Fourth Turning*, which challenges us to find connections between our present-day world and the not-so-near past.

Relationships to Other Papers

Daria Kim

When I first began my studies on the agricultural sustainability of a small village in North Vietnam, my purpose was clear cut: in order to explore the relationship between population and natural resources, I would focus my project on just those two aspects, the growth rate and the region's agricultural yield, expecting to see that one would simply be the inverse of the other. As I continued my research and as I became exposed to the projects of my fellow students, I began to notice that the challenges in exploring the dynamics between population and environment could be both amazingly simple and yet tantalizingly complex.

Most projects were developed within the framework of transitional theory. Transitions as defined by Professor Drake is "a specific period of time which spans the shift from slow to rapid change in the sector and then usually a return again to relative stability." Transitions are usually characterized by the fact they can exist over many different sectors, have similar trajectories, and are apparent at different geographic or temporal scales. Because of the nature of change within transitions, there is a period when sectors may become vulnerable to damage and, in some transitions, pass a threshold of irreversibility. Therefore, unless steps are taken to address some of the societal implications of transitions, the resulting stability may indeed be one that's undesirable.

The projects which were explored within this framework shared the common themes of transitional theory, and thus could be compared simply along those same lines. What is interesting about transition theory is that despite the many similarities transitions may share, transitions frequently interact with one another which makes analyzing them quite complex. Most the projects in this class presented policy changes as a way of addressing these transitional vulnerabilities.

Thammasack's paper on Deforestation in Southeast Asia looked at both forestry transitions and economic transitions, whereas my paper explored the relationship between demographic transitions and agricultural transitions. Her paper was of direct interest to me because one of the things I wanted to research was the role of forestry in Vietnam's socioeconomic and environmental development. Her transitional theory revealed that Vietnam's deforestation rates were alarming (annually over 100,000 hectares), and that this will continue to grow. Because forests are important for the protection of water resources, control of soil erosion, as well as for shelter, and for providing medicinal plants, its protection and its conservation is of utmost importance.

Based on transitional theory and on Thammasack's careful analysis, Vietnam is currently going through the vulnerable stages of its forestry transition, and sectors such as the economy, agricultural cultures (including my once oh-so-simple village in North Vietnam), and urban centers will become affected by its current trajectory. The key to addressing this is in the creation of policies aimed at restoring forestry and with the long term goal of sustainable development. Thus, unless deliberate steps are taken to ensure the protection of Vietnam's current forest coverage, the country's deforestation rate may pass into one of irreversibility and eventually undesirable stability.

A scenario no one wants.

Relationships to Other Papers

Thammasack Manokham

An increasing population (especially within developing countries) has many consequences. Some of these consequences may be much needed within that country, such as providing a steady labor supply for agricultural production and industrialization. In many cases, however, a rapidly increasing population easily forecasts destruction for that country and the world.

A rapid increase in population has been shown to be a major cause in deforestation, or the loss of forest cover, in eight Southeast Asian Countries; the cause of conflict among different ethnic groups, and between nomadic farmers and permanent plantation farmers, in regions such as South Africa; and the depletion of natural resources and minerals (in Vietnam). As the population increases, there is an increasing demand for land for agricultural production, fuel wood collection, and housing accommodation. The rates of consumption of forest products and services will also increase. To accommodate demands placed by the increasing population, forest areas will be encroached upon for cultivation, commercial logging, and uncontrolled fuel wood collection.

Consequently, many developing countries, with a rapidly increasing population, destroy their environment and natural resources for socio-economic development. As the available land diminishes and natural resources become scarce, there are regional, local, and government disputes about the ownership and use of the land (such as in Thailand) and natural resources. Most will claim ownership, but not responsibility for its destruction. As the quality of the land deteriorates because of overuse, many will move to other areas until that land has deteriorated too. This results in deadly conflicts between many nomadic groups and plantation owners. In order to limit deforestation and to reduce contestations between groups, agroforestry on a sustainable basis will have to be practiced by all groups. Ownership will also have to be extended because it will provide incentives to the nomadic farmers to permanently reside there and harness and manage the renewable and reproductive capacities of their land. It will also prevent them from crowding out forest-dependent communities from their traditional forest farming land. Thereby, it reduces deadly confrontations between groups.

As the population increases and living space decreases, the density of people per housing area increases. As a result, the city becomes crowded and the quality of life within that city declines (such as in South America). Overall, housing conditions are characterized by overcrowding and inadequate infrastructure. Many are forced to living within the congested confines of the city area, where their exposure to diseases and other health related problems are increased. Water is stored in buckets where they become ideal breeding spots for malaria-carrying mosquitoes. Because urban planners are more focus on maximizing the number of dwelling units that could be achieved within the housing area, they are not including recreational space such as parks and playgrounds within their urban plans. However, as a country becomes more affluent, less emphasis is placed on increasing the number of people per housing area, and more focus is shifted to decentralization and the development of new towns and a green belt to

stop the continued expansion of the central area (such as the new Russia). Urban planners must consider the impact of the increasing population and its distribution of people, as well as ethnic group distribution, on current and new cities if they are to improve the quality of life within the city.

An increasing population can translate into destruction and death for the people and environment, but it can also translate into opportunities for sustainable management of resources. Fortunately, the people of both developing and developed countries are given the role as the translator and can affect its translation.

Relationships among the Papers: Common Themes

Rosalyn Scaff

In the Fall 1998 Population and Environment course many common themes appeared throughout the student papers. The three themes that relate specifically to my paper are: urbanization, environmental impacts on communities and regional planning.

Urbanization patterns were one of the common threads in some of the papers, particularly Seema Iyer and Ken Lo's works. Both students examined the patterns of urbanization in two very different places. Seema Iyer investigated the urban fabric of Moscow. In this country communist control overpowered land development. Private ownership of land and market driven development were non-existent. While the government controlled where people lived, they also provided low rents for citizens. As buildings became rundown, the government merely moved people into new developments instead of fixing the old. Thus, Moscow has been left with poor-quality, run-down residential units.

Ken Lo's paper examined the urbanization patterns in Brazil. This work provided an interesting juxtaposition to the Iyer paper. Unlike Russia, Brazil does not exist under communist rule and therefore does not purport equalization of the citizens. This is clearly seen in areas such as Sao Paulo where wealthy, gated communities coexist with slum areas. This country, driven by capitalism and a market economy, has seen massive development for its million plus citizens. Mega cities like Sao Paulo have sprung up in the past decade and can not support the needs of the people.

These two papers represent two extremes and fit rather nicely with my work. East Germany became a communist country under Russian rule after WWII. Urbanization patterns like those in Moscow are also apparent in East German cities. The main difference is that East Germany had a declining population throughout the Cold War period. This coupled with the fact that the country had a relatively small population meant that East German cities were not as large and densely populated as Moscow. On the other hand, post WWII West German development was driven by demand and a market economy. One difference I see between West Germany and Brazil is that land development in the FRG has been very controlled. Solid planning mechanisms have been used to help protect the environment and control growth. Yet, my research shows that a declining to stable population in Germany is, nonetheless, using more land than necessary. Although I do not expect the country to look like Sao Paulo any time soon, I suggest Germany examine closely their land use planning policies.

The second theme which I found interesting was that of environmental justice. John Callewaert wrote about this topic as it is occurring in Michigan. His findings concluded that minorities, no matter what their income level, were more likely to live near hazardous waste sites than any non-minority community. I am interested in how this topic relates to my work, particularly the idea that communist governments promoted environmental injustice through their policies. While suppressing information and controlling growth patterns, the government was able to place intensely hazardous sites near communities. This coupled with a lack of environmental regulations produced extremely polluted areas in East Germany. Statistics show that East Germans suffered from the poorest water quality in the

eastern block. The idea of how governments or systems get away with placing or allowing people to live near contaminated sites relates very well with my paper.

Regional planning also became a theme in the presentations. Thammasack Manokham spoke specifically about regional controls in Southeast Asia that could help curb deforestation. Her paper and mine come to the same conclusions, namely if we are going to help the environment we need to do it on a regional basis. While work must be done on a small scale in communities and countries, it is equally important to examine the depth of our actions on a regional inter-country and global scale.

Relationship to Other Papers.

Dengue Fever's Widespread Impact: Implications for the Regions Studied

Jennifer Wegbreit

Dengue Fever is a disease intimately associated with the majority of the regions studied by the students in this course. According to D. J. Gubler¹, the incidence of dengue infection has increased dramatically in the past 30 years, first in Asia, then in the Pacific and Americas, and finally in Africa. If warming occurs, it is likely that cases of dengue fever will rise even further. The possibility of warming may enhance the environmental changes focused on by the students of this course which have the potential to enhance dengue transmission. Therefore the policy measures recommended in my paper to mitigate future impacts, namely control and surveillance, should also be implemented in the other regions studied.

In her paper, Thommasack Manokham detailed the loss of forested area in Southeast Asia to create land suitable for agriculture. Increased agriculture may provide food to support a greater population. Increased population in a region already very dense may facilitate transmission. It

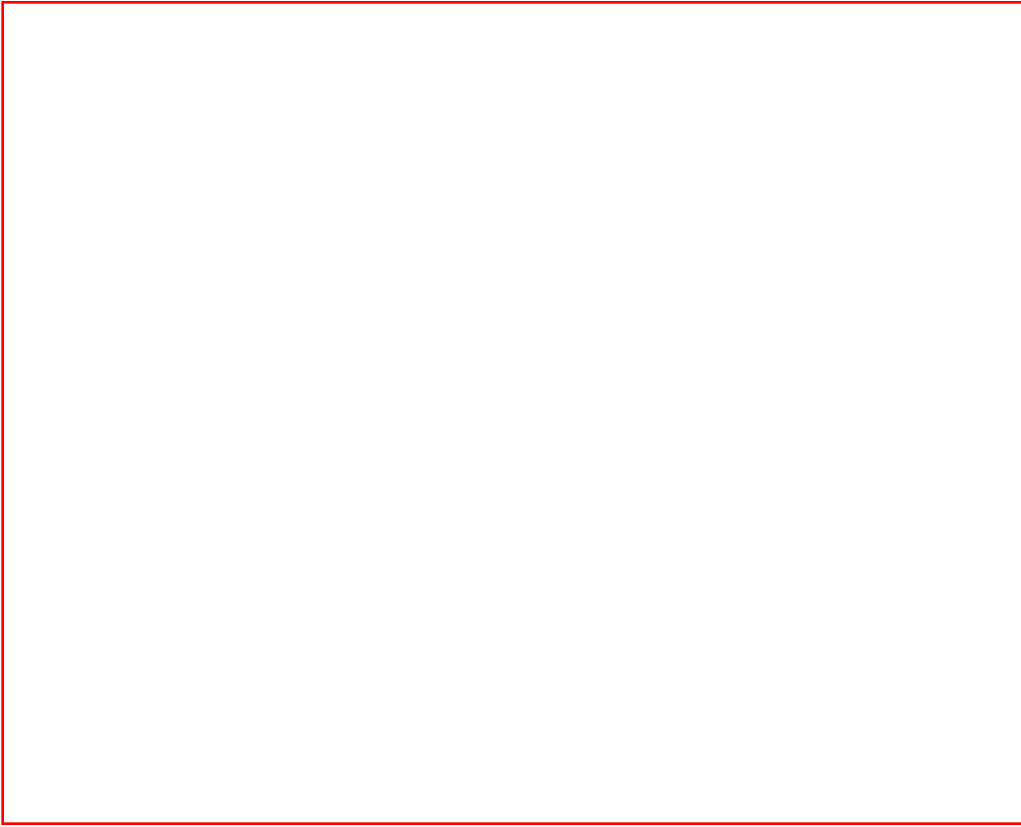
is estimated that that in Southeast Asia alone, there have been over 700,000 hospitalized cases of Dengue Hemorrhagic Fever in the past 30 years with over 200,000 deaths. These numbers may jump dramatically if the population continues to expand.

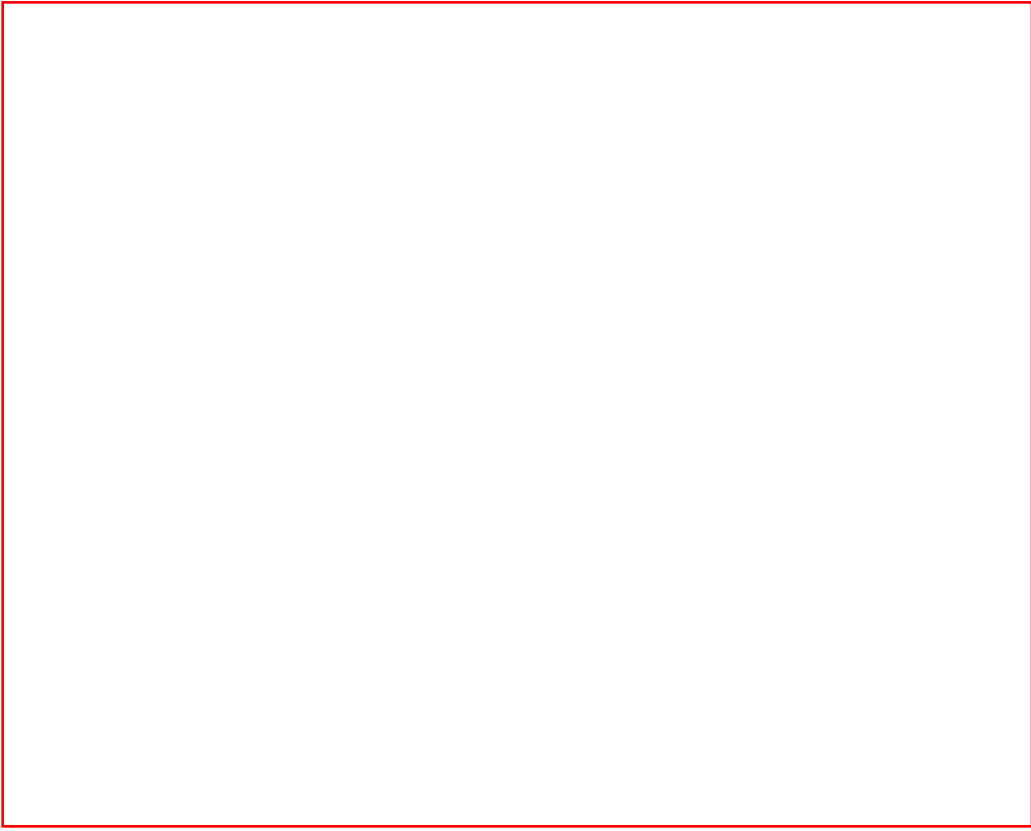
In 1987, seriological surveys estimated that one million infections occurred in Rio de Janeiro in 1986 and 1987.² The implications of this number for the region studied by Ken Lo are tremendous. Lo's study focused on the effects of urbanization on the public health of this region. He found that urbanization has not only decreased the general public health of this area as measured by life expectancy and incidence of various diseases, but that the difference between the health of the rich and poor was dramatic. Increased urbanization will increase the incidence of dengue fever in this region as has been found in past studies. Also, because of the living conditions of the poor in which a lack of running water necessitates containers of water often infested by *Aedes aegypti*, those living in poverty will be disproportionately impacted. The effects of global warming may cause the expected rise in dengue fever to be even greater.

The two situations illustrated in Southeast Asia and Brazil underscore the importance of dengue fever surveillance and control measures in the Americas, Asia, and Africa as well. Public policy should mandate that dengue be a reported disease in hospitals and clinics to allow scientists and doctors to monitor the problem and focus on the most sensitive regions. Control policies should also be mandated in order to decrease the population of infectious *Aedes aegypti*. Because the possible effects of global warming are not restricted to Trinidad alone, comprehensive measures to mitigate the likely increase in dengue fever in all tropical and subtropical regions is necessary.

Chart 1: Projection starts after
1994.

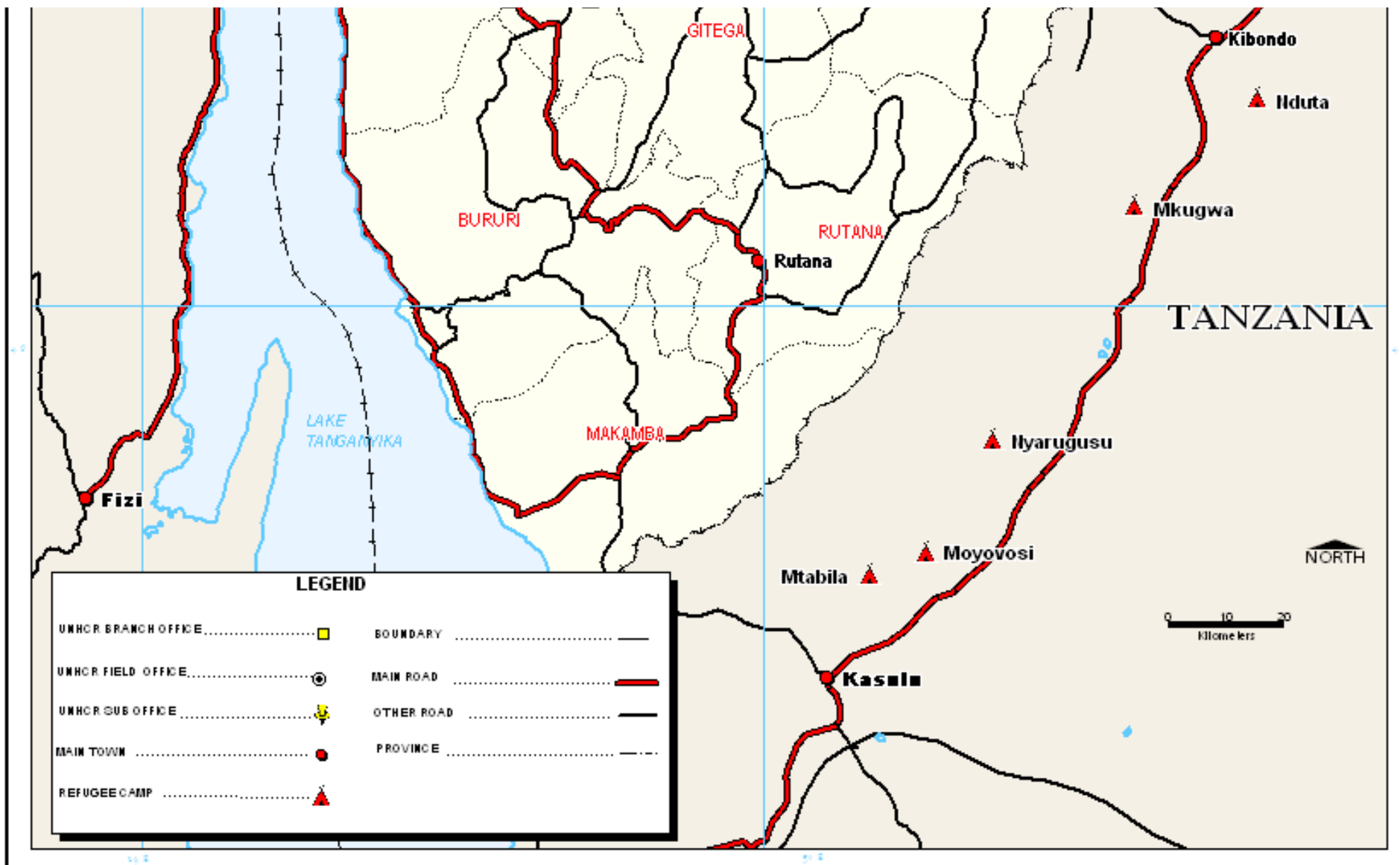






BURUNDI





THE BOUNDARIES AND NAMES SHOWN ON THIS MAP DO NOT IMPLY OFFICIAL ENDORSEMENT OR ACCEPTANCE BY THE UNITED NATIONS.
 UNHCR ENVIRONMENTAL DATABASE, APRIL 1997.

Chart One

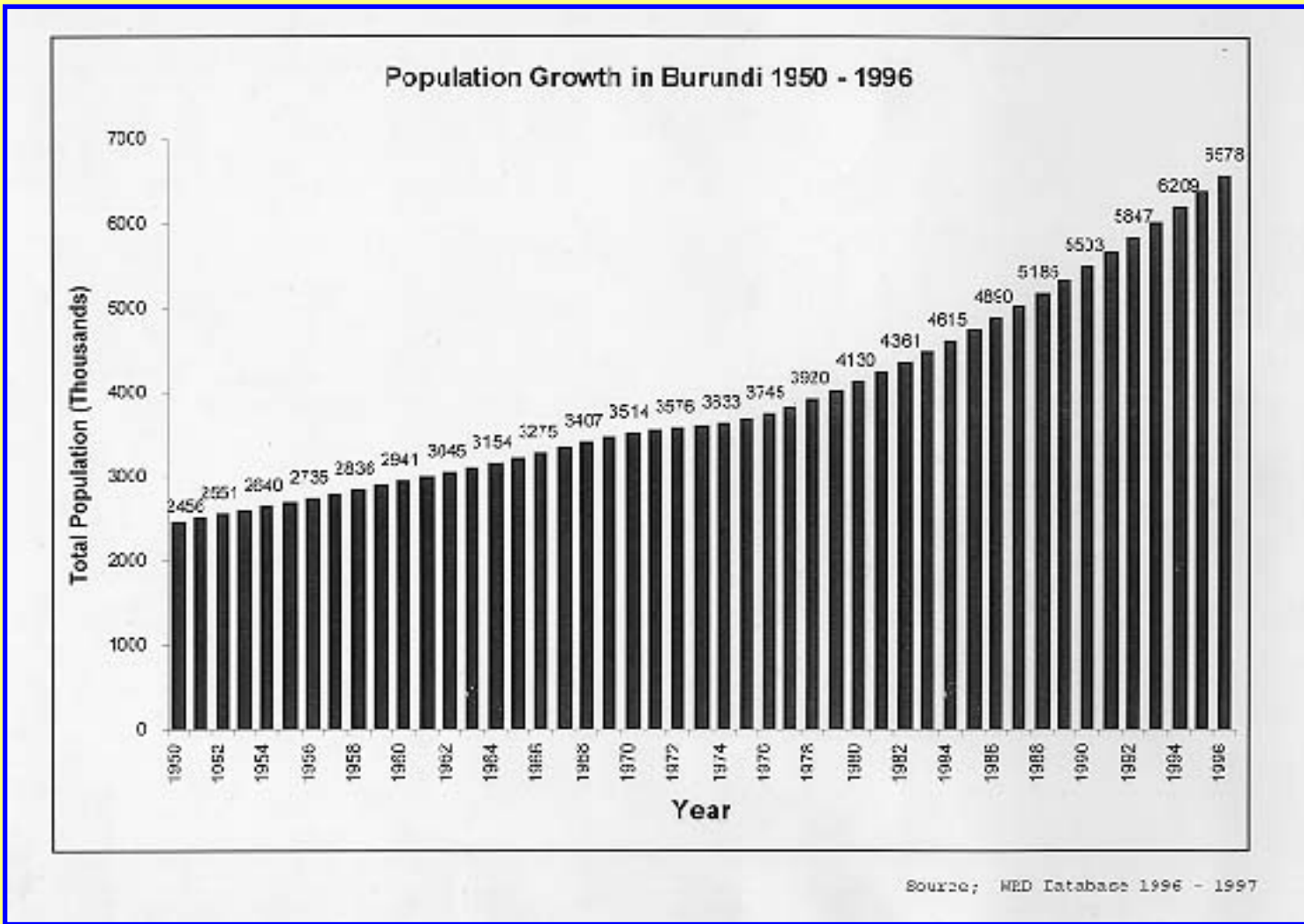


Chart Two

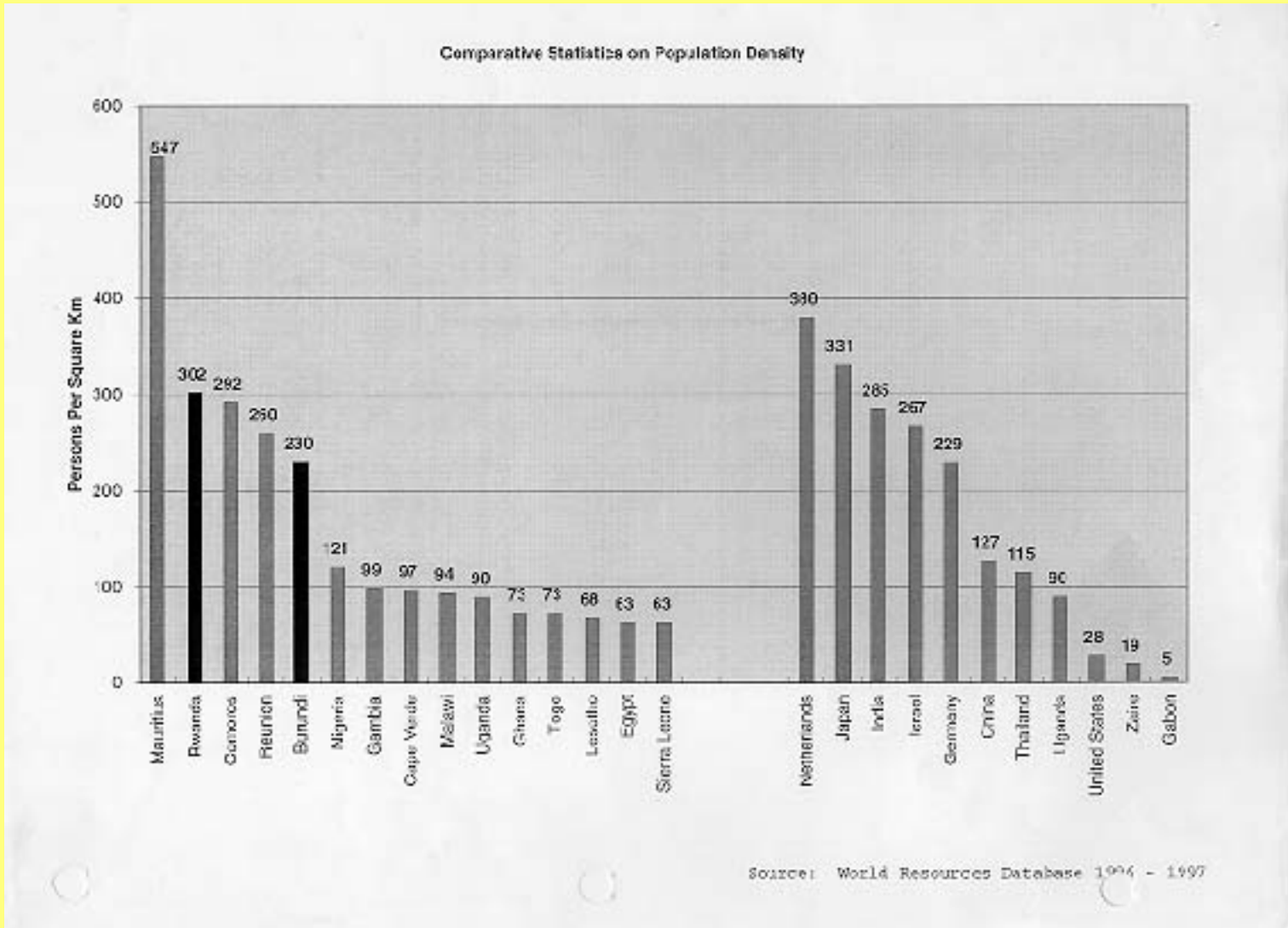
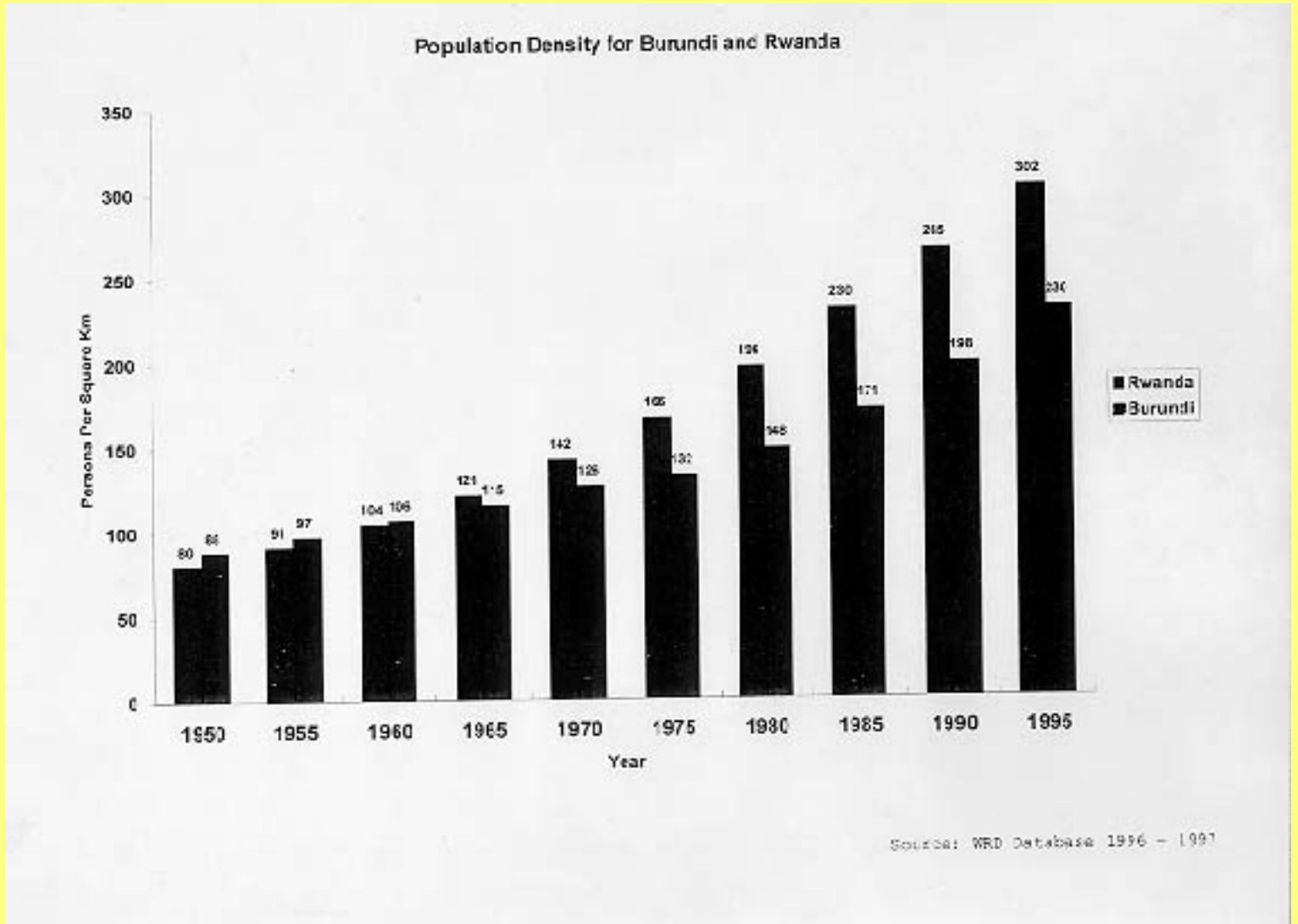
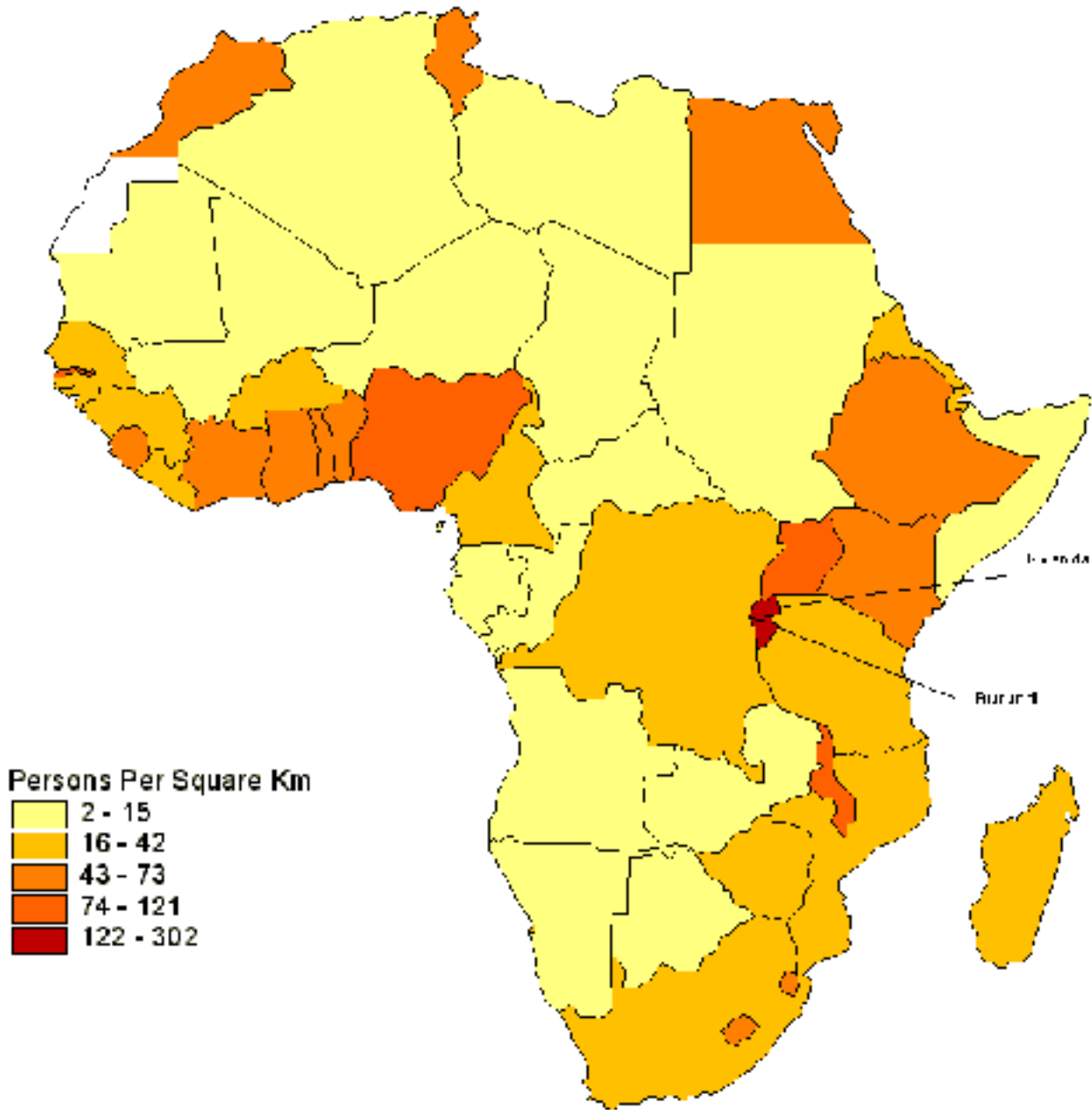


Chart Three

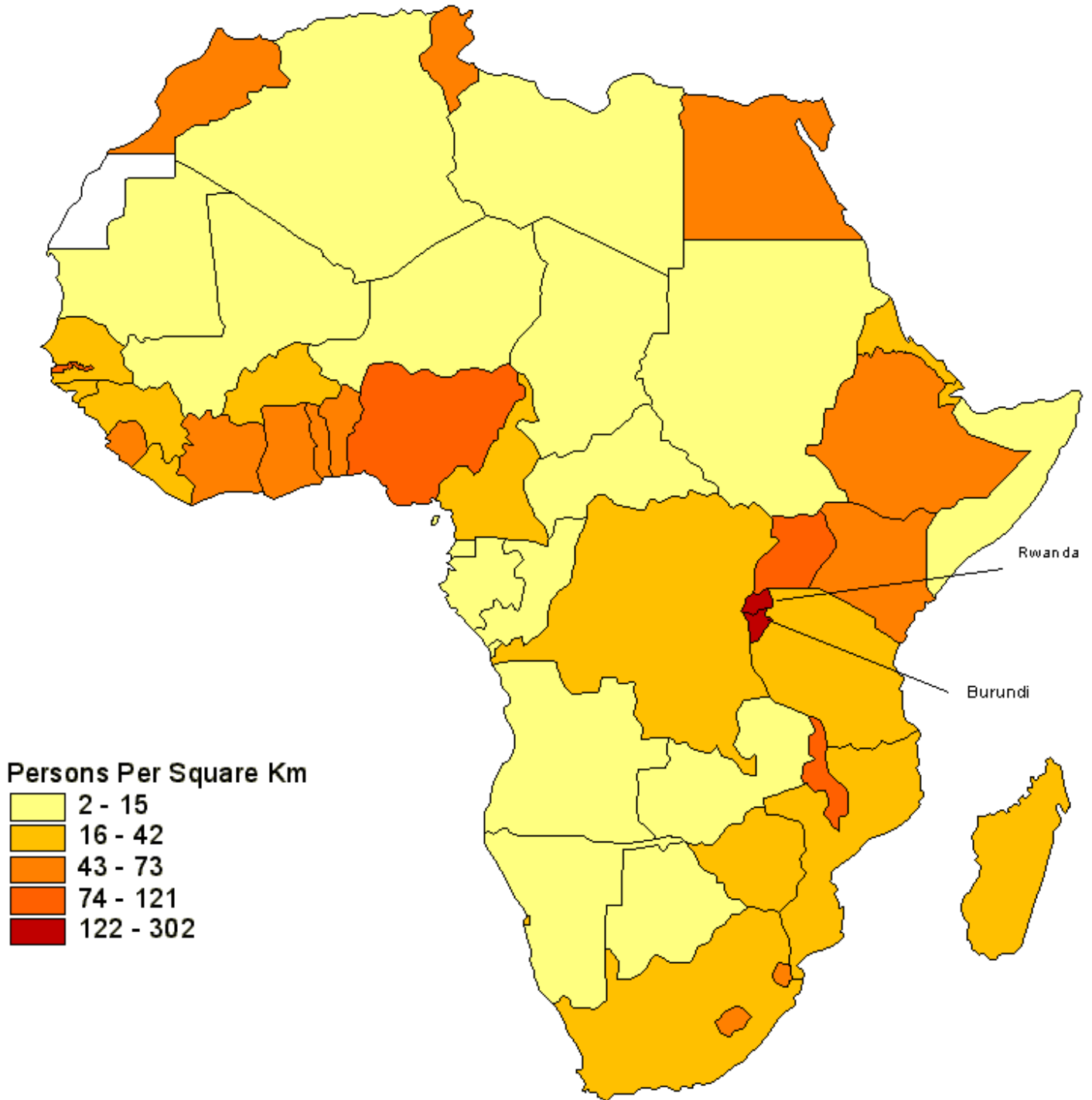


Population Density in Africa



Source: Annals, CIB, Division D.8 and The World Resources Database-1988-1987 (Data from 1985)

Population Density in Africa



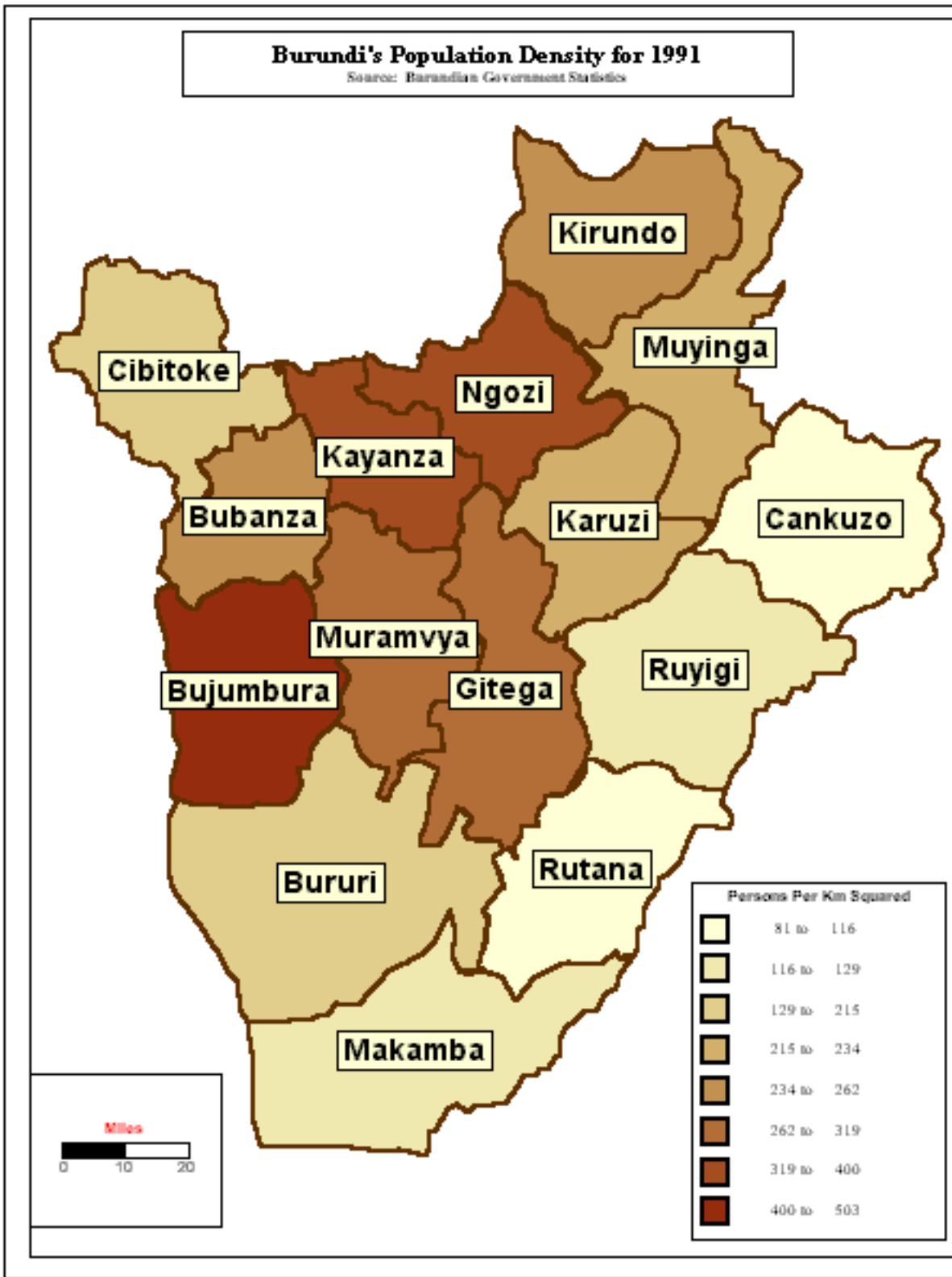
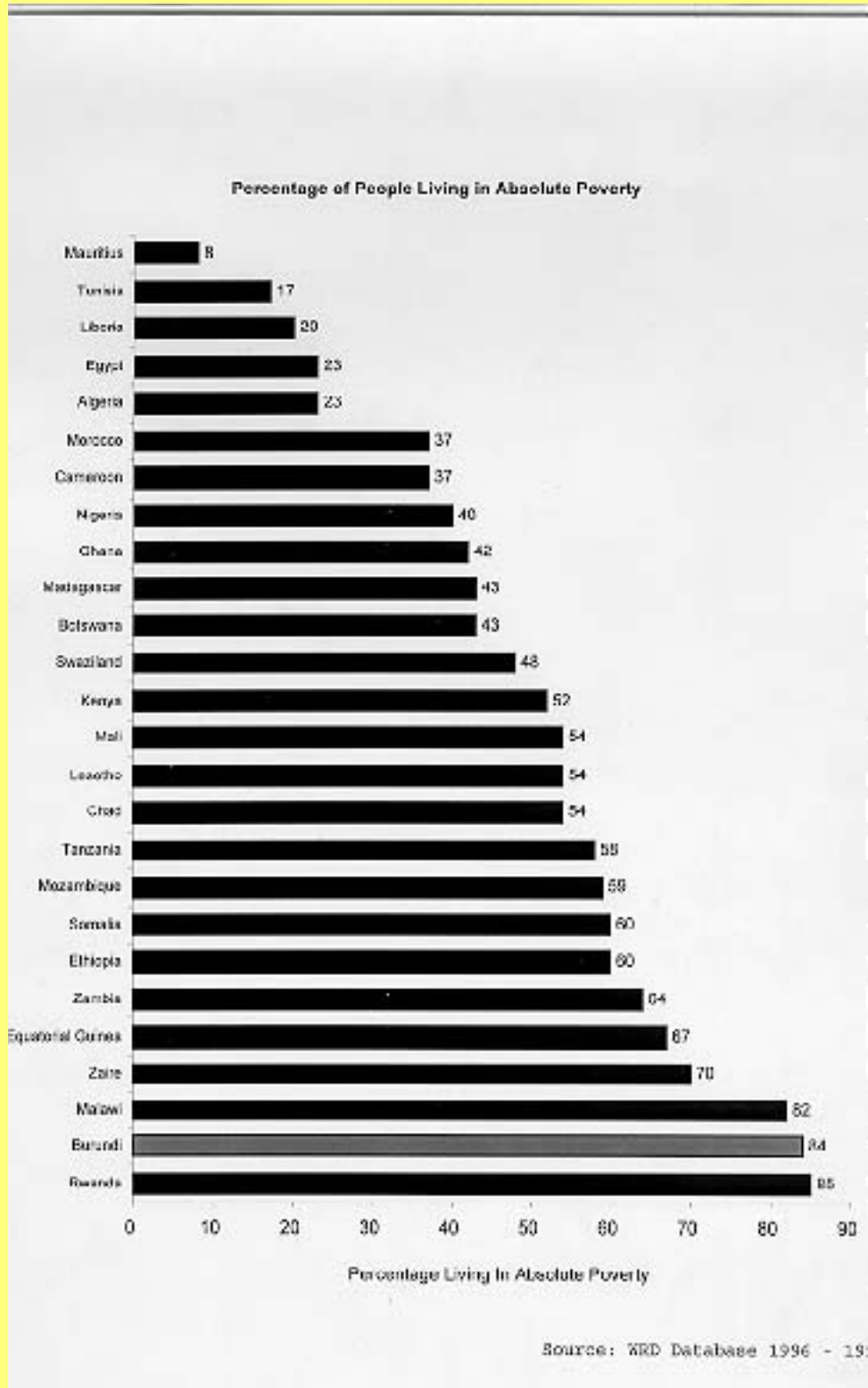


Chart Four



Major Agricultural Areas

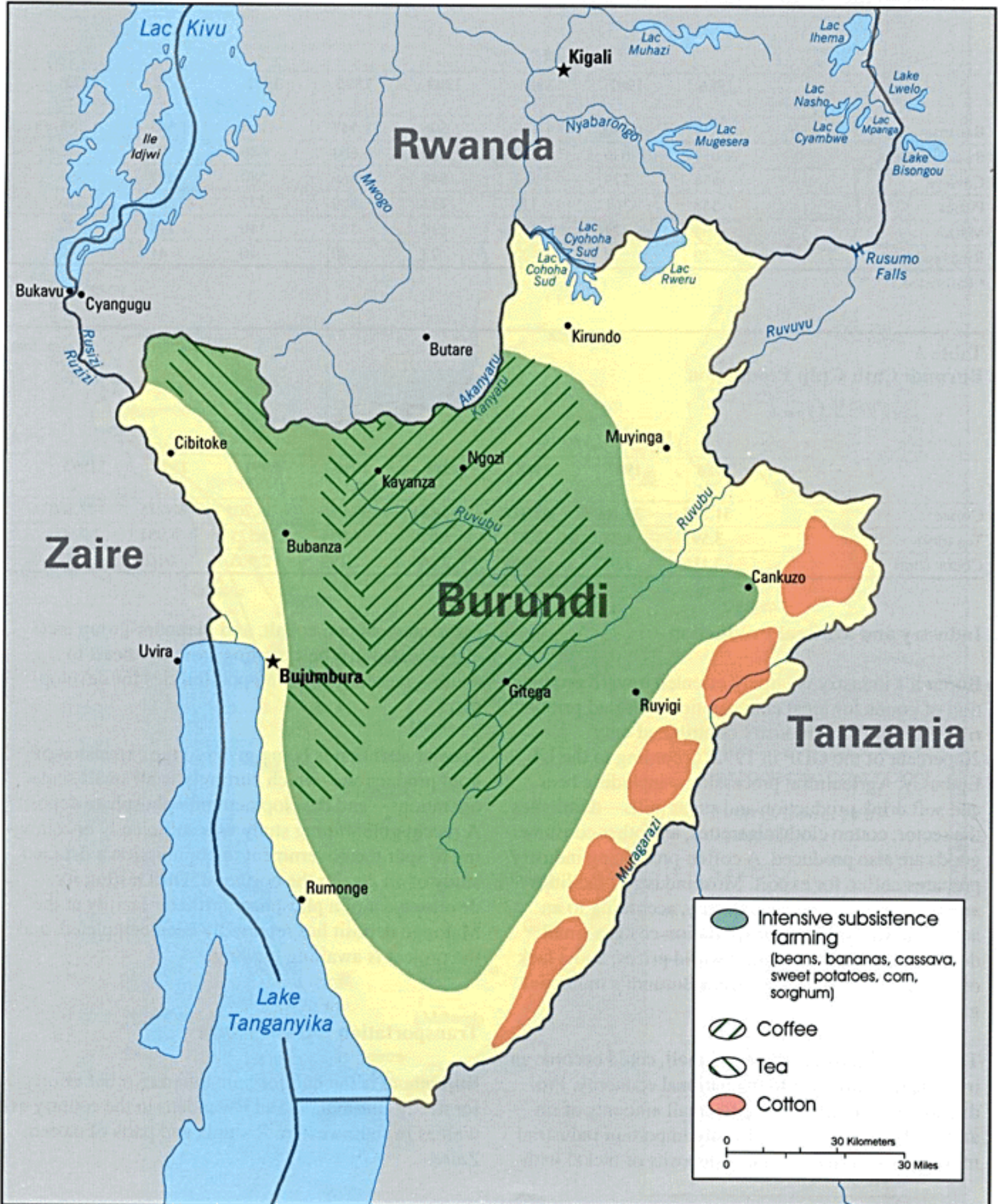


Chart Five

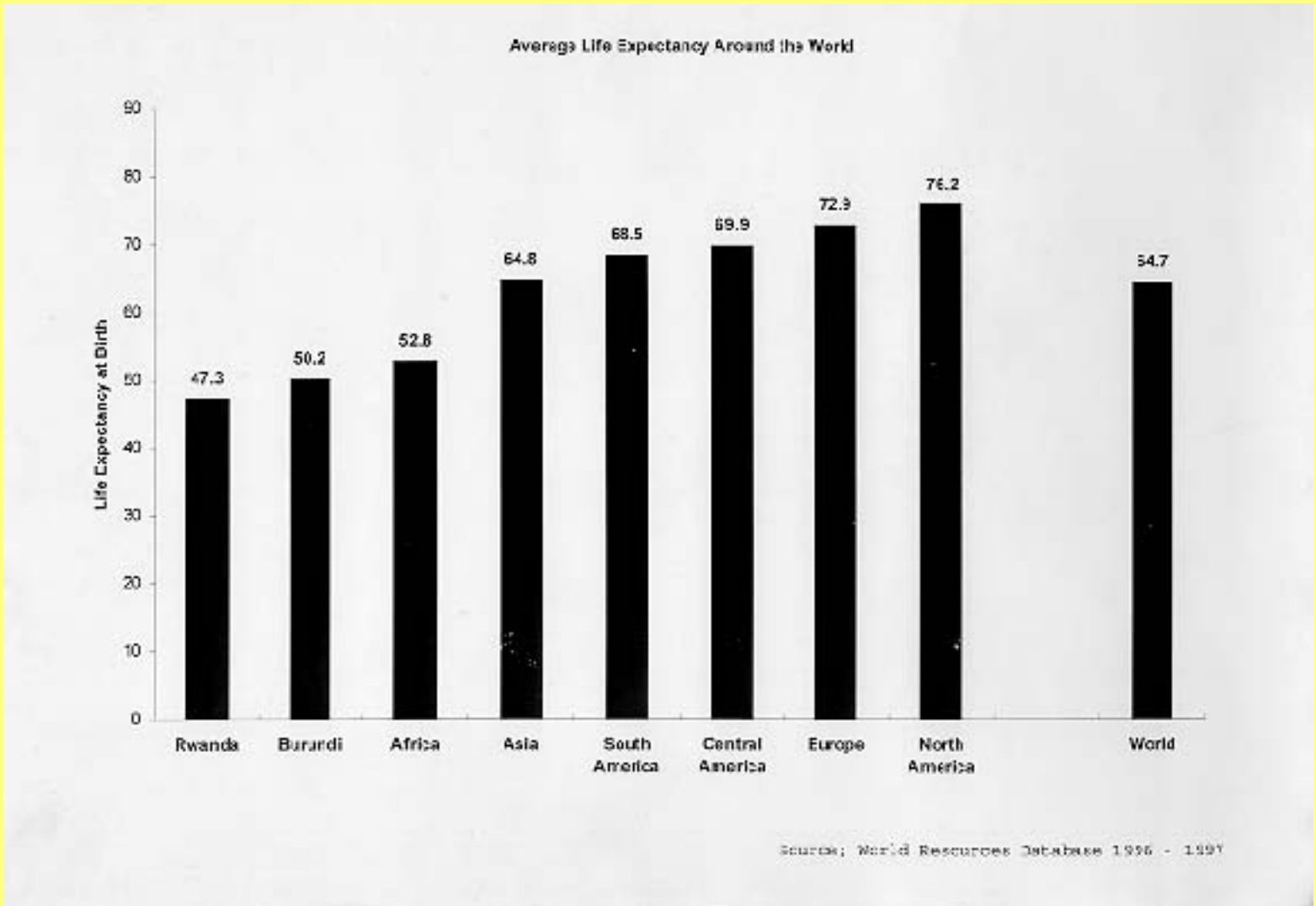
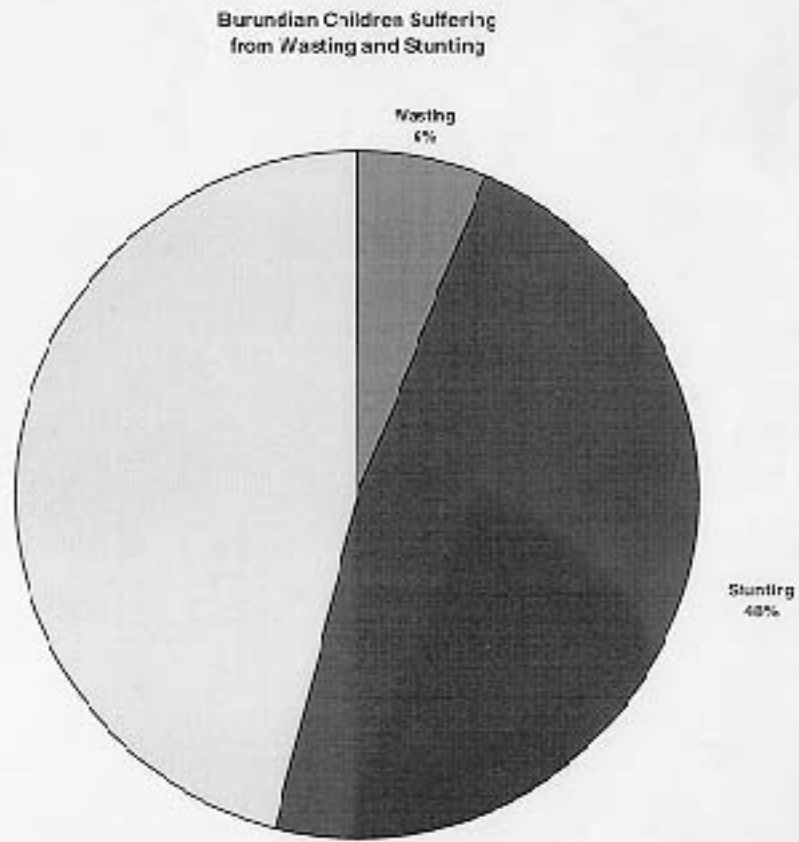
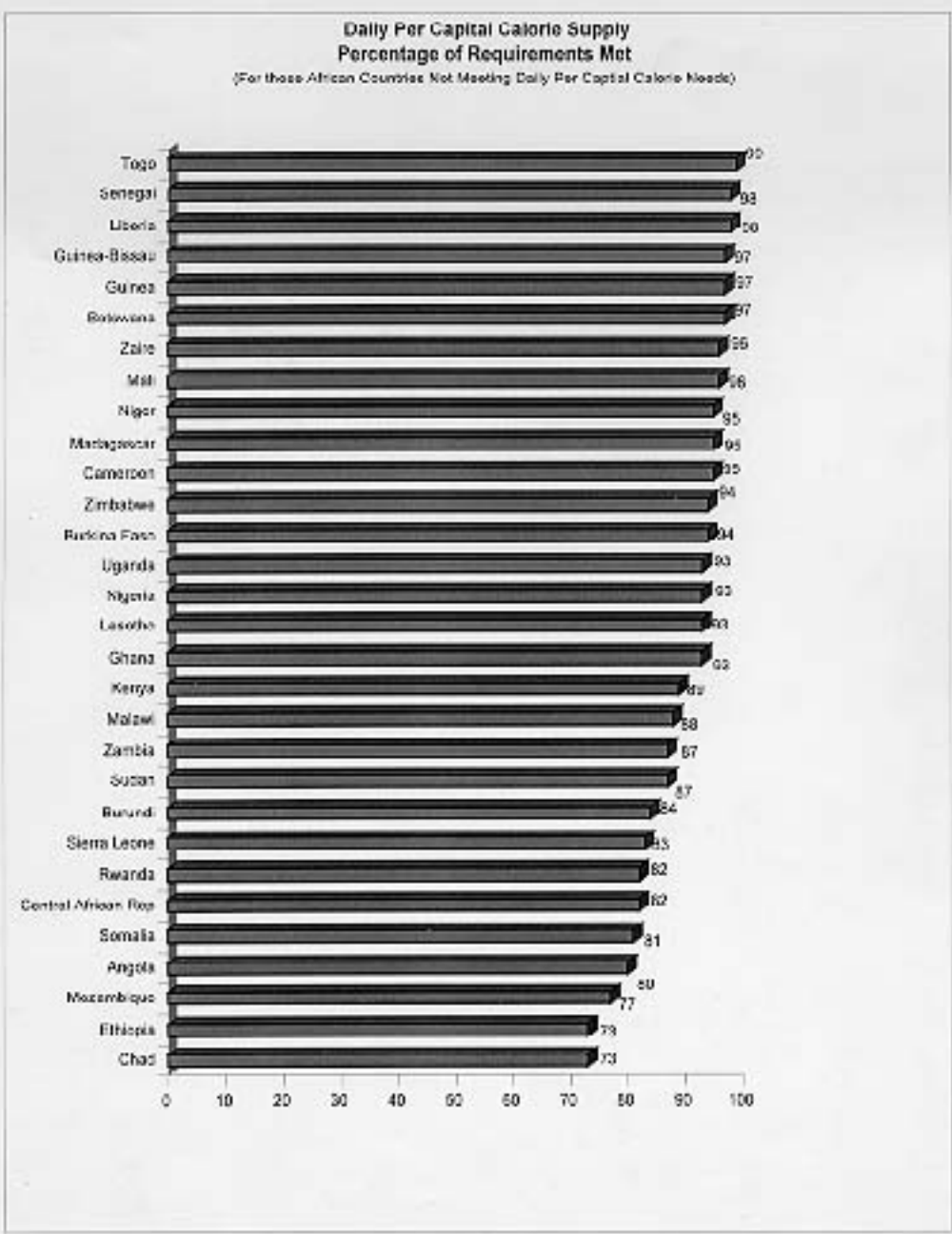


Chart Six



Source: World Resources Database 1996 - 1997
Unicef, State of the World's Children

Chart Seven



Source: World Resource Database 1003
Unicef State of the World's Children 1995

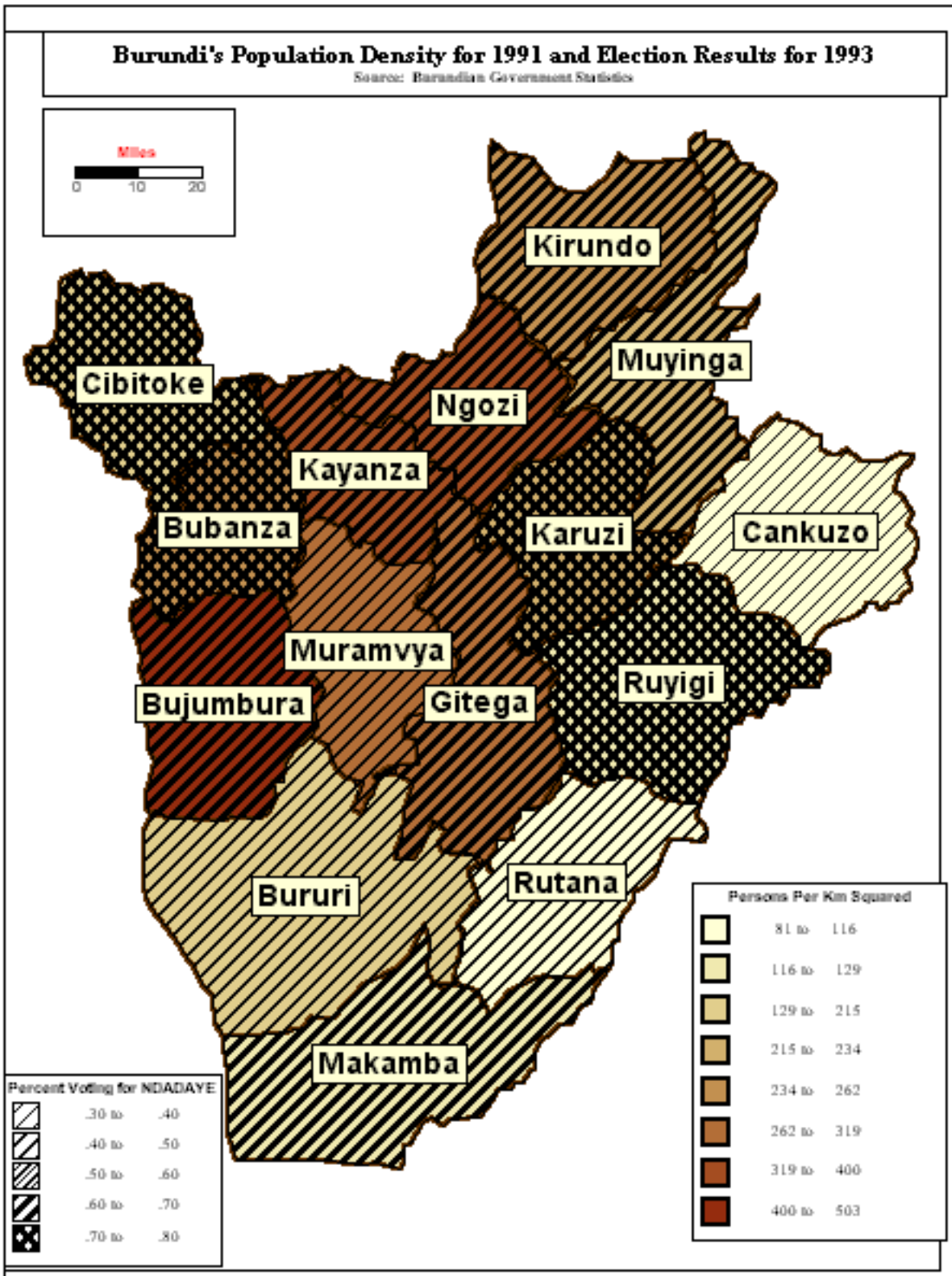
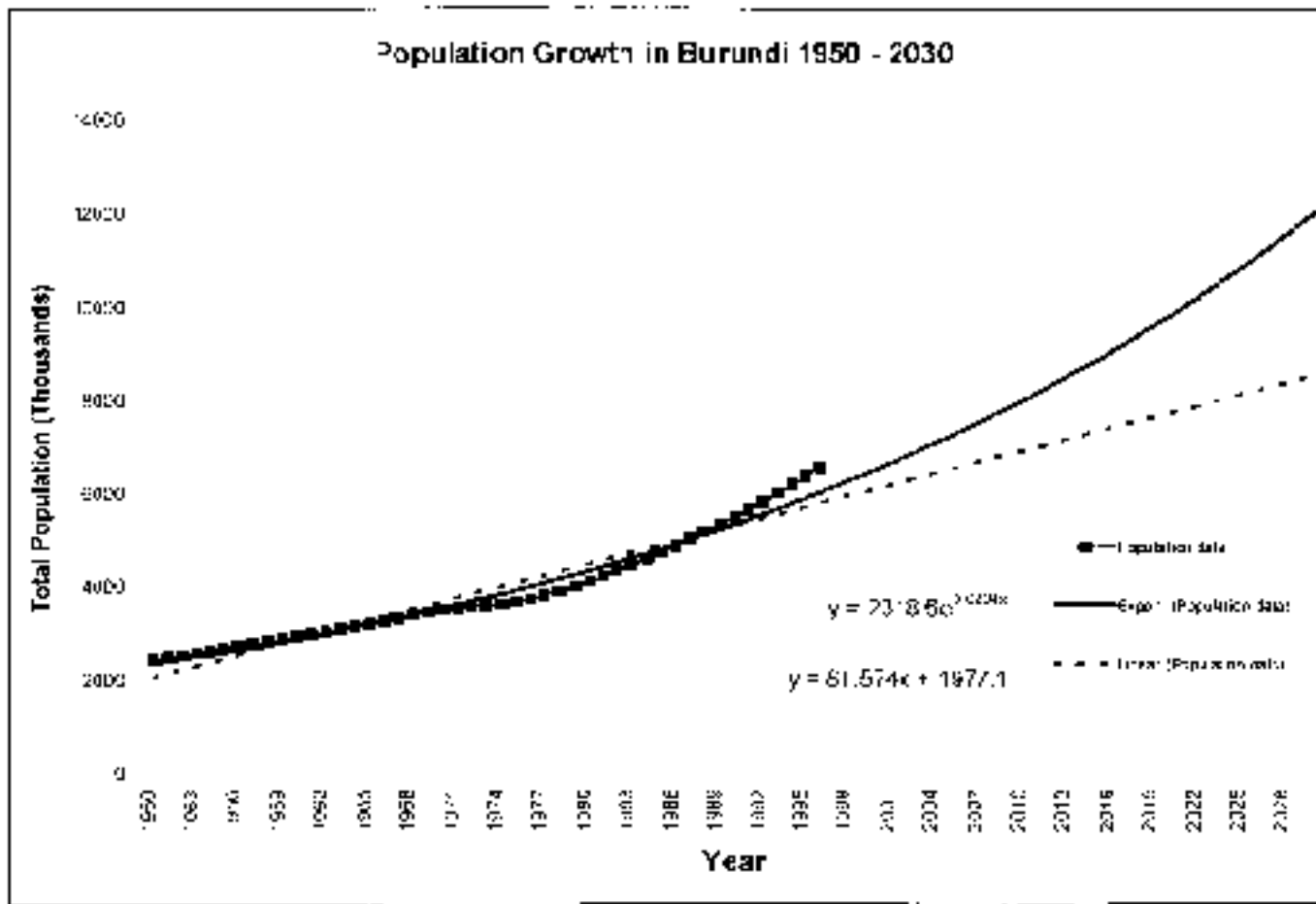


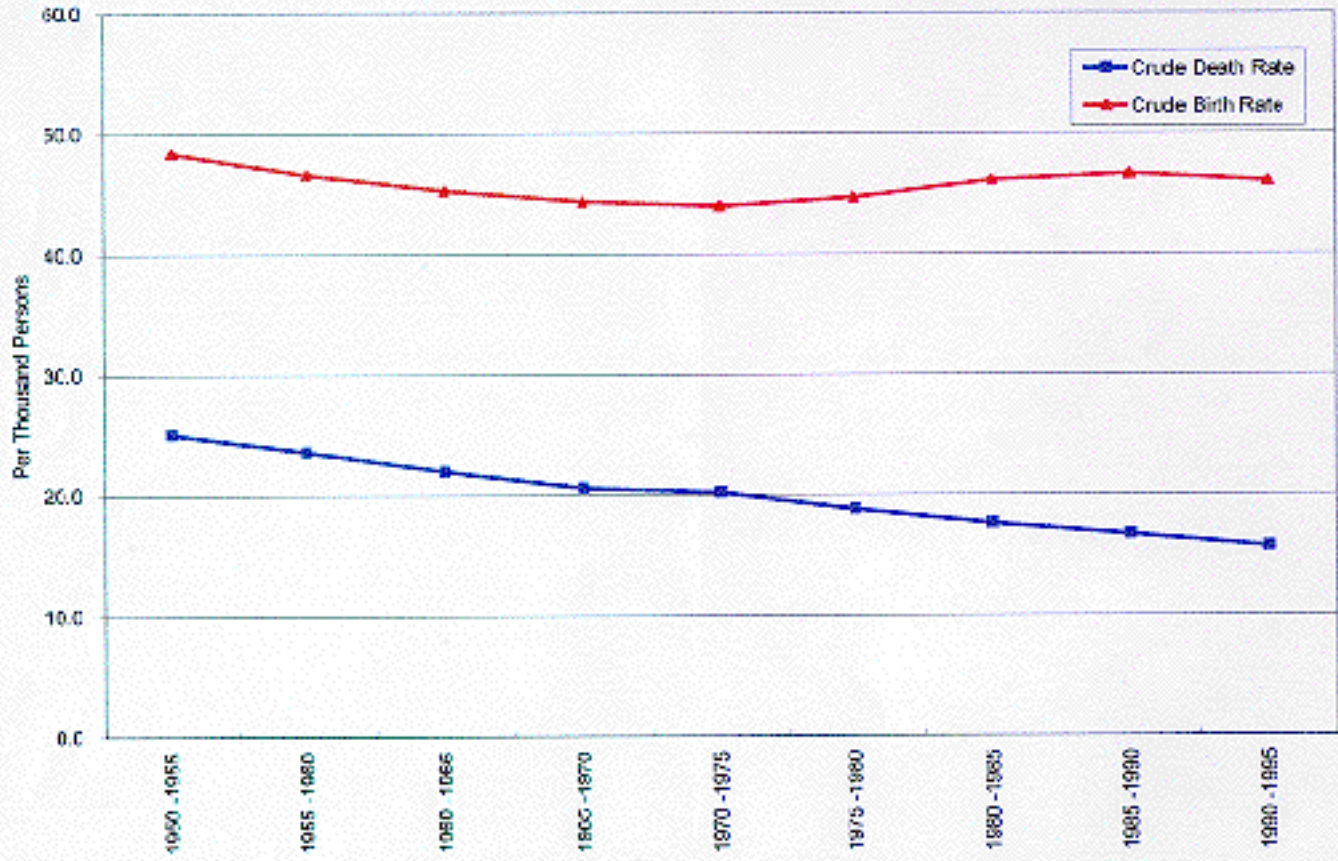
Chart Ten



Source: CIA Database with linear fitting by Shannon England

Chart Eleven

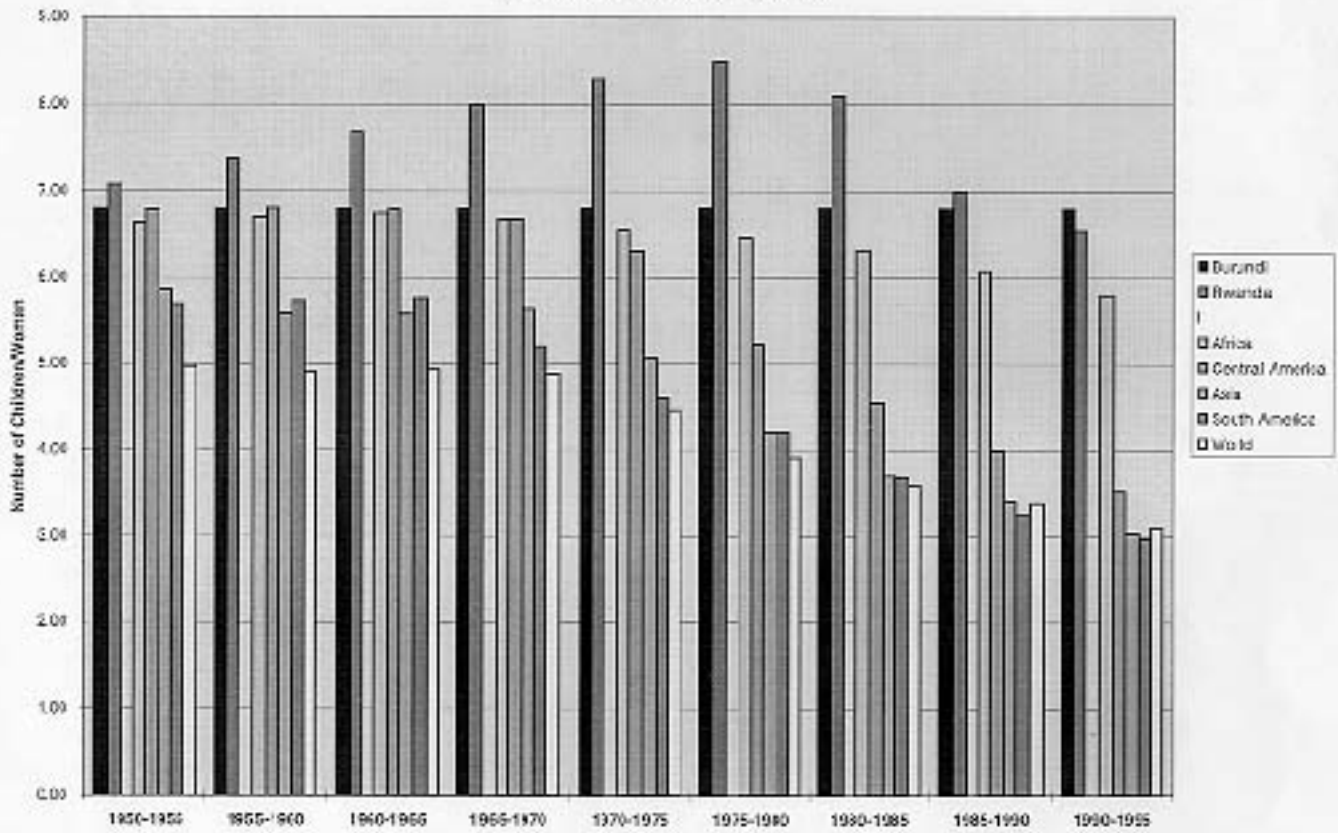
Crude Birth and Death Rates for Burundi



Source: WWD Database 1996 - 1997

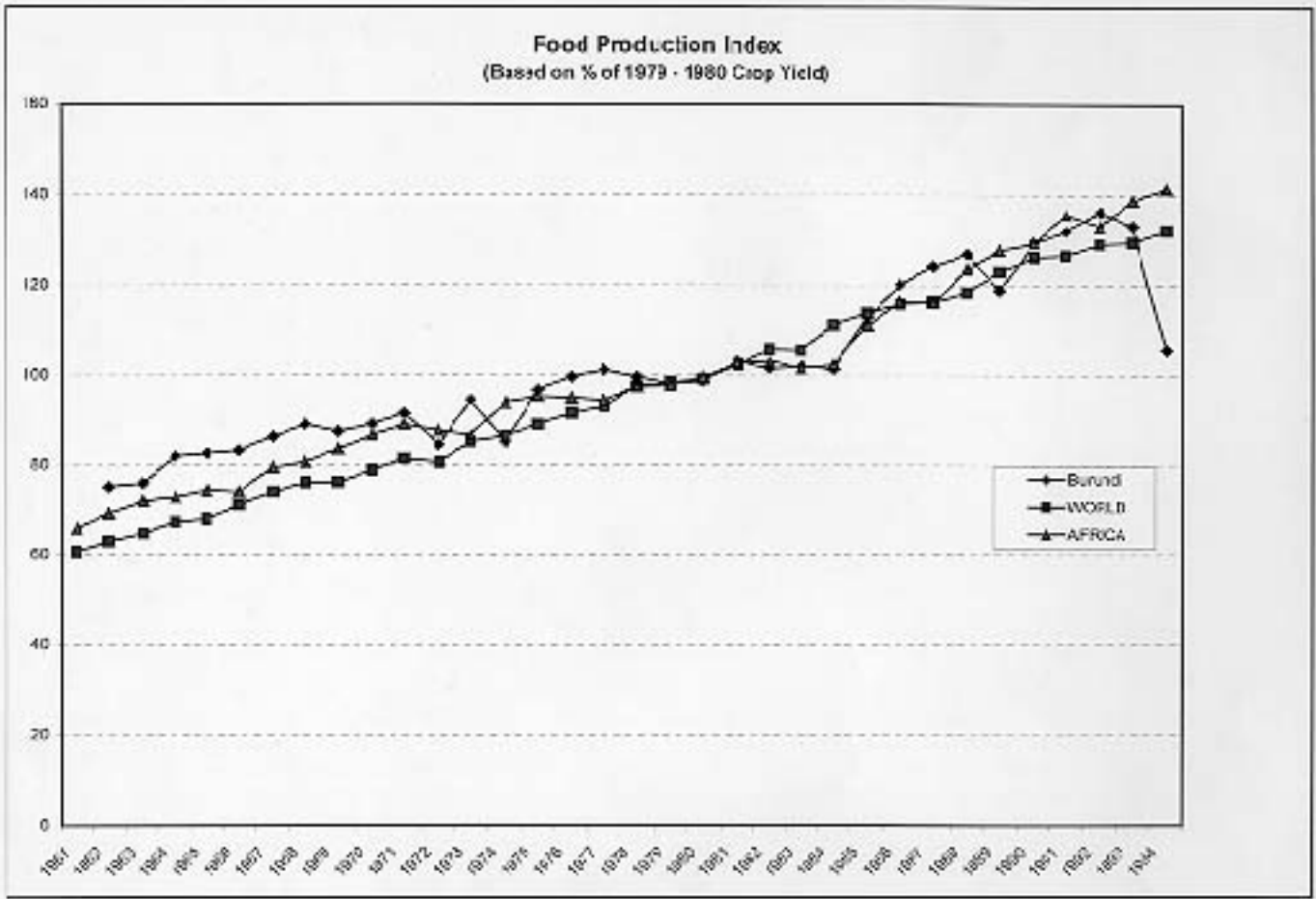
Chart Twelve

Comparing Total Fertility Rates in Burundi & Rwanda
With Developing World, 1950-1995



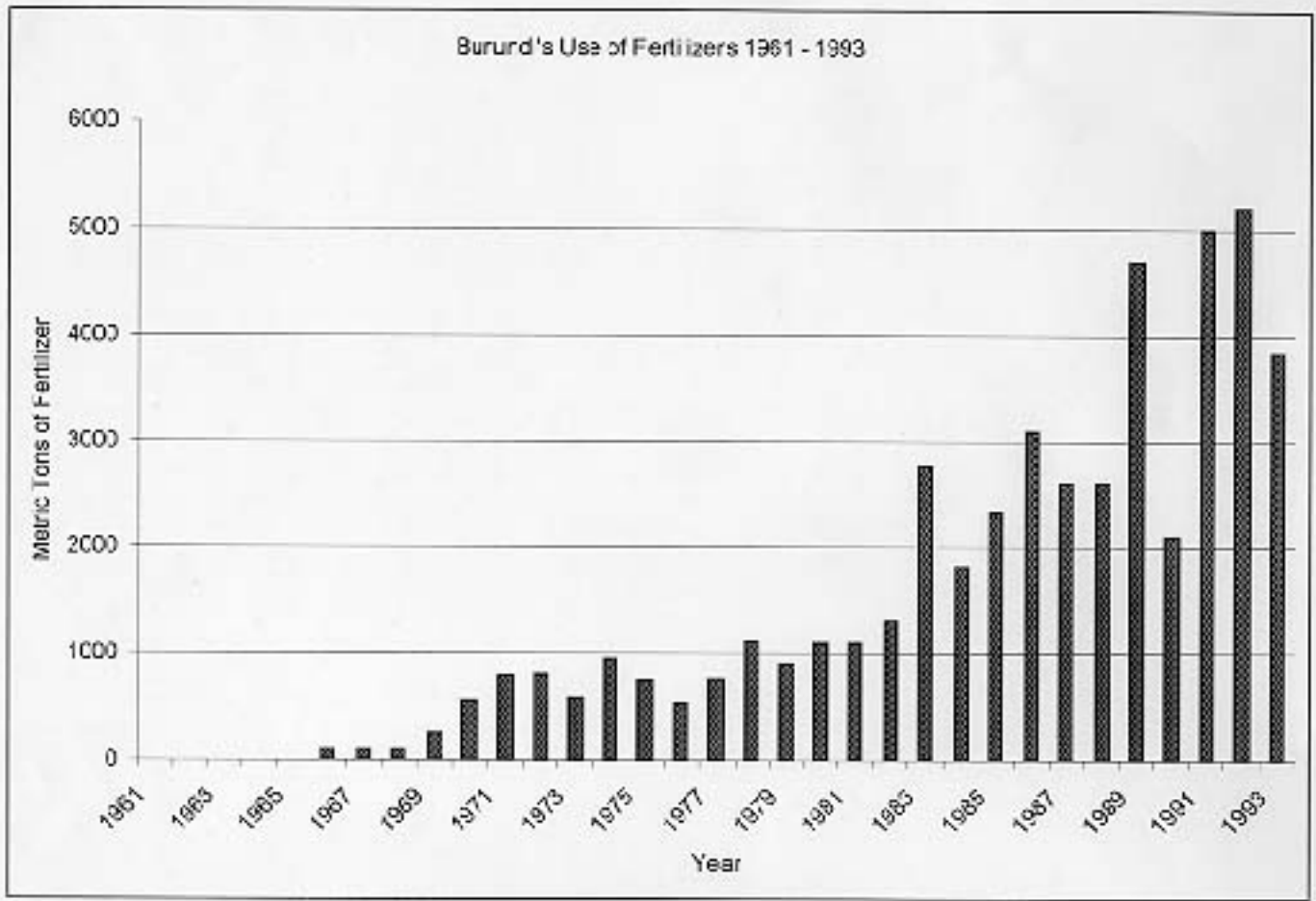
Source: World Resource Database 1995 - 1997

Chart Thirteen



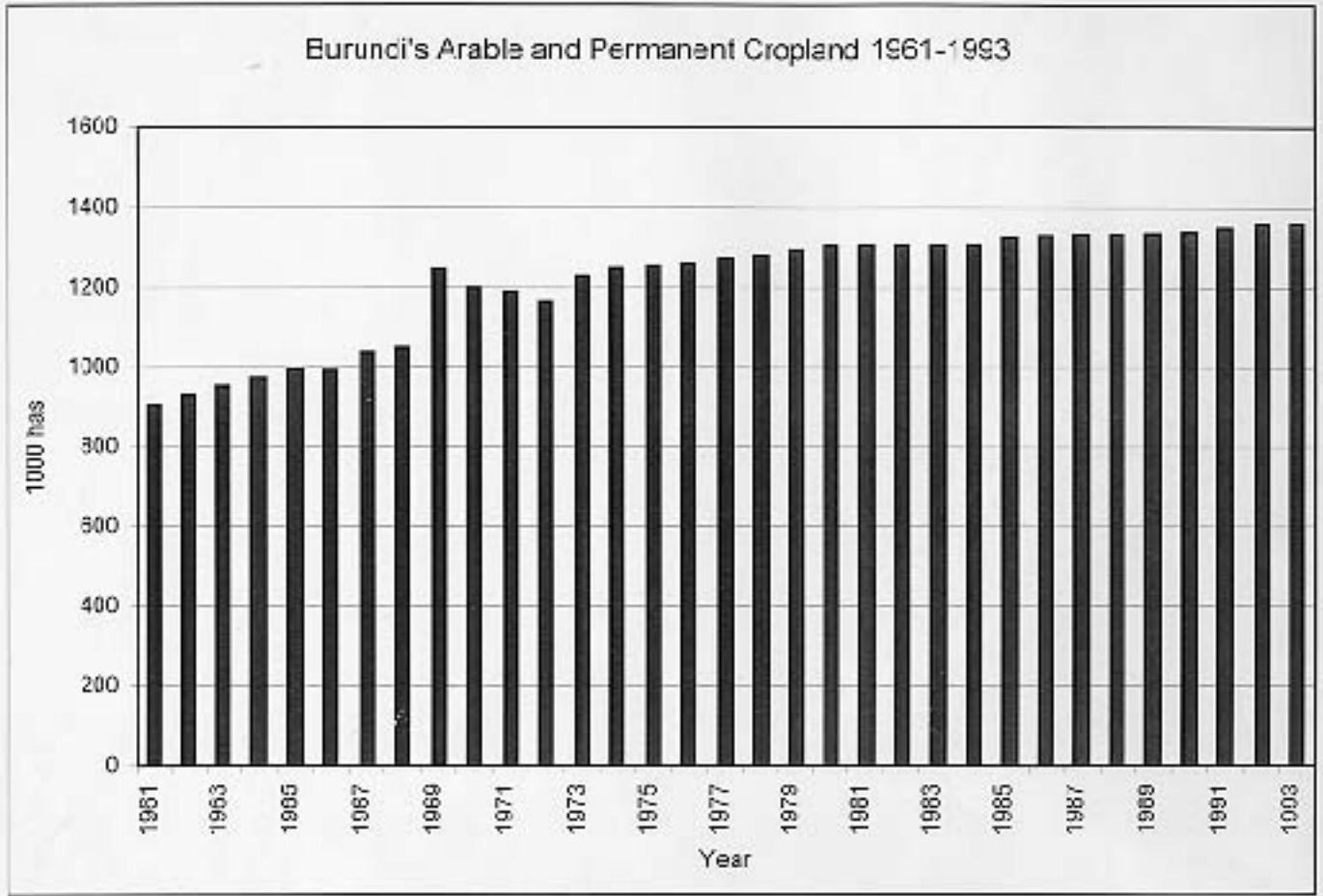
Source: YRD Database 1996 - 1997

Chart Fourteen



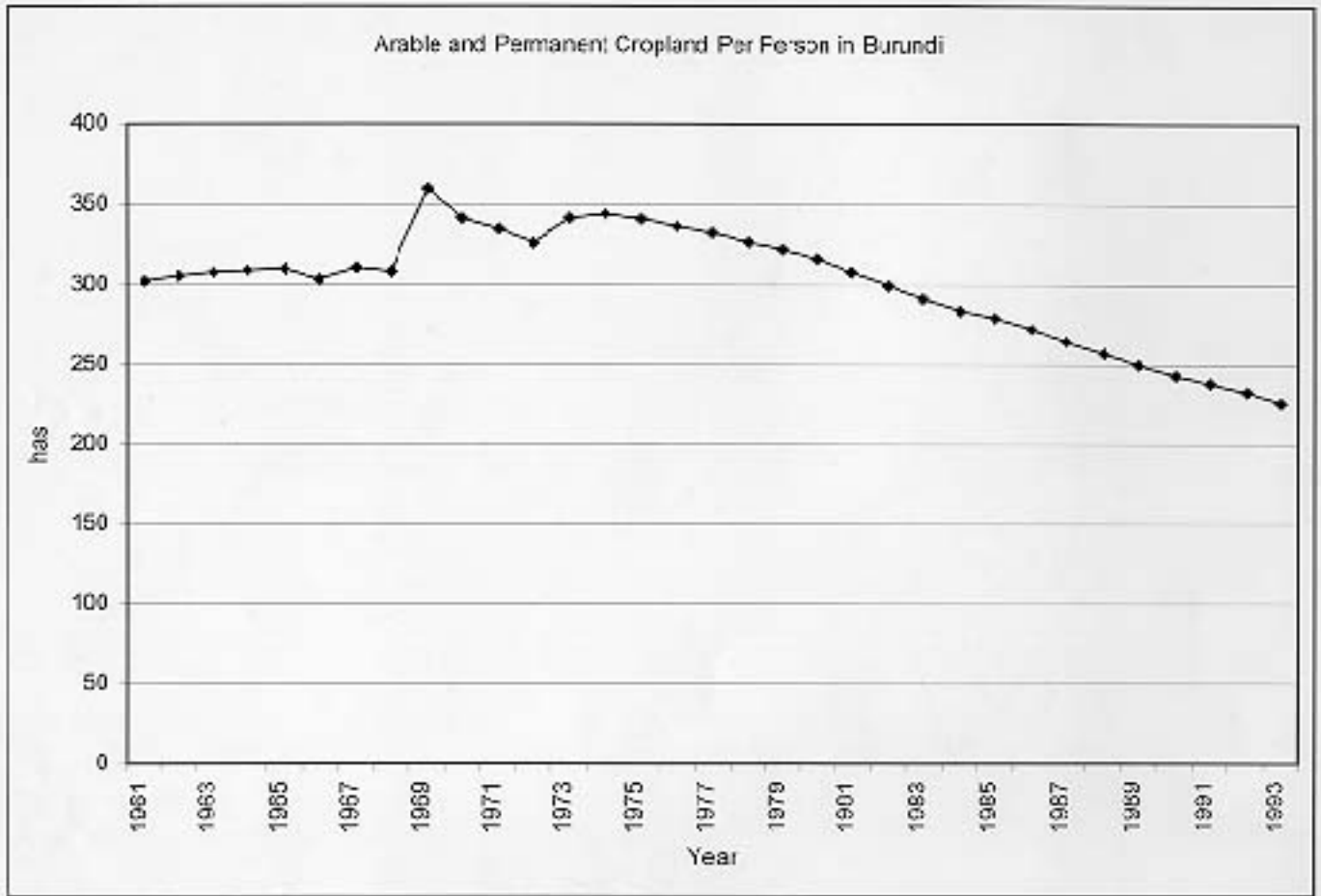
Source: WRD Data base 1995 - 1996

Chart Fifteen



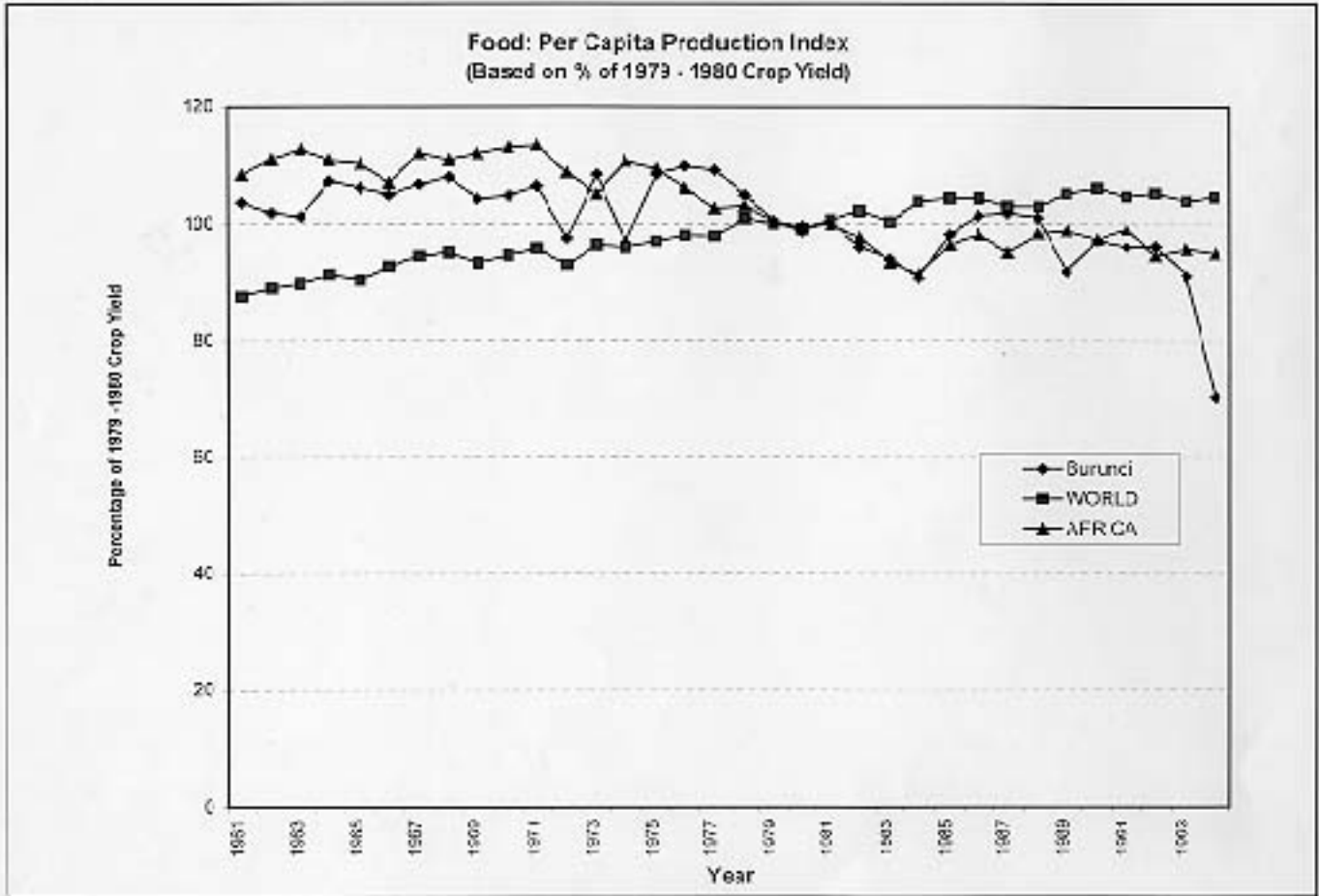
Source: WFD Database 1996 - 1997

Chart Sixteen



Source: WRD Database 1996 - 1997

Chart Seventeen



Source: WED Database 1996 - 1997.

Chart Eighteen

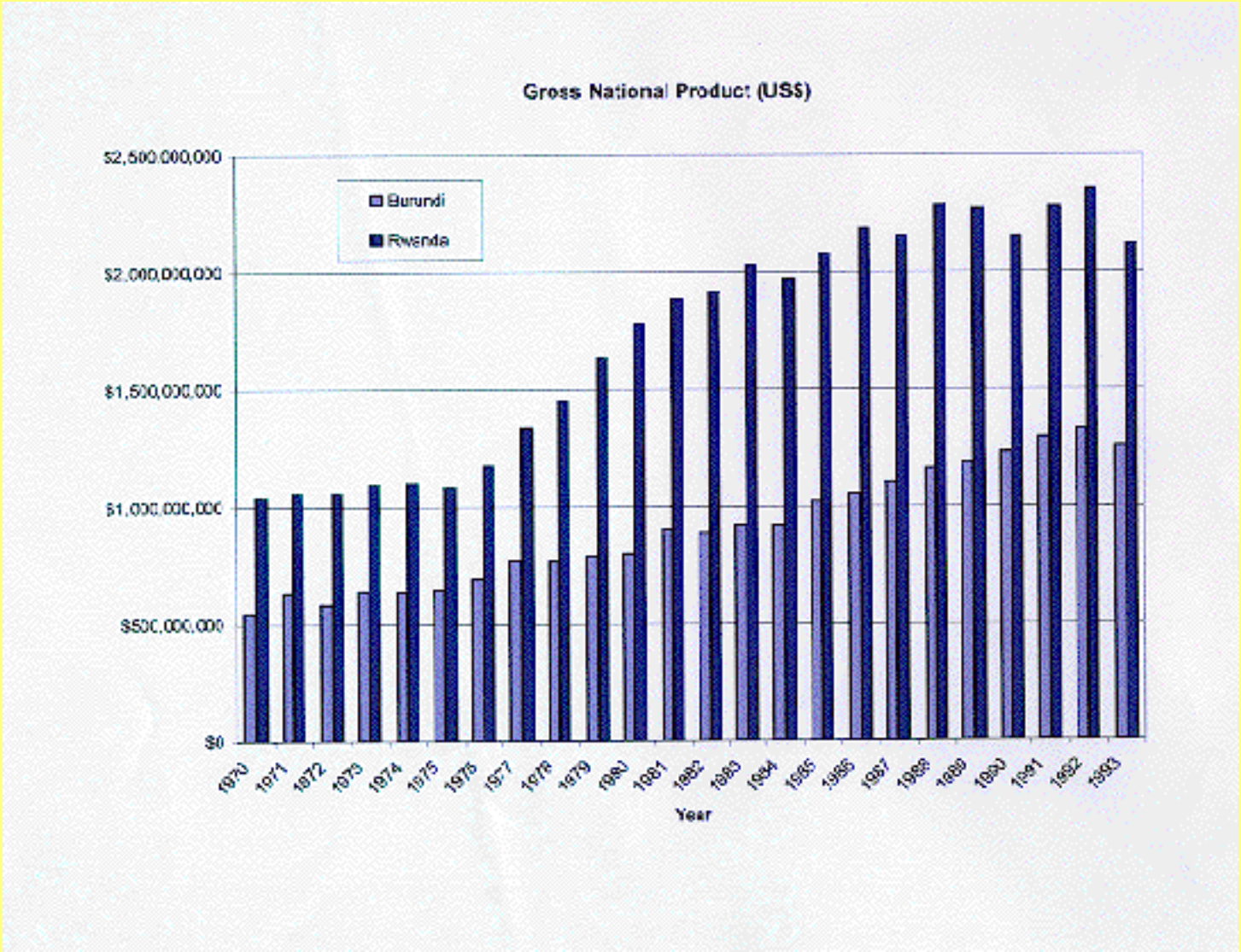


Chart Nineteen

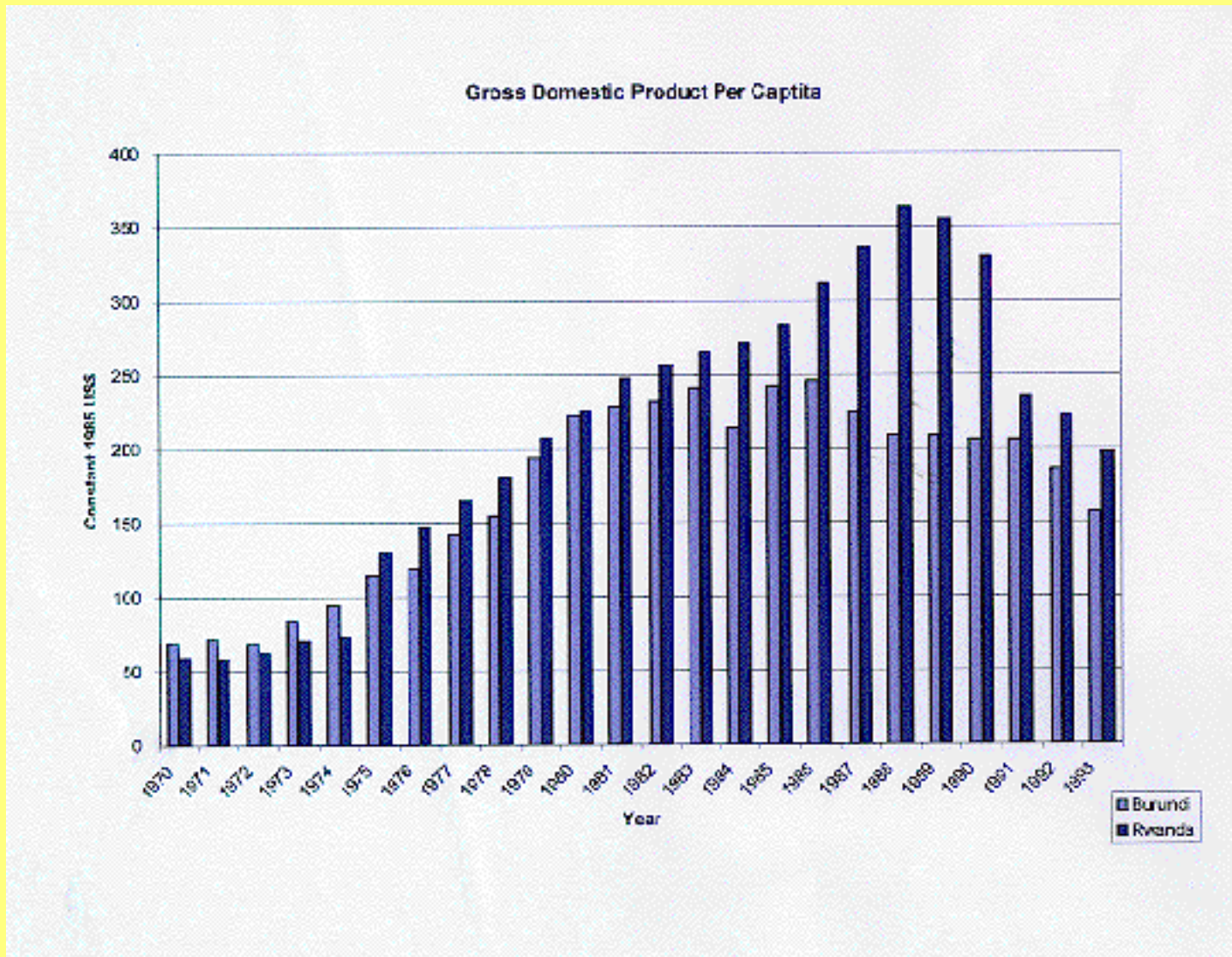


Chart Twenty

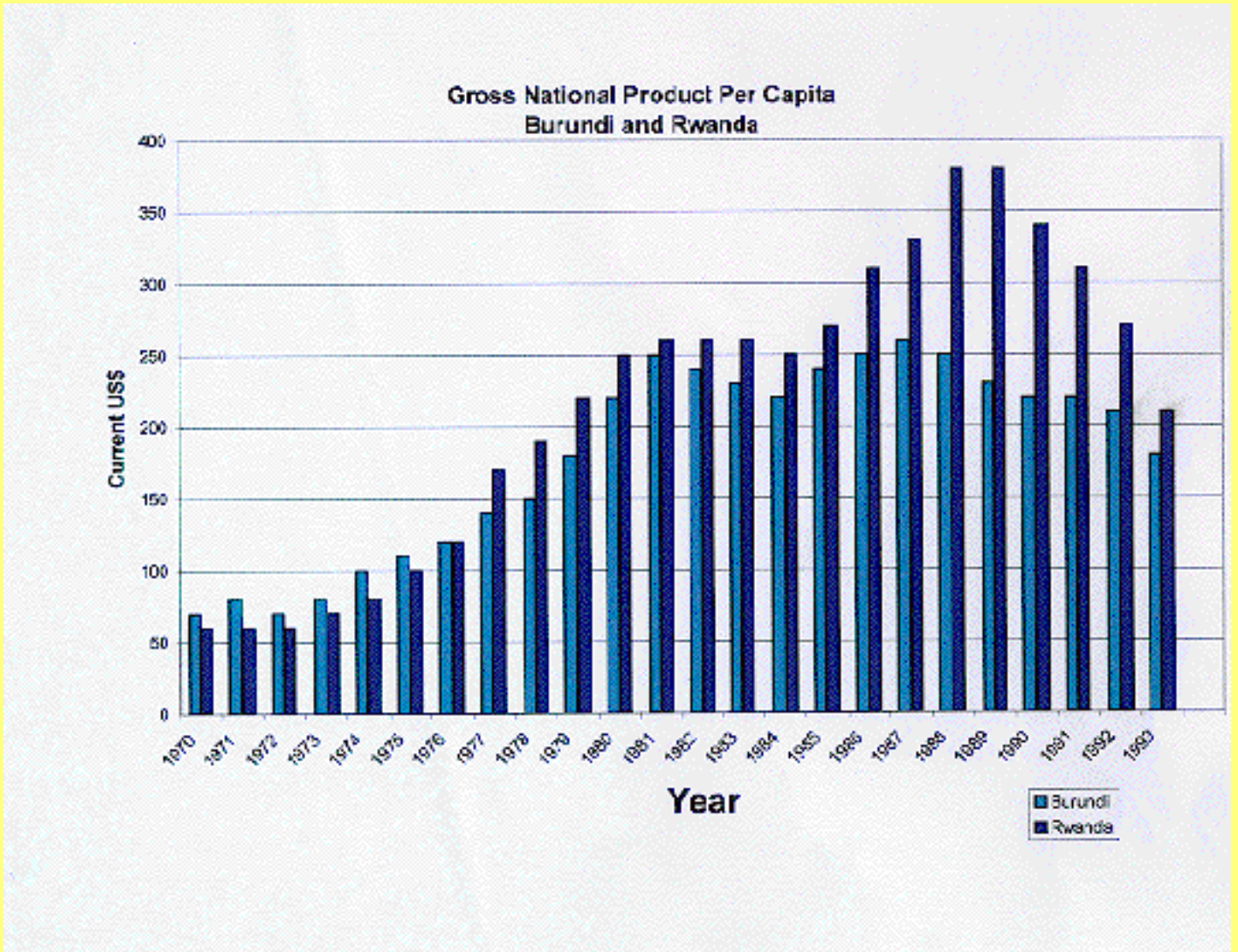
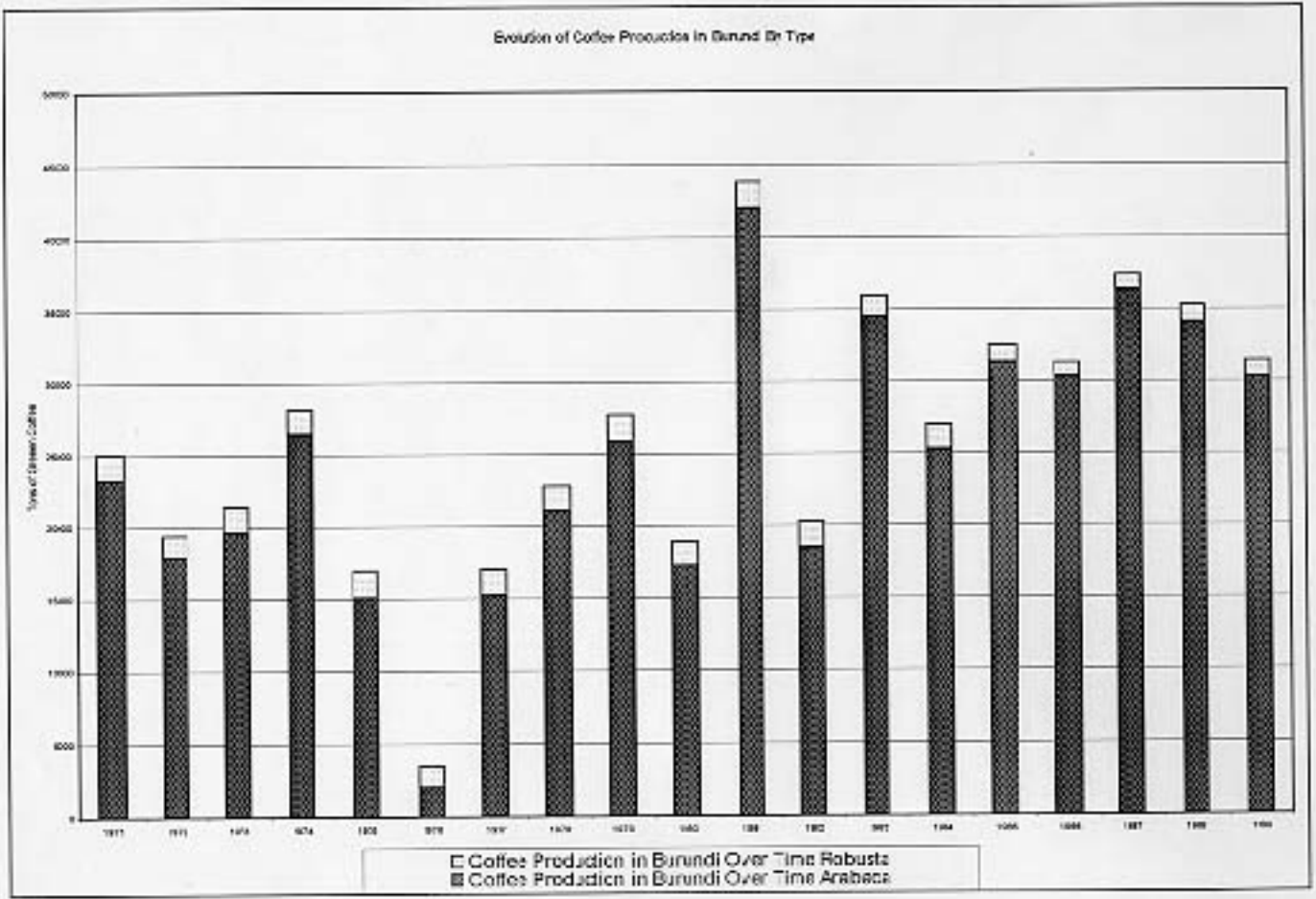
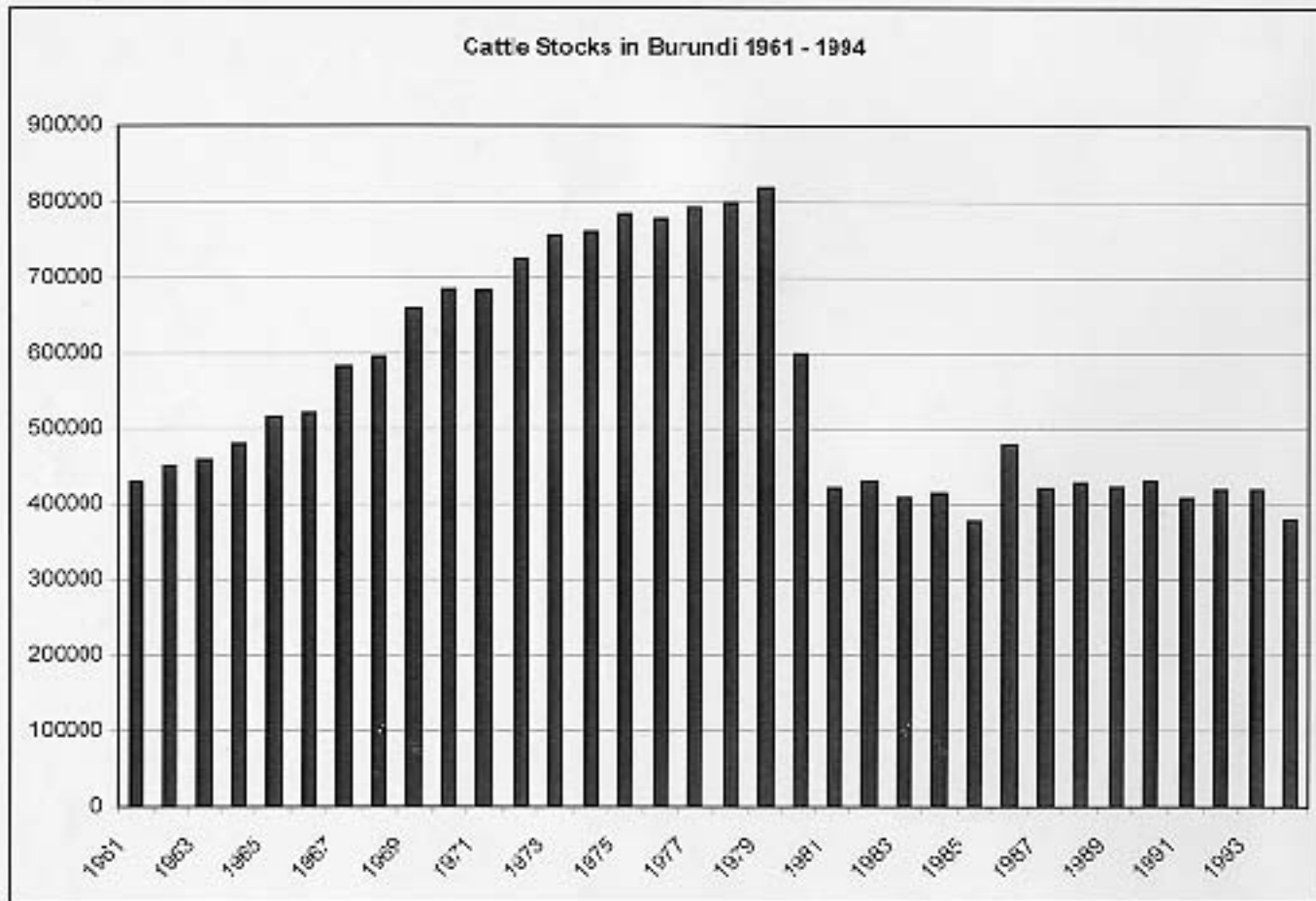


Chart Twenty-One



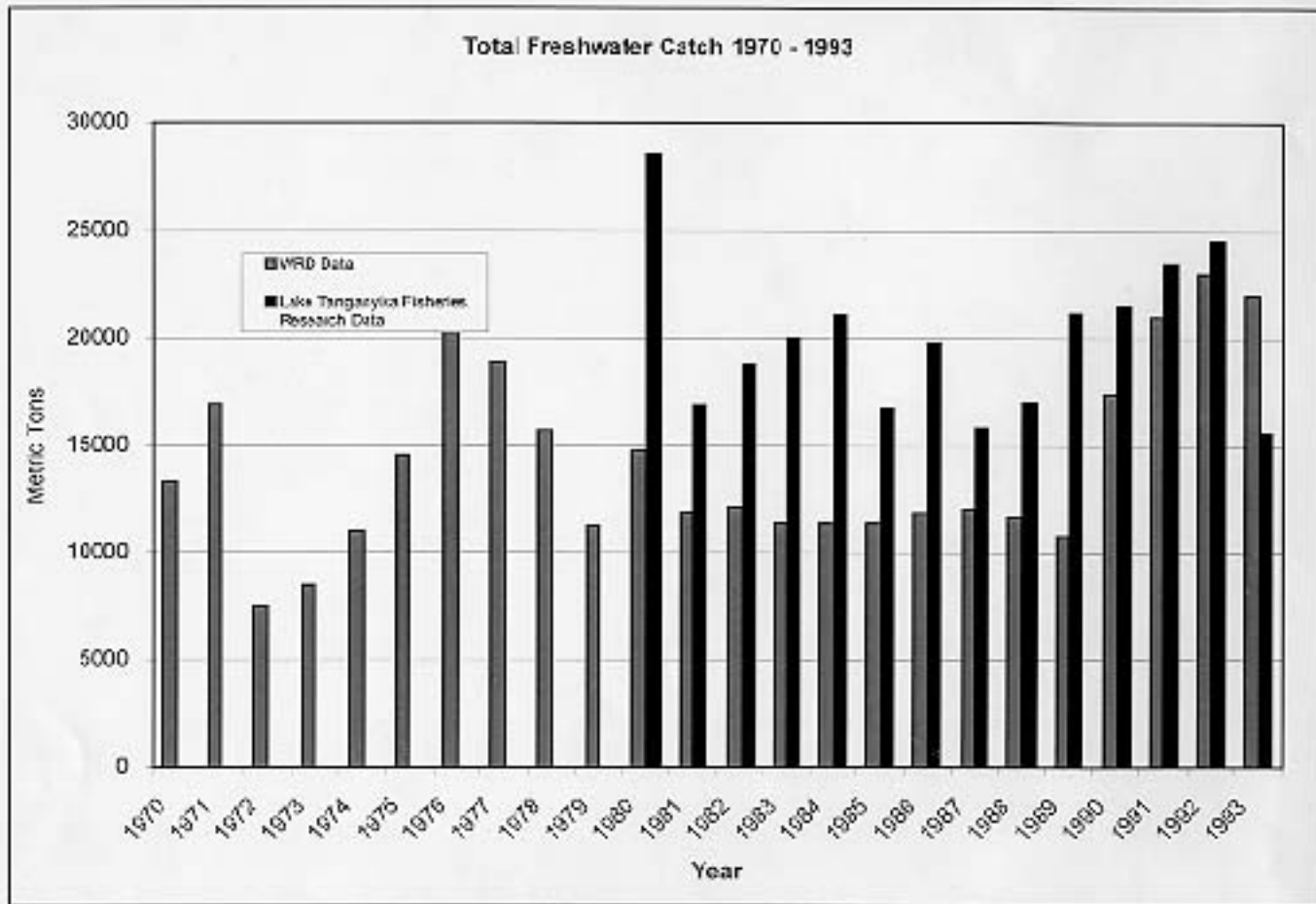
Source: Burundian Government Statistics, 1988

Chart Twenty-Two



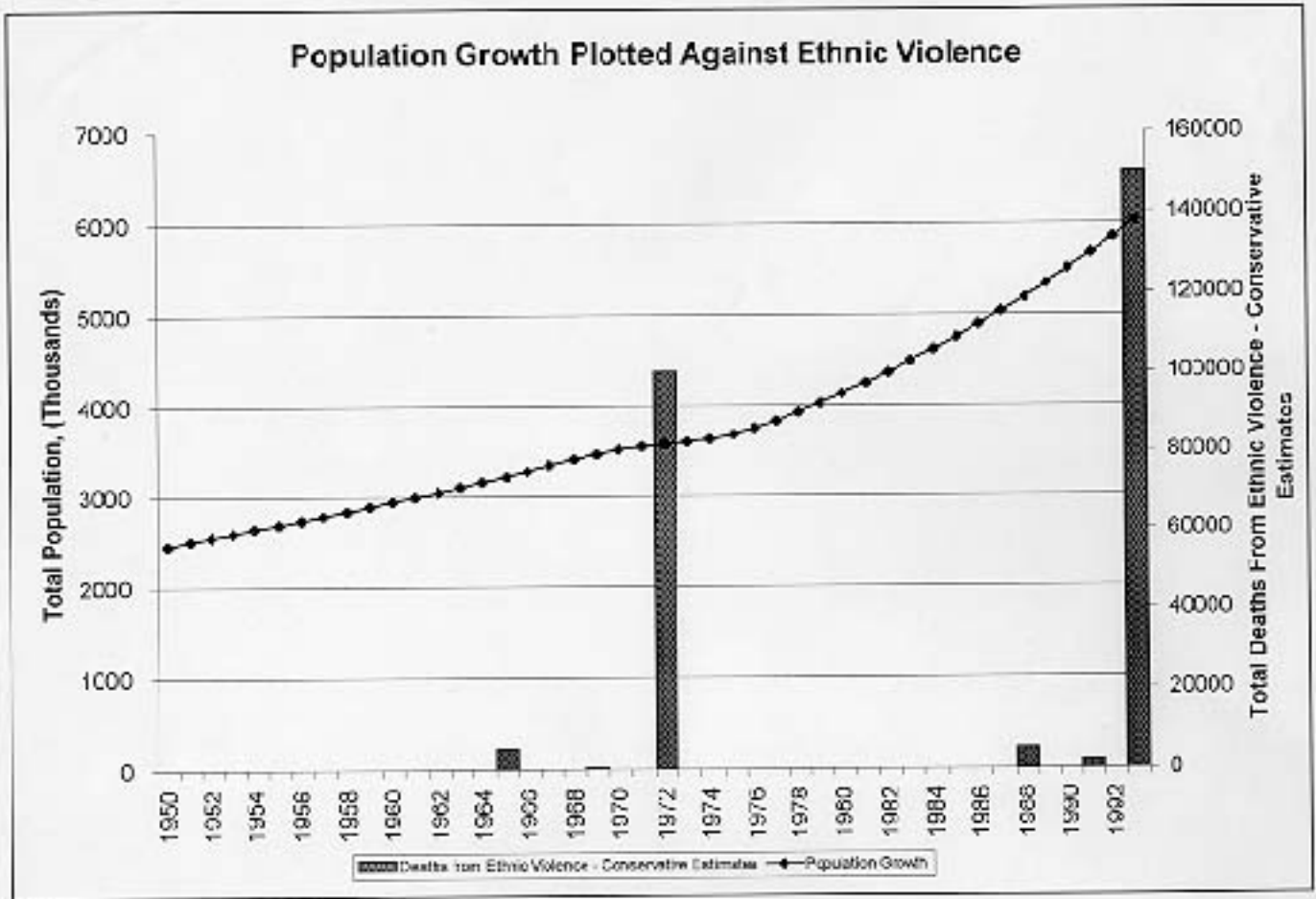
Source: NCD Database 1966 - 1997

Chart Twenty-Three



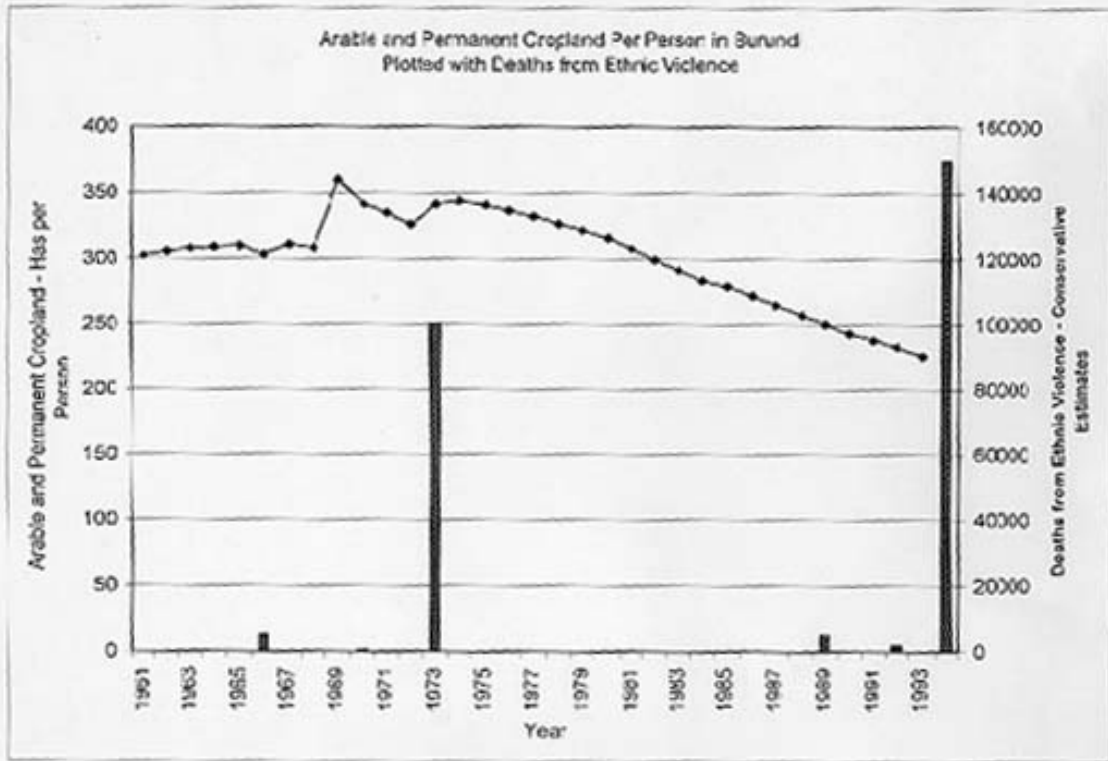
Source: Lake Tanganyika Fisheries Research. Bujumbura, Burundi. WVRD Database 1996 - 1997

Chart Twenty-Four



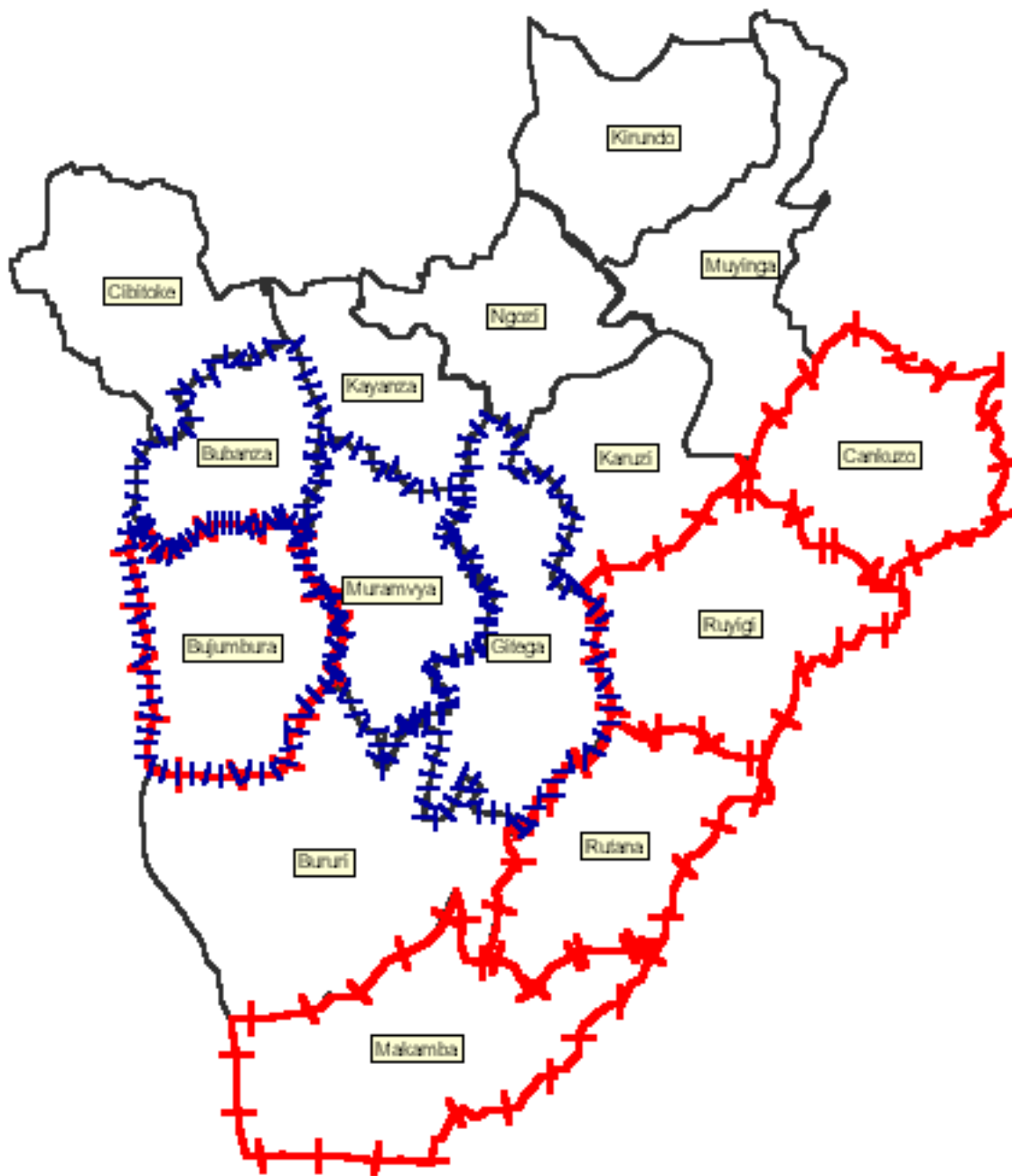
Source: USAID Data, WRD Data base 1995-1996, Rene LeMarchand, Burundi, Ethnicité as Discourse and Practice.

Chart Twenty-Five



Source: WFP Database 1961 - 1993, Rima LeMarziani, Burundi, Ethnicity as Discourse and Practice, USAID Database

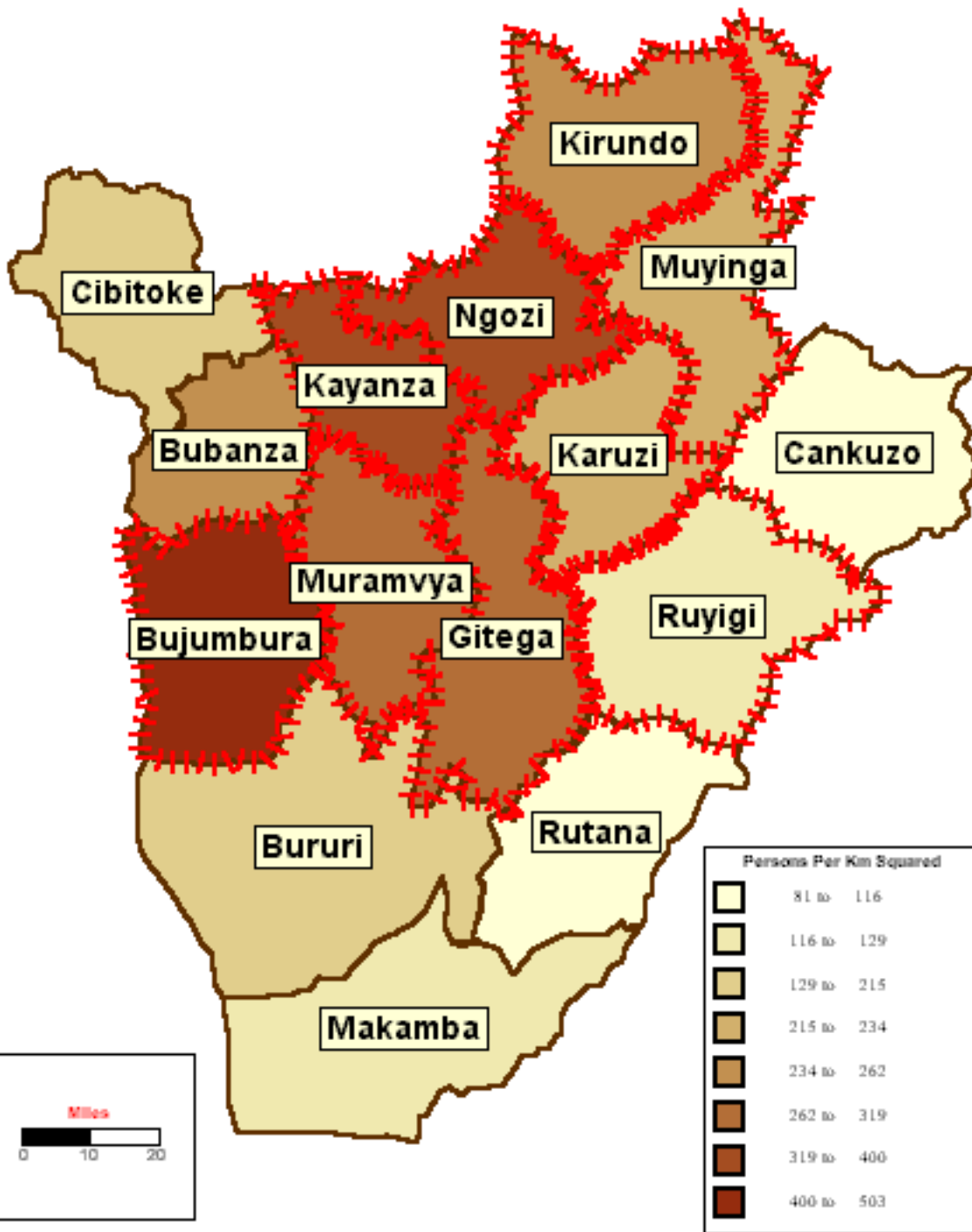
Burundi's Modern Provinces Marked With Areas of Initial Violence in 1972 in Red
Areas of Violence in 1965 Marked in Blue

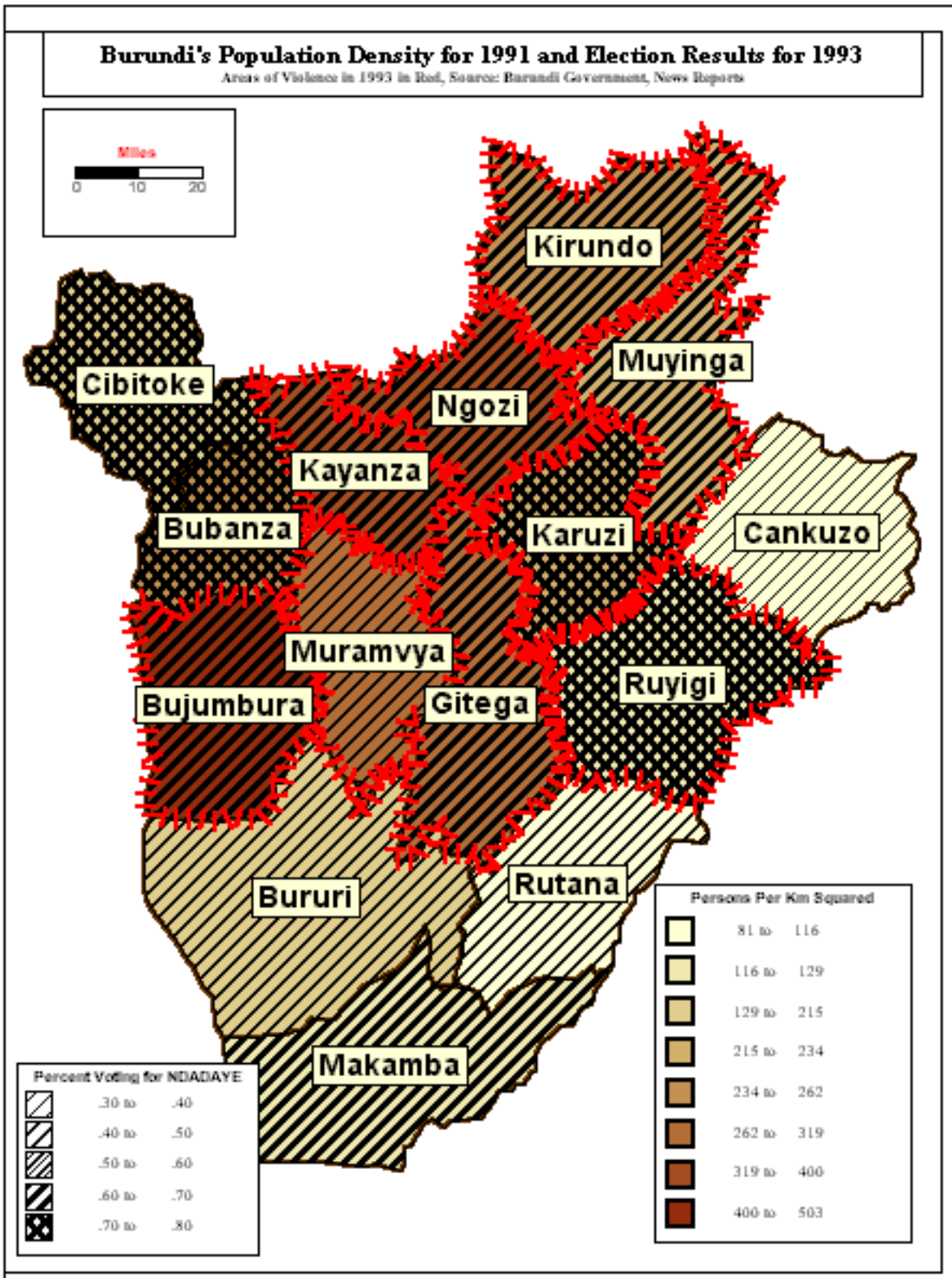


Source: Rene LeMarchand, Burundi: Ethnocide as Discourse and Practice

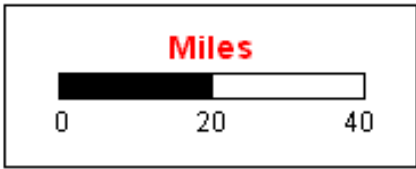
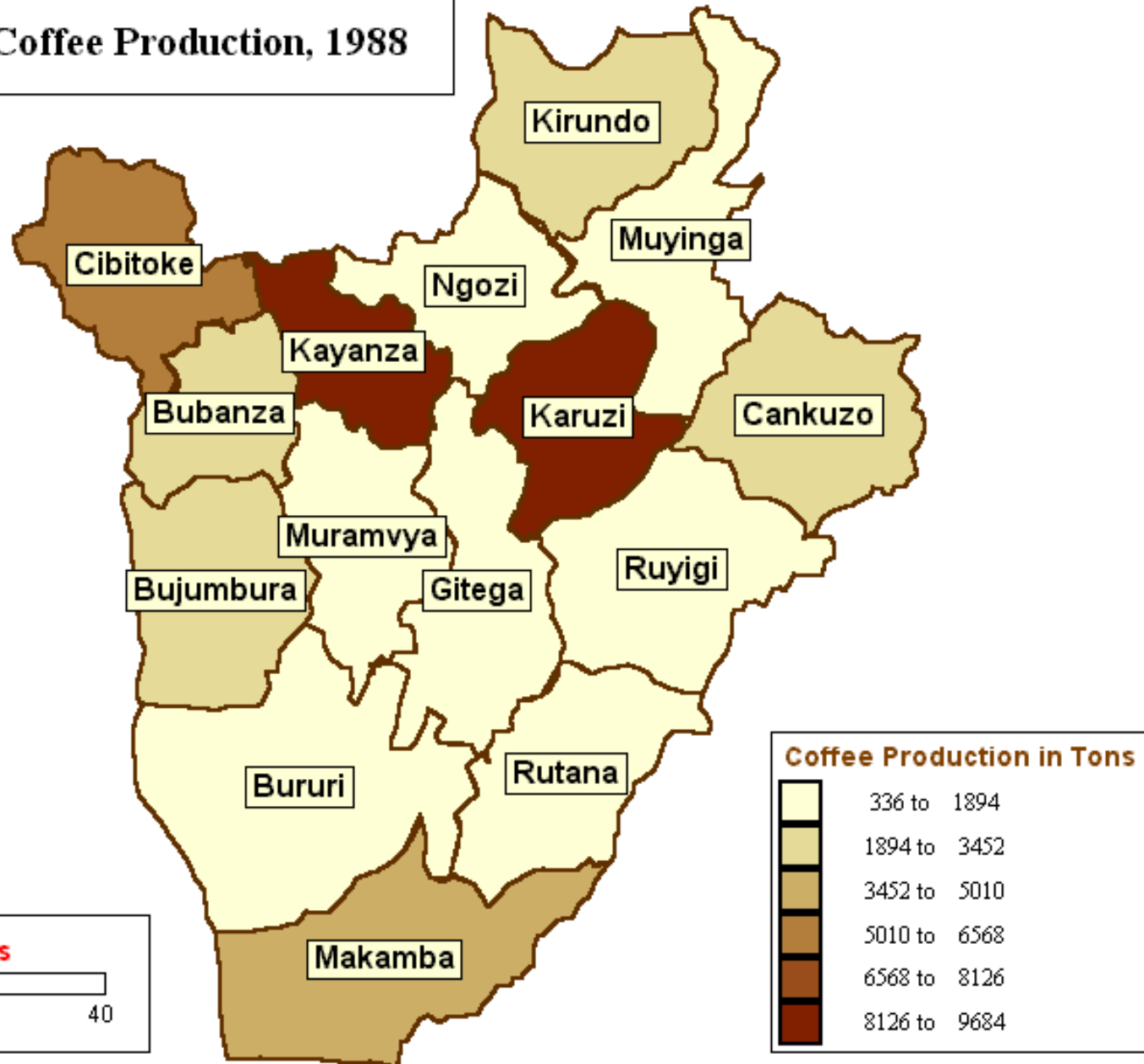
Burundi's Population Density for 1991 with Areas of Heaviest Violence in 1993

Source: Burundian Government Statistics, News Reports





Burundi's Coffee Production, 1988



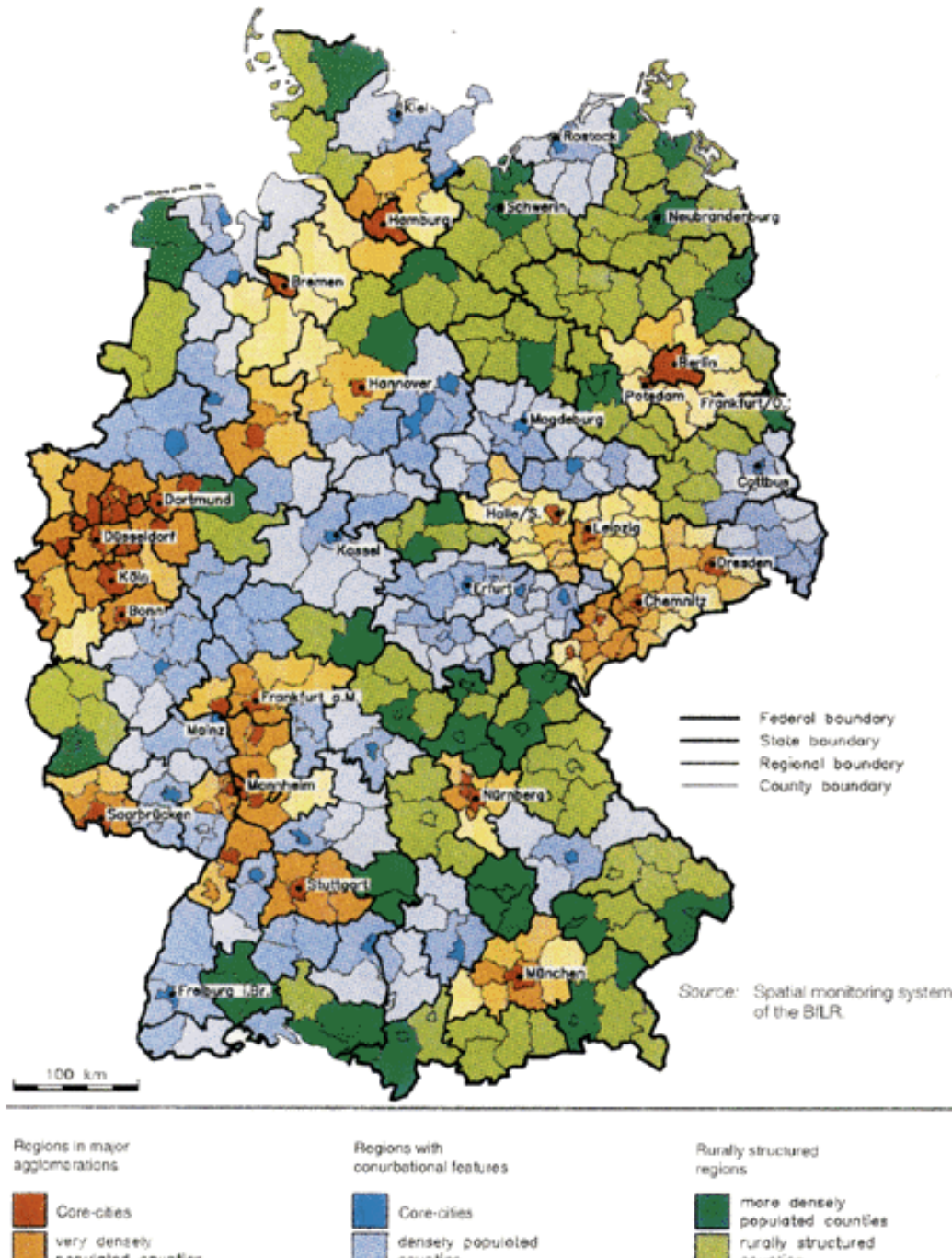
Outline/Table of Contents

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4. Economics
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9. Implications

List of Abbreviations and German Words

Altstadt	old down town district
Bebauungsplan	master plan
CS	contaminated site
Flächennutzungsplan	regional plan
FRG	Federal Republic of Germany
GDR	German Democratic Republic
Land	a German state (singular)
Länder	the German states (plural)
new Länder	the states which make up the former German Democratic Republic
old Länder	the states which make up the former Federal Republic of Germany
PPP	polluter-pays principle
Treuhandanstalt	federal privatization agency set up after reunification

German cities and counties according to settlement structure

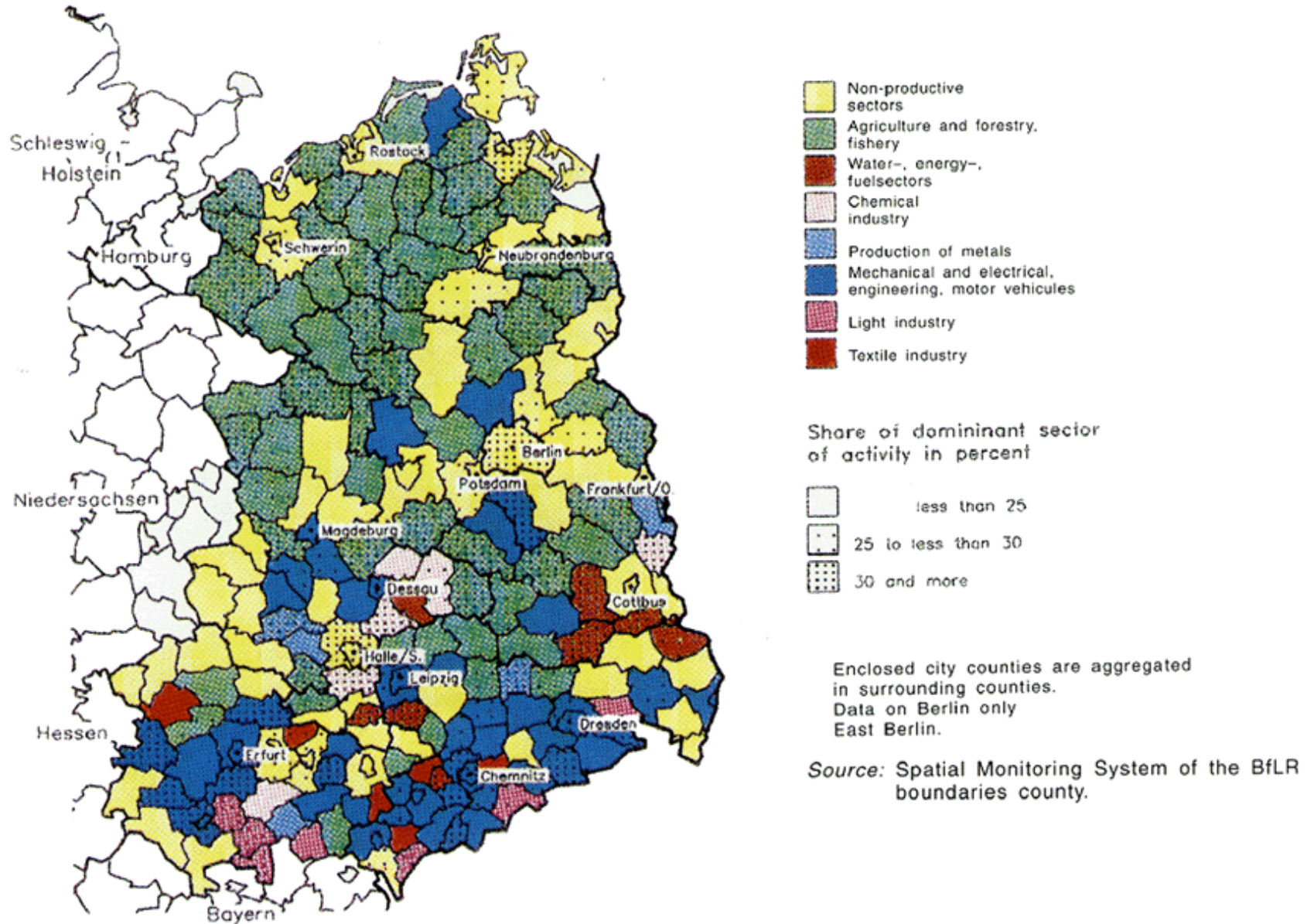


populated counties
densely populated counties
rurally structured counties

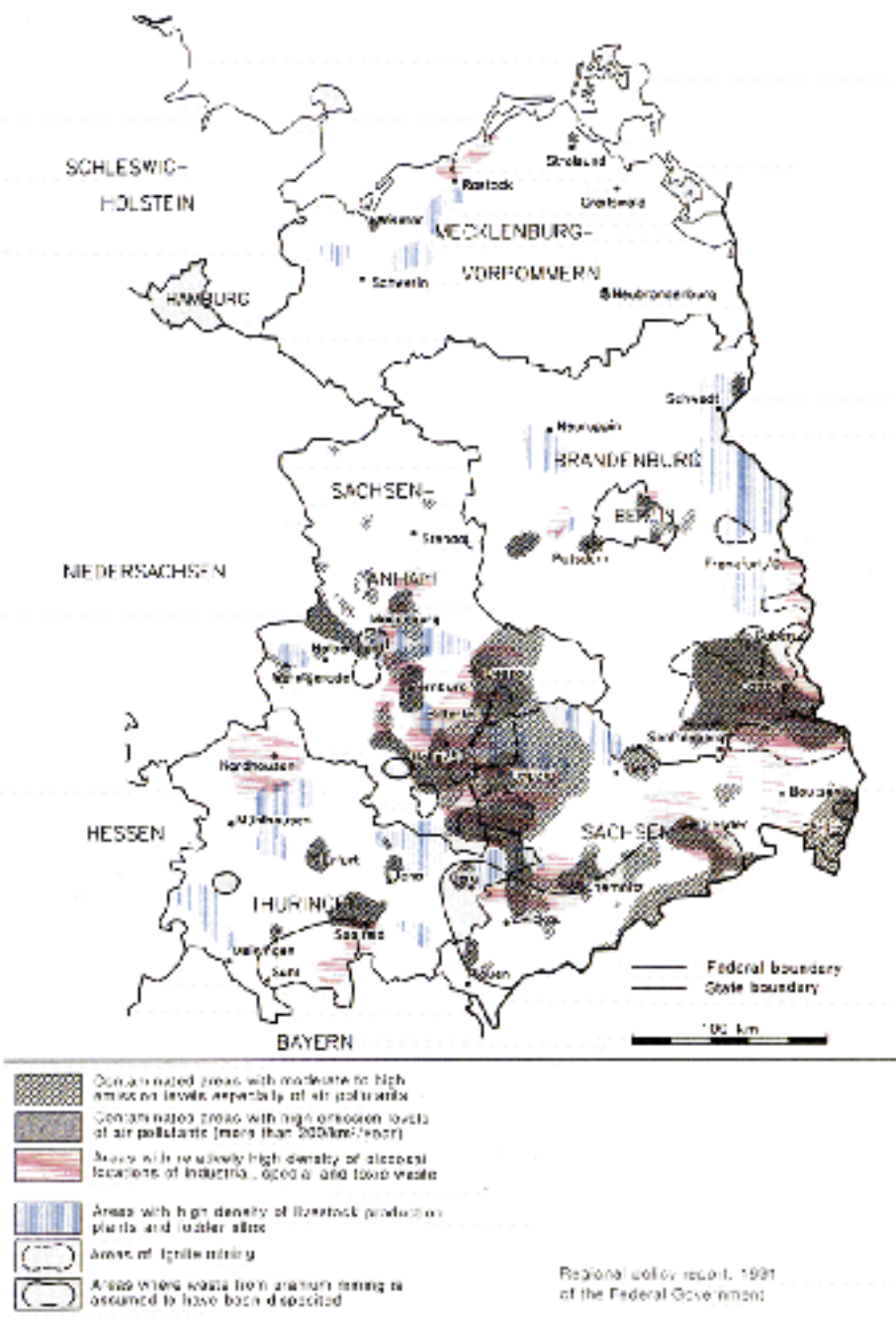
counties
rurally structured counties

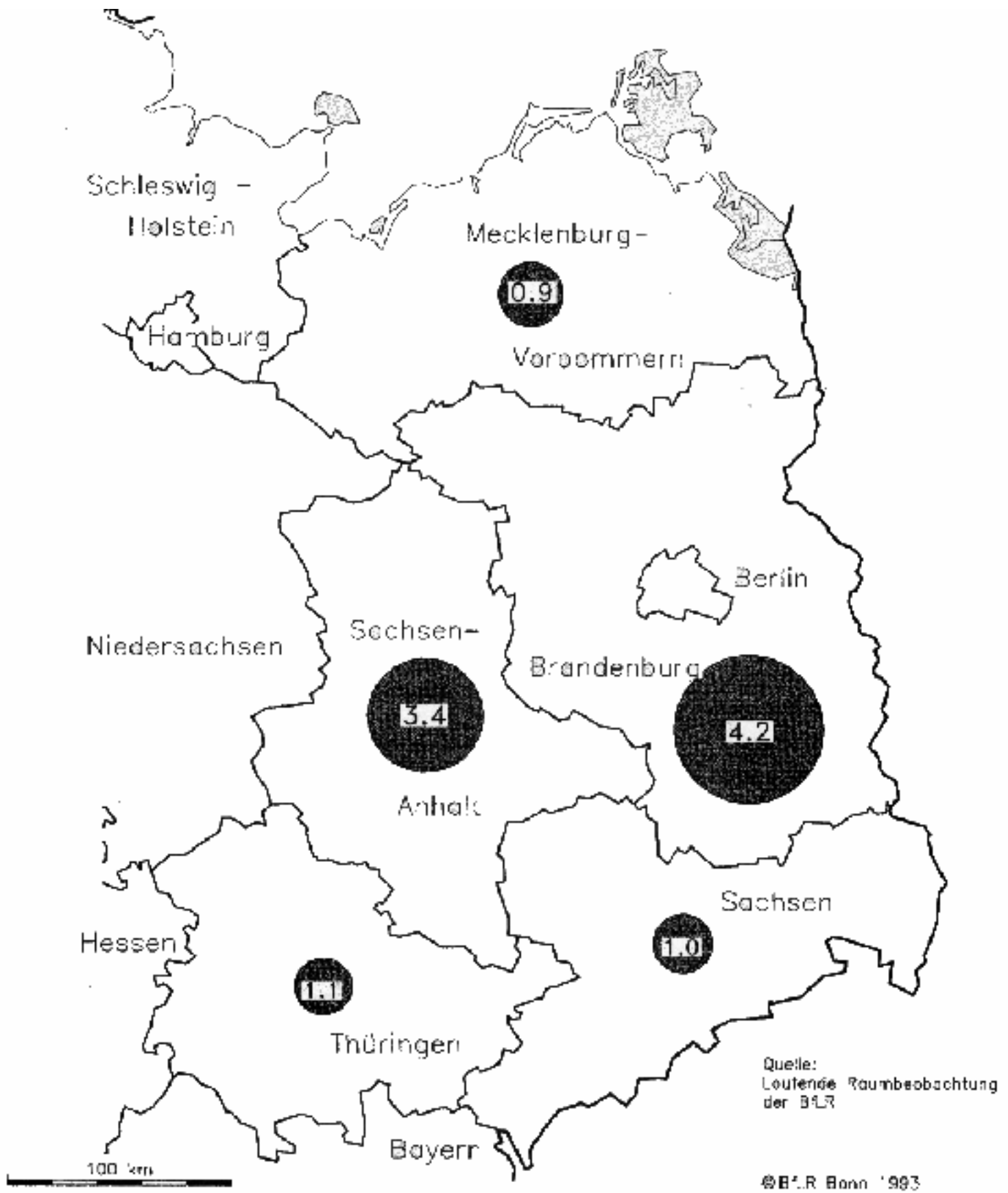
counties

Dominant sectors of activity in the former GDR, 1989



Contaminated areas in the new German Laender





Military sites of the CIS forces in km²
(as of 31 July 1990)

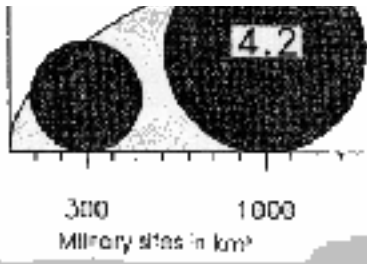
Mecklenburg-Western Pomerania	218
Brandenburg	1170
Saxony-Anhalt	689



— Federal boundary
— State boundary

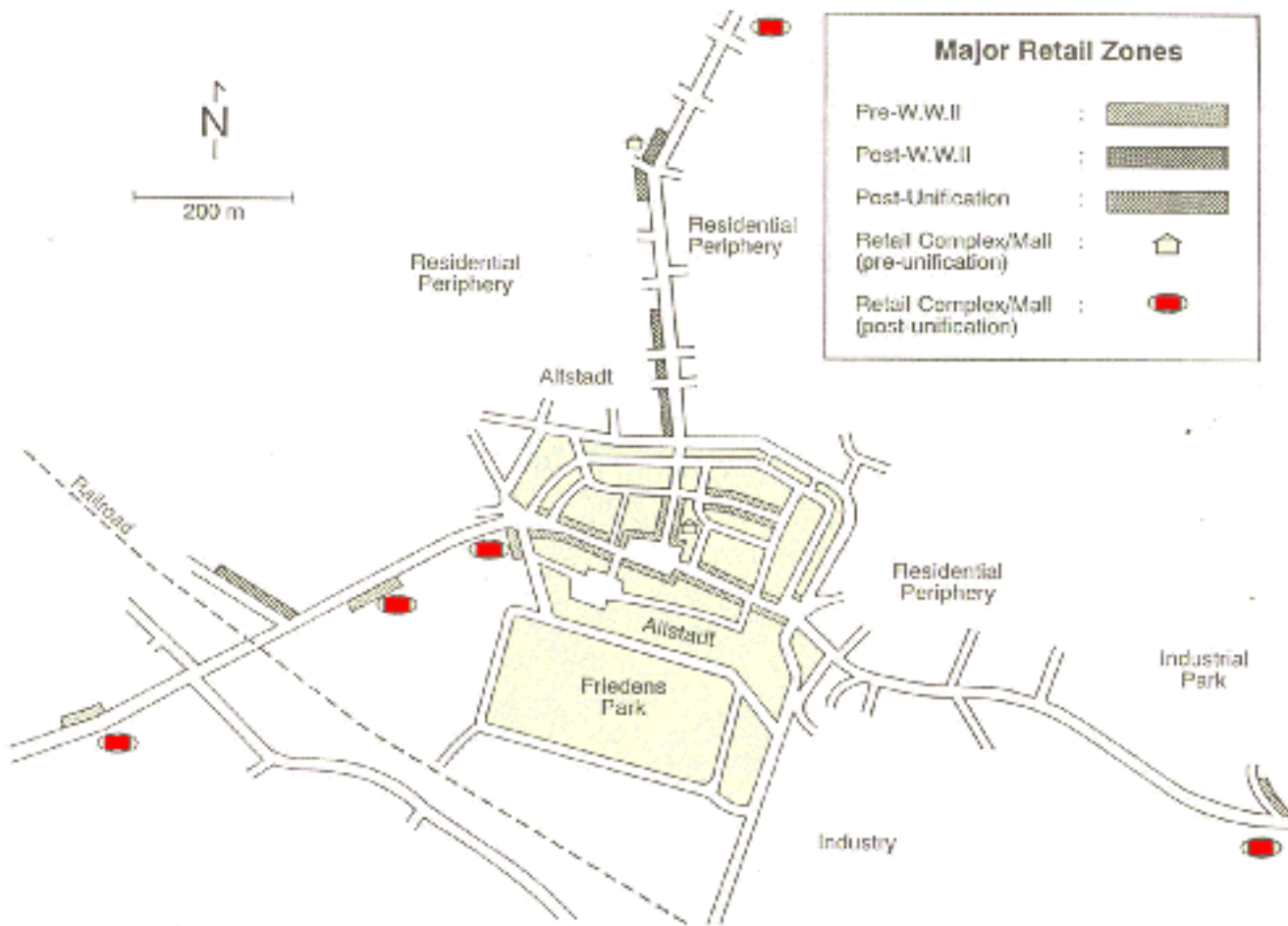
Share of military sites
in total facilities: 4.2

Saxony-Anhalt	689
Saxony	187
Thuringia	170



Share of military sites
in land territory as %

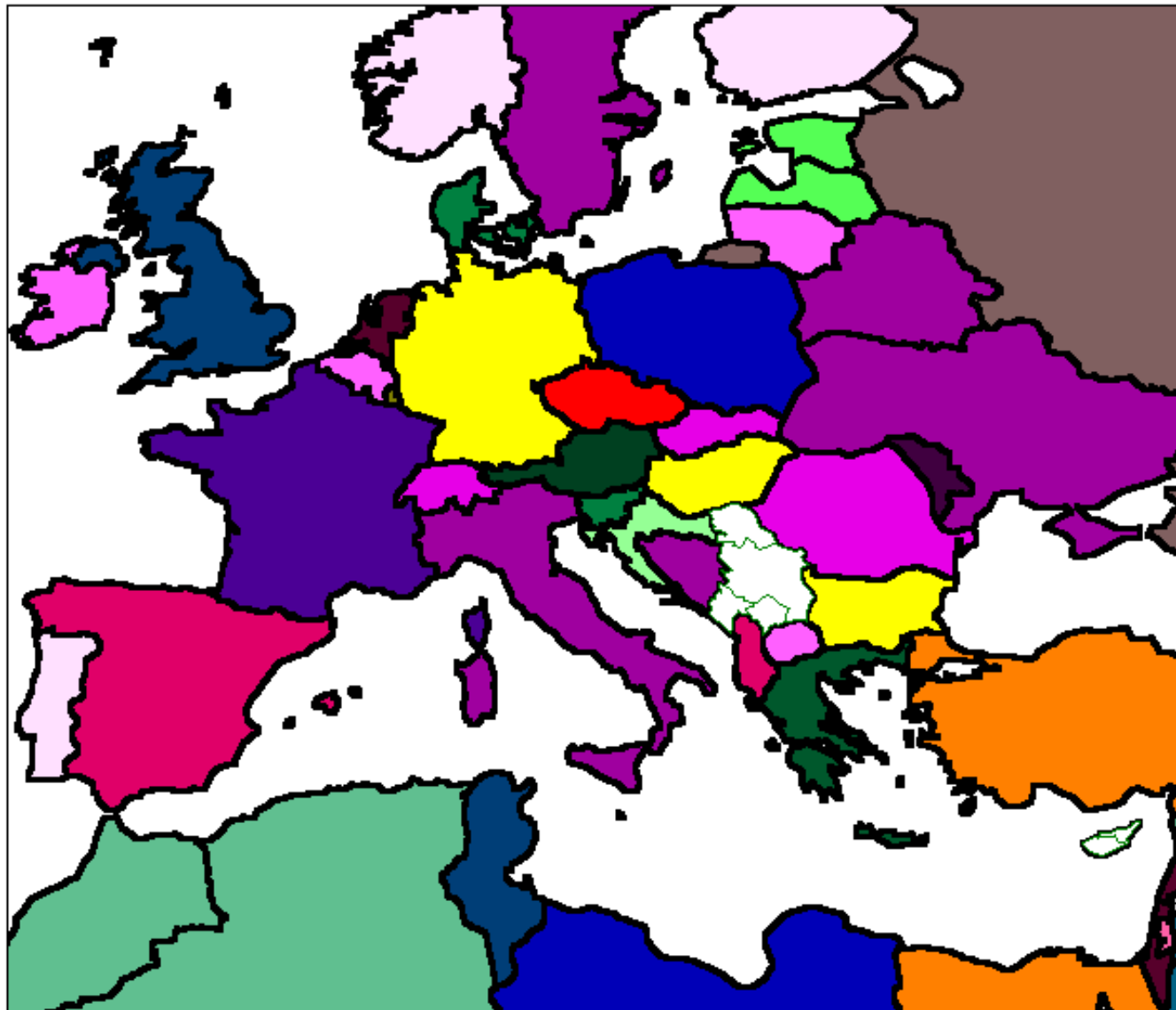
Hildburghausen: Major Retail Zones, pre-World War II to 1993



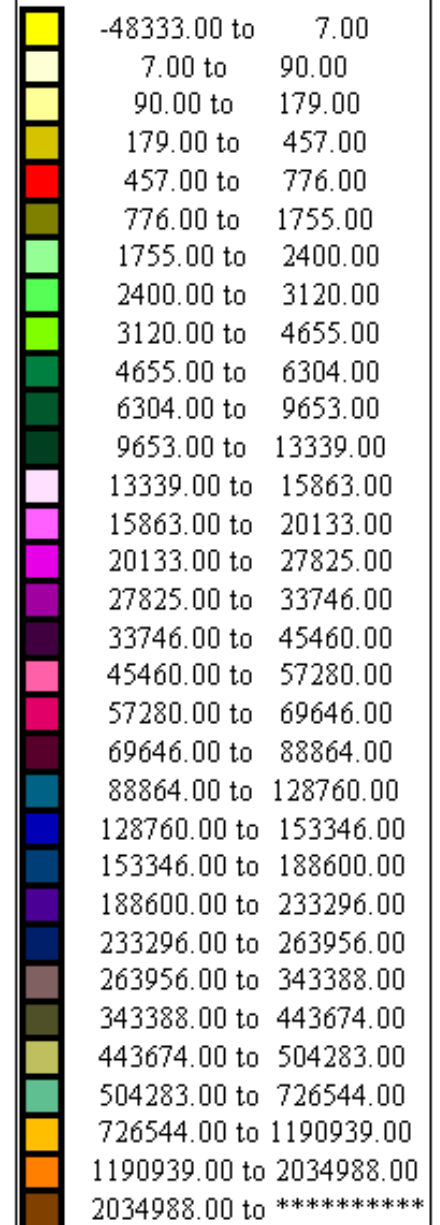
Source: Adapted from Dannhaeuser (1994:88).

European Population Growth

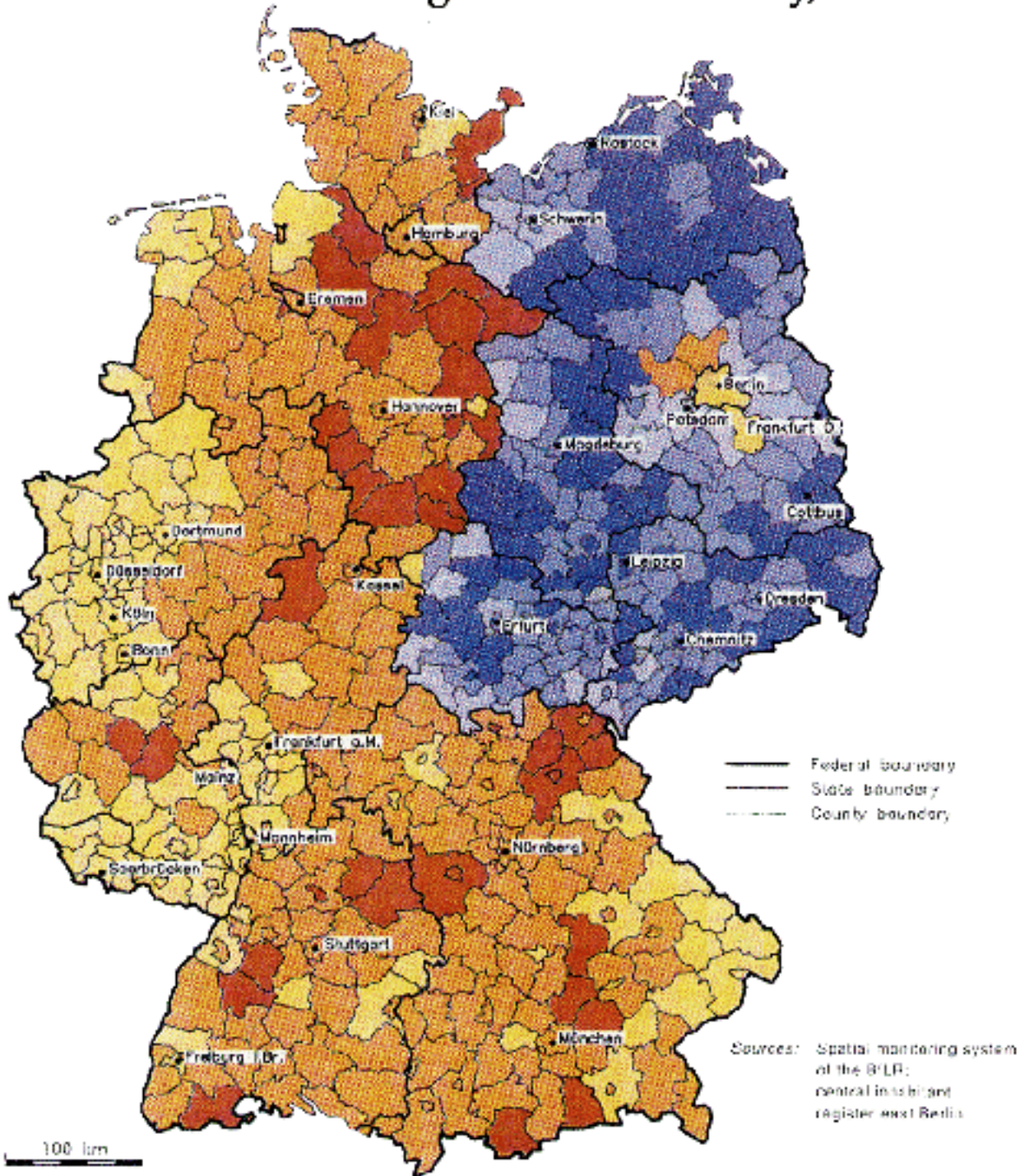
Births - Deaths



BIRTHS-DEATHS (per 1,000)



Balance of internal migration in Germany, 1989-1991



Balance of internal migration 1991 by in- and out-migration between the new and the old Länder per 1 000 inhabitants to 1990

