POPULATION PRESSURE IN KITUI DISTRICT, KENYA.

by

Leonard Musyoka Kisovi

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A thesis submitted to the Faculty of Graduate Studies of
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DEDICATION

This Dissertation is dedicated:

1. To the loving memories of my late father, Kisovi Makau, and to my late kid brother, Absalom Makau Kisovi, whose sudden deaths in a row at the begining of my PhD programme left my heart bitter and lonely.

2. To my loving wife and children for their great understanding and encouragement.

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registered. Professor Rogge's priority for the welfare of many of us who studied under his supervision, is something admirable and which some of us hope to emulate.

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ABSTRACT

Population pressure is a global problem which especially foreshadows the future of Third World countries. In many of these countries, the problems of land fragmentation and subdivision, declining crop yields and malnutrition, deforestation and increased soil erosion, and a swelling flow of urban-bound migrants are all widespread.

Consequences of population pressure function as neither discrete nor as linear variables. Instead they interact synergistically, accelerate, and compound exponentially. As populations grow and require more from finite resource bases, pressures gain momentum with pervasive impact. Man-land and man-man balances tilt. Deterioration of rural resources progress with lasting effect. Conditions of life worsen for following generations.

Kenya is one of many underdeveloped countries with a worsening population-resource balance. Its rapidly deteriorating population-resource balance is a product of limited resource base and an explosive demographic growth rate. Four fifths of the country is classified as arid and semi-arid, and throughout these dry regions, signs of environmental stress and evidence of deteriorating human conditions have become increasingly common.

This study sets out to investigate the magnitude of population pressure in Kitui District. Kitui District is one of Kenya's marginal regions; while the overall population density is low, population pressure has reached crisis proportions. Whereas in many of the arid and semi-arid regions of Kenya research has been undertaken on the issue of population pressure, Kitui District has so far been neglected. This study attempts to fill this apparent gap.

Three approaches are applied to the investigation of population pressure in the district. First, an historical search for the roots and evolution of population pressure is undertaken; second, an estimation of carrying capacities is made; and finally, the symptoms (or indices) of population pressure are analysed. Principal Component Analysis and Multivariate Analysis of Variance are used to analyse data on the symptoms of population pressure.

The results of the study indicate that population pressure is not a recent phenomenon in Kitui District. It dates back to the begining of British colonial intervention in 1893 when African Native Reserves were first established to confine Africans to specifically bounded areas. Carrying capacity estimates indicate that the district is now 'overpopulated' and that some Locations[1] in Central and Mwingi Divisions[2] have already exceeded their carrying

[1] see Glossary

[2] see Glossary

capacities by more than one hundred percent.

Results of the analysis of selected population pressure indices indicate that there is a significant difference between the three ecological zones that occur in Kitui District. The analysis shows that population pressure is most severe in the high- and medium-potential ecological zones, but that the low-potential zone has still some capacity for settling more people.

In its recommendations, the study calls for increased effort in the reduction of population growth, for population resettlement, and for greater levels of environmental education.

GLOSSARY

The following terms are used at different stages in this study.

Akamba (singular, *Mukamba*) - the Natives of Kitui and Machakos districts.

Kikamba - the language of the Akamba

Ukambani - refers to Kitui and Machakos districts

Asomi - the educated, or the previledged

Syengo - cattle posts

Weu - communal grazing lands where cattle posts are established

Misyi (singular, *Musyi*) - homestead, household

Muunda - a piece of cultivated land

Munanda - a gathering for animal inoculation

Nzuki, Mawa, Muatine, Kithio, chang'aa - types of locally brewed beer

Kaweto - a woman (usually young) "married" to a sterile woman for purpose of procreation

Crown Lands - areas which were reserved for exclusive use of the colonial government and to which local people had no access

Trustlands - lands which have not been gazetted or allocated on title

Division - an administrative unit in a District

Location - an administrative unit in a Division

Sub-location - an administrative unit in a Location

KES - Kenya Shillings (*KES* 17.00 = $ 1.00 Canadian)

Murram Roads - roads constructed using gravel

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Chapter I

INTRODUCTION

Throughout Kenya today, and Africa in general, the arid and semi-arid regions (also known as the marginal regions or the rangelands) are facing a very serious problem of demographic stress. Environmental degradation has become increasingly apparent on the landscape as a result of this stress. Denuded hills and plains, large erosion shelves, and deep gulleys are, among other features, now quite conspicuous.

These features are manifestations of an imbalance between humans and the resources which support them, or what some scholars have termed as "Population Pressure" (Zelinsky, et al, 1970; Anzagi and Bernard, 1977; Steel, 1970). However, the process of population pressure (PPR) cannot be simply defined.

By and large, studies on landscape deterioration and degeneration of human conditions see population pressure as a complex process having several interrelated parts. This complexity requires careful analysis so as to identify and illuminate the various components of the process and show their multicausal relationships. Perhaps the best way to understand population pressure is to examine the systems view of the process.

Systems theory is an analytical tool for studying complex situations in order to bring into the discussion the largest possible number of interconnected factors. According to this view, the behaviour of each individual component can best be seen in the light of the whole. A systems view not only helps to specify parts but leads to an understanding of their role and function within the entire framework (Munton, 1973:685). Systems analysis focusses on the flows and interconnections between parts and addresses the question of how a system is organised, how it functions, its degree of stability, and how it has evolved through time (Harris, 1969; Munton, 1973; Stoddart, 1965). A systems evolution through time is an appropriate conceptual basis within which to examine change. The answers to the questions on the attributes common to all systems can lead to informed projections on how the system might work in the future under a variety of hypothesized circumstances (Harris 1969:135).

Unlike ecosystem theory in biology, which emphasizes stability and regularity behaviour of systems phenomena, systems analysis is more flexible (Bennet, 1976:21). Although human actions concerning the environment engender feedbacks and processes resembling biological systems, there are distinct human factors that ought to be considered. These human factors include "means and ends, purposive actions, rational and irrational decisions, uncontrollable and controlled wants and desires..."(Bennet, 1976:32).

Bennet (1976:32) continues to argue that if these aspects of cultural ecology are emphasised, the focus will shift away from views of the relationships of technology, population and environment as a static or balanced system characterising small, relatively isolated groups, to concern for dynamic processes of resources use in complex socio natural systems that characterize most of the world. Human processes are dynamic and operate in an open system. A systems perspective allows population pressure and its components to be considered at various scales. Bernard (1977) noted that it provides an opportunity to consider both hidden and observable consequences in the light of subtle sociocultural processes.

An attempt to apply systems concepts in the Study of Population Pressure by Bernard (1977) illuminated the complex nature of the process. Bernard's theoretical framework allows both the environmental consequences and the socio-economic effects of population-resource imbalance to be put within a single framework. While noting that it is not possible to fully quantify the cycle of population pressure as proposed by some scholars like Allan (1965), Bernard argues that the systems approach leads to a greater understanding of a process previously explained in simple, and even erroneous terms.

Bernard's formulation begins with the assumption of a cybernetic system which theoretically is an equilibrium or

homeostatic state. This assumption is based on the premise that society has through time negotiated a set of practises to utilize the environment without leading to degradation of the physical resource and human conditions or both. As the population increases, the homeostatic state is disturbed. This may be corrected in either of two ways (Figure 1). Following Boserup's (1965) view, should population increase be gradual, density increase may lead to more intensive land use and careful resource conservation. This requires investment in human labour, better tools and higher technology. The total effect of this investment leads to higher levels of production that support more people. At this point, the system may be said to have reached a new equilibrium.

Alternatively, the adjustment mechanism can take the path first proposed by Malthus (1798). Malthus argued that the tendency or power of every species, including the human one, is to increase at a geometric progression (1, 2, 4, 8, 16, 32, ...), while under the most favourable conditions, its subsistence increases at an arithmetic rate (1, 2, 3, 4, 5, 6, ...). Thus, when unchecked, population doubles once every generation, while the supply of food increases at a much lower rate and in effect the population puts strain on the food and all the other resources which support it. In other words, population growth leads to higher densities and overcrowding, food shortages and resource degradation.

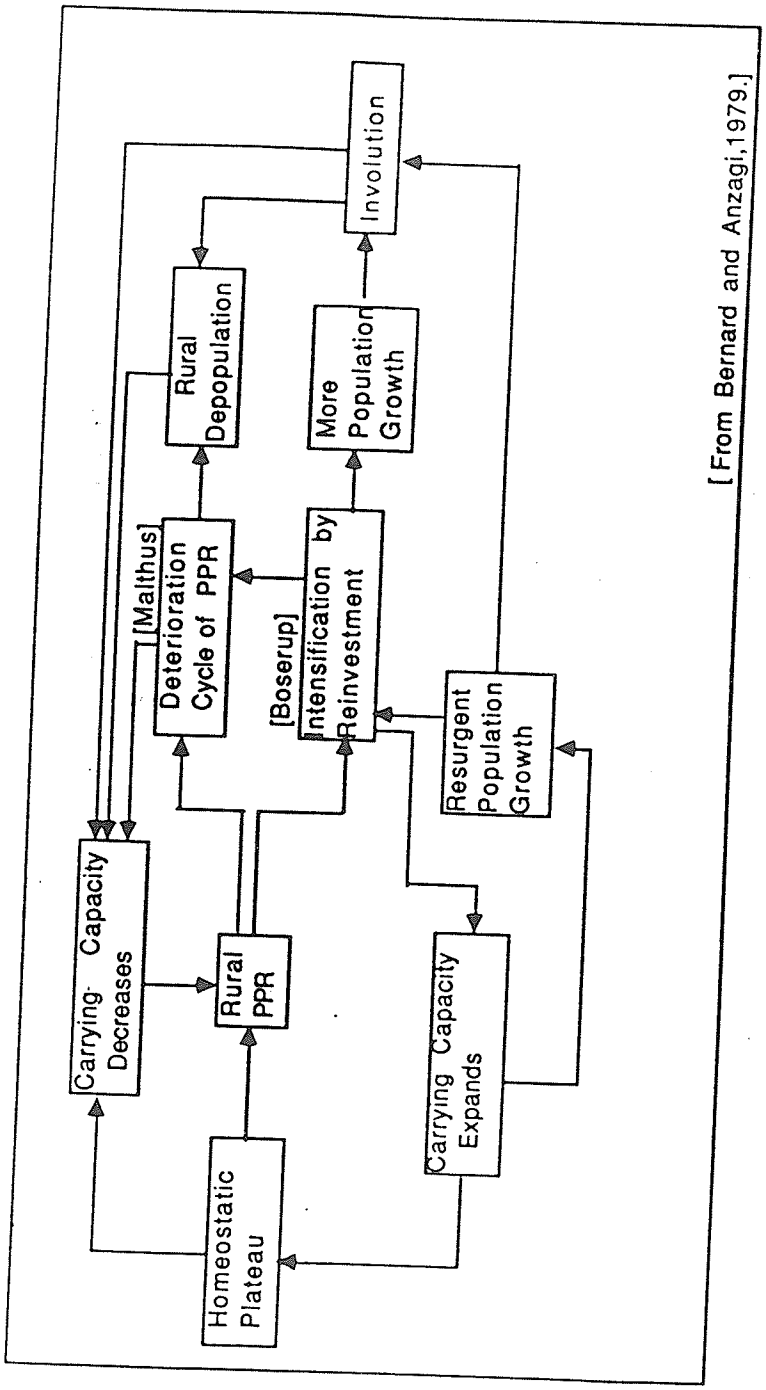

Figure 1: Rural Population Pressure and Agricultural Change

Under crowded circumstances an area would be suffering from population pressure and the resultant environmental deterioration briefly mentioned earlier, and comprehensively discussed in Chapter Two, would ensue. Increasing numbers of people per unit area and their activities would place heavy stress on the system and may lead to increased mortality or outmigration (Sindiga, 1986:45). Both resource base and society will suffer from population pressure. Bernard diagrammed this scenario to illustrate the cycle of population pressure (Figure 2). Most of the symptoms of population pressure mutually reinforce one another and the chain reaction is cyclical.

1.1 THE OVERRIDING PURPOSE OF THE RESEARCH

This research is an attempt to study population pressure in the arid and semi-arid lands of Kenya by using Kitui district as an example. Three different approaches are used in the investigation. First, an attempt is made to explore the historical evolution of the population pressure problem in Kitui district through literature review on the subject. Second, human carrying capacities for different administrative units[3] of Kitui district are computed. Third, symptoms of population pressure throughout the three ecological zones are analyzed using Principle Component

[3] Kitui, like other districts in Kenya, is divided into administrative units ranging from the largest to the smallest from Divisions, Locations, Sub-locations and Villages (see Figure 10).

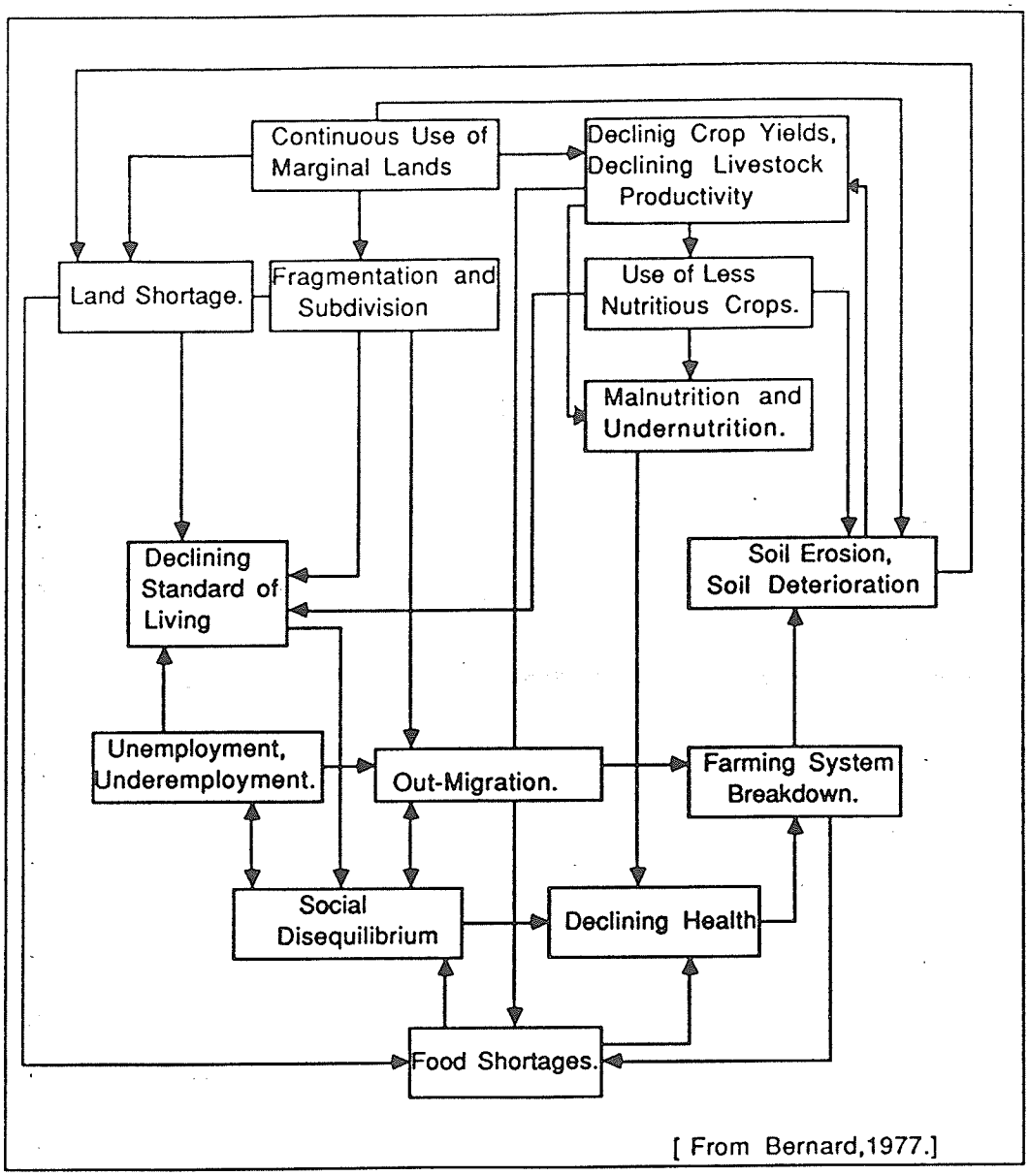

Figure 2: The Cycle Of Population Pressure.

Analysis, Multiple Analysis of Variance, and descriptive statistics. An attempt is also made to relate the results of the carrying capacities to the population pressure symptoms.

The study is organised into seven chapters. The current chapter presents the statement of the problem, objectives, and scope of the study, and provides the specific research questions and the conceptualised significance of the study. In Chapter Two, a literature review is undertaken. Specifically addressed in this chapter is a detailed discussion of the concept of population pressure, its measurements, and the empirical research which has been carried out in the process. Chapter Three gives background information of the area of study in terms of its location and size, ecological potential, population growth and trends, and the emergence of population pressure in Kenya in general, and in the arid and semi-arid regions of the country. Chapter Four presents the methodology: sampling procedures, types of data, methods of data collection and analysis, and critical evaluation of the methods used to analyse data. Data analysis is presented in Chapters Five and Six. Summary and conclusions are stated in Chapter Seven.

1.2 THE STATEMENT OF THE PROBLEM

Population-resource relationships have created major contemporary problems, yet their study has often been less than vigorously pursued or neglected. Kenya has one of the highest population growth rates in the world (4.1% p.a., Population Reference Bureau, 1989a) but only a limited portion of arable land. Four-fifths of Kenya's land can be classified as marginal (defined as land of low agricultural potential). As a result of this high population growth these marginal areas are experiencing continuing demographic stress.

However, talking of high demographic stress in Kenya's marginal lands may be surprising to those familiar with the comparatively low population densities in these areas. Nevertheless, crude density *per se* has been described as a misleading statistic (Hance, 1968:7). This is because population pressure upon resources may occur where densities are low.

In general, Kenya's rangelands are densely populated relative to pastoral areas in other African countries (Von Kaufmann, 1976:255). The Kenya government has noted the urgency of dealing with social problems related to the rapid population growth in the medium and low potential areas of the country where crop production is feasible but very risky (Kenya, 1979b:211). These regions constitute fragile ecosystems susceptible to environmental destruction under human occupation and use.

As population pressure is exerted in Kenya's higher potential highland areas, shock waves travel down the ecological gradient and overspill on the marginal areas. Migrants from high-potential districts, which have reached or exceeded carrying capacity, move into the marginal areas in search of a place to settle and cultivate (Mbithi and Barnes, 1975). In these latter regions population pressure has reached crisis level (Sindiga and Burnett, 1988:234; Bernard, 1978:12; Kenya, 1979b:211) -- see Table 3.3 in Chapter Three.

About two decades ago, the International Labour Office mission to Kenya noted that surface soil degradation and erosion in the marginal areas had become chronic (ILO, 1972:405). Other symptoms of the physical destruction of the land included drying up of streams, cultivating on river banks leading to silting of streams and dams, unchecked gullying of cultivated slopes, and sheet erosion following bad grazing practices. Much later, the World Bank noted that increasing population growth in the drier areas of Kenya has led to a pressure exceeding the carrying capacity of the land, which in turn has led to lower income per capita, and even famine (World Bank, 1980:53).

Besides population growth, strong political forces and cultural practises have been identified as among the most important factors responsible for population pressure in these regions. For instance, land adjudication and

consolidation on the highland areas and in the marginal zones often creates landlessness. In addition, an inheritance system which provides land tenure only to sons (and at times only to one, the eldest) still produces more population pressure in Kenya (Benard, 1986).

Yet, with this mounting awareness of population pressure and its disastrous consequences, relatively little attention has been focussed on the effect of people and their activities in the marginal areas of Kenya, especially at the district level like Kitui. Past studies on Kenya's rural population-land relationship have concentrated on crude densities (Ominde, 1963; Owako, 1969 and 1971; Anzagi and Bernard, 1977). As indicated earlier, crude density is not a good measure of population-resource relationship. Sindiga (1984:23) stated that population pressure is a relative term, meaningful only in the context of such variables as an area's natural resource potential, its socio-economic organization, methods of production and the standard of living. Also Mabogunje (1970:115-8) noted that the factor of "expectations" of a community is crucial to understanding population pressure.

Thus, lack of relevant information is still a major handicap in understanding population pressure in these areas. Several researchers have noted this (Mbithi and Wisner, 1973; Mutiso, 1975; Bernard, 1972). Unless we understand the nature and magnitude of population pressure

in these areas, it will be difficult to stabilize land use systems, reverse environmental destruction and raise the standard of living of local communities.

This study sets out to investigate the nature and the magnitude of population pressure in Kitui district, Kenya. Kitui district provides an excellent example of an arid region where overall population density is relatively low, but where recurrent famine, escalating malnutrition especially among the infants and children, and chronic poverty and diseases continue threatening the lives of the Akamba people (the Natives of Kitui and Machakos districts). On the landscape, signs of over-exploitation of resources (soil erosion, clearing of bush, water resource misuse, etc) are apparent. Yet, the population has continued to grow at an alarming rate without any assessment of how much pressure it places on the environment.

Among all the arid and semi-arid districts of Kenya, Kitui is the only district which has been neglected in terms of research related to population-resource relationships. In neighbouring Machakos district, some research has been carried out (Owako, 1969 and 1971; Mbithi and Barnes, 1975; Moore, 1979). Other areas in Kenya under similar ecological conditions, have also been researched such as Kajiado and Narok districts (Sindiga, 1984 and 1986; Campbell, 1986), Baringo district (Ominde, 1963) and Embu district (Bernard, 1972 and 1978). This research focusses specifically upon

Kitui district to close this apparent gap and partly to bring to centre-stage the population pressure problem which is facing the district at present.

1.3 OBJECTIVES AND SCOPE OF THE STUDY

The broad theme of the current research is to investigate and provide background information on the origin of population pressure problem in Kitui district. In addition, the research aims at assessing the magnitude and spatial occurrence of the contemporary population pressure within Kitui district. Specifically this research has the following aims:

1. To undertake an historical search for the roots and evolution of the population pressure problem in Kitui district. This involves the investigation of events and circumstances in both colonial and independent Kenya which might have led to population pressure in the district.
2. To compute carrying capacities for the five administrative Divisions and the twenty seven Locations of Kitui District in order to expose the spatial occurrence of the population pressure problem within the area. This requires identification of the areas which have reached or exceeded their carrying capacities, and for areas which have not, an

estimation of how long they would take to reach such a stage.

3. To investigate the impacts of population pressure on the environment, as well as upon human conditions within the district. This necessitates the identification of population pressure symptoms on the environment and on human conditions, as well as an assessment of how severe these symptoms are throughout the three ecological divisions.
4. Also, the research attempts to discuss the factors responsible for high population growth in Kitui district.

Basically, population growth has been repeatedly cited as one of the major elements fuelling population pressure in Africa (Hance, 1968; Allan, 1965; Bernard, 1977). Investigation of the factors which lead to high population growth is considered quite essential because once such factors are identified, it is possible to plan strategies to counter the problem.

In order to explore the factors underlying high population growth in Kitui district, a review of relevant literature published by scholars, the Kenya government, and by non-governmental agencies is undertaken. An attempt is also made to establish how local people in the district perceive population pressure. This is done to establish if local people are aware that they have a population problem,

and if so, to suggest possible/potential solutions to the problem. In addition, this is deemed necessary since once the attitudes of the community towards population pressure are identified, it becomes easier for planners to design acceptable ameliorative measures to reduce the problem.

1.4 RESEARCH QUESTIONS

To achieve these objectives in terms of the perspective presented in this chapter, this research attempts to answer the following specific questions:

1. What were the historical events and circumstances which led to population-resource problems and population pressure in Kitui district?
2. What are the significant population pressure symptoms on the environment and upon human conditions in Kitui district?
3. How severe is the population pressure problem in Kitui district? Which areas are most or least affected, and how long will the least affected areas take to begin experiencing the problem?
4. Which factors have led to the failure of population policy in Kenya after more than two decades of active government and non-government population control programmes?

5. What are the local perceptions of the effects of population pressure upon the environment?
6. What types of community reactions to population pressure exist? That is, what are local strategies for coping with population pressure?

1.5 THE SIGNIFICANCE OF THE STUDY

Population pressure is a critical constraint to regional development in Africa. In particular, population pressure is closely related to the need for economic development in tropical Africa. Yet the problem of population pressure has frequently been underestimated or ignored (Bernard, 1982; World Bank, 1984). Although theoretical opinion differs on the definite effects of population pressure upon rural transformation of agrarian-based societies, there is no denying that the two are interlinked.

A study of population pressure on resources reveals areas which may, under existing land use, farming practises, and at the current stage of development, be suffering from acute pressure. This knowledge can help shape wiser policies towards economic transformations by focussing on such variables as soil conservation, land use intensification, increasing production, and creating new opportunities of employment to absorb new labour. In other words, the information which emerges from this research can

be very useful in laying strategies for counteracting problems such as soil erosion, malnutrition, forest depletion, and many others. The Government of Kenya can also plan strategies for population redistribution and resettlement much more easily with the help of the type of data being made available by research such as this. Thus, wiser interventionist policies for rural transformation can emanate from the knowledge of population dynamics and the available resources within the context of prevailing technologies. Because population pressure investigations consider not merely population numbers and area, but also population and resources within given land use systems, the understanding of population pressure becomes a useful planning tool.

It is suggested that this research will be of great value not only to the Government of Kenya, but also to other organizations and individuals who may be dealing with population-resource relationships within the arid and semi-arid regions of Africa or elsewhere.

Chapter II

LITERATURE REVIEW AND HYPOTHESES

The purpose of this chapter is to examine more closely the process of population pressure (PPR) and the various techniques used in measuring it. After a review of various methods of measuring the process, carrying capacity and consequences of population pressure are selected and discussed in more detail for the purpose of this study.

2.1 THE CONCEPT OF POPULATION PRESSURE

Although population pressure is an extremely widely used term in all the disciplines that deal with human-environment relations, notably Geography and Anthropology, its definition is a major problem and its measurement is another difficulty.

The numerous reviews of seminal works on population and agricultural development by Boserup (1965) and Allan (1949 and 1965) attest to the interest focussed upon the notion of population pressure (for example, Grigg, 1976; Porter, 1970 and 1978; Reining, 1973; Moore, 1971). But Browning (1970:71) noted that the concept is conceptually based on vague and uncertain notions. The concept also lacks

universal definition. Different practitioners within the same discipline and those in different fields conceive of population pressure differently.

Browning (1970:72) and Kay (1970:363), for instance, defined population pressure as an imbalance between the resources of a community and its population. They noted that population pressure may be caused by either an increase in population, a deterioration of resources or both. Population pressure symptoms then manifest themselves on the resources or the community or both.

About two decades ago, a symposium on population pressure upon physical and social resources in developing lands could not come up with a single universal definition of the concept. After reviewing voluminous contributions from the participants, the editors in their epilogue (Zelinsky, et al, 1970:581-582) metaphorically concluded that:

> The beast we call PPR is too large, ambiguous, and ambulatory to be simply catalogued. It is bigger than we suspected previously; it has too many appendages, angles, and wrinkles for comfort, and it may travel in herds. We have succeeded only in demonstrating that it is truly multidimensional, that it involves relationships among many different sets of variables - ecological, social, technological, psychological, and historical. It is impossible to produce a simple, universal definition that subsumes all the many kinds of pressure situations observed at different places and in different periods. But we are all uneasily aware that it exists. It is quite possible that the interdisciplinary perplexity concerning the essential nature of PPR reflects a profound truth, that we are in the presence of a highly relative concept that must be defined afresh in every new context.

The participants of the symposium, however, seemed to agree that population pressure suggests some imbalance between human numbers and their needs and the natural and human resources of a given area. The reason why a precise definition of population pressure eluded the participants of the symposium is because each one of them had a working definition for his own unique background.

Thus, population pressure can only be given at least a relative definition. It has meaning when put in the context of the number of people utilizing an identifiable area, taking into account the level of technology of the group and its socio-economic needs. This means that for every new investigation of population pressure, the concept must be defined operationaly. To begin with, population pressure may be viewed as a process of deteriorating habitats and human conditions when the capacity of an environment has been surpassed.

Having given a relative definition, the next problem is sorting out its many "appendages, angles, and wrinkles". That is, what are the detailed elements and processes which make up population pressure? How are they interlinked? The complexities of population pressure make it difficult not only to identify various elements in the equation but to unravel the way these interact with one another. This problem further complicates attempts to explain in any certainty causality in population pressure circumstances.

Land practises must be thoroughly probed and the interrelationships with the biophysical environment determined. Population pressure involves many elements which make it hard to quantify the variables. Also these elements interact in dynamic rather than a static manner. Population pressure is a process and not a condition (Browning, 1970).

Another issue is that different agricultural groups utilize resources differently. Kay (1970:366) for instance noted that agrarian economies rely heavily on natural resources directly within their environment whereas industrial ones rely upon "adaptation of natural forces to produce required commodities". Population pressure study requires a detailed understanding of the culture of the group in question. In addition, a study of population pressure must consider the environmental potential and how this varies over space (Sindiga 1986:23). Porter (1970:189) added that the purpose for environmental assessment is to find out the "optional land uses which are compatible with nature and society".

Further difficulty of working with the concept of PPR relates to the issue of the definition of resources. Resources are defined differently in the underdeveloped and developed worlds. Browning (1970:72) noted that in the former, the preoccupation still is with the basic necessities of life such as shelter, clothing, and food. In

the developed world resources are not defined in the sense of vital sustenance requirements (because basic necessities, except for isolated pockets, do not pose serious problems to supply) (Browning, 1970:72). Instead, the definition goes beyond to include such amenities as recreation, clean air, education, health care, and so on. Population pressure may thus mean different things in the two worlds.

Finally there is the problem of scale, both temporal and areal. Short term fluctuations in the economy could affect population pressure. These shifts must be identified and defined if the concern of an analysis must be defined. The scale of investigation might be a community, region or nation-state. A national level analysis obscures local and regional variations in population pressure. These variations may be a result of cultural differences in resource perception and use, and ecological factors. Anyhow, despite these problems involved in defining resources, scales of investigation and the like, population pressure study and analysis has increasingly become an important tool for planning in many parts of the semi-arid and arid regions of Africa. Population pressure analysis is largely inevitable in many of these regions.

For the purpose of this study, population pressure is defined as the long-term process of deterioration of the physical earth and human conditions as a result of excess numbers of humans, with a given technology, in relation to the carrying capacity of the land.

2.2 MEASUREMENT OF POPULATION PRESSURE

A number of techniques have been advanced towards the measurement of population pressure. This section presents those commonly used. Carrying capacity and consequences of population pressure are discussed in more detail because they are the ones used in the current research.

2.2.1 Crude Density (Arithmetic Density)

Crude density, or what is popularly termed as arithmetic density, is the ratio of people to a unit of land area. It is the most frequently used measure of population distribution. This is probably because the aggregate data required to compute it are always available from government population census and land reports. Arithmetic density is, however, most useful when applied to small statistical areas. When used at regional or national scales, the statistic is misleading because it conceals the areal variation of population and resources (Sindiga, 1984).

Bernard and Anzagi (1979:23) argued that arithmetic densities alone cannot lead to conclusions about population pressure even when dealing with small areas. To this Hance (1972:40) added that

> Taken by themselves, crude density figures cannot be used to adduce pressure of population or lack thereof even when relating one local density figure to another

In fact, Hance argued that the persistent use of the arithmetic density by scholars is responsible for the popular but erroneous notion that large parts of Africa do not suffer from population pressure.

2.2.2 Physiological (Nutrition) Density

Physiological or nutrition density is the ratio of total population in a given area to the amount of arable land in the area. According to Trewartha (1979:23), physiological density is a more accurate measure of population pressure than crude density since it "eliminates from the denominator barren areas and others like hills and steep slopes which are not suitable for agricultural production".

The problem with physiological density technique is that it assumes that non-arable land is not in productive use. Moreover, it is difficult to define what is arable in light of varying ecological potential. Again, actual land productivity will depend on farming technology which also varies from one community to another. Trewartha (1970;74) succinctly summarized the problems of physiological density as follows:

> It errs in eliminating all productive non-arable land, including forests, wild pasture, mining land, and scenic areas. It likewise does not recognize the great variations in output of various arable lands having different climates, soils and drainage characteristics.

Trewartha was convinced, however, that physiological density provides better indicator than does arithmetic density of the degree of crowding in a region compared with its physical potential for producing food and agricultural raw materials (Trewartha, 1970:74).

2.2.3 Agricultural Density

Agricultural density is a further attempt to refine the population-land ratio. It is expressed as

$$\frac{\text{Agricultural Population}}{\text{Cultivated Area}}$$

Agricultural density as a measure of population pressure has a number of limitations. Agricultural density compares people in an area with only that portion of land which is cultivated. The measure is limited in the sense that all people in a given region are assumed to be cultivators. Furthermore, the varying ecological potential from one area to another and differing farming practises make comparison of population pressure of one place and another difficult. Both physiological density and the agricultural density are too limited in focus and are unsatisfactory measures of population pressure (Sindiga 1986:26).

2.2.4 Equilibrium and Optimum Population Density

As already noted, population pressure is an imbalance between the numbers of people and the resources which support them. This view implies a specific figure or range

of densities whose bounds represent some balance between numbers of people and supporting resources in a given area without deterioration of environment. Thus population and resources can be said to be in some form of equilibrium. This equilibrium is often described as the optimum population density or population optimum (Grigg, 1976).

Optimum population density is the population at which with given resources and a given technology output per head is maximized (Grigg, 1976:140). Ideally a community could maintain the equilibrium once the optimum population has been attained. Should numbers of people increase beyond the optimum, the total output will continue to increase but the average output per person will decline; and so too will the marginal productivity (Grigg, 1976:140). At this point, a community is said to be suffering from population pressure.

The problem with the technique is that the optimum population density is difficult to define or measure and assumes no changes in either technology or resources. While the concept is attractive to use, it cannot be meaningfully defined (Steel, 1970:4). For instance, maximization of output per head "depends upon external needs of a population as well as their internal expectations and perceptions" (Anzagi and Bernard, 1977:4). Peoples' expectations about the standards of living and their perception about the future are, however, ever changing (Mabogunje, 1970).

Despite these criticisms, the concept still is popular (Bernard, 1977). Optimum density is a useful tool, even if in practise there are difficulties with its measurements. The persistence of the concept of optimum population density might be attributed to the increasing role of planning in the modern world where optimal allocation of scarce resources is a central consideration (Browning, 1970:71).

Attempts to measure population optimum suggest that there is some equilibrium state which would be upset by further population increase to cause overpopulation. But both optimum population and overpopulation lose meaning because they raise numerous difficulties in definitions. Optimum population appears to be an elusive measure in a dynamic world with constant changes in technology, economy and social relations. Browning (1970:75) stated that

> So dynamic is the relationship between population and resources that the notions of equilibrium and disequilibrium lose much of their meaning, for it is only during short periods that equilibrium states can be maintained.

The idea of equilibrium can only be supported with diachronic data (Sindiga, 1986:28). However, such data are not easy to get. Like crude density and agricultural density, optimum population density are unsatisfactory indices for population pressure (Sindiga, 1986:28).

2.2.5 Carrying Capacity

Applied research for rural development planning in Africa almost inevitably raises the question of how many people and how much of their activity a given tract of land can support at a given level of technology. Development planners attempting to improve productivity in East Africa have often applied the concept of carrying capacity to assess the present and potential man-land relationships and to plan accordingly. In colonial times governments wanted to know how many people could live in an area without environmental deterioration or how many workers could be drawn away from an area without depleting the area's productivity (Porter, 1978). Now carrying capacities are computed either as an initial point of departure in rural development planning or as the culmination of a regional development plan. The intention of modern carrying capacity modeling is "to achieve a prefered maximum density of population which can be supported in each vegetation - soil region of the country without damage to the land" (Bernard, 1986:1).

The concept of carrying capacity has been borrowed from wildlife biology and range management where it has been applied to the management of wild and domesticated animal populations. Wildlife biologists know, for example, the capacity of the rangelands for various species of herbivore. Knowing the specific carrying capacity, biologists can manage the resource base through the adjustment of predator or hunting pressure or by altering habitat conditions.

Carrying capacity is a venerable idea in geography, although many in the discipline have been dissatisfied with the way it has been measured (Clarke, 1965). Carrying capacity is defined as the maximum number of people and the level of their activities an area can sustain in perpetuity at an acceptable quality of life without resource deterioration (Bernard, 1986). Allan (1965:89) stated that:

> For every area of land to which a given system of land usage is applied, there is a population limit which cannot be exceeded without setting in motion the process of land degradation. This limit may be termed the critical population or carrying capacity for that system of land usage.

Carrying capacity recognizes that all habitats have a finite assimilative capability. In theory when this upper limit is violated, an environmental decline sets in, ultimately leading to food shortages. Few would deny that the earth and its regions have limits. Carrying capacity is a quantitative expression of such limits.

A number of scholars have applied the concept of carrying capacity to the study of population-resource relationships. Before examining the applications, it should first be mentioned that carrying capacity research has not always had a strictly applied purpose. From the very early times much research on carrying capacity focussed on paleotechnic systems of shifting cultivation because of their relative simplicity and their self-sufficiency (Brush, 1975). Studies in this genre include Carneiro's (1960) work in Latin America, that of Conklin (1959) and Gourou (1966)

in Southeast Asia, and Rappaport's (1968) Study of the Tsembaga of New Guinea. Zubrow (1975) and Bayliss-Smith (1974) used the concept to estimate aboriginal or pre-historic populations. In none of these studies is carrying capacity an end in itself. In all cases the outcome is more theoretical than applied.

On the African scene, Allan (1949) computed carrying capacities for different regions under the shifting cultivation system known as, citemene, in Northern Rhodesia (now Zambia). He used his results to recommend resettlement of people from overcrowded areas.

Allan's formula required three pieces of data: the "cultivation factor" (C), or the cultivated area needed to support one person; the percentage of land in the area that is fit for cultivation (P); and the land use factor (LU), defined as the total number of "garden areas" or fields required to keep one field continuously under cultivation. The area required for one person is determined by combining the above variables in the formula 100CLU/P where:

$$C = \frac{\text{Cultivation Period + Fallow Period}}{\text{Cultivation Period}}$$

where C = Cultivation Factor

LU = the mean acreage in cultivation at any one time per head of population.

P = the cultivatable percentage of the type (that is soil and land)

$$\text{Critical Population Size} = \frac{X}{(100\ \text{CLU})/P}$$

where X = total land area available to the community.

Allan (1965:291) noted that land requirements of a wholly pastoral society can be determined by two factors, namely: the number of livestock needed for individual or family subsistence, and the stock carrying capacity of the pastures.

Another study which used the carrying capacity method was that of the Relief and Rehabilitation Commission in Ethiopia (Brown, 1975). This Commission was appointed at the end of 1968-73 Ethiopian drought to recommend measures for the long-term rehabilitation and rural development of Wollo and Tigre provinces and other parts of the country that had been devastated by the drought.

The mission constructed ecological and topographical profiles for the two provinces. The classification yielded eight major ecological zones. The mission then defined the agricultural potential of each zone, noting in particular the principal factors likely to hinder agricultural development. The next step was to work out the availability of arable land on the basis of the ecological conditions. Further, using the ecological and topographical criteria set

forth, the mission worked out crop and animal combinations for each zone and possible average yields. The final outcome of the analysis was theoretical carrying capacities or "safe maximum population densities per square kilometer".

This mission used these data together with the projected population growth rates to predict areas which would suffer from famine for the next decade. The assessment was used to recommend ameliorative measures and identify viable future development programmes. Among its major recommendations was a call for flexible land tenure system taking into account social and ecological conditions, encouragement of existing large productive farming schemes, reaforestation of wider catchment areas, and greater coordination of development activities by the various departments of government and semi-autonomous agencies.

Carrying capacity was also the methodology employed in studying cultivation and settlement in three villages of Upper Volta (now Burkina Faso) and Niger in West Africa by Reining (1973). These villages, representing three major ethnic communities, had relatively high population densities and suffered considerably from the 1968-73 drought (Reining, 1973:15). Reining's work at the three sites initially undertaken during the summer of 1973 also was prompted by the ravages of the 1968-73 Sahelian drought.

She used Landsat imagery interpretation and fieldwork to study the three relatively closed farming communities. The research was designed to yield estimates of the numbers of people that could be supported by the land resources of each of the villages. Allan's method to compute carrying capacity was employed. One of the problems which Reining encountered was that certain villagers also cultivated land further away from where they lived. In addition, some villagers especially adult men, were absent from home, reflecting seasonal migrations. Reining's calculations were adjusted to account for these circumstances. The results showed that one village had a higher population than postulated by her carrying capacity model, the second had a lower population, while the results from the third site were inclusive (Reining, 1973:18). She cautions however that although her study sites represent a range of environmental and socio-cultural conditions, they were not randomly selected. In general, Reining found Allan's method to be suitable for her study sites. In particular, she recommended systematic fieldwork as a way of establishing "ground truth" on population pressure.

In East Africa Moore (1971) estimated carrying capacities for various districts of Tanzania following a methodology earlier developed and applied by Cunningham (1968). Cunningham calculated land carrying capacities for various ecological zones of mainland Tanzania. He assumed a

minimum gross income of 8,000 shillings per family to be provided by cultivation and/or livestock husbandry. He then computed the potential family farm size in each ecological zone. Cunninghan's analysis is qualified in the sense that land unfit for cultivation because of poor relief or shallow soils was not taken into account. Also, areas under forest and game reservations were not considered. The result of the analysis was that some districts had exceeded their carrying capacity and some had reached their optimum population. Although large parts were still underpopulated, large-scale migrations into these areas seemed imprudent because of poor physical resources.

Moore's study attempted to assess the population which each district of Tanzania could support at an adequate level of income under prevailing agricultural practises. The study assumed a gross income of 2500 shillings per standard household of five per year. Following Cunninghan's procedure, Moore worked out, per district, a population figure that would be supported from agriculture alone given a certain income and level of nutrition. He then compared this figure with the actual population density of each district as provided in the 1967 Tanzania national census report. The resulting values represented ratios of the calculated population capacity to the actual population.

Although Moore (1971:2) stressed that the results of his study were tentative, because the analysis was based on

generalized and debatable assumptions and inadequate data, he nonetheless found that overall, Tanzania had surplus land although some areas are overpopulated. Significantly, areas suffering from population pressure were not necessarily those that were most densely populated. In general, Moore found the analysis to be instructive for national development planning and for stimulating interest in population-resource issues (Moore 1971:52). Regarding the applicability of his findings, Moore (1971:1-2): noted that

> Methods used here may have relevance to the formulation of Ujamaa village plans. Of special significance are land requirements for households. This may be used as a basis for planning village sizes and structures. Population-land ratios may be used for deciding the priorities for implementing agricultural change.

At a more regional scale, Tanzanian studies by Thomas (1972) and Datoo (1973) were drawn on similar lines.

In Uganda, the Food and Agricultural Organization (FAO, 1971) conducted a preliminary national evaluation of the extent of under-utilization or unutilized potential in that country. FAO estimated land capability and computed carrying capacity to form the basis of a plan to "foster a more even distribution of development among the geographical areas of the country". Their carrying capacity estimates revealed that only about forty-one percent of Uganda's potential rural population carrying capacity was being utilized in 1969, that fifty-six percent would have been used by 1979, and seventy-eight percent by 1990. Uganda's

habitable land on the whole can support projected population increases to the end of the century.

However, the study also discovered regional disparities in certain provinces in which projected rural population increases would outstrip habitable land by late 1980's. Anyhow, what impact the chaotic political situation of the past one and half decades, under leaders like Idd Amin, has had on the land capability and carrying capacity is unknown. The FAO findings certainly require revision.

This brief review suggests that carrying capacity has value as a tool for applied resource management purposes. A number of other studies exist where carrying capacity is used both for planning and scholarly work. Studies in Kenya both by the government or international aid agencies will be discussed in chapter three. Also detailed consideration of the potentials and limitations of carrying capacity as measure of population pressure is made in Chapter Four when methodology is dicussed. The following section discusses yet another technique for measuring population pressure.

2.2.6 Consequences of Population Pressure

Another approach for investigating the dynamic nature of population pressure on resources is through describing and analyzing its consequences (Hance, 1970). Practitioners of the "consequences of population pressure" approach argue that instead of struggling for years with explanations of

optimum conditions, physiological density, and searching for universal base level definitions, research could fruitfully be undertaken in the field on symptoms of population pressure (Bernard, 1986).

A number of studies have focussed on describing and analyzing the consequences of population pressure (Hance, 1968 and 1970; Steel, 1970; Grigg, 1976 and 1980; Anzagi and Bernard, 1977). As is indicated in Chapter One, an agricultural community under population pressure will respond by either increasing its output, by utilizing the increased labour supply or by out migration if there is any place to move to. None of these may succeed, especially in the short-term. Consequently, a number of physical symptoms may occur which have an impact on both the land and the social system. Hance (1970:47) in particular developed a list of population pressure symptoms for the African situation: soil erosion and depletion, declining crop yields, use of marginal lands, changing crop emphases, reduction in fallow, breakdown of indigenous farming systems, food shortages, malnutrition, landlessness, land disputes, rural indebtness, underemployment/unemployment and certain types of migrations.

However, Hance (1970:418) pointed out that not all these symptoms need exist in an area at the same time to signify population pressure, neither do all of them necessarily signify population pressure. Nevertheless, the

occurrence of multiple symptoms in an area usually provides evidence for population pressure.

One limitation with this technique of consequences of population pressure is that many indicators require diachronic data. Because the subject has hardly been studied systematically, there is no benchmark in many African countries from which change can be measured. However, individual case studies discussing either a single symptom or handling the consequences holisticaly are available (for example Owako, 1971; Anzagi and Bernard, 1977; Hance, 1970). Further, as Browning (1970:79) noted on the effects of population pressure:

> If I were to use one word to describe the situation, that word would be scarcity. There will be a growing scarcity of land, of full and renumerative employment, of access to public services such as schools. While the production of goods and services for the community need not decline in absolute terms, the community is an expanding one.

Sindiga (1986) argued that symptoms of population pressure cannot be used exclusively to explore population pressure. He argued that effective analysis of population pressure consequences requires an historical approach where various accounts and reports are studied to gain data on past population-resource circumstances. This can help to gauge the problem at present.

In summary the review of literature has brought out a number of important points which are of relevance to the

current research. To start with, it is quite apparent from the literature review that population pressure is a complex process involving several interrelated parts (Bernard, 1977). It lacks universal definition, although it suggests a deterioration of habitats and human conditions when numbers exceed carrying capacity of the land (Zelinsky et al, 1970; Browning, 1970; Sindiga, 1986). Thus for every new investigation of population pressure, the concept should be defined operationally. But then the problem of comparability is exacerbated.

Also different techniques for measuring population pressure have been used in empirical research including crude density, physiological density, agricultural density, equilibrium and optimum population density, carrying capacity and consequences (or symptoms) of population pressure. However, all these techniques, except the last two, have been found unsatisfactory in measuring population pressure in African situation where most of the necessary data is lacking (Sindiga, 1986; Bernard, 1977; Grigg, 1980). It has also been argued that neither carrying capacity nor the symptoms of population pressure alone can be used to measure population-resource imbalance. Effective analysis of population pressure consequences require an historical approach where many various accounts and reports are studied to gain data on past population-resource circumstances.

The practitioners of consequences of population pressure have also developed a list of pressure indicators or symptoms: soil erosion and depletion, use of marginal lands, breakdown of indigenous farming systems, and rural indebtness, among others (Hance, 1970; Steel, 1970; Grigg, 1980). These symptoms, however, need not exist in an area at the same time to signify population pressure but their combination in an area provides evidence for population pressure.

Empirical researchers cited in this literature review have also brought out one very important fact: areas suffering from population pressure are not necessarily those that are densely populated (Moore, 1971; Reining, 1973; Allan, 1965). Thus population pressure may occur where overall population densities are low.

On the basis of the literature review and the objectives stated in Chapter One, section 1.3, a number of hypotheses are formulated for this study.

2.3 HYPOTHESES FOR THE STUDY

In order to achieve the four objectives of the study stated in section 1.3, four hypotheses are formulated and tested.

Hypothesis 1

The first objective of the study is aimed at exploring the roots of the population pressure problem in Kitui district. In response to this objective, the first hypothesis is

> that population pressure in Kitui district is not a recent phenomenon.

That is, the problem has developed over time. It is therefore hypothesised that distinct historical events in Kenya and in Kitui district can explain the roots and the past trends of population pressure in the latter. Such events as colonial intervention, political land alienation, land consolidation and demarcation, population growth, reduction in the amount of agricultural and grazing land and others have repeatedly been cited by researchers as satisfactory explanatory variables for emergence of population pressure in Africa (Sindiga, 1984 and 1986; Campbell, 1986; Grigg, 1980). These variables are assumed to be significant in this study.

Hypothesis 2

The second objective of the study is aimed at computing carrying capacities for the different administrative units in Kitui district with an aim of identifying the areas which have reached and exceeded their carrying capacities and which have not. A corresponding hypothesis for this objective is

> that there are no significant differences in population pressure between the five administrative divisions of Kitui district.

Some studies have suggested that areas with low population density, like southern division, parts of eastern, and Kyuso divisions of Kitui district, may experience more population pressure than high density areas, like the central division and parts of Mwingi division in Kitui (Moore, 1971; Reining, 1973; Allan, 1965). This presupposition is also tested.

Hypothesis 3

The third objective is to investigate the impact of population pressure on the environment as well as on human conditions. The hypothesis formulated in response to this objective is

> that contemporary population pressure in Kitui district has led to the following social and economic implications: land shortages, land fragmentation, declined crop yields, and malnutrition.

These symptoms have been cited as the main indicators of population pressure (Hance, 1968 and 1970; Steel, 1970; Anzagi and Bernard, 1977). Also, it is hypothesised that

> there is no significant difference between the three Ecological zones in terms of population pressure indices.

Hypothesis 4

The fourth objective of the study is to identify the factors responsible for high population growth in Kitui district. The hypothesis formulated for this objective is

> that the main factors which determine high population growth in the district are: strong cultural practises, lack of demand for modern contraception, high birth rates, and ineffective Government population policy.

Odile and McNicoll (1987) pointed out that these are the major determinants of population growth in Africa.

The detailed methods, on how data used to test these hypotheses were collected, are discussed in the methodology Chapter Four. The following chapter provides some background information on the study area.

Chapter III

BACKGROUND INFORMATION

The purpose of this chapter is to provide some background information about the study area. The chapter focuses on three main themes. First, background information on Kitui district, in terms of its location in Kenya, size, ecological potential and demographical characteristics is presented. Second, the emergence of population pressure in Kenya in general is examined. Finally, an attempt is made to trace the origins and development of population-resource problems in the arid and semi-arid lands of Kenya. This is considered necessary because Kitui district, the study area, is classified as a marginal region (Jaetzold, 1983).

3.1 LOCATION AND SIZE OF KITUI DISTRICT

Kitui district is located in the Eastern Province of the Republic of Kenya. It lies approximately between 37 degrees 45' and 39 degrees East; 0 degrees 3.7' and 3 degrees South (Figure 3). It borders with Machakos district to the west, Embu and Meru districts to the north, Tana River district to the east and Taita-Taveta districts to the south.

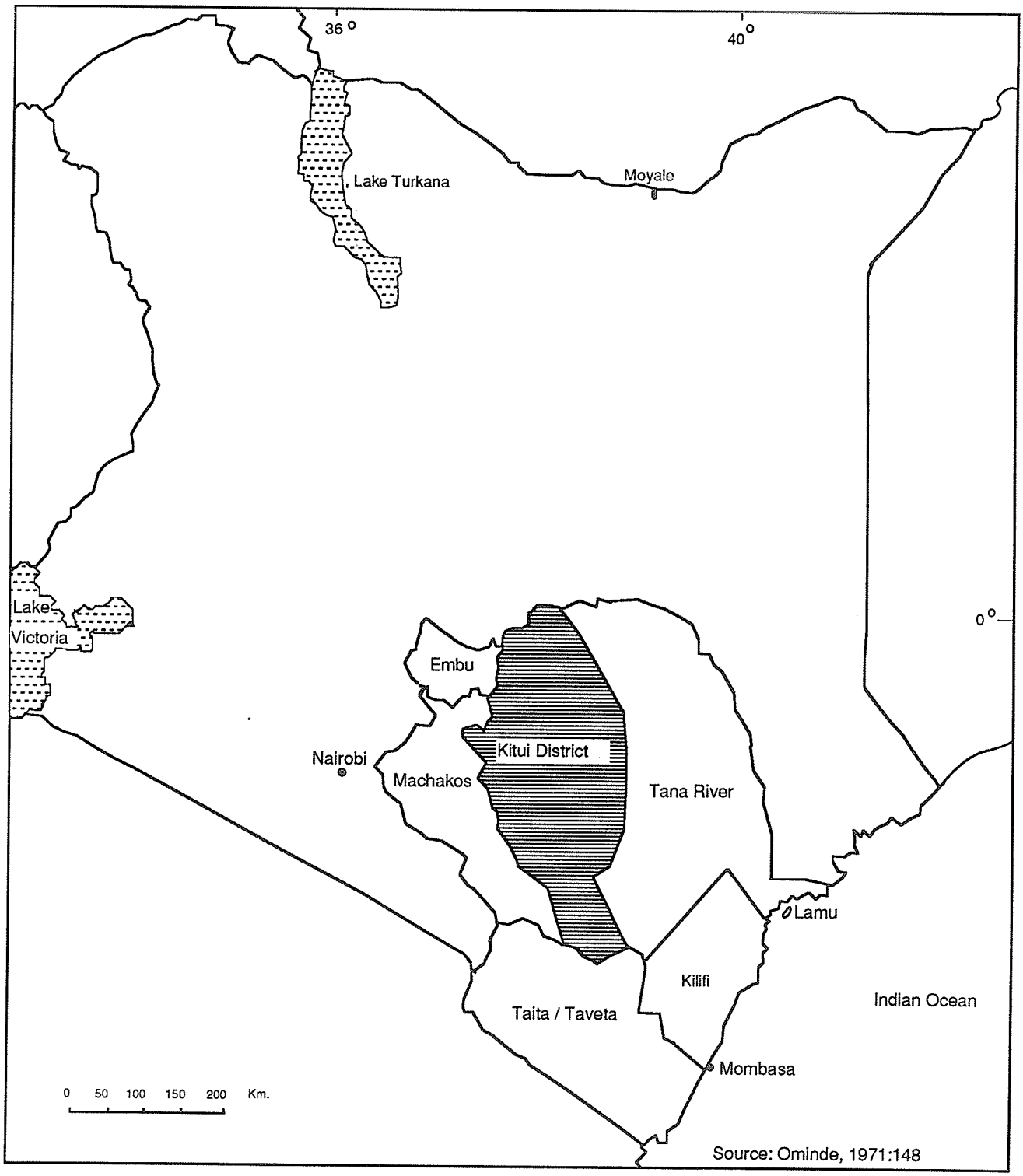

Figure 3: The Location of Kitui District in Kenya.

The total land area of Kitui is 22,814 square kilometers, excluding Tsavo National Park in the southern part of the district. The district is divided into five administrative Divisions namely: Mwingi, Kyuso, Central, Eastern and Southern, twenty seven Locations and a hundred and eighty Sub-locations. There are two local authorities, Kitui county council and Kitui town council.

3.2 ECOLOGICAL AND RESOURCE POTENTIAL

Kitui district has been classified as one of the arid and semi-arid lands of Kenya (Jaetzold, 1983; Woodhead, 1968). Figure 4 shows that the central and eastern parts of the district, i.e around Kitui and Mutitu hills and extending north of Mumoni hills, receive 510-760mm of rainfall per annum. Within this area, Mulango, Nzambani, Kisasi, Miambani, Changwithya, Matinyani, Mutonguni and Migw'ani locations receive 760-1015mm of rain a year. The rest of the district (except Endau hills which receive 510-1015mm) receives 225-510mm of rain a year.

This low amount of rainfall makes crop production very marginal and risky since during most months the rains do not supply adequate moisture to meet crop growth requirements. In addition, much of the rain is torrential and of short duration, causing much run-off and flooding. This exacerbates the problem of soil erosion.

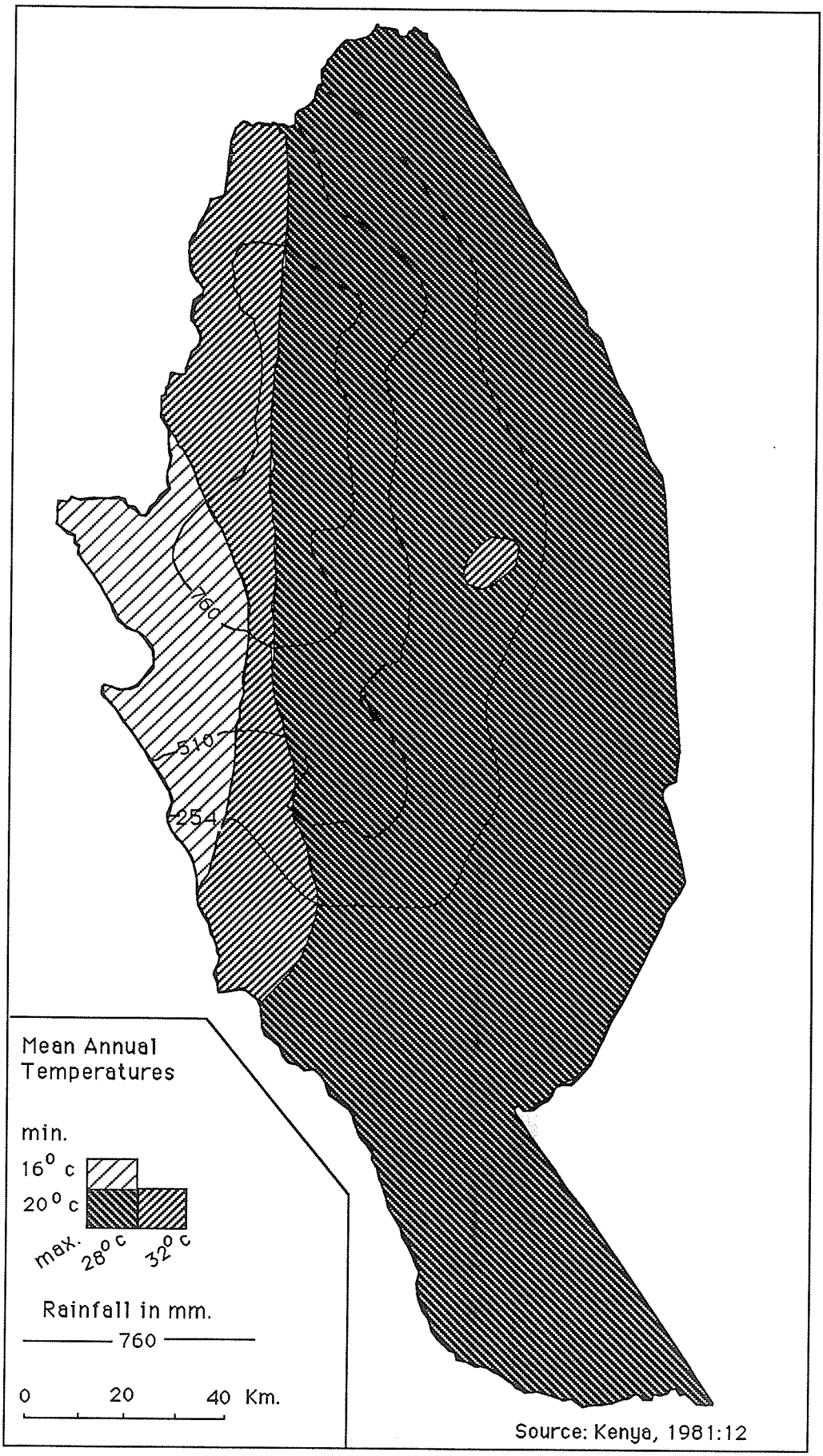

Figure 4: The Climatic Divisions of Kitui District.

Also as a result of high temperatures, which vary from 26-34 degrees centigrade in the eastern part (Kenya, 1981:15), evapotranspiration is very high throughout the year. Given the fact that more than 90% of the rural people are poor peasant farmers who cannot afford water storage facilities, lack of water is a major problem of development. During dry periods, most people have to walk distances of up to 24 kilometers in search for water. Water for both livestock and domestic consumption is supplied by wells, weirs, earthen dams, rock catchment and springs. Only about 3% of the rural population in the District is within reach of piped water (Kenya, 1988).

On the basis of soil moisture, natural vegetation, and evapotranspiration, Kenya is divided into six main ecological divisions (i.e ecozones I to VI). Ecozones I to III are of high agricultural potential, ecozone IV of Medium potential, and ecozones V and VI of low potential. Only three of these occur in Kitui district, namely, ecozone III, ecozone IV, and ecozone V (Jaetzold, 1983). Ecological zone III (the high potential) covers only 2.2 per cent of the land in Kitui district (Figure 5). This zone has a moisture index of -10 to -20. Agricultural production is quite feasible, although cases of crop failure due to loss of moisture through evapotranspiration, especially during years of low rainfall, have been reported in the past (Kenya, 1981:24). The vegetation in this zone is varied, consisting

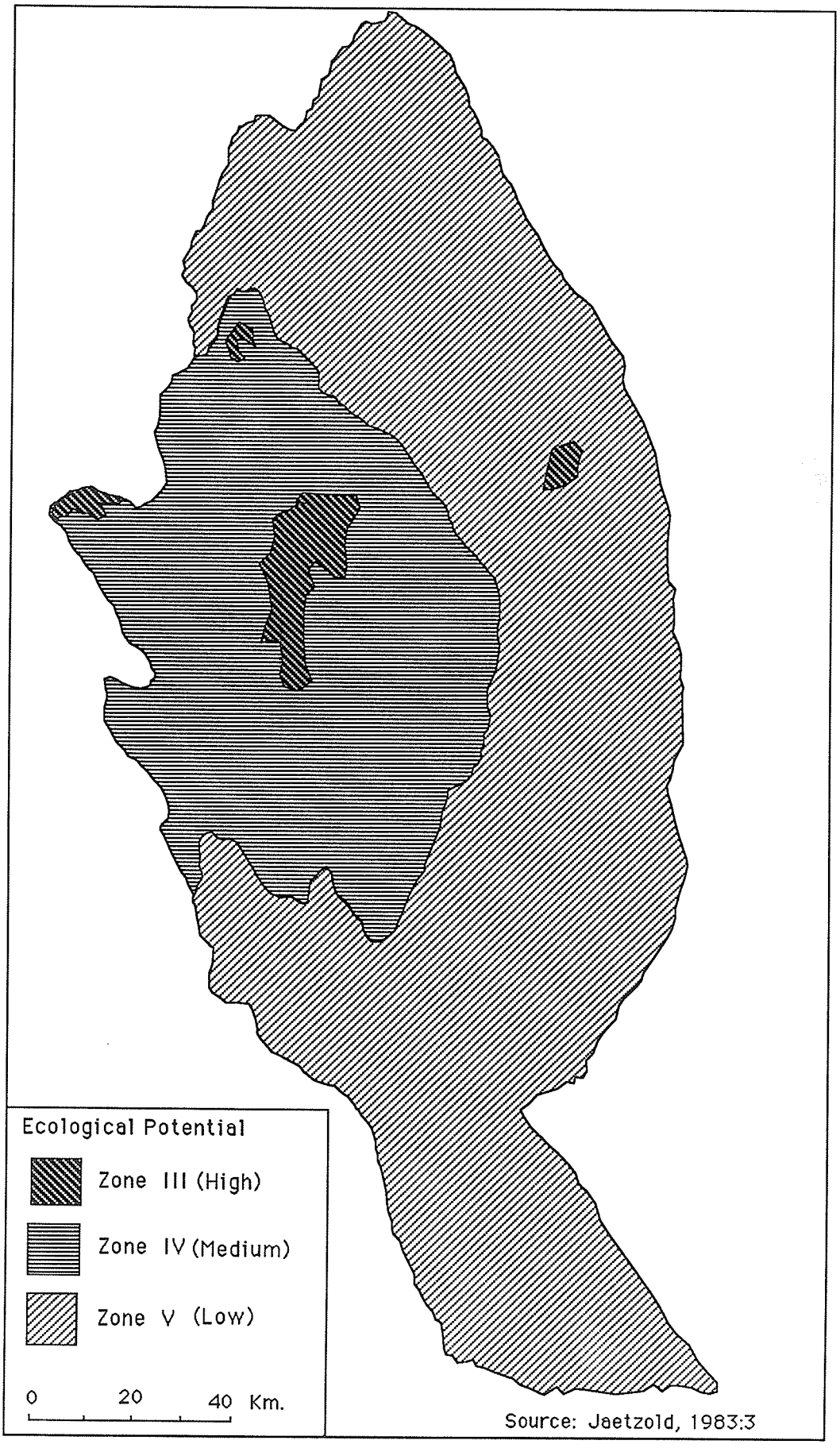

Figure 5: The Ecological Potential in Kitui District.

of moist woodlands, bushland or savannah. The trees are mainly broad-leaved, for instance combretum, and large shrubs mostly evergreen. Ecological zone III occurs mainly in Central Division, and in patches in Mwingi Division.

Ecological zone IV covers about 36% of Kitui district, and is moderately suited for rain-fed agriculture. It has a moisture index of -30 to -42 (Kenya, 1981). It consists of dry forms of woodland and savannah (often Acacia Themada association) or derived semi-evergreen or deciduous bushland. It has high potential for rangeland and has a stock carrying capacity of less than 4 hectares per stock unit[4] (Kenya, 1981). This zone occurs largely in Central and Mwingi Divisions and in isolated pockets in Kyuso and Eastern Divisions.

More than 68% of the total population in Kitui district live within the ecological zones III and IV (Figure 6). More than half of the 68% live in the high potential ecological zone III.

Ecological zone V covers over 60% of the district and is of low agricultural potential. The low potential areas can be divided into two: First, those that get 254-508mm of rainfall per annum. The lack of rainfall in these areas is more probable than in the medium and high potential zones.

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[4] A stock unit is a standardised animal unit by which animals of different ages, types or species are compared (Pratt and Gwynne, 1977:279). It can be carcass weight or weight of an animal on foot.

Five out of eight seasons get less than 254 mm of rainfall resulting in crop failure. These areas may be better utilized by growing drought resistant crops such as pigeon peas, sorghum and sunflower, using soil and water conservation methods (Kenya, 1980:4).

The second category of low-potential areas of Kitui are those which get less than 254mm of rainfall per annum. Here, risk of crop production is very high. Six out of eight seasons get less than 254mm of rainfall and hence the regions are not suitable for rain-fed agriculture. The vegetation is mainly woody, being dominated by Comiphora, acacia and allied genera. Perennial grasses such as Cenchrus ciliaris and Chloris roxyburghiana are dominant. Owing to the unreliability of rainfall and poor methods of farming and storage of agricultural produce, several famines have occured in many parts of the marginal areas of Kenya. For instance, Table 3.1 presents such famines and other events in Kitui District.

Despite recurrent famine and water problems, among other difficulties in Kitui district, the population has continued to grow and increase pressure on supporting resources. Yet, there has hardly been any research carried out in this area to study the problem. Lack of information regarding the magnitude of population pressure in Kitui, and in other areas of similar ecological conditions remains a major problem of development (Sindiga, 1986; Mutiso, 1975; Livingstone, 1986).

TABLE 3.1

Famine and Other Hazards and Events in Kitui District

1878	- A prolonged famine in Kitui district; many people migrated from Kitui to the neighbouring districts in search of food.
1894	- Rinderpest; many cattle died.
1908	- Famine
1917	- Cerebral-spinal meningitis invaded the district.
1924	- A great famine.
1929	- Famine.
1930	- Famine. This year people were busy digging dams.
1942	- There was a great famine which extended up to Kikuyuland. The only crop available was cassava, and this helped people not only in Ukambani but in Central Province.
1944	- Locusts invaded the district, and a prolonged famine followed.
1946	- Famine.
1950	- Famine.
1952	- Mau Mau oath-taking and declaration of emergency in Kenya.
1961	- Transportation of famine relief by air; heavy rains and much flooding in the district.
1963	- Kenya's independence
1965	- Famine.
1966	- Kitui people were buying food from Masinga in in Machakos.
1970	- Famine
1984	- Drought and Famine

source:
Based on District information and Kenya (1981:137), Kitui District Environmental Assessment Report.

The following section attempts to provide some information on the demographic characterestics of Kitui district.

3.3 DEMOGRAPHIC CHARACTERESTICS

The demographic situation in Kitui district is one of the most alarming in Kenya. The 1969 census recorded 342,953 persons in the district, with an annual growth rate of 2.8 % per annum and an overall density of 15 persons per square kilometer (Kenya, 1969). According to the 1979 census, Kitui had 464,283 persons and an overall density of 20 persons per square kilometer (Kenya, 1979a). The total population in the district is currently estimated at 640,304 persons and has an annual growth rate of 3.8 per cent (1989 estimates from Kenya, 1979a census). The average density is about 30 persons per square kilometer. This density varies considerably from over 100 persons per square kilometer in central division to under 30 persons per square kilometer in parts of Kyuso, Eastern and Southern divisions (Figure 6). Table 3.2 presents the population growth for the two decades 1969 to 1989.

It should be added that Total Fertility Rates in Kitui have been also high. In 1969, the overall rate was in the range of 11.97 for the 30-39 age-group to a low of 7.96 for the 25-29 age group throughout the district (Kenya, 1969). In the 1979 census, the fertility rates were still high with a mean of 9.37 for the whole district (Kenya, 1979a). Recent reports, however, indicate that Total Fertility Rates in Kenya have now declined to 6.7 lifetime births per woman

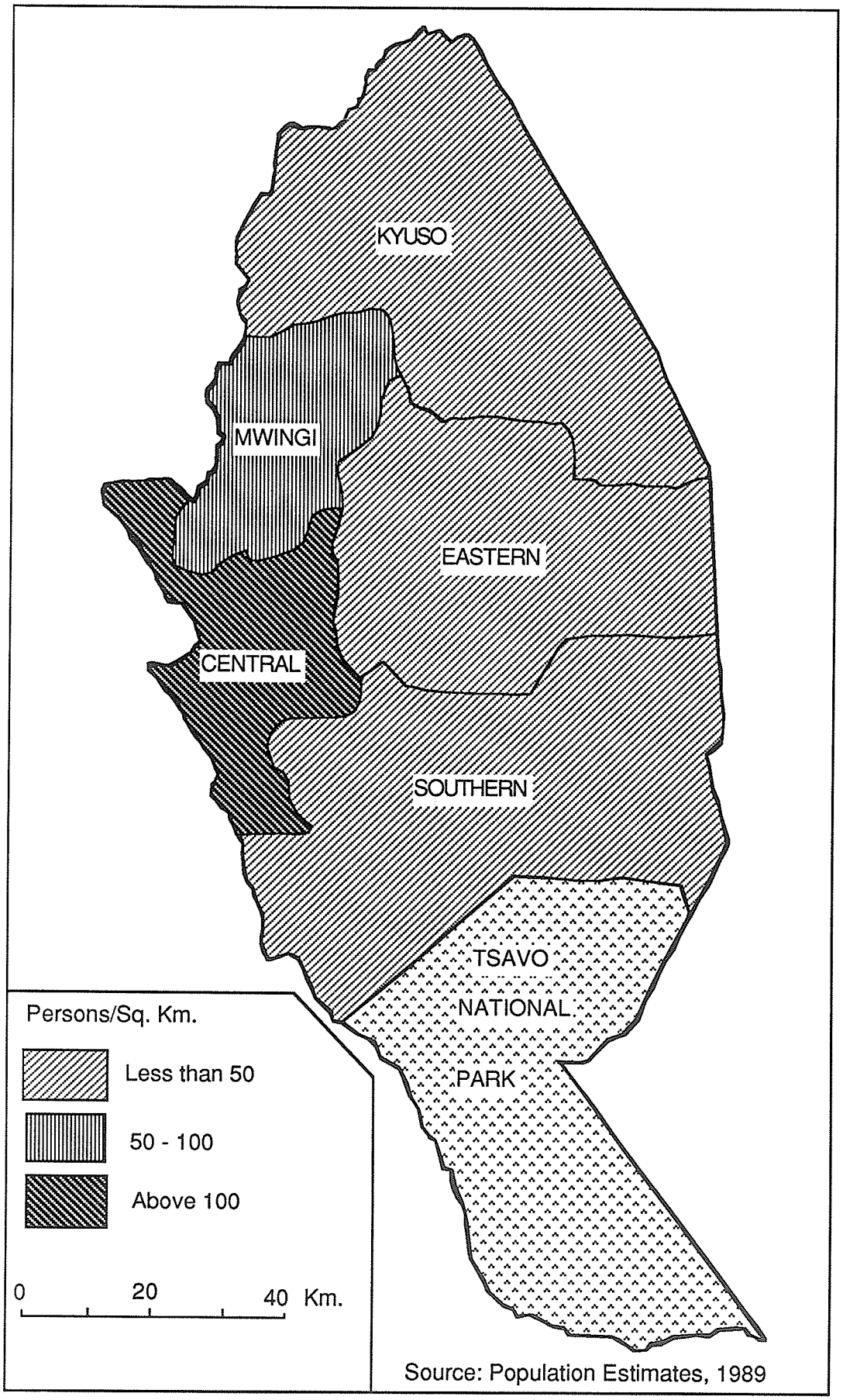

Figure 6: Population Density by Division in Kitui District.

TABLE 3.2

Population Growth by Division 1969 to 1989

Division	1969	1979	1989 (estimate)	Growth % p.a. 1979-89
Central	111,853	158,667	232,606	4.7
Eastern	36,062	49,665	69,416	4.0
Southern	56,182	73,857	95,594	2.9
Mwingi	80,854	109,880	149,225	3.6
Kyuso	54,848	72,214	93,463	2.9
Kitui (Total)	342,953	464,283	640,304	3.8

Source:
Compiled from Kenya (1969 and 1979a) Population Census.

(Population Reference Bureau, 1989b; Weekly Review, september 22, 1989).

By moderate estimates, the district's current population will exceed one and a half million people in the next twenty years. Thus, the population will more than double in this short period. This figure of one and a half million people does not, however, seem excessive or startling, especially for a district of 22,814 square kilometer in area, until one realises that more than 60% of the district is not suitable for rain-fed agriculture. If we also consider the fact that nine out of every ten people in Kitui district earn their living from agriculture, and if we assume that the current farming technology (simple

subsistence traditional tillage) is to continue for a long time, which is very likely, then this aggregate population is certainly high.

Field observations throughout the study area confirm that population pressure symptoms have now become conspicuous in the district: land fragmentations and subdivision, food shortages, malnutrition, and diseases are widespread. Moreover, the average land holdings per capita ranged from 2 hectares in some parts of Mulango, Changwithya, Nzambani, and Matinyani locations of Central division to about 4 hectares in parts of Eastern and Mwingi division in 1980 (Kenya, 1980).

More recently, Livingstone (1986:10) estimated the availability of good agricultural land in Kitui at 0.5 hectares per person. As a result of land subdivision and fragmentation, food production has declined considerably and famine relief has become a recurrent Government expenditure. For instance, the Government gave out 45,907 and 8,070 bags of maize and beans as famine relief in 1976 and 1977 respectively (Kenya 1980). At the same time, 904 destitutes from the whole district were referred to the Department of Social Services in 1977/78 period (Kenya 1980:32).

Between 1976 and 1978, a total of over 15,000 cases of malnutrition were attended at various health facilities in the district (Kenya 1980:34). The main causes of

malnutrition was a diet low in protein which resulted in kwashiorkor, marasmus and starvation (Kenya, 1980:35). Although these statistics refer to a situation existing more than ten years ago, no significant changes have occured; if anything the situation has deteriorated

All these cases are a reflection of population and resources imbalance (or population pressure) in Kitui district. As will be noted in the following two sections 3.4 and 3.5 and in Chapter Five, the population pressure problem in Kenya has a long history dating from the colonial period.

3.4 EMERGENCE OF POPULATION PRESSURE IN KENYA

Population pressure in Kenya began during the colonial period following land expropriation for European settlement (Sindiga, 1986). As the European settlers came into the Kenya highlands during the decade 1900-10, the administration saw that it would have to take steps to 'protect' the existing land-rights of the Africans while making room for the immigrants. It therefore took possession of 'empty lands' and created reserves for Africans (Munro, 1975:77).

The settler pressure, however, quickly altered this protective device into one of throwing the largest possible area open to European farming (Sorrenson, 1968). In drawing up reserve boundaries, administrative officials lacked any

clear idea about the kind of occupation which should carry unalienable rights. The policy did not take into consideration the African custom of moving annually with the intention of returning periodically to any given area. Neither were the officials capable of determining the amount of land required for the Africans. They did not realize that although land was not demarcated or registered, there was an individual right of occupation in a definite holding so long as it should be used definitely.

Thus, bringing with them European concepts of rights over fixed areas of land, they were ill at ease in an area where greater flexibility in land distribution prevailed and where, with shifting cultivation and transhumance pastoralism, the land over which rights were exercised could change over a period of time. As a result of the low African population at that time and their nomadic way of life, there was misconception of an "empty land" on part of the settlers.

The better-watered lands in the limited highland portion of the country were alienated for European settlement. The settlers obtained rights to land through the 1902 Crown Lands Ordinance (Munro, 1975).

In some of the highland areas, Africans were left with no more than small patches of land here and there while others were forced to occupy semi-arid and arid lands

(Munro, 1975; Odingo, 1971). Dispossessed of their land, a considerable number settled on the European farms as squatters or labourers. In the reserves the African population quickly multiplied and population pressure ensued: overcrowding, soil erosion, low farming productivity, and lack of socio-economic services and opportunities were common (Odingo, 1971; Sindiga, 1986).

Recognition of these problems led the colonial government to establish a Commission to look into land problems in the colony (Great Britain, 1934). This Commission approached the problem of population and resource relationships from a tribal standpoint, attending to claims and counter claims of various ethnic groups with regard to land. It did nothing to alleviate population pressure in the African occupied lands.

Population-land problems continued into the 1940's until the then colonial governor of Kenya, Sir Philip Mitchell, once again drew the attention of the British government to population problems. This led to the formation of the East African Royal Commission (1952-1955) to probe population pressure not only in Kenya but in East Africa as a whole.

On his despatch to London in 1951, Sir Philip noted that the "rapid but at present not exactly known rate of increase of parts of the African population has led to acute

local congestion on the land and excessive pressure of people and livestock in some districts..." (Great Britain, 1961:2). He further wrote that farming systems, even in the most ecologically favourable areas, were providing a low standard of living "little above bare subsistence" and could not continue without seriously degrading the land. Mitchell noted that the population was increasing in the most favourable areas at the rate of two per cent per year, thus straining the carrying capacity of the land to the utmost.

The Commission down-played the population pressure issue (Steel, 1970), although it noted several trouble spots in Central Province and Machakos district and recognized overgrazing problems especially in low-potential areas (Great Britain, 1961). The Commission disputed Sir Philip Mitchell's population growth rate of 2% per annum as it found no statistical evidence to substantiate it.

Two other studies by Norman Humphrey (1945) are among the earliest to refer to population pressure problem in Kenya. Humphrey, using carrying capacity modelling, addressed the problem of overpopulation and deteriorating landscapes in the Kikuyu-occupied lands in the Central province of Kenya. Later, during the Mau Mau rebellion, under extraordinarily stressful circumstances foretold by Humphrey, population pressure became the basis for a plan to intensify African agricultural development.

Another early study focussing on the problem of population pressure and rural development was the Swynnerton Agricultural Reform Commission of 1955. The purpose of this Commission was to study ways of modernizing African farming, and raise standard of living while conserving natural resources. The Swynnerton plan, as it came to be known, was based upon a map of ecological zones. Minimum farm sizes for each zone were computed. These were intended to provide an average family subsistence and a cash income within the capabilities of the land to support them. From this plan the government proceeded to implement a massive redistribution of population through land consolidation and resettlement and later promoted technological improvements such as dairying, cash crops, and irrigation.

The Swynnerton plan, however, focussed on the problems of population in the high potential areas and gave little attention to the drier parts of the country. Nonetheless, as white settlers abandoned farming in Kenya in the early and mid-1960's, ecological zonation, farm planning based on minimum farm sizes to obtain subsistence and cash income, and carrying capacities became the basis for resettlement of more than 30,000 landless Kenyan families (Carey-Jones, 1965).

By the time of independence in 1963, some of the Swynnerton plan's recommendations were still being implemented. Population pressure in the highlands was not

solved. The newly independent government took to land redistribution to alleviate the problem of population pressure and overcrowding, not only on former European settler lands, but also in adjacent areas (Carey-Jones, 1965). However, this program has not alleviated population pressure in most of the districts and demand for more land continues to be voiced.

A number of planning studies in the post-independence period have focussed upon carrying capacity as a way of quantifying population pressure in Kenya (IBRD, 1973; Kenya, 1973a). The World Bank mission inquiring into Kenya's agricultural sector found population pressure to be worsening as "the pressure on land is increasing, people are moving into marginal areas..." (IBRD, 1973: 13-14). As part of their study of the agricultural situation, the team computed carrying capacities at the provincial level (Table 3.3). The mission assumed current technology and use of family labor. The minimum acceptable annual income per family was taken to be Kenya Shillings (KES) 1,400, enough to give subsistence and cash for essential purchases at 1972 prices. Table 3.3 also shows how the rural population compares to the maximum carrying capacity by province. The difference between the actual and potential carrying capacity provides a quantitative index of population pressure for the year of study.

Table 3.3 also shows that only in the Rift Valley and Coast provinces was land underused at that time. But most of the underused land in these two provinces is not readily

TABLE 3.3

Kenya Provincial Carrying Capacities, 1973

Province	Present Rural population (millions)	Estimated population which could obtain KES.1400 Annual Income	Difference (millions)
Western	1.44	1.34	-0.1
Nyanza	2.4	1.56	-0.84
Rift Valley	2.3	5.0	2.7
Central	1.8	1.8	0.0
Eastern	2.0	1.7	-0.3
Coast	0.75	2.0	1.25
N. Eastern	--	--	--
Total	10.7	13.4	2.7

Source: World Bank 1973:31

accessible to settlement as it is Trustland.[5]

The rest of the results indicate population pressure in the other provinces of the country.

Another national assessment of population-land problems which has attributed Kenya's recurring and worsening problem of rural squatter settlements to "overpopulation" in high

[5] Trustland in Kenya is land which has not been gazetted or allocated on title. Authority to manage such land is vested in the local authorities (county councils) for the benefit of present occupants. The Central government lands department however acts as the final arbiter.

potential farming areas is by Mbithi and Barnes (1975). To arrive at this conclusion, the authors borrowed carrying capacity estimates from regional physical development plans designed in the early 1970's. These estimates assumed that each household would provide its own food requirements plus a net yearly income of KES.2,000.

Carrying capacity in this regard drew attention to the emerging Kenyan population-land problems. Mbithi and Barnes noted that at present levels of technology, "... there is insufficient land in Kenya to provide for all or even most of the children of the present generation of farmers. The conventional assumption that Kenya has great sections of land which can absorb her increasing population under constant technology is erroneous" (Mbithi and Barnes, 1975:9).

Campbell (1986) using Kajiado data, constructed a table showing the date at which Maasai livestock population would outstrip the carrying capacity of the District. If all Kajiado lands were available for grazing and traditional and intermediate rangeland technology are assumed, "overpopulation" of livestock and dependant human systems began in the district in 1983 (Campbell, 1986:33). At progressively higher levels of technology, "overpopulation" will occur sometime between 1984 and 2016. Campbell concludes that the process of desertification will inevitably follow if systematic attention is not paid to Kajiado's rapidly changing man-livestock-land ratios.

Another study, Rift Valley Province Regional Physical Development Plan (Kenya, 1973b), computed the carrying capacity for each district in the province in the year 2000. This study assumed a standard income of KES.2,000 per annum plus subsistence, and a mean family size of 6. Overall, the Rift Valley Province, by the assumptions of this carrying capacity model, could accommodate an additional 1.4 million people by the year 2000. However, some districts are not directly accessible to farming either because they have large-scale[6] farms, gazetted forests, and/or Trustlands.

From this account it is quite apparent that most of these studies of population pressure are at national or regional level and they may not be useful for local planning. Also these studies, except for the Kajiado case, have focussed almost wholly on high potential lands of Kenya. Nearly all the studies indicate that the effects of population pressure on high potential agricultural locations spread their effects to the marginal low potential areas. As population pressure in the highlands intensifies, so does the spill-over of landless, unemployed or underemployed people to the semi-arid and arid areas. But seldom has population pressure in these low potential parts of the country been systematically studied. In the following

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[6] Large-scale farms produce only about one-quarter of the total agricultural output. They usually are under plantation crops such as tea, wheat or coffee. Most large-scale farms are underutilized because the owners may be senior civil servants living elsewhere. In Kenya, land is owned for its asset value rather than for productive purposes.

section, a review of some case studies of population pressure in Kenya's arid and semi-arid areas is undertaken.

3.5 POPULATION PRESSURE IN THE MARGINAL LANDS OF KENYA

The arid and semi-arid lands of Kenya are those areas which receive low amounts of rainfall, generally less than 700mm per year, and which is unpredictable in time and space. These areas are also referred to as low potential areas. Further, these areas have natural vegetation which provides a habitat for wild or domesticated ungulate populations. The marginal areas occur mainly in ecological zones IV to VI.

The arid and semi-arid areas of Kenya cover more than 80% of the country (Figure 7) and are more densely populated than comparable areas in other African countries (Von Kaufmann, 1976:255). Income opportunities are meagre and poverty is widespread (Sindiga, 1986:49). As will be seen later, this is partly a result of past neglect.

Although the crude densities of the arid and semi-arid areas are comparatively low, they do not reveal the nature of population problems in these areas. About two decades ago, the ILO (1972:155) noted that the continuing problem of soil erosion and degradation in the rangelands had reached alarming proportions. Streams were drying up and people were

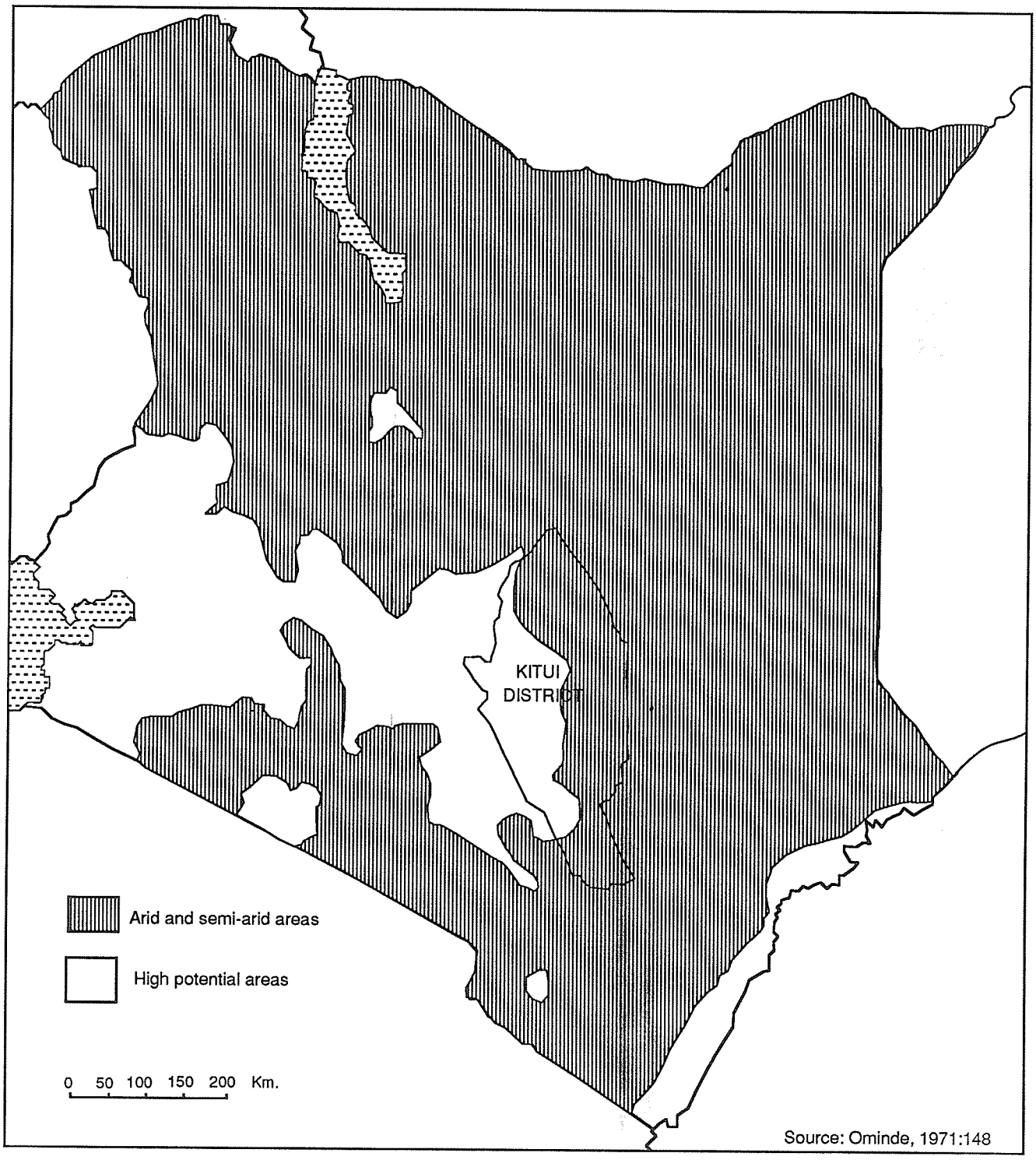

Figure 7: The Arid and Semi-arid Areas of Kenya.

cultivating along river channels leading to silting of streams and dams. A World Bank Mission (IBRD,1973:48) to Kenya found the arid and semi-arid areas of the country to be:

> - - under severe population pressure. Parts of Ukambani[7] and Baringo districts are tragically eroded and erosion and ecological deterioration is common feature throughout the range areas.

More recent assessments suggest that things have deteriorated. The World Bank (1980) and the ILO (1986) found that increasing population growth in the drier areas of the country has led to population pressure which has exceeded the carrying capacity of the land and ended up in very low income per capita and sometimes to famine. Severe food shortages and famines periodically occur causing a disruption of the environment and leaving people destitute. In these areas, famine relief has become a recurrent government expenditure. Conservative estimates of direct famine relief were KES.12 million in 1961 and KES.20million in 1970-71 (ILO, 1972). The costs have undoubtedly increased. During the 1984 drought, the Kenya government provided food to about 1.2 million people compared with some 150,000 who received relief supplies during the 1970-71 famine (Sindiga, 1986; Kenya, 1979b). The majority of these people were in the marginal zones.

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[7] Ukambani refers to Kitui and Machakos, the districts inhabited by the Akamba people.

Population pressure in the marginal arid and semi-arid lands of Kenya is not a new problem. As indicated earlier, it has its roots in colonial land policy. Colonial intervention in the form of proscribing African native reserves and confining them in specifically bounded areas formed the antecedents of the problem. British colonial authorities opposed shifting cultivation and transhumance pastoralism throughout East Africa (Munro, 1975; Ngau, 1983).

Government policy throughout the colonial period was that African reserves needed to be destocked and people encouraged to abandon pastoralism for settled crop cultivation. Meanwhile, many pastoral areas were either "closed" - people could not move out of the reserves without special permission - or under animal disease quarantine. Trade and circulation were circumscribed. Attempts by Africans to market their stock was seriously opposed by European ranchers because of the competition with their own production of livestock. It is also to be noted that the European settler lobby was extremely influential in the colonial government and legislative assembly. Another reason for the preference of settled cultivation was, of course, administrative. It was easier and cheaper to maintain law and order, and collect taxes among sedentary people than among seasonal migrants.

The colonial government officials widely discussed the problems of overgrazing, soil erosion, and other symptoms of population pressure but failed to accurately diagnose the cause of resource deterioration. They viewed the problem simply as overstocking beyond the subsistence requirements of pastoralists. While overstocking relative to resources or carrying capacity existed, it did not relate to subsistence and socio-economic needs of Africans (King, 1975:99). In fact, overstocking of the land in most of Kenya was a result of continued reliance on pastoralism for subsistence where each family attempted to maintain a minimum herd for subsistence (Pratt, 1968:183). To this, Brown (1971:98) added that:

> When we speak of overgrazing by domestic stock we are often in fact observing a situation in which the human population density is excessive in relation to the carrying capacity of the environment. To live themselves they are forced to try to keep sufficient stock for subsistence, and in doing so may exceed the carrying capacity of the environment in terms of the primary user, namely the stock --- thus causing widespread destruction. It is necessary to think not only in terms of the number of livestock, but of people as well.

In order to understand population pressure in the arid and semi-arid areas, Brown contends that we must understand the "biology of the pastoral man"; that is, food needs of the people, stock requirements and environmental capability.

In summary, it may be stated that the indigenous people of Kenya's dry lands had lived for centuries in a state of equilibrium until the advent of the British rule. In fact,

studies sympathetic to their cultural perception and adaptation indicate that pastoralists are almost the only people capable of making good use of their formidable areas (Swift, 1977; Porter, 1966; Conant, 1965; Bernard, 1977; Lewis, 1961). Through a process of trial and error they developed survival mechanisms for these delicate ecosystems.

With British colonial rule (1893-1963), fundamental changes to the Kenya's dry lands were set in motion. Convinced that traditional practices were chaotic and primitive, the colonial administration sought to introduce "rational" development. Their intent was quite obvious: to integrate these areas into the world monetary market economy. The best lands were alienated for commercial farming and livestock production, depriving the pastoralists of their essential dry season pastures (Odingo, 1971; Smith, 1976). Administrative structures were also imposed to reduce the military power of the indigenous people (Ngau, 1983:127).

The only development undertaken by the British government in the dry lands was the initiation of three irrigation schemes: Mwea Tabere(Kirinyaga), Tana(Embu), and Pekera (Baringo). But these were introduced essentially to make work for nationalist political detainees. The impact of British rule in Kenya's dry lands is summarized by Ngau:

> The effects of colonial intervention were that the indigenous people lost their power of decision and lost their ecological and economic flexibility. Social control and organization broke down. As

> population increased and was confined, it led to a more intense and less organized use of land; what became known as overstocking meant ecological devastation and economic breakdown (Ngau, 1983:127-8).

The result of colonial misconception of population pressure in these dry lands was that the government made decisions which worsened rather than alleviated population pressure.

Meanwhile, the population continued to grow in the 1950's and land shortages and resource deterioration became insuperable problems. The Swynnerton plan for agricultural reform found population to be a major problem in the development of the arid and semi-arid areas (Swynnerton, 1955). Because of the devastation of Kenya's arid and semi-arid lands, the Swynnerton plan concluded that the failure to control stock numbers and to preserve land against denudation represented the greatest failure in the field of agriculture since British rule began in Kenya. But because the unproven assumption that the primary cause of overstocking was a basic desire for wealth was so pervasive, little effort was made to quantitatively define overstocking in relation to prevailing pasturing regimes and the normal needs of the pastoralists themselves (Swynnertom, 1955:32).

Under these circumstances, population pressure increased, resulting in severe soil erosion and dereliction, and culminating in 1961, with a catastrophic drought and famine (Sindiga, 1986:88). Writing in 1963, Brown observed mounting pressure in Kenya's dry areas and argued that with

a population growth of 3% per year, many of these areas would end up in a "process of destruction, in a desperate effort to keep enough stock on which to live" (Brown, 1963:41). In a number of districts, such as Turkana and Baringo, the basic problem was overpopulation of both people and stock in relation to the national resources available. Population pressure forced the Turkana people to rely in part on wild vegetable foods including the pods of Acacia tortilis (Pratt, 1969:153).

Since Kenya's independence in 1963, population pressure has intensified in many of the arid and semi-arid areas. A number of processes have aggravated the problem. These are considered in Chapter Five.

This analysis has indicated that the arid and semi-arid areas of Kenya are suffering from population pressure. In many districts, population numbers have more than doubled in short periods. Equally of concern is the continued land deterioration which this population pressure engenders. However, the magnitude and the distribution of population pressure are not well known within these areas. Does population pressure occur at varying levels in different ecological zones? If so, how does it affect rural development in each zone? The understanding of this problem is largely lacking.

The following chapter sets out a methodology and detailed research design for field investigation of population pressure. This is followed by its application on Kitui district in Chapters Five and Six.

Chapter IV

METHODOLOGY

This chapter sets out methodology and a detailed research design for field investigations of population pressure in Kitui district. The chapter focuses on a number of themes: types and sources of data, methods of data collection, questionnaire design and selection of variables, sampling procedures, techniques of data analysis and their critical evaluation.

4.1 TYPES AND SOURCES OF DATA

The data required for the research were collected in Kenya over a nine-month period between May 1988 and January 1989. During this period, two types of data were collected: documentary and field survey information. A variety of sources and research techniques were used to gather the data and these are summarized below.

4.1.1 Documentary Data

A number of studies exist which focus on population, resources and ecological imbalance in Kenya. The initial task of this study was to review these somewhat fragmentary and isolated case studies and to place them within a firm

theoretical base. This synthesis yielded the questions which were subsequently asked during the fieldwork, as well as the variables which were used to investigate population pressure symptoms in Kitui district.

In order to collect the documentary information a search was undertaken through academic journals and other field survey materials in various libraries at Kenyatta University, the University of Nairobi, the UNEP headquarters in Nairobi, and the Kenya National Archives. This helped in bringing together information on the conceptual underpinnings of the research. A further documentary search through government records and reports relevant to this research provided wide ranging data on environmental deterioration, land use systems, and the emergence of population pressure in the study area.

These data, especially from the Kenya's Ministry of Agriculture, Kenya Soil Survey, Kitui Town Council and Eastern Provincial headquarters (Embu) provided detailed information on environmental potential upon a which computation of carrying capacities was based. As Porter (1970) noted, computation of carrying capacity can only be based on a thorough assessment of environmental capability of a given area. The Elizabeth Dafoe library of the University of Manitoba, among other libraries on the campus, provided supplementary information for this research.

4.1.2 Field Survey Data

Fieldwork in Kitui district involved administration of a carefully constructed questionnaire (Appendix A) at various administrative and ecological levels throughout the district. Before fieldwork could commence, permission to undertake the research (Appendix B) was sought from the Kenya Government. Respondents (household heads)[8] were interviewed to elicit background information about family size, land use, land tenure, food sufficiency and other socio-economic variables. This information was required to compute carrying capacities as well as for the analysis of population pressure symptoms.

Since Kitui is such a large area, it was difficult for the writer alone to cover its five administrative divisions. Therefore five research assistants were recruited, one for each division. They were selected from primary school teachers who were high school graduates. The selection was based on the length of residence in the respective division, estimated maturity, and the ability to effectively communicate in English and Kikamba (the local language).

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[8] Households are comprised of a group of persons of the same kinship living together in the same house or in several houses within the same compound, who share a common source of food and are answerable to the same head. Polygamous wives living within a single compound are regarded as members of the same household.

A two-day training session was held for the research assistants. On the first day, each questionnaire item was discussed in detail so that each research assistant understood the meaning. Also, the training session focussed upon offering advice about how to approach sensitive questions like counting children, crop inventories and income. On the second day, each assistant was observed performing interviews on "test subjects". Further advice and instructions were provided as interviews proceeded. Each of the research assistants was provided with a list of numbers of households, and the respective names of heads within each Division which had been selected using random sampling technique (see Section 4.3). In addition, they were issued with the area's 1:250,000 topographic sheets, prepared by the Survey of Kenya, to enable them to locate the respondents.

Thus, this research adopted the household as the basic survey unit. This strategy was predicated on the logic that development programmes must meet individual needs of different areas. In any case, the household is the single most important institution in rural development in Kenya. A household survey therefore illuminates the potential and present condition of resources and human characteristics in the study area. The main questions asked during the interviews and the variables used to investigate population pressure in Kitui district are discussed below.

4.2 QUESTIONNAIRE DESIGN AND SELECTION OF VARIABLES

The review of literature in Chapter Two indicated that when an imbalance between human numbers and the resources which support them occurs, a variety of symptoms like food shortages, land subdivision, fragmentation, outmigrations, malnutrition, and soil erosion begin to show on the environment and in human conditions. In this study these symptoms constitute the main variables for the investigation of the problem of population pressure in Kitui district. The questions asked to generate the data for analysing the problem are discussed under the respective variables as follows:

1. Landlessness, land subdivision, land fragmentation and land disputes.

   A traditional communal land tenure system normally has arrangements by which user rights are identified and regulated. One of the major elements that has a strong effect on land tenure, especially after the introduction of a money economy, is population pressure (Porter, 1970). When population growth is high, land becomes scarce; good land becomes fragmented and poor land is brought into use. Land becomes a real estate commodity and some people are thrown into landlessness as land becomes a commodity for speculation. Litigation involving

boundary disputes between neighbours and inheritance cases among siblings begin (Sindiga, 1986).

Subdivision is the splitting of land into smaller holdings. If subdivision continues for long, the land parcels become too small to provide reasonable standard of living (Allan, 1965:379). In theory, severe land subdivision occurs soon after carrying capacities have been exceeded. While it is one means of allocating a scarce resource, when parcels fall below a desirable minimum, the entire agrarian structure is susceptible to dissolution (Bernard, 1977:145). This is a clear hazard in many densely settled high potential regions of Kenya and is inevitably occuring in Kitui district. Moreover, the World Bank has noted that the decline of arable land per capita in Kenya is startling (IBRD, 1986:39).

Land fragmentation refers to a form of parcellation in which a holding consists of a number of physically separated pieces of land so scattered as to make efficient cultivation and management difficult (Allan, 1965:379). Fragmentation develops under conditions of land shortage in permanent cultivation systems where land has been traditionally held in a range of ecological zones (Bernard, 1977). Severe fragmentation is often a surrogate of

population pressure (Bernard, 1977; Sindiga, 1986). It is evident from field observations that land fragmentation is a problem in Kitui district.

A number of questions were formulated (Appendix A) to obtain data related to the amount of land owned by each respondent (question 10), type of land ownership (question 14), land fragmentation (questions 12 and 13), land disputes (questions 33 and 34) and informal land subdivisions (question 17). Allan (1965) argued that land subdivision may be 'hidden' in the sense that rights are held in undivided shares and too many people are working on, and trying to earn living from a single land parcel. Question 10 explored this situation.

2. Declining crop yields, food shortages and malnutrition.

Bernard (1986:5), among others, noted that when the assimilation capability of an habitat reaches its upper limit as a result of excess numbers of humans and their activities, environmental deterioration sets in, ultimately leading to food shortages. There is hardly any doubt that population pressure leading to landlessness, land fragmentation and subdivision may undermine the ability of the environment to support its inhabitants. This in turn is manifested

in reduced crop yields, food shortages and malnutrition.

However, not all food shortages in the arid and semi-arid areas of Kenya should be attributed to excess human numbers. Environmental instability caused by low and unpredictable rainfall may lead to variable food supply, but there is no denying that the relatively high population densities in marginal areas like Kitui play a significant role in intensifying food shortages and malnutrition.

Declining crop yields, food sufficiency, and malnutrition were addressed with questions 23 and 41 to 47. With the exception of number 47, these questions examine levels of food production and responses to them provide data on the ability of the land to support its residents and prevailing mechanisms of coping with food shortages. Question 47 deals with possible diseases which may result from undernourishment.

3. Breakdown of Indigenous Farming Systems.

The development of population pressure destabilizes many indigenous farming systems leading to a progressive reduction of fallow and a decline in indigenuous crop emphases. Carving out land for other

uses, such as game conservation, urban development, and cash crop cultivation can bring similar results (Sindiga, 1986).

In order to explore the issue, respondents were asked several questions on changing farm sizes and about the implications on their subsistence practices. Questions 24 and 25 examine whether fallowing has reduced or increased from that existing five years ago. Question 26 asked for reasons why fallowing has declined. Question 27 inquired indirectly into whether a breakdown of indigenous farming systems has occured and whether other land-uses are now being practised.

4. Use of Marginal Lands and Forest Depletion.

In one sense, the entire problem of population pressure in eastern Kenya is a problem of increasing encroachment on ecologically vulnerable lands. Thus, Mbithi and Wisner (1973:114) noted that immigrants to the lowlands of the Eastern Plateau exploit harsher environments with concomitant increase in crop failure, famine, and epidemics. As the dense population in Kitui Central becomes redistributed to the drier parts of the district, life becomes riskier.

At another level, movement into marginal lands can refer to local utilization of microhabitats normally considered too poor for production. In this sense, cultivation of steep slopes, removal of vegetation for charcoal burning, and grazing in all manner of places represent desperate survival mechanisms to exploit every marginal corner of these harsh lands (Wisner and Mbithi, 1973).

At both scales, pressure exerted on marginal lands can further promote deteriorating conditions. This is the heart of what Allan (1972:1) termed the cycle of degeneration, and is the main message of Figure 2 (Chapter One). The use of marginal lands, and the clearing of bush are examined through questions 35, 38, 39 and 40.

5. Soil Erosion

As Allan (1965:385-388) noted, most African land-use systems traditionally had built-in protective devices against soil erosion such as fallow, mixed cropping, avoidance of steep slopes and terracing. The Akamba were no exception, but as their populations expanded and as accidents of history changed their agricultural systems, many traditional practises became neglected, leading to soil erosion. Mutiso (1975:5-6) describes stripping of vegetation

cover causing havoc in Kisio river watershed in Kitui, which he predicts will lead to still further ecological decay. Brown (1975:7) confirms this prediction on a wider scale, stating that Machakos and Kitui are experiencing 'shocking' levels of erosion and denudation.

The fragmentary nature of this information impairs any spatial overview of the extent, type, and degree of soil erosion in the study area. There is no doubt that soil erosion is a serious problem. Two questions (36 and 37) were formulated to inquire into the seriousness of the problem. Question 37 elicited soil conservation measures being undertaken, and indirectly asseses the magnitude of the problem on the basis of the conservation techniques applied.

6. Unemployment, Decline in income and outmigration.

Migration is directly related to population pressure. People migrate to other areas in search of employment and fresh economic opportunities when rural conditions deteriorate. Todaro (1981) explained the decision to migrate in purely rational economic terms. Migrants consider the various labour market opportunities available between rural and urban sectors and choose the one which maximises their expected gains from the migration. Prothero (1972:7)

however, argues that it is difficult to measure the economic disparities in many rural areas of Africa.

Outmigrations among the Akamba to rural areas within and outside the district have been identified as a form of pressure-induced movement leading to spontaneous settlements (Mbithi and Barnes, 1975). These two authors considered squatter settlement as one of Kenya's more urgent human-land crises. Inter-district and intra-district movements are, however not well known (Thom, 1977); it is apparent that a study of migration in Kitui would therefore yield useful insights into population pressure in the area. The analysis of data obtained from questions 8, 9, 28, 29, 30 and 32 is used to explain migrations within and out of the district. Questions 6, 7 and 53 to 59 address employment and income. These questions also inquire into whether off-farm income is earned, by whom, and how often, as well as whether respondents' incomes have declined or remained the same.

7. Perception of Population Pressure.

Questions 60 to 66 examine respondents' views on whether they consider their areas overpopulated, and, if so, what measures should be taken to solve the problem.

These views are crucial for recommending workable policy programmes to counteract population pressure. Also, answers to questions addressing respondents' desires for children (questions 60 to 64), provide insights into possible future population and resource balances in Kitui district. In addition to data from questions noted so far, household heads were queried to elicit information regarding accessibility to social amenities (questions 48 to 52). When population pressure in an area builds up, public utilities are the first to suffer from stress. Responses to questions 50, 51 and 52 were intended to gauge the scarcity of social amenities as well as to draw inferences about low levels of living.

In sum, the variables used to investigate population pressure and the respective questions in the survey are summarized in Table 4.1. Other variables which were used in computing carrying capacities are discussed in section 4.4 in the current chapter.

TABLE 4.1

The Variables Used to Investigate Population Pressure

Summary Variable	Variable explanation	Relevant questions (see Appendix A)
LAND	Landlessness	10,14,15,26
LASU	Land subdivisions	16,17,18,19
LAFR	Land fragmentation	12,13
LADI	Land disputes	33,34
DCRY	Declining crop yields	23,43,44,45,46
FOOD	Food shortage	41,42,43,44,45,46
CHCE	Changing crop emphases	23,24,25,26,27
MALN	Malnutrition	43,44,45,46,47
FALO	Reduction in fallow	25,26,27
BRIF	Breakdown of farming systems	23,24,25,26,27
UMLA	Use of marginal lands	35,36,37,38,39,40
SOER	Soil erosion	36,37,38
ACCE	Accessibility to amenities	48,49,50,51,52
UNEM	Unemployment	1,6,7
OMIG	Out migration	8,9,28,29,30,32
FORD	Forest depletion	38,39,40
INCM	Decline in income	53,54,55,56,57,58,59

4.3 SAMPLING PROCEDURES

In planning a sample survey, a decision must be made about the sample size. This decision is important because too large a sample implies a waste of time among other resources, and too small a sample diminishes the utility of the results. An initial task in sampling is therefore to estimate the size of a sample required to meet the needs of the research. In order to attain this objective a technique formulated by Cochran (1963:72) was adopted:

$$N = \frac{4xPxQ}{ExE}$$

where N = Sample size (attempts)

P = Proportion of the most important characteristic in the total population

Q = 100%-P

E = Precision error

Regarding the application of this formula, Cochran made the following two observations:

1. There must be some statement concerning what is expected of the sample. This statement may be in terms of error, which is left at the discretion of the researcher.

2. The computed value of N may be appraised to see whether it is consistent with the resources available like cost, time, labour and the materials required to obtain the proposed sample size (Cochran, 1963:74).

In order to estimate P, a precision error equal to ±1.8% was used. P was estimated using the proportion of land to the total population, which is a very important indicator of population pressure. This was calculated by

expressing as a percentage the total land area in Kitui district divided by total population. This worked out to P=3% and Q=97% and, by applying the formula, a sample size of 360 persons was estimated. However, out of the 360 persons interviewed in the field, fifteen of them were "non-response" cases and thus only 345 observations were considered in the analysis. This, however, did not affect the quality of the results.

4.3.1 Sample Selection

The smallest areal unit used in sampling was a sub-location (an administrative area smaller than a location, which Kenya's Central Bureau of Statistics (C.B.S.) uses as a sampling unit). However, the analysis was based on Locations, Divisions, and Ecological zones. The reason for using sub-location was to ascertain that there was representative population samples selected from the various ecological zones in each location.

A political district map of Kitui showing Divisions, Locations, and Sub-locations, at a scale of 1:250,000 was prepared. This map was then superimposed on the map of ecological zones (Figure 5, Chapter Three) to make a composite map showing administrative and land potential boundaries. In the next stage, a simple random sampling technique was used to select Sub-locations from the various

ecological zones in each of the twenty-seven locations in Kitui district. Lists of households and names of their heads were then obtained from Central Bureau of Statistics (C.B.S.) for the selected Sub-locations. Further application of random sampling yielded a sample of households from the selected Sub-locations. With the help of the area's sub-chiefs (heads of sub-locations) and village headmen, the selected households were identified and their heads were approached for interview.

The number of interviewees per sub-location was determined by a sampling proportion (the number of households in the sub-location expressed as a ratio to the total number of households in the location). The same principle was used to determine the number of interviewees from each location. The number of respondents per location and the respective sampling proportions are summarized in Table 4.2 It is important to note that four main zones within the study area were excluded from the survey, namely:

(a) All Areas reserved for forests. There are about 43,657 hectares of gazetted forests in Kitui district which represent about 1.4% of the total land area. The main forest reserves include Kavonge, Mutito, Nuu, Engamba, Makongo, Mumoni, Endau, Mutha, Mutuluni, Kyawea and Museve.

TABLE 4.2

Sample Selection

Location	Population estimate (1989)	Estimate no. of households	Number of households successfully interviewed	Sampling proportion
Mulango	39,579	5,140	22	0.17
Kisasi	32,549	4,227	18	0.14
Matinyani	34,261	4,449	19	0.14
Changwithya	41,784	5,427	24	0.18
Miambani	24,639	3,200	14	0.11
Nzambani	24,744	3,214	14	0.11
Yatta	28,619	3,717	16	0.12
Yatta B2	6,431	835	4	0.03
CENTRAL	232,606	30,209	131	0.36
Mutito	13,379	1,738	7	0.19
Endau	11,160	1,450	6	0.16
Mui	13,692	1,778	9	0.20
Zombe	15,341	1,993	9	0.22
Nuu	15,844	2,057	9	0.23
EASTERN	69,416	9,016	40	0.11
Ikanga/Mutomo	30,943	4,018	17	0.32
Ikutha	26,726	3,471	15	0.28
Kanziko	14,881	1,933	8	0.16
Voo	13,711	1,781	7	0.14
Mutha	9,333	1,212	5	0.10
SOUTHERN	95,594	12,415	52	0.15
Mutonguni	47,947	6,227	23	0.32
Migw'ani	47,194	6,129	23	0.32
Mwingi	40,211	5,222	20	0.27
Endui	13,873	1,802	7	0.09
MWINGI	149,225	19,380	73	0.23
Mivukoni	28,917	3,756	15	0.31
Katse	21,895	2,844	11	0.23
Tseikuru	13,756	1,787	8	0.15
Ngomeni	21,066	2,736	11	0.23
Tharaka	7,829	1,017	4	0.08
KYUSO	93,463	12,140	49	0.15
KITUI(Total)	640,304	83,160	345	1.00

(b) Trustlands and all areas used exclusively for wild animals. For instance, Tsavo East National Park which covers about one-fifth of the district and a few concentrations of wildlife in Yatta B2 in Central Division.

(c) All areas designated for urban and other non-agricultural land uses, like Townships and market centres.

(d) All areas under land uses which do not represent traditional Akamba livelihood, like commercial ranching in Mbeu(Katse), Mikuyuni(Yatta), Mutw'ang'ombe(Endau) and Sosoma(Ngomeni).

4.4 METHODS OF DATA ANALYSIS

Three techniques were used to analyse the data collected in this study. These are: (a) carrying capacity, (b) principal component analysis, and (c) multivariate analysis of variance. In addition, descriptive statistics was used to investigate the severity of population pressure between ecozones and to compare the results of the carrying capacity model with the analysis of population pressure symptoms.

4.4.1 Carrying Capacity

The concept of carrying capacity has been comprehensively discussed in the preceding chapters. For instance, it has been noted that the intention of modern carrying capacity modelling is to define a preferred maximum density which can be supported in each ecological zone of a country without causing damage to the land (Bernard, 1977). This section

presents the general outline of the carrying capacity model used in this study. The detailed data manipulations and assumptions are dealt with in Chapter Six.

The computation of carrying capacities was based upon the potential amount of calories that can be produced, using the existing technology, from the food sector in each location of Kitui district. The aim was to calculate the maximum (or safe) number of people that each location can support without causing stress on the environment. Once this was done, it was possible to identify locations which have population numbers above their carrying capacities by comparing potential to current population numbers in each location.

In order to compute carrying capacities for the various locations, the following data are required: average household size per location, amount of calories required to sustain the average household per annum, amount of arable land in each location, possible crop combinations and their potential yields (in millions of calories) per location per annum, and minimum size of a farm which can meet the annual food requirement of the average household. Also, data on livestock requirements for the average household is necessary, since animal products provide people with the qualitative aspects of diet like proteins, vitamins, and trace minerals.

The carrying capacity model used in this study is adopted from Thom (1977). According to him, carrying capacity for an agrarian society operating at full subsistence technology, which assumes that all household requirements are derived from on-farm activities, may be computed using the following formulae:

$$S = \frac{TfxPc}{Y} + Lr$$

where S = the minimum farm size in hectares necessary to sustain an average household per annum

Tf = total subsistence food requirement for an average household in millions of kilocalories per annum

Pc = per cent of calories derived from crops

Lr = livestock requirement in hectares per average household

Y = average yields of food crops per hectare in millions of kilocalories per annum

and $$C = \frac{A-aW}{S}$$

where C = carrying capacity in number of households

A = total area of a location in hectares

aW = area of a location neither suitable for grazing

nor cultivation. (In the current research this area is determined by overlapping the ecological zones map with the political map of Kitui district, allowing the amounts of arable and non-arable portions of each location to be calculated (see results in Chapter Six)

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

A spatially more explicit expression of these data requires the conversion of households to number of persons and of the surplus or deficit population for all locations. The population pressure ratio provides a comparative index of the degree of pressure between locations in the study area. For those locations with excess capacity to accommodate more people, further estimation using population growth rates for each location, determines the number of years remaining before carrying capacities are reached in the respective locations (see Table 6.3 in Chapter Six).

4.4.2 Principal Component Analysis (PCA)

Principal Component Analysis (PCA) is concerned with explaining the variance-covariance structure in a multivariate system through a few linear combinations of the

original variables. Its general objectives are (1) data reduction, and (2) data interpretation (Johnson and Wichern, 1982:361).

Thus, in a system where the total variation is explained by P original variables, PCA can derive a small number of principal components, K, to account for the total variation. In this case, K<P but has as much information as there is in P. The original data set which consists of N measurements on P variables is thus reduced to one consisting of N measurements on K principal components.

For instance, consider a system which has X_1 ,X_2 - - - Xp variables. The PCA can generate K (Y_1 - - - Yk) principal components which are a linear combinations of X_1 - - - Xp variables as follows:

$$Y_1 = q_{11}X_1 + q_{21}X_2 + - - - - + q_{p1}X_p$$

$$Y_2 = q_{21}X_1 + q_{22}X_2 + - - - - + q_{p2}X_p$$

-

-

-

$$Y_k = q_{k1}X_1 + q_{k2}X_2 + - - - - + q_{pk}X_p$$

The first principal component is the linear combination with maximimum variance, and explains the highest percentage of total variation among the Xi's (Mardia, et al, 1982:219).

In this study, eighteen variables were initially formulated to explain variation of population pressure in

Kitui District. PCA was then used to summarize the data into two principal components (PRIN1 and PRIN2), which account for 76.9% and 23.1% of the total variation, respectively. On the basis of correlation between the first principal component (PRIN1) and the 19 original variables, the most important indicators of population pressure in the study area are determined (see Chapter Six).

Analyses of principal components are more of a means to an end rather than an end in themselves since they frequently serve as intermediate steps for further investigation. In this study, PCA is used to generate data upon which the three ecological zones in Kitui District are compared using multivariate analysis of variance, which is discussed in the next section.

4.4.3 Multiple Analysis of Variance (MANOVA)

This section discusses the main features of MANOVA and how the model was applied in this study to compare the three ecozones of Kitui on basis of nine population pressure indicators which were selected through principal component analysis.

Often, in empirical research more than two populations need to be compared on the basis of some variation. Random samples collected from each of, say K, regions may be arranged as follows:

population 1: X11 - - - Xn1

population 2: X21 - - - Xn2

-

-

-

population K: Xk1 - - - Xnk

Multivariate analysis of variance is normally used to investigate whether the population means u_1 - - - uk are the same. This is equivalent to testing the null hypothesis Ho: $u_1 = u_2 =$ - - - uk, or testing of whether there is no significant difference between the K populations or regions (Mardia et al, 1982:334).

To test the null hypothesis (Ho) against the alternative (H_1 : $u_1 \neq u_2 \neq$ - - - $\neq$uk), Wilks' lambda criterion (L) is used. In MANOVA, the Wilks' lambda criterion is computed using the procedure outlined in Table 4.3 In this case, the Wilks' lambda corresponds to the equivalent of the F-test of null hypothesis in univariate systems. F is computed using Wilks' lambda (L) as follows: $F_1 = 8/3(1-L^{1/2})/L^{1/2}$ (Mardia, et al 1982:336).

In order to test the null hypothesis, the computed F_1 is compared to a table F_2 value which is derived from the F distribution tables, using (2P, 2(m-P+1)) degrees of freedom. In this case, m=N-K, and P is the number of variables being investigated. If the computed F_1 is greater

TABLE 4.3

Method of Computing Wilks Lambda by MANOVA

source of variation	d.f.	SSP matrix	Wilks' lambda
Between samples	K-1	B	
Within samples	N-K	W	L=lWl/lW=Bl
Total	N-1	T=B+W	

source: Mardia, et al(1982:335).

where: SSP = sum of squares and product matrix
B = between samples SSP matrix
W = within samples SSP matrix
N = number of observations
K = number of regions being studied.

than table F_2 , the null hypothesis is rejected and the alternative adopted (Mardia, et al 1982:337).

In this study, Wilks' lambda is derived using the SAS software computer package. F_2 is determined from the F distribution Tables (Appendix D) using (2x9, 2(345-3-9+1)) or (18, 668) degrees of freedom, where N=345 respondents, P=9 variables derived by PCA, and K=3 ecozones (see Chapter Six).

4.5 CRITICAL EVALUATION OF THE DATA ANALYSIS TECHNIQUES

(a) Carrying Capacity.

Although carrying capacity has value as a tool for applied resource management, it has both advantages and disadvantages when applied to human beings. The measure of carrying capacity has been criticised as a static estimate unable to accommodate change such as, the introduction of cash crops (Sindiga, 1986). A reviewer of Allan's book (1965) also argued that the technique does not consider the impacts of change such as technological growth (McMaster, 1967:140).

Another criticism of the concept is that it implies an optimum (homeostatic) level between population and resources. Furthermore, carrying capacity estimates always assume a certain level of technology. There is no reason why any society should be locked into a particular set of tools and techniques, yet this is often an assumption made in carrying capacity models. The assumption of a static technology is clearly a serious shortcoming. Other scholars have also argued that carrying capacity is ahistorical (Porter, 1978:22; Zubrow, 1975:129) because it tends to be mainly concerned with current status.

Essentially, several points must be considered when the concept is applied to humans. Human needs and aspirations beyond subsistence must be taken into account (Mabogunje,

1970:115-118). But, as Browning (1970:73) noted, expectations are "imputed to people rather than being empirically demonstrated". It is not possible to grapple with the problem of expectations without very detailed data requiring extensive and expensive field surveys. In addition, carrying capacity analysis must assess the role of political, social, economical and cultural constraints of a community (Thom, 1977:387). This requires a thorough understanding of the culture of the society being studied. These data should tell of the general human condition, including food requirements, work regimes, cropping patterns and cycles, wage employment, cash income, crop and livestock yields (Bernard, 1977). Other data required are on environmental potential (Porter, 1970).

However, such sophisticated data are often lacking in African countries (Hance, 1968:7). The current study was fortunate in the sense that a substantial amount of information on the productive potential of land is now available in Kenya. Examples include Edwards (1956); Pratt, (1966); Pratt and Gwynne (1977); Kenya (1973a); Jaetzold (1983); Jaetzold and Schmidt (1983); Sombroek (1980); Sombroek et al (1982); Braun and Mungai (1983). Also, the Ministry of Agriculture has a substantial amount of information on crop inventories and the potential land capabilities for various regions of Kenya.

In addition, value judgements are required throughout the process of carrying capacity modelling. The definition of an acceptable standard of living is often problematic. Even worse, carrying capacity can be misconstrued as a ceiling to development. It might be assumed that as soon as a minimum set of conditions have been met in the model and on the landscape, the task of rural development is complete (Bernard, 1986). This too, is an erroneous application of the concept.

Despite these criticisms, carrying capacity is a promising tool in the hands of planners. It allows systematic approach to problems of agriculture and requirements in peasant agrarian communities (Allan, 1965). It is also a means of studying and assessing the urgency of population pressure (Sindiga, 1986:37). Because carrying capacity aims at indicating a point beyond which population cannot grow without causing damage to the land, its determination may lead to a search for demographic solutions. In this study, it pulls no punches: it clearly calls for a reduction of population growth rates, limitation of resource misuse and technological change aimed at increasing productivity. The next and more difficult step is to plan ways of accomplishing these goals.

Carrying capacity also seeks optimal and achievable solutions in attacking development problems. It also engenders broad-based planning, including productive

activities, environmental protection, infrastructure, employment and population dynamics.

For better results, researchers have suggested that instead of using one carrying capacity model, several could be constructed by varying such elements as technology, income, crop and livestock combinations and land use strategies (Sindiga, 1986; Bernard, 1977; Thom, 1977). These researchers argue that multiple modelling would provide valuable data for planning purposes.

To summarize, carrying capacity is used only as an organising concept for studying the interactions between population, development and conservation issues in a particular regional setting. As such, the concept is a heuristic tool for planning. Its major strength lies in the fact that it draws attention to the finite nature of resources and thus allows broad-based planning. The method provides for various adjustments in the variables used to compute the carrying capacities. This can yield a number of development options for an area. In order to be a useful guideline to planning, carrying capacities must be computed continuously and projections must be revised periodically (Sindiga, 1986:39).

Weighing the strengths and the weaknesses of carrying capacity, it is possible to conclude that the modelling can lend insights to the development process. Any model must be

sensitive to the cultural context of the setting in which it is being applied. Implementation of plans to expand carrying capacity, whether using subsistence or advanced technology cannot succeed if such technology is incompatible with perceptions, values, beliefs, and practises of a society.

Moreover, carrying capacity modelling alone is not sufficient for devising strategies for rural development (Bernard, 1986:13). It is one tool, among many, which may be used to confront the complicated yet exigent problems of development now present in the crowded rural landscapes of Kenya. In the case of Kitui district, both the opportunities and the limitations of using carrying capacity in rural development are demonstrated.

(b) Principal Component Analysis.

One of the greatest advantages of principal component analysis is its ability to summarize variation, in fewer variables, in a situation where a large number of observations are made. The technique can also reveal relationships between the original variables and the derived components that were not previously suspected and thereby allows interpretation that would not ordinarily result.

However, PCA has been criticised because the derived components are sometimes meaningless and difficult or impossible to interpret (Morrison, 1976:228). The technique also assumes a closed model in the sense that in any

situation, all the variation is assumed to be accounted for by the variables themselves. That is, no outside influences are allowed for in PCA (Mardia, et al,1982:218).

Researchers have also argued that, as a method for modeling real world situations, PCA is totally unrealistic. They argue that, by not allowing for any unique variance in variables, PCA obscures the true factor structure (Johnson, et al, 1982:362; Taylor, 1977:242). Despite of all these criticisms, principal component analysis has been quite useful for researchers seeking solutions in multivariate systems. It is relatively easy to apply and is available in convinient computer packages.

(c) Multivariate Analysis of Variance.

Often in empirical research, the variables used to investigate variation in a multivariate system are themselves correlated and significantly affect the results. One advantage of using MANOVA is that it takes into account, and adjusts for, the correlation structure between the variables (Johnson and Wichern, 1982:253). In addition, when MANOVA is applied in SAS, it sorts out and eliminates from the analysis, all missing values of either the dependent or independent variables (SAS Institute, 1985:445).

However, MANOVA's major limitation is that it does not indicate which treatments or treatment-combinations are different and which could be considered as coming from

common populations, when the null hypothesis is rejected (Morrison, 1976:182). Other techniques, like the Roy union-intersection approach, have to be applied to determine similarities and differences in treatments. MANOVA is thus, an intermediary for further investigation. In this study, this limitation is overcome by using descriptive statistics to determine the differences between the three ecozones in terms of severity of population pressure symptoms in Kitui district.

4.6 FIELD SURVEY PROBLEMS

Most empirical surveys are faced by numerous logistical problems. The current study is no exception. Unexpected financial problems began to plague the research almost from the inception of the fieldwork. The funding which was expected from the Kenyatta University turned out to be quite inadequate. Due to this constraint, a planned total of ten research assistants proved unworkable and in the end only five could be hired. Also, because the study sub-locations were randomly selected and stratified by ecological zones, the sample areas were far apart and this added the transport costs, and required long tedious walking across difficult terrain.

Another problem faced in the field was skepticism and unwillingness of some respondents to answer questions. This may have been caused by many factors. First, some

respondents were unwilling to answer questions unless they knew where the research assistants came from. This problem was prevalent in almost all sub-locations. In a number of areas in Katse, Mivukoni and Ngomeni, skepticism may have emanated from the fear that the research assistants were government agents sent to arrest the many brewers of local illicit drinks like, Muatine, Mawa, Nzuki and Chang'aa ---- all brewed and consumed against the government policy.

Skepticism and unwillingness to answer questions were more prevalent in the more remote parts of the study area and also where people were illiterate. This problem was in some cases surmounted by the research assistants first reporting to the local administrators (sub-chiefs and headmen) who would inform people about their (research assistants') presence in the area. This method was helpful in gaining cooperation from the local people.

In the more enlightened sub-locations of central division (like Itoleka, Wikililye, Mutune, Nzewani) and parts of Mwingi and Southern divisions, local people cooperated with the research assistants and raised few questions. Here, most people appeared to understand the purpose of research and were probably more familiar with the government's exercise of population census taking.

The Akamba regard counting of children and domestic animals as a taboo. Research assistants had to ask questions

related to these two aspects in a round-about manner so as not to offend the respondents. On top of this taboo, a number of respondents may have feared to state their correct land acreage, lest the government takes part of it away ----- a residual of mistrust inherited from colonial days when large chunks of land were alienated for government use. In many cases, where there was considerable doubt about the number of fragments a respondent owned, the research assistants consulted the District Lands Office for verification. Also data on farm income must be interpreted with care. The high level of illiteracy hindered many respondents from giving a monetary value for their produce. These data did not provide accurate estimates.

In summary, answers to questions on land (questions 10 and 11) and on income (questions 53 to 59) were not wholly reliable. However, despite these logistical problems, all possible efforts were made to ensure the success of the study.

Chapter V

EMERGENCE OF POPULATION PRESSURE IN KITUI DISTRICT

The purpose of this chapter is to examine the causes and evolution of population pressure in Kitui district. To begin, information about the Akamba cultural background is presented. This background knowledge is essential for understanding the emergence of population pressure in the area. This is followed by a discussion of events and circumstances which led to population pressure in Kitui district during the colonial period and since Kenya attained independence in 1963.

Finally, population growth is isolated as the most important determinant of current population pressure in Kitui district. Hence, the factors which favour high fertility in the area are discussed. Of great importance is the high pronatalist pressure in Akamba family structure and the failure of Kenya's population policy to provide incentives favouring low fertility rates among the majority of the rural inhabitants in the country. Thus, the chapter addresses the first and fourth objectives and hypotheses of the study in addition to tackling the first and the fourth questions stated in Chapter One.

5.1 ROOTS AND EVOLUTION OF POPULATION PRESSURE IN KITUI

Approximately 98% of the population of Kitui district is Akamba, a Bantu-speaking group ethnically related to the neighbouring tribes such as the waEmbu, waGikuyu, waMeru and the waTaita. The Akamba initially settled in Mbooni Hills in the 17th century having moved slowly northwards through the Chullu Hills, Kibwezi, Makueni and Nzaui (Ochieng, 1975; Owako, 1971). Originally confined to the hill massifs of central Machakos, the Akamba settlers dispersed to other areas, reaching Kitui Hills at the begining of the 18th century. This dispersion was fostered by mainly three factors, namely: population growth and pressure, a flexible social system in which fission was a norm and a gradual declining threat of the Maasai and other pastoral peoples who occupied the plains of eastern Kenya (Mutiso, 1975; Kimambo, 1970; Kisovi, 1985).

The spatial and the ecological design of the traditional Akamba life provided a sustaining foundation for their economy. Originally, pastoral activities predominated, but by the begining of the 19th century a mixed economy began to emerge (Kimambo, 1970:80). In spite of this, livestock, particularly cattle, continued to play an important subsistence and social roles. The traditional strength of Akamba attachment to livestock was indicated by the importance of Syengo (cattle posts) as pioneer outposts in territorial expansion (Munro, 1975). Through an

elaborate social system, stock were collected at the local level and dispersed among relatives in different moisture zones (Mutiso, 1977:2-3). This process provided a check system against natural calamities like drought and diseases.

Availability of water and distribution of tsetse fly controlled movement of Akamba livestock keepers, but oral traditions suggest a wide dispersal of wet season grazing grounds in the lower unoccupied areas (Weu). For example, the Akamba traditional grazing areas in the last century extended as far as Holla and in the north-eastern as far as Garissa (Mutiso, 1975:34). To the west, the Akamba grazed the whole of Yatta plateau as far as the Mwea plains, Katw'anyaa and around Doinyo Sabuk in the environs of Thika/Athi River. To the south they claim to have grazed all of what is now Tsavo East National Park and Kibwezi region (Figure 8). Other tribes grazed in these areas also, but the point is that the Akamba established Syengo in these zones and later receded to their tribal core areas in Kitui district.

Pastoral activities were combined with crop agriculture in a system of shifting cultivation in the hills where rainfall was more abundant and reliable. Because of long fallowing, the system required homesteads (Misyi) to hive away frequently to settle new lands. The Akamba thus gained a reputation for being frontier people. This outward expansion engendered a tradition of continuous adaptability

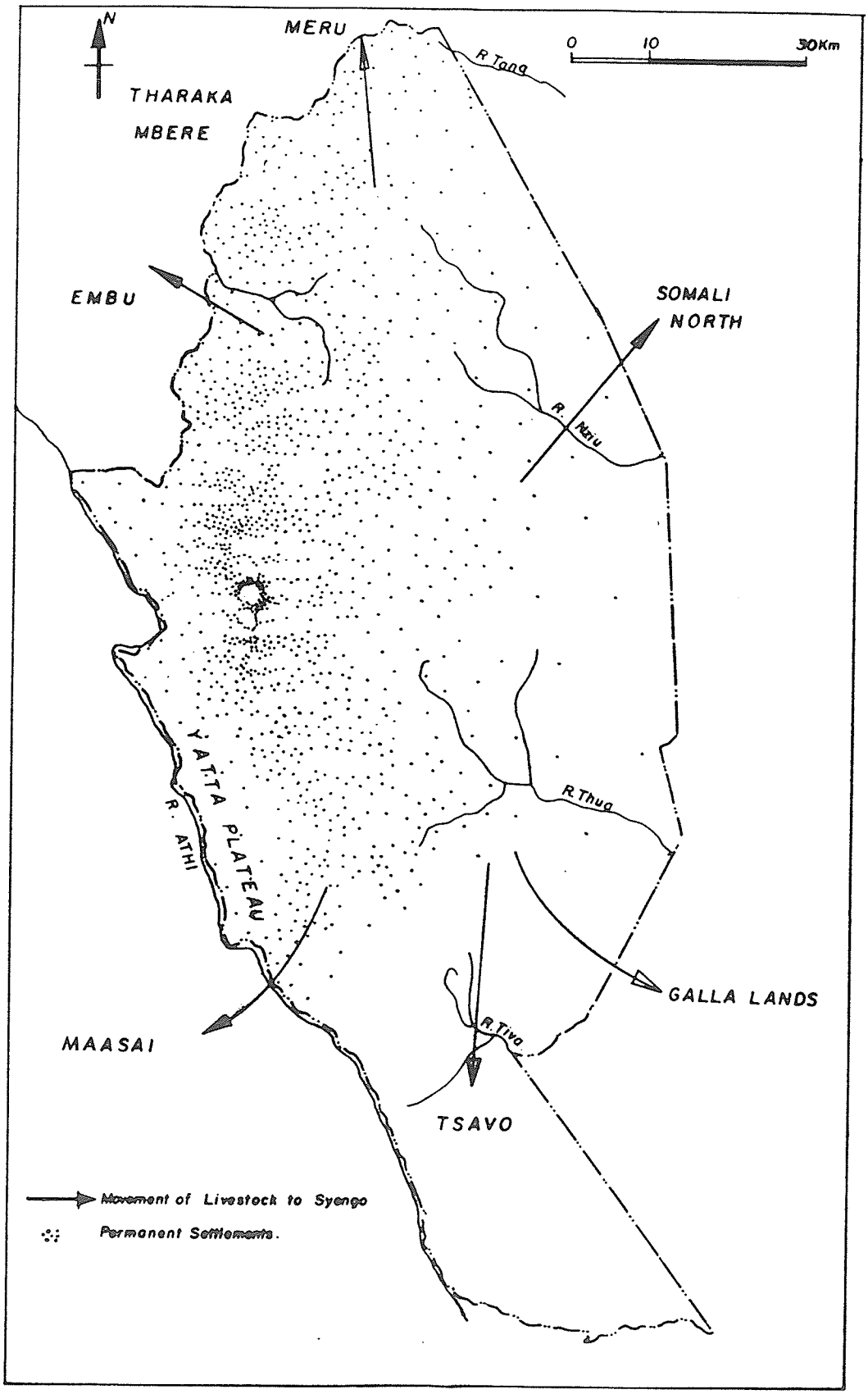

Figure 8: The Extent of Akamba Grazing Areas Prior to 1893.

to new surroundings, fluid and flexible adjustments to new economic and ecological conditions, and an informal attachment to land. As long as there was abundant land for agriculture and grazing, the frontier Akamba life usually provided adequate subsistence.

An important underlying element in the traditional Akamba spatial and ecological system was a symbiosis between hills and plains. Although this was common in other areas of East Africa , it was especially important for survival in Ukambani (Kitui and Machakos districts) because of the environmental risks like pests, diseases and rainfall variability (Porter, 1966). Misyi in the hills depended upon the herds in the Weu and vise versa. Other mechanisms such as trade and hunting were further insurance against risks in the precarious habitat.

Occasionally these risks would overwhelm traditional checks and balances. 'Local desertification' seems to have generated a certain degree of movement and it undoubtedly diminished food resources (Mutiso, 1976:20). But of more importance and at a broader scale, drought and famine, especially in the plains, were periodically significant and certainly stimulated outmigration. Recorded droughts in the 19th century and the numerous famines indicated in Table 3.1 (Chapter Three), for example, drove the Akamba communities to the Kenya coast and to Tanzania, and further concentrated those who stayed behind on the hills (Akong'a, 1982:29;

Kimambo, 1970:80). Droughts also forced the Akamba to trade more heavily with both the coast and the interior people.

Oral tradition suggest that the Kitui Akamba sold most of their livestock and livestock products to the waGikuyu who did not have good range as a result of endemic diseases (east coast fever and contagious pleuropneumonia) in their cooler environment (Mutiso, 1977:4). In addition to livestock and livestock products, the Akamba traded with the coast people (waTaita, waDuruma and waDigo) in hides, wild honey and game trophies through the present day Tsavo National Park. The Akamba bought from the coast people mainly clothes and dates (Ndeti, 1972:49; Mbiti, 1972:100).

In summary, this brief overview provides some highlights into the socio-economic background of the Akamba life prior to British rule in Kenya in 1893. For many years the Akamba had lived in a state of relative equilibrium with their dry formidable environments. Traditional mechanisms of transhumance pastoralism and semi-sedentary agriculture, supplemented by trade and hunting, provided insurance against environmental risks and hazards. Famine and epidemics were major checks to population pressure and outflow.

When British colonial rule began in Kenya, many things changed. The colonial intervention in Kitui led to the breakdown of traditional ecosystems (Bernard, 1977:134;

Kimambo, 1970:83; Mutiso, 1977:2). Native reserves were prescribed, thereby limiting wet season grazing grounds. Discouragement of movement outside reserves foreclosed the Akamba frontier ethic. Often, herds were confined to areas of which some of their richest grazing and breeding lands had been excluded. The problems of overcrowding thereby created were further aggravated by the wholesale imposition of quarantines. First, by cutting down movement of livestock, quarantines initially tended to increase the incidence of disease. Secondly, under quarantine regulations, the export of cattle from reserves was prohibited or severely restricted.

Under these circumstances, livestock increased rapidly until maximum grazing capacities of reserves were reached. Overgrazing was inevitable, which in turn caused soil erosion and reduction of cattle and human carrying capacities (Mutiso, 1977:2). The declaration in 1902 of the Yatta plateau, and majority of the former traditional grazing areas as Crown Lands[9] was disastrous to the Kitui Akamba. The imposition by the colonial government of the Hut and Poll tax forced the Akamba to sell most of their livestock to meet the imposed financial obligations. The consequence of this was that the Akamba had nothing to fall upon during times of drought and famine. The colonial government thus undermined the economic base and food

[9] Crown Lands were areas which were alienated for exclusive use of the colonial government and to which the local people had no access.

security.

A class-based interpretation of the impact of colonial rule on the Akamba has been suggested by Mutiso (1977:6) and by Munro (1975:115). According to them, concentration of colonial amenities in the high potential hills of Ukambani led to a reversal of pre-colonial migration pattern, drawing people back into the hills to gain access to colonial society. Those who were in the uplands, and those who returned, became a privileged class (the Asomi) through education and gained an advantage over those at the periphery. Ultimately, they achieved status and special access to land and livestock and were legitimized by the colonial political system.

For instance, a number of ranching schemes had been developed by the same Asomi in Yatta, Yatta B2, Ikutha, Katse and many other places in Kitui the early 1950's (Mutiso, 1977:8). These ranches were later in 1961 converted into co-operative ranching societies of Kanyonyooni, Katoteni, Mikuyuni, Ngunyumu and Mbeu by pretty the same Asomi (Mutiso, 1977:21). Land adjudication finally formalized the maldistribution of land and enlarged the problem of land hunger in Ukambani (Munro, 1975:118).

While it is impossible to evaluate this interpretation in detail, there is little doubt that the colonial impact did contribute to the disintegration of the traditional

spatial and ecological order. The interdependence of plains and hills had been broken down in Kitui by the 1940's (Mutiso, 1977; Munro, 1975). This historical context is important in understanding the emergence of population pressure in Kitui district.

Population pressure in Ukambani became one of Kenya colony's most difficult problems. In the long run, it was probably worsened rather than alleviated by government decisions and strategies throughout much of the colonial era. Encouragement of fixed crop agriculture, particularly the cotton campaigns of 1934-36, forced the Misyi to become permanent and limited the range of the Syengo. These actions brought degradation to the local areas in the hills and regional denudation to the plains. Meanwhile in the former grazing areas farther afield, bush and tsetse encroached again (Bernard, 1977; Mutiso, 1977).

Recognition of land problems in the late 1920's and early 1930's led to the formation of African Land and Carter Commissions of 1929 and 1932 respectively (Great Britain, 1936:206). Both Commissions recognized the limitations and problems of land in Kitui district. The colonial office identified human and animal population pressure in the area as a problem of worsening proportions and in 1935 appointed another commission to plan reconditioning of farming areas (Van Zwanenberg and King, 1975:147).

From 1937 to 1944 a soil conservation programme involving terracing, grass planting, compositing and manuring was promoted. This was followed by a government attempt in 1938 to destock parts of the area through compulsory sales. So misunderstood and unpopular were these programmes that people from different parts of the district confronted the District Commissioner demanding their withdrawal. Other people, especially from Mulango location, migrated to Mbitini and Kanduti to avoid their participation in the programmes (Mutiso, 1977:22). Others joined the Machakos Akamba and marched en masse to the Government House in Nairobi. Their protest led to failure of both efforts.

After the World War II a second rehabilitation programme was initiated. It met similar distrust. Rumours circulated that once the land had been rehabilitated, it would be turned over to European farmers who would compel the Akamba labourers to cultivate it. Munro (1975) reports that the first attempt to introduce mechanical terrace construction in 1946 met sustained resistance with some Akamba throwing themselves in front of the tractors.

The government was undaunted. Conceived as a war to be won, soil conservation became a major policy in late colonial times. Gradually some progress was made. Narrow based bench terraces were constructed across the district; grass planting, manuring and water impoundments supplemented the terracing programme. By 1958, observers recorded an

impressive recovery of the badly eroded and denuded landscapes in Mulango, Changwithya, Matinyani and Mutonguni locations (Bernard, 1977:136).

The lessons of the colonial era are therefore clear: alteration of traditional agriculture and animal husbandry produced devastating results. Compulsory programmes to respond to this devastation backfired to such an extent that well beyond independence, a residual of distrust and bitterness towards soil conservation and livestock management was retained. Silted dams, terraces in disrepair, gullied cut-off drains, and resistance to animal inoculation (Munanda), because of its association with compulsory sales/destocking, all testify to the extent of Akamba backlash towards government intervention in their agricultural system.

The creation of a privileged class (Asomi) and declaration of the former Akamba grazing lands as Crown Lands, denied the ordinary Mukamba (singular for Akamba) access to adequate land for his own subsistence. To a large extent these forces inherited from colonial days have been carried forth to the present, causing population pressure to continue tearing the fabric of the Akamba society and landscape.

5.2 POST-INDEPENDENCE POPULATION PRESSURE

Population-resource imbalance in the arid and semi-arid areas of Kenya has intensified since the country was decolonised in 1963 (Pratt, 1968; Bernard, 1977). Four processes which began in the colonial time have exacerbated population pressure in these areas: wildlife conservation, land adjudication, development of ranching schemes and more important, natural population growth (Sindiga, 1986:94).

The carving out of wildlife conservation areas (in the form of national parks, national and game reserves) in Kenya began in 1945 and was aimed at primarily developing these areas for tourist industry (Kenya, 1975). Once set up, the areas were closed to settlement and use by the public. In the case of Kitui, about one-fifth (6,309 square kilometers) of the district is occupied by Tsavo East National Park. Apart from Tsavo East, other protected concentrations of wildlife in the district are in Yatta B2 in the central division.

The establishment of exclusive wildlife conservation areas in Kitui district has contributed to population pressure problem in a number of ways. First, as has already been indicated, these areas previously offered year-round grazing for the local people. The creation of wildlife reserves has increased competition for perennial grazing and surface water between domestic stock and wild animals (Pratt, 1968:). In addition, Pratt (1968:191) argues that it

is impossible to practise deferred rotational grazing in the presence of such large numbers of zebra, antelopes and gazelle because once these animals move into an area, they clear the forage that may be reserved for the next season. In addition, these areas may be used for human settlements and development of supportive infrastructural facilities.

A number of other problems are associated with wildlife conservation and tourism. Wildlife usually move out of their reserves to the surrounding areas where they destroy crops and livestock. Instances of lions, leopards and hyenas attacking domestic animals or elephants, rhinoceroses and hippos causing havoc to stored food and crops in the fields, are numerous in Ikutha location and in many other areas of Kitui district in the periphery of Tsavo East National Park.

Similarly, a combination of wild animal species such as hyenas, jackals, warthogs and wildebeast transmit certain diseases like catarrh, rabies, anaplasmosis and trypanosomiasis which cause mortality in livestock and humans (Sindiga, 1986:90). All these contribute to the destabilization of the Akamba social system and resource base. Population pressure then heightens and leads to impoverishment of both the local population and the supporting resources.

It has already been indicated that commercial ranching in Kitui district began during the colonial era following a

creation of a privileged class. After Kenya attained independence in 1963, these ranches were converted to co-operative societies, owned by a few relatively wealthy individuals. The total land area occupied by these ranches is about 920,000 hectares (Kenya, 1988), of which Sosoma (304,000 ha) in Mwingi division is the largest.

In addition to commercial ranching, land in Kitui has been carved out for forest conservation (43,657 ha), townships (10,000 ha) and for a variety of other uses in the category of government Trustlands (435,000 ha) (Kenya, 1988). All these and the associated bureaucracy continue to deny many people access to land for settlement, cultivation and grazing. Consequently, population pressure outside the ranches, the forests and the Trustlands ensue leading to land destruction and poverty. Post-independence land-use patterns in Kitui district are summarized in Figure 9.

Land adjudication is a Kenya government's policy to survey, demarcate and grant freehold title deed to every land owner in rural Kenya. The process began in Kitui district in 1971. Although it is recognized that land adjudication in Kenya is a prerequisite for development of the marginal areas, the process has a number of disadvantages. First, it generates a landless class by creating a land market whereby the rich progressive farmer buys out his poorer neighbour(s). Also, land adjudication does not consider the traditional inheritance laws and

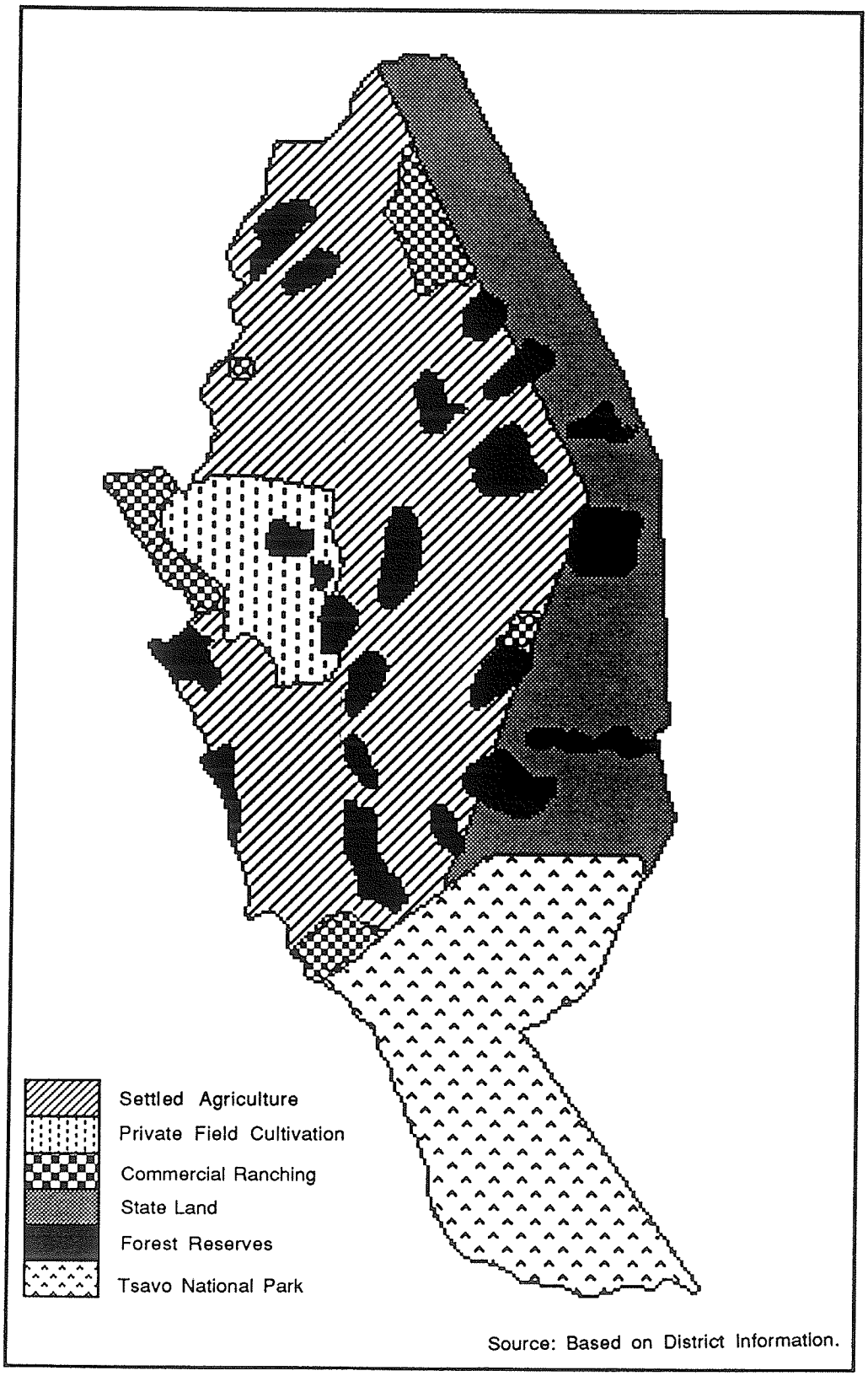

Figure 9: Post-Independence Land-use Patterns in Kitui District.

therefore married women's and their children's traditional rights to land are not guaranteed. In any case, a title deed does not automatically lead to better land use practises.

In Kitui district, adjudication and cultural practises are partly to blame for current population pressure. According to the Akamba tradition, for instance, only men own property and its distribution is arranged before the death of the household head. The sons inherit land through their mother. In polygamous unions, each wife knows the land she cultivates (muunda), which her sons inherit, the eldest (or the most favourite) receiving a relatively larger share. If a man dies leaving his wife with only daughters, his brothers inherit the property. Although such customary practises are changing in some areas, their impact on land distribution, especially where land has not been demarcated, remain quite significant. Unmarried daughters and divorced women, plus their children, have often been rendered landless. Landlessness is increased when the custom provides land tenure in favour of only one son in a large family. Often, those rendered landless co-habit with relatives or migrate. The advantage of this practise is that land subdivision is considerably reduced.

The provision of individual freehold title to land through adjudication, has denied the Akamba pastoralists access to their former communal grazing lands (weu), and has deprived them of the hill-plain symbiosis of subsistence.

Consequently, the misyi-syengo (homestead-cattle posts) duality has broken down. The Akamba have been forced by these circumstances to sell the bulk of their livestock and have thereby lost their ecological and economic flexibility. Yet, other subsistence alternatives seem to be unavailable. In this situation, population pressure has built up and reached crisis proportions.

Since Kenya attained independence, people have also been encouraged to settle permanently by the development of drought-resistant crop varieties such as katumani maize which matures in about 120 days ---- 60 days earlier than that taken by traditional varieties like kikamba maize (Mann and Kariuki, 1978:7). The result of this crop-development is that local people now encroach upon and cultivate ecologically fragile areas with adverse consequences to the land. Higher population densities cannot be permanently supported in these areas. Research in agronomy remains inadequate, and dry crop husbandry techniques have yet to be well developed. Experimental work has still to be undertaken to find crop and animal combinations that can be profitably maintained in these dry areas without causing environmental degradation.

Population growth has been cited by scholars as the most important factor creating the levels of population pressure currently being experienced in Kenya's marginal areas (Von Kaufmann, 1976:272; ILO, 1972:105; Pratt,

1969:153; Anzagi and Bernard, 1979:48; Bernard, 1982:145 and 1986:5). Population growth and trends in Kitui have been examined in Chapter Three, and the theory underlying population and resource relationship has been dealt with in Chapter Two. For instance, it has been indicated that Kitui district has one of the highest population growth rates in Kenya. As a result, total numbers in the district have more than doubled since Kenya's independence, 1963. The high population exerts heavy stress on land and other meagre resources within this fragile ecosystem, and leads to environmental degradation.

But as population pressure continues to grow in Kitui district and and in other areas of Kenya, many local people do not seem to notice it as a problem (see Chapter Six). Scholars have tried to investigate this attitude by researching on specific aspects. For instance, (a) why do the local people still prefer many children despite the government's concerted effort in encouraging them to limit birth? (b) what factors lead to failure and/or non-use of traditional as well as modern methods of contraception? The next section will discuss some of these issues.

5.3 THE KENYA'S DEMOGRAPHIC DILEMMA

On a global scale, Kenya is often cited as a classic example of a country which has one of the highest population growth rates. Since 1965, the Kenya government and private agencies have taken positive and active roles in family planning, both for maternal and child health as well as for demographic purpose. Yet, little progress has been achieved in reducing fertility rates in the country.

Kenya's family planning history appears impressive. In 1967 Kenya became the first sub-Saharan African country to launch an official family planning programme (United Nations, 1979). Private family planning efforts had begun even earlier in 1955 by two associations in the major cities of Nairobi and Mombasa (Odile, 1985). These joined forces in 1957 to form the Family Planning Association of Kenya (FPAK) and, in 1962, the FPAK became affiliated with, and largely financed by, the International Planned Parenthood Association of Kenya ----- also the first in sub-Saharan Africa. By 1968 the FPAK was operating some 40 clinics, mostly in cooperation with the Kenya government's Ministry of Health.

By 1978, family planning services were established throughout the country in 505 integrated maternal and child health/family planning clinics, 416 run by the central government and the rest by local agencies, churches and the FPAK (Kenya, 1978). Since then, large sums of money have

been spent on this programme. For instance, the programme cost US dollars 30 million in 1974-78 period, a large part of which was covered by the Kenya government, the World Bank, the U.S. Agency for International Development, and the Overseas Department of the United Kingdom (Mott and Mott, 1980:31).

Kenya's current population policy targets are mainly: (a) to curb the rate of population growth by encouraging Kenyans to have smaller families, (b) to reduce infant mortality, (c) to reduce internal migration, and (d) to motivate Kenyan males to adopt and practise family planning. In addition, the programme adopts some educational goals aimed at improving the status of women, as well as clinical goals aimed at ensuring contraceptive availability and awareness, among other priorities.

After more than two decades of active government-sponsored effort to reduce population growth, Kenya's fertility level and the rate of natural increase remain at a peak rarely attained in many countries. The Total Fertility Rate (TFR) remains at eight births per woman and natural increase at about 4.1% per annum (Population Reference Bureau, 1989a). Recent reports, however, indicate that Kenya's population growth rate may be declining (Weekly Review, September 22, 1989; Population Reference Bureau, 1989b). Currently, population growth is estimated at 3.8% p.a. and the Total Fertility Rate at 6.7 children (Population Reference Bureau, 1989b).

While Kenya's economic growth, despite of this demographic expansion, has been noteworthy, the outcome of her population policy has been a conspicuous failure (Mott and Mott, 1980). The most important factor which can explain the apparent failure, is the continuing high demand for children among the majority of Kenyans (Odile, 1985; Faruqee 1980; Bongaarts, 1987). This pro-natalist pressure emanates from various sources. In the case of the Akamba, as has already been indicated, land is governed primarily by men but subsistence production is largely the responsibility of women, who are granted rights to the land for agricultural purpose by their husbands.

To farm, women must recruit their children for cultivation as well as for other domestic tasks. Children between the ages of 6 and 14 typically work part time on the small-holdings, with highest participation rates during the peak planting, weeding, and harvesting seasons. Besides subsistence production, the responsibility for feeding the family rests with mothers. That responsibility includes all elements in the food chain from the transportation of food from the fields, to the preparation of meals. Meal preparation also entails the collection of water and fuel (usually firewood). Children are not only needed to help with farming and baby-sitting their younger siblings, but are also involved in cash producing activities such as petty trade.

According to Akamba marriage custom, it is the children (especially sons) a woman bears that guarantee her access to her husband's land. Her children, through their labour contribution, provide her with some relief from the volume of work. Indeed, she defers to her husband not only by providing him with her labour on 'his' land, but also by bearing and raising 'his' children. This structural and status dependency of women co-exist with the requirement for virtual economic self-sufficiency. The women as such must seek to manage this apparently ambiguous and paradoxical dilemma. Fertility is a major instrument in that management task. By continuing to bear children, a woman confirms her status in the marriage (in part, in competition with existing or potential co-wives), makes more secure her continued access to land, and serves the family and lineage interests of her husband (as well as ensuring that her own family can keep the bride price that was paid for her).

In sum, an Akamba woman produces a large family as a result of a set of economically and culturally defined, and socially enforced, obligations. Indeed, the notion of parity-specific planning of fertility probably is not even contemplated as a behavioural alternative, whether or not her spacing of births is planned. To planners, it may appear that differences in fertility are being resolved, but under typical family circumstances the woman herself, in that cultural setting, may not consider controlling her procreation.

Perhaps even more important, is that children are a major source of old age support for their mother. Since a woman, must in large measure, assure her own livelihood, often with little or no claim on her husband's estate after his death, only the children offer a promise of old age security that may in effect be indispensable. Women normally marry men much older than themselves, and on average outlive their husbands. As such, they anticipate many years of widowhood when they are dependant on their sons for support (since their daughters have been married). In order to be satisfied that she has adequate old-age security, Akamba women must therefore bear as many sons as they can. This means that if a woman gets only girls initially, she has to keep on 'trying' until she gets some sons. In effect, women have potential and existing fertility interests grounded in two largely separate domains of life ----- one concerned with livelihood and old-age security, the other with marriage and lineage relations.

In addition, Akamba society places a high value on children. To them, children are like flowers in the homestead. Grandparents treasure children and they love playing with them. Mothers become known by their first borns as Inya wa (mother to ---). Sterile women are looked down upon and often they 'marry' a young girl (kaweto) so that they can acquire children through her.

Other factors favouring high population growth in many parts of rural Kenya are: (a) declined traditional long periods of female post-partum abstinence from sex, (b) declined breast-feeding: abstinence from sexual relations after birth of a baby prevents an early next pregnancy; breast-feeding blocks ovulation, although the effect wears off several months before the baby is weaned. Both practises have been declining since the 1970's (Odile and McNicol, 1987:211); (c) decline in infant mortality, (d) early age at first marriage for most women, and (e) low levels of education (Bongaarts, 1987:133; Lesthaeghe, 1986:229). Education is probably the single most important factor in the enhancement of women's status. It has positive impact on health, the motivation and ability to control the number and spacing of children, and access to paid employment.

All these factors enhance the desire to have many children and are associated with the limited roles and opportunities prescribed for the majority of women in Kenya. Often, attempts to expand women's roles that might result in lower fertility, are viewed as a threat to their power by the dominant males. An attempt to alter this power imbalance between husbands and wives was in 1979 soundly defeated in the predominantly male Kenyan National Assembly. A bill which would have required a wife's permission for her husband to take a second wife and which would have given wives in polygamous unions equal property and inheritance

rights, was labeled by several members as un-African and culturally unacceptable. The bill would also have made adultery legal grounds for divorce and wife-beating a crime (Mott and Mott, 1980:10). Since then, further attempts to change the family power structure have been unfruitful.

Although Kenyan men share similar demographic interests with the women, they have notably different reasons which hinder them from recognizing the importance of family planning. In the Akamba society, for instance, the major traditional family responsibilities of fathers are: (a) to clear and plow the land their wives will cultivate, (b) to ensure that bride price commitments are met, and (c) to cover major family expenses beyond subsistence. Among these, schooling expenses have become steadily more important in the period since independence.

However, the major part of economic costs of children is effectively invisible to most fathers in rural Kenya (Tarver and Miller, 1986:35). This is because once the older children become employed, they support their mother and their younger siblings, and thus relieve their father of the economic pressure of school fees and other financial obligations. Even an emerging land shortage is not necessarily felt by most men as a reason to limit fertility (Dow and Werner, 1983). Older children often buy their own pieces of land and may not require a share of their father's land. The expense of schooling, combined with the perceptive

value of education in labour market, is a more plausible influence on positive male demographic interests (Bongaarts, 1987:135).

In addition, bride price expectations remain a likely object of explicit economic calculation, on a balance probably favouring high fertility: the bride price received for daughters can add appreciably to family assets, while increasingly sons have to accumulate their own dowry through their earnings.

The cultural value of high fertility to most Akamba men extends beyond narrow economic considerations. Paternity confers status and prestige. A reproductive life extended by polygamy continuously reaffirms to the community a man's command over his household. The majority of Akamba men do not allow their wives to use any contraception, nor do they use any themselves (Kabwegyere, 1972). Although this was the case almost twenty years ago, hardly any progress has been achieved in changing these male attitudes.

In addition to the cultural practises which continue to fuel the demographic flames in Kitui, as well as elsewhere in the country, Kenya's population policy has a number of flaws. Among these are its narrowness in focus and lack of demand for its services (Mott and Mott, 1980:83). The traditional family structure briefly described above, suggests that there is no easy route towards begining a

fertility transition. There are strong incentives within the family system and society that support continuing high fertility. These obstacles to change may erode in the future, but only if the family system is itself modified. No attempt was made in the two decades of Kenya's anti-natalist effort to design policy interventions that might have weakened these family incentives (Way, et al 1987). The policy lacks penalty and reward elements like those seen in the successful policies of China and South East Asia. In the one-child policy of China, for instance, the first child has access to free schooling and medicare. But parents who produce a second child have to pay heavily for their children to gain access to these services (Tien, 1984:393).

The discrepancy in recognizing the salient features underlying the demographic interests of men and those of women, discussed above, is echoed at another level, namely, between the way in which the government and international agencies look at Kenya's economic-demographic interrelationship and the view of scholars with more demographic or anthropological orientation. Reports by the World Bank (IBRD, 1986), by ILO(1972), and by Burrows(1975) show a clear identification of the adverse consequences to national development of continued rapid population growth, but make little acknowledgement of the issues which are stressed here. For instance, the low status of women is duly noted, but it is treated as a problem of income

distribution, remedial by transfer of payments, rather than a manifestation of resilient societal arrangements (Way, et al 1987). No attention is paid to the relationship between the low status of women and high fertility.

The important omissions of the 1960's and 1970's lay in not investigating thoroughly the social and economic base of Kenya's high fertility. The weakness of demand for fertility regulation has only gradually come to be realised, and when recognized, as is common today, the policy strategy has been to wait for economic growth and distributional improvement in education, income and other 'basic needs' to engender demand.

Above all, the availability and quality of family planning services are inadequate (Way, et al 1987). Also, inappropriate means of disseminating birth control information through such outlets as the television, radio and the press are heavily used. The majority of people lack these items, besides their inability to read. This method of delivering family planning information is less effective than using community-based extension workers.

Often, programme advisors and extension workers are brought from other areas into communities in which they cannot communicate in the local languages. A number of these workers are young university and college graduates. From personal experience in Kitui district, the majority of

the older people would not take these young advisors seriously. For instance, it is very difficult among the Akamba adults to discuss fertility and sex related matters with a younger person. The outcome is that family planning message is not taken seriously by local people. Most people are aware of modern methods of contraception, but they do not understand them. Also, chemical contraception is viewed with skepticism due to its numerous side effects.

In summary, this chapter demonstrates that population pressure in Kitui began during the colonial era as a result of several events and circumstances, like the creation of native reserves, imposition of quarantines and limitation of movement out of the reserve areas. After Kenya attained independence, land adjudication, creation of co-operative ranching societies for only a few, wildlife conservation and population growth took over and aggravated the problem. Two important factors namely, cultural practices and a national population policy which has many flaws, are to blame for the continued demographic stress currently experienced in Kitui district and in other parts of the country.

It appears that so long as the survival and old-age security for majority of Akamba women are dependent on their families and agriculture, there is no rational reason for them to significantly limit their fertility. Successful policy attempts to reduce birth rates can thus not be expected until substitute raisons d'etre are developed for

the vast majority of these women. Pronatalist pressure will continue at village level while anti-natalist arguments will continue to be articulated at the national level. Perhaps, success in birth control in Kenya will take longer to attain.

Under the circumstances, population pressure will continue threatening lives of the majority in rural areas such as Kitui as well as in other marginal parts of the country. Little is known about the magnitude of population pressure at local level. For instance, (a) which areas have reached or exceeded their carrying capacities and by how many? (b) what are the major symptoms of population pressure and how do the local people perceive of the problem? These and other related questions remain unanswered for many rural areas in Kenya, like Kitui district. The next chapter will address some of these issues.

Chapter VI

CARRYING CAPACITY AND CONSEQUENCES OF POPULATION PRESSURE

This chapter presents and discusses the results of the analysis of data collected by the field survey in 1988-89 on population and land capability in Kitui district. The results are presented under two headings: (a) carrying capacity analysis, and, (b) symptoms of population pressure. Thus, this chapter focuses mainly on the second and the third objectives and hypotheses of the study.

6.1 CARRYING CAPACITY ANALYSIS

This section addresses the second objective and hypothesis of the study. As explained in Chapter Four, the main data required for computing human carrying capacities for an agrarian societies living in the marginal areas, and operating at traditional technology are: the size of the average household, total subsistence food requirement, the minimum size of a farm required to sustain the average household, potential amount of food calories which can be produced by the arable portion of land, and the livestock requirement for the average household.

The following section presents the various methods used in Kitui, and the assumptions made in generating the data required for the carrying capacity analysis.

6.1.1 Assumptions and Methodology

Based on the field survey information, the average household in Kitui district consists of 7.7 resident members (excluding married daughters and family members who are away). Of the 7.7 members, 3.49 (or 3.5) are children under 15 years of age. Following the method of Brown (1977), which assumes that adults require twice as much food as children under 15 years, it implies that an average household in this area has a resident population of 5.96 (or 6) adult equivalents.

Each adult member of the household requires a minimum of 2,400 calories per day, since much energy is neccesary for the heavy manual work (Brown, 1977). The minimum daily requirement for the average household is therefore 14,304 or 5,220,960 calories per annum. It is recognized that a focus on calories alone overlooks some of the qualitative aspects of diet and does not necessarily provide a balance of vitamins, and trace minerals (Bernard, 1977). It is assumed that the livestock component of the diet provide high quality proteins, since people in Kitui are also dependant upon raising cattle and goats.

The potential livestock carrying capacity for various ecological zones, and the amount of land required by each household to meet its basic livestock subsistence needs, are adopted from the work of the Kenya's department of soil survey (Jaetzold and Schmidt, 1983) as indicated in Table 6.1.

TABLE 6.1

Household Basic Livestock Requirement in Hectares

Ecozone	Household livestock requirement in hectares (ha)
III	2.0
IV	4.0
V	12.0

Source: Jaetzold, R.and H.Schmidt (1983:47).

Ecological zones, as defined by the Kenya's department of soil survey (Jaetzold, 1983), were the basis of evaluating the environmental potential or land capability in each location using the method outlined in Chapter Four. This analysis yielded the important information upon which possible crop combinations and yields, as well as the proportion of arable to non-arable land in each location, was based.

Representative food crops for each ecozone were assigned after consultation with agronomists in Kenya's Ministry of Agriculture. With the exception of pigeon peas (Nzuu), which is harvested only once in a year, two crop harvests per annum are assumed. Potential yields per season are based on the Ministry's estimate yield ratio: short to long rains is 1 to 0.75. The short rains are more reliable than the long rains; hence, higher yields are usually

realised because the risk of crop failure is low. Yield estimates in Appendix C are applied to each ecozone and smallholder rain-fed arable farming using traditional technology is assumed. Also, inter-cropping is assumed. It is further assumed that only family labour is available for agricultural production.

The proportion of calorie intake from crops and animals for the various ecozones are derived from a special district assessment report by the Kenya National Secretariat for Environment and Human Settlements (Table 6.2). In addition, no account is taken of the periodic drought although it is recognised that drought reduces subsistence carrying

TABLE 6.2

Percentage of Calorie Intake Derived from Crops and Animals

Ecozone	Per cent of calorie intake from: crops	livestock
III	83.3	16.7
IV	66.7	33.3
V	50.0	50.0

Source: Kenya (1981:160).

capacity to zero in severest years.

6.1.2 Analysis and Results

Table 6.3 shows results of the carrying capacity estimates for different administrative locations of Kitui District, which were computed from the field survey information. From this table several observations can be made. First, it is evident that Kitui district exceeds its carrying capacity by about 67,405 people at present levels of technology. The bulk of this surplus population is in Central and Mwingi Divisions, which exceed their carrying capacities by about 70% and 60% respectively.

Locations with the highest absolute population pressure are Changwithya, Matinyani, Kisasi, Mulango, Mutonguni, Migw'ani and Mwingi. The same locations rank high in relative terms, as is indicated by the population pressure ratios (Table 6.3 and Figure 10).

In contrast, the Southern, the Eastern and Kyuso divisions do not yet face severe population pressure, although some locations in these areas like Nuu, Ikanga/Mutomo, Kanziko and Katse have exceeded their carrying capacities. Also, within these areas, locations like Mutito, Mui, Endui, Mivukoni and Tseikuru are on the verge of experiencing population pressure and have only an average of three and half years to reach their maximum carrying capacity.

Table 6.3 Kitui District Potential Human Carrying Capacities.

Location/ Division	(a) Total area in hectares	(b) Area available for cultivation and grazing	(c) 1989 estimate population	(d) 1989 estimate no. of households	(e) Carrying Capacity	SURPLUS OR (DEFICIT) No. of households	SURPLUS OR (DEFICIT) No. of persons	(f) PPR ratio	(g) Years to reach Carrying Capacity
Mulango	31500	23878	39579	5140	2469	2671	20566	2.1	0
Kisasi	25400	16800	32549	4227	1458	2769	21321	2.9	0
Matinyani	22000	14300	34261	4449	1362	3087	23770	3.3	0
Changwithya	23100	13860	41784	5427	1761	3666	28228	3.1	0
Miambani	29000	20720	24639	3200	3163	37	285	1	0
Nzambani	20900	14630	24744	3214	2310	904	6961	1.4	0
Yatta	72400	43440	28619	3717	3106	611	4705	1.2	0
Yatta B2	45600	27360	6431	835	1946	(-1111)	(-8555)	0.4	28
Central	**269900**	**174988**	**232606**	**30209**	**17575**	**12634**	**97281**	**1.7**	**0**
Mutito	41700	25854	13379	1738	2187	(-449)	(-3457)	0.8	6
Endau	253500	38025	11160	1450	3008	(-1558)	(-11997)	0.5	26
Mui	41200	24720	13692	1778	1966	(-188)	(-1448)	0.9	3
Zombe	80100	40050	15341	1993	3169	(-1176)	(-9055)	0.6	15
Nuu	82700	38593	15844	2057	3053	(-996)	(-7669)	0.7	0
Eastern	**499200**	**167242**	**69416**	**9016**	**13383**	**(-4367)**	**(-33626)**	**0.8**	**12**
Ikanga/ Mutomo	82600	49147	30943	4018	3640	378	2911	1.1	0
Ikutha	126400	63200	26762	3471	4654	(-1183)	(-9109)	0.7	12
Kanziko	68200	22733	14881	1933	1674	259	1994	1.2	0
Voo	69000	42881	13711	1781	3119	(-1338)	(-10303)	0.6	26
Mutha	318850	52610	9333	1212	3874	(-2662)	(-20497)	0.3	75
Southern	**665050**	**230571**	**95594**	**12415**	**16961**	**(-4546)**	**(-35004)**	**0.7**	**13**

Table 6.3 cont....

Table 6.3 continued

Mutonguni	46500	30225	47947	6227	3184	3043	23341	2	0
Migw'ani	68900	43063	47194	6129	3771	2358	18157	1.6	0
Mwingi	68500	42470	40211	5222	3465	1757	13529	1.5	0
Endui	4100	20500	13873	1802	1854	(-52)	(-400)	0.9	1
Mwingi	**224900**	**136258**	**149225**	**19380**	**12274**	**7106**	**54716**	**1.6**	**0**
Mivukoni	163500	61000	28917	3756	4254	(-498)	(-3835)	0.9	4
Katse	53500	37450	21895	2844	2742	102	785	1	0
Tseikuru	55700	27850	13756	1787	2030	(-243)	(-1871)	0.9	4
Ngomeni	361300	60000	21066	2736	4090	(-1354)	(-10426)	0.7	13
Tharaka	32600	14300	7829	1017	1097	(-80)	(-616)	0.9	2
Kyuso	**66660**	**200600**	**93463**	**12140**	**14213**	**(-2073)**	**(-15962)**	**0.9**	**5**
KITUI	**2325650**	**909659**	**640304**	**83156**	**74406**	**8754**	**67405**	**1.1**	**0**

(a) Source: Kenya, 1981:41
(b) Computed using method outlined in Chapter Four
(c) Estimates from 1979 census (Kenya, 1979:103)
(d) Computed from (c), using 7.7 members per household
(e) Computed using formulae in Chapter Four

$$\text{(f) PPR ratio} = \frac{\text{actual no. of households}}{\text{carrying capacity no. of households}}$$

A PPR ratio of 1.0 means that population is at balance with an area's resources. A PPR value greater than 1.0 suggest that an area has surpassed its carrying capacity and is suffering from population pressure, while values less than 1.0 suggest that an area has not yet reached its carrying capacity.

(g) Estimates using a population growth rate of 3.8% p.a. for Kitui District.

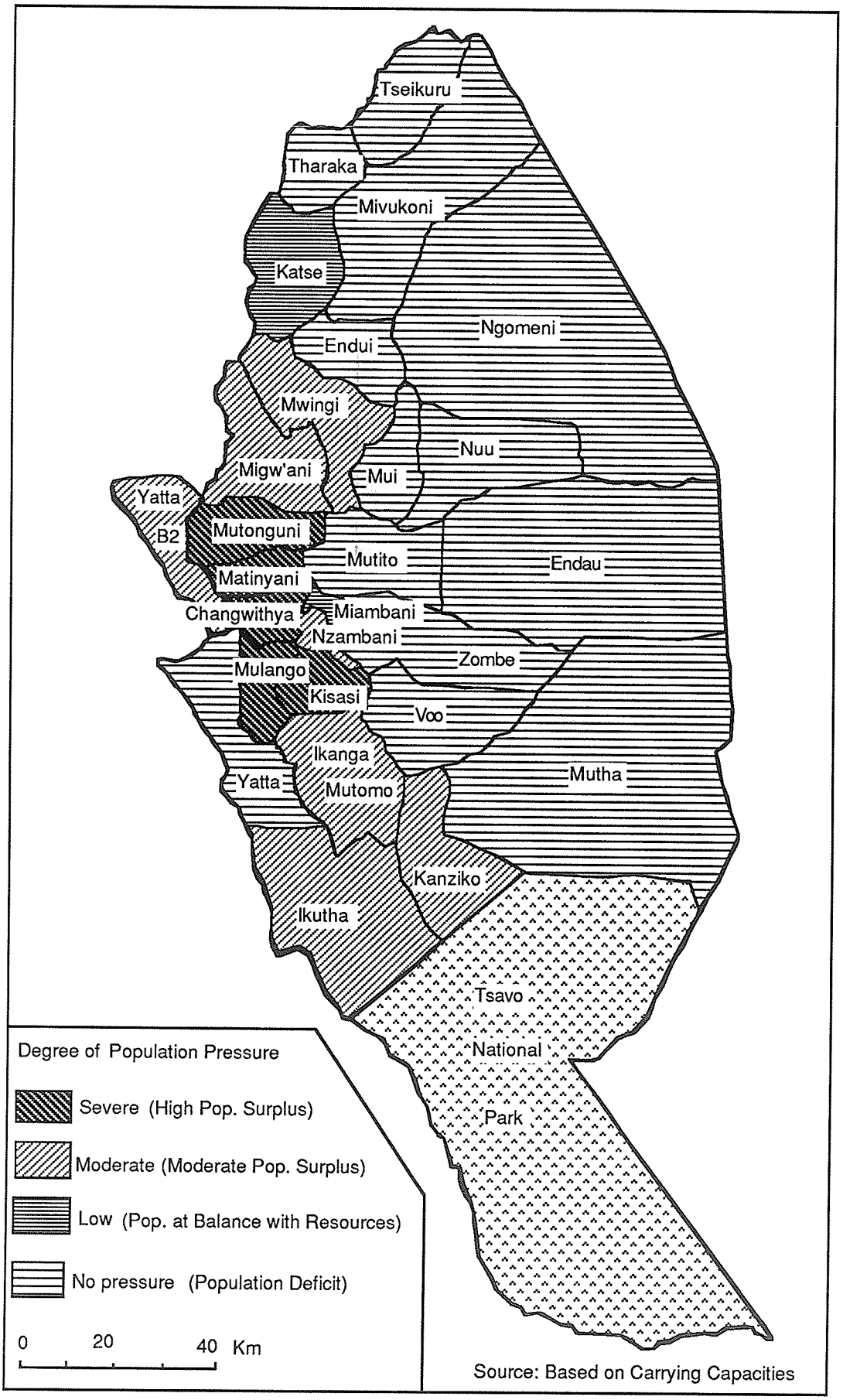

Figure 10: Degree of Population Pressure in Kitui District.

These Locations are primarily in the least productive ecological zones (zone V) and therefore manifest exceptionally low carrying capacities relative to their land area. In these barren areas, approximately 16 hectares of land are required to provide a basic subsistence level for a family. However, despite their environmental limitations, these Locations are perceived by local people as being empty. Down-slope migration from the higher population pressure hills of Kitui Central promises to exacerbate the problem further.

Generally, the high and the medium potential zones (zones III and IV) in Kitui district are suffering from severe population pressure (see section 6.2). A large proportion of the more arid zone (zone V) is still relatively underpopulated and can provide land for an additional 33% (or 84,592 people) of its present population. However, given the current annual population growth rate of 3.8%, this zone will reach its maximum carrying capacity around the year 1998.

6.1.3 Summary of Carrying Capacity Analysis

It is quite apparent from the carrying capacity estimates that many parts of Central and Mwingi divisions of Kitui district have now reached a critical level of population pressure. The district as a whole has indeed surpassed its

carrying capacity. However, to the south (in Mutha, Voo and Ikutha), to the east (in Endau and Zombe) and to the north (in Ngomeni and Mivukoni) lie areas that are not yet experiencing population pressure. It seems likely that as the population pressure becomes more acute in Central and Mwingi divisions, movement into these adjacent areas will increase because of the availability of land.

Population pressure and land shortage will become an ever increasing problem which must be faced without further delay. Already signs of environmental stress caused by overpopulation are evident throughout the district. Even in the sparsely settled areas, environmental deterioration caused as much by mismanagement as by overpopulation, is becoming a serious threat to the future productivity of the areas.

While vigorous efforts to rehabilitate the land through soil and water conservation have been undertaken, and indeed should be increased, so far they have been insufficient. Unless the basic problem of population pressure in the marginal lands is resolved, further efforts will also fail. It is hereby hoped that the newly created Ministry of Arid, Semi-arid and Waste Lands (Weekly Review, May 1989) will develop immediate ameliorative measures to counteract land and population problems in these areas.

In expressing these results it must be reiterated that the carrying capacities of these areas are likely to change with varying technology and farming techniques. Should other methods of farming be introduced that require land for cash crops, more livestock, new crop varieties or an augmentation of other productive rural activities requiring land, a different set of carrying capacities would be derived. For instance, production of cash crops whereby a family could earn KES.3,000 (US$ 150) per season, would require more land and reduce the carrying capacities unless there is a technological change.

On the other hand, carrying capacities can be increased by the introduction of higher yielding crops. For instance, at the present level of technology, sorghum yields about 700 Kg/ha in ecozone IV (Appendix C). If sorghum were to be cultivated more widely than maize, which yields only 500 Kg/ha, more people could be supported on the same land. In itself, this isolated change from maize to sorghum could feed three more adults per hectare each season, or five adults per hectare per annum. This does not suggest an isolated unidimensional development strategy, but demonstrates that carrying capacity is an intimate function of technology.

The concept of carrying capacity, with all the refinements suggested, can provide a baseline for development projects in areas presently underpopulated, and

thus might avoid some of the mistakes of colonial development strategies. But until these changes and improvements are in place, population pressure will pose severe difficulties in the development of marginal areas like Kitui district.

Amelioration of some of the present consequences of population pressure, such as soil erosion, vegetation destruction, declining crop yields, outmigration, and land fragmentation is difficult without a spatial picture of the magnitude of these elements. A spatial analysis of the consequences of population pressure can provide such a picture and can thereby serve as a basis for setting priorities in improving these conditions. The following section is intended to provide this picture for Kitui district.

6.2 SYMPTOMS OF POPULATION PRESSURE

This section addresses the third objective and hypothesis of the study. In particular, the hypothesis that there is no significant difference between the three ecological zones in terms of population pressure indices, is tested. Results of two techniques which are used in data analysis are discussed, that is, (a) Principal Component Analysis (PCA) and (b) Multivariate Analysis of Variance (MANOVA). In addition, descriptive analysis is used to compare the three ecological zones on basis of selected population pressure indices.

6.2.1 Principal Component Analysis

In Chapter Four it is indicated that two of the main utilities of principal component analysis are (a) to summarize variation in a multivariate system, and (b) to reduce the number of variables on basis of their correlation with the first principal component (Morrison, 1967:228).

The first step in this analysis was therefore to summarize data by following the procedures outlined in the SAS software statistical package. The results of this analysis are summarized in Table 6.4. From Table 6.4 it is evident that the first two principal components account for the total variation in population pressure indices, the first (PRIN1) accounting for 76% (or 0.761472 proportion) and the second (PRIN2) for 23% (or 0.238528 proportion). Principal components three and four (PRIN3 and PRIN4) are included in this table to emphasize that the rest of the

TABLE 6.4

Results of the Principal Component Analysis.

	Eigen value	Difference	Proportion	Cumulative
PRIN1	11.5850	6.17006	0.761472	0.761472
PRIN2	5.4150	5.41497	0.238528	1.000000
PRIN3	0.0000	0.00000	0.000000	1.000000
PRIN4	0.0000	0.00000	0.000000	1.000000

principal components do not account for any variation.

Also, on basis of the factor loadings generated from this analysis, all the variables can be classified into groups depending on the sign (positive or negative) and the size of the respective factor loadings. However, the main concern for the analysis was to identify the important population pressure indices and to determine their variation within the three ecological zones.

In the next stage of analysis, variables were correlated with the first principal component. The purpose of this analysis was to determine the relative importance of each original variable in the derived component (PRIN1). Results of the analysis are presented in Table 6.5

Results of correlation analysis in Table 6.5 indicate that nine population pressure indices do not have a strong linear relationship (<0.5) with PRIN1. These are: Landlessness (LAND), Land disputes (LADI), Farming/grazing around swamps (SWAM), Cultivation on steep slopes (SLOPE), immigration (OMIG) and food deficiency diseases: Pellagra (PEGRA), Kwashiokor (KWA) and Rickets (RICKS). As indicated earlier, the first principal component (PRIN1) is very important because it accounts for 76% of the total variation of population pressure indices. Since these nine indices do not have strong correlation with PRIN1, they are overall

less important in measuring the degree of population pressure in the study area.

However, it should be noted that the results of correlation analysis are based on aggregate data of population pressure for the three ecological zones. Thus, some of the indices classified as overall less important, are quite important in some ecozones. For instance, further analysis indicate that outmigration (OMIG) is a very important indicator of population pressure in ecozone III where 43% of respondents indicated that some members of their households were away on "permanent terms". Also, in ecological zone V 53% of respondents indicated that they are migrants in the zone.

The weak correlation between PRIN1 and the food deficiency diseases (kwashiokor, pellagra and rickets) should be interpreted with care. Incidence of these diseases may be higher than the survey data indicates. The Akamba are normally shy about matters related to diseases and may have been reluctant to report that their kin are sick.

In summary, results of the principal component analysis demonstrate that population pressure in the three ecological zones is indicated mainly by land subdivision (LASU), land fragmentation (LAFR), declined fallowing (FALO), cultivation along river channels (RIVER) and roadsides (ROAD), soil

Table 6.5 A Section of Correlation Matrix of Principal Component 1 and Population pressure Indices.

	PRIN1	LAND	LASU	LAFR	LADI	FALO	RIVER	SWAM	ROAD	SLOPE	BUSH	SOIL	YIELD	FOOD
PRIN1	1													
LAND	0.00001	1												
LASU	0.94021	0.00001	1											
LAFR	0.63364	0.00001	0.79751	1										
LADI	0.48653	0.00001	0.74911	0.99712	1									
FALO	0.64552	0.00001	-0.96074	-0.93364	-0.90351	1								
RIVER	0.65026	0.00001	0.02794	0.62531	0.68311	-0.30412	1							
SWAM	0.02331	0.00001	0.58776	-0.01953	-0.09587	-0.34021	-0.79245	1						
ROAD	0.99936	0.00001	0.92754	0.51412	0.44714	-0.78732	-0.34796	0.84766	1					
SLOPE	0.38734	0.00001	-0.96623	-0.92614	-0.89462	0.99983	-0.28465	-0.35921	-0.79973	1				
BUSH	0.15692	0.00001	-0.82871	-0.32332	-0.25011	0.64009	0.53633	-0.93982	-0.97792	0.65643	1			
SOIL	0.99745	0.00001	-0.87823	-0.32333	-0.25012	0.64093	0.53635	0.86601	0.99942	-0.77774	0.99342	1		
YIELD	0.98267	0.00001	0.86008	0.37943	0.30761	-0.68582	-0.48483	0.91774	0.988874	0.88743	0.17432	0.00001	1	
FOOD	0.98345	0.00001	-0.74142	-0.18642	-0.11008	0.52604	0.65023	-0.97874	-0.93853	0.54332	0.99002	-0.95031	-0.97973	1
PEGRA	0.37883	0.00001	-0.45342	-0.87654	-0.24371	0.45321	0.56382	-0.78352	-0.89995	0.46904	0.88843	-0.87675	-0.97654	0.64511
KWA	0.46351	0.00001	-0.58773	0.01952	0.09584	0.34001	0.79243	- 1	-0.84762	0.35922	0.93986	-0.86601	-0.91774	0.50001
RICK	0.47289	0.00001	-0.58773	0.01951	0.09578	0.34011	0.79243	- 1	-0.84765	0.35926	0.93984	-0.86604	-0.91772	0.50001
OMIG	0.14641	0.00001	0.99312	0.72122	0.66621	-0.92153	-0.08963	0.67863	0.96491	-0.92932	-0.88872	0.95492	0.91463	0.29692
ACCE	0.99111	0.00001	-0.97721	-0.65111	-0.59125	0.87981	0.18512	-0.74623	-0.98573	0.88941	0.92873	-0.97912	-0.94931	-0.20354

erosion (SOIL), decline in crop yields (DECL), food insufficiency (FOOD), and inaccessibility to social amenities (ACCE). This analysis, however does not indicate whether the three ecozones are significantly different in terms of these indices. The next section will address this issue.

6.2.2 Multivariate Analysis of Variance

In Chapter Four it is indicated that in Multivariate Analysis of Variance (MANOVA), the Wilks' lambda criterion (L) is used to determine a F value which can be used to test the hypothesis that there is or there is no significant difference between a given number of regions on basis of observed variation. That is, the F which is computed using the Wilks' lambda may be used, for instance, to test the null hypothesis Ho: $u_1 = u_2 = - - = uk$ in a situation where there are k regions, P variables and N observations whose means are $u_1 - - - uk$; or to test whether at least one of the u's is not equal to the rest.

In this research, MANOVA is used in testing the null hypothesis that there is no significant difference between the three ecozones on the basis of the nine population pressure indices determined by the principal component analysis in Section 6.2.1. In this case, N=345 (345 respondents), k=3 (3 ecozones), and p=9 (9 population pressure indicators). By use of the SAS software system for

data analysis, Wilks' lambda is determined (L=0.2872). F_1 is computed using the formula: $F_1 = 8/3(1-L^{1/2})/L^{1/2}$ (Mardia et al,1982:336). Therefore $F_1 = 2.30$. From the F distribution table, the critical value $F_2 = 1.57$ at 0.05 significance level and (18 668) degrees of freedom (Appendix D).

Since the computed F_1 is greater than the critical F_2 the null hypothesis is rejected and the alternative adopted. Therefore, we conclude that there is a significant difference between the three ecological zones on the basis of the nine population pressure indices derived by principal component analysis.

However, the results of MANOVA do not indicate which ecological zone is different from the others or which zones are similar. This information is important for this research because it provides a picture of variation of population pressure across the land potential in the study area. Section 6.2.4 addresses this issue. The next section discusses the perception of population pressure in Kitui district.

6.2.3 Perception of Population Pressure

Table 6.6 presents synopsis of the respondents' perception of population pressure in Kitui district. From the results, it appears that desire for many children is fairly strong in all ecological zones. About 40% of the

respondents in the three moisture zones desire more than six children and only a minority, varying from 6% in ecozone III to 3% in ecozone IV, desire one to two children. In aggregate, more than 50% of the respondents indicated that they desire three to six children.

Regarding opinion about the number of people in their villages, a majority of the respondents said that the numbers are "aright". This feeling is strongest in ecozone V and weakest in zone III, where 67% and 48% of respondents answered "YES" when asked whether they felt that numbers of people in their villages are "aright". Only about 8% of respondents from zone V felt that there are "too many" people in their villages (Table 6.6).

As to what should be done about the rural surplus, the respondents had mixed feelings. But "out migration" and "family planning" seemed to be a popular option among the respondents as a possible solution to population pressure in their area.

From this brief discussion, it appears that majority of the respondents do not realise that there is a problem of population pressure in Kitui district. They do not associate soil erosion, land subdivision, land fragmentation, and the physical destruction of resources with population pressure. More than half of the respondents desire large families. Should this desire be realised,

Table 6.6 Perception of Population Pressure : Respondents' Views and Observations.

VARIABLE		ECOZONE		
Name	Explanation	III	IV	V
Desired No. of children				
-- 1--2	% reporting YES	6	3	4
-- 3--4	% reporting YES	24	26	13
-- 5--6	% reporting YES	30	28	38
over 6	% reporting YES	40	43	45
Opinion about No. of people in the village				
-- too few	% reporting YES	11	15	20
-- aright	% reporting YES	49	58	67
-- too many	% reporting YES	32	24	8
What should be done about surplus population				
-- resettlement by govt.	% reporting YES	29	16	18
-- migrate to other areas	% reporting YES	33	40	44
-- use family planning	% reporting YES	33	32	28

population pressure will worsen and inevitably put further strain on the land and other available resources. Unless the local people are educated about the danger of high population growth, population pressure will continue to be a major barrier to rural development in Kitui district and similar areas of Kenya.

6.2.4 Summary of Population Pressure Symptoms

The above discussion provides highlights of the consequences of population pressure in Kitui district. The principal component analysis provides the significant indices of population pressure in the district. The Multivariate analysis demonstrates that the three ecozones are significantly different in terms of population pressure indices but does not indicate how the pressure varies between the ecozones. This section presents an overview of this variation by comparing interviewees' responses on individual symptoms by moisture zone.

Table 6.7 presents a summary of the respondents' views and observations about the various symptoms of population pressure by moisture zone. The moisture zones are ranked on the basis of the averages of the respondents' views about the symptoms. The ranking provides a composite view of the severity of population pressure between the ecozones. The zone suffering most is ranked first and the one suffering least, last.

Results in Table 6.7 indicate that population pressure is most severe in ecological zone III followed by zone IV. These zones, as is pointed out earlier, are of relatively high and medium agricultural potential. They also carry the highest population densities in the district (see Chapter Four). However, it should be noted that the terms "high potential" and "medium potential" are only relative and should therefore be used with care. In fact, these zones are scarcely humid in terms of climatic classification. Rain-fed agriculture within the two zones is quite feasible but crop failure has been recurrent in the past as a result of erratic rainfall patterns.

It is also significant to note that zones III and IV not only rank high in land fragmentation and subdivision, but also in soil erosion and food insufficiency. Due to land scarcity in these zones, the local people must encroach all parts of their land in order to produce food. Land fallowing within these zones has declined considerably. This means that the indigenous farming systems are changing. Inevitably, as population pressure compounds, land becomes scarce and fallowing declines. People move further afield down the ecological gradient to the more marginal areas in search of land to graze and cultivate.

It is also evident that only a small proportion of respondents in each of these zones directly associates resource deterioration and food shortages with population

Table 6.7 Ranking Ecozones by Selected Population Pressure Indices.

VARIABLES		ECOZONES		
Name	Definition	III	IV	V
Land fragmentation	% reporting YES	93	94.7	49
Land subdivisions	% reporting YES	97	71.1	53
Non fallowing	% reporting YES	88	68.4	33
Use of Marginal lands				
-- river channels	% reporting YES	56.4	68.4	66
-- roadsides	% reporting YES	78.5	7.9	5
Soil erosion increase	% reporting YES	84	81.6	81
Declined crop yields	% reporting YES	86.5	78.9	80
Food insuficiency	% reporting YES	98.8	100	98
Lack of access to amenities	% reporting YES	52.1	74	80
	AVERAGE	81.59	71.67	60.56
	RANK	1	2	3

pressure. Only about 32% and 24% of the respondents in zones III and IV, respectively, who gave opinion about the number of people in their area in relation to resources, said that there are "too many" people already.

Perhaps question 65 (Appendix A), which sought the respondents' opinions about the number of people in relation to the amount of land, was not asked clearly enough to evoke accurate local perception of the issue. It may also be noted that the matter of population numbers is a sensitive one among the Akamba, as among other tribes of Africa. The Akamba have a taboo against counting their kin (Mbiti, 1972:98). They would not openly admit that there are "too many" of their own kin.

Many African societies believe that daily life and family relationship and activities are tied to dead ancestors. Procreation is the surest way of keeping the ancestors' spirits alive by maintaining continuity of their blood relations (Mbiti, 1970:26). It is believed that a curse would befall the people if they said that there are "too many" of their kin in the villages.

Although the respondents in zones III and IV did not directly admit the existence of population pressure, inferences about the subject can be made from their responses to the related questions. About 80% of the respondents noted that their farms are now smaller, and that

crop production on their farms has declined within the last five years.They also said that land fragmentation and subdivision, soil erosion and use of marginal parts of their land have now increased. These responses can be taken as suggesting increased population pressure which has led to greater demands of land and deterioration of resources in these areas.

Ecological zone V offers land with the lowest agricultural potential on the basis of the existing technology. It also carries the lowest population density in the district. The zone shows the fewest signs of ecological deterioration and socio-economic stress. It exhibits only modest land subdivision and fragmentation. More people than in zones III and IV, practise fallowing. This zone holds the greatest potential for absorbing additional population even at the existing farming technology.

But it appears that if migrants move into this fragile zone and continue with the current land use practises, their unsuccessful adjustments to population pressure will have disastrous human and environmental consequences as the land is cleared, crops fail and economic dislocations set in. In other words, it appears that the process of outmigration from zones III and IV into zone V will merely redistribute the population pressure in Kitui district rather than ameliorate it.

6.3 CARRYING CAPACITY AND POPULATION PRESSURE SYMPTOMS

The purpose of this section is to discuss population pressure in Kitui district as it is revealed by both the carrying capacity estimates and the analysis of population pressure symptoms. Ultimately, the magnitude of the spatial variation of population pressure will crystallise.

One of the most conspicuous outcomes of the analysis is that the low potential parts of the district are not suffering from population pressure. This dimension is clearly brought out by both the carrying capacity estimates and the analysis of population pressure symptoms. Computation of carrying capacities demonstrate that 100% of the rural surplus population is in Central and Mwingi divisions (Table 6.3). These two divisions are mainly covered by ecological zones III and IV, which have been shown to suffer from the most severe pressure on the basis of population pressure symptoms.

On the other hand, many parts of Eastern, Kyuso, and Southern divisions have not yet reached their carrying capacities. All the three divisions are basically in ecological zone V which also ranks lowest in terms of intensity of population pressure symptoms. This means that carrying capacity estimates tally with the results of the population pressure symptoms.

In summary it may be stated that both the results of carrying capacity and population pressure symptoms demonstrate that a large part of Kitui district is suffering from population pressure. In particular, zones III and IV where most people live, are suffering from the worst effects of population pressure. Environmental deterioration and food insufficiency have become characteristic each year.

Population spill-over from the arable to the less arable ecosystems within the district has been noted. Until the less arable parts of the district (and similar areas in Kenya) are well managed, resource destruction and population pressure will inevitably worsen. This management task should be the main challenge of the Kenya's Ministry of Arid, Semi-arid and Waste Lands.

To meet this challenge, the Ministry and other relevant government departments need to take resource conservation and farm management more seriously than appears to be the case at present. The agricultural and ecological management of the arid and semi-arid lands is a much more difficult task than that of managing the arable lands. It requires competent and highly dedicated personnel in the government to support the entrepreneurial spirit of the farmers who will move into these areas. The Kenya government should therefore focus attention on the training of such manpower if that objective is to be attained.

Chapter VII

SUMMARY AND CONCLUSION

This Chapter will summarise the findings of the study and suggest their policy implications as well as directions for further research. The prime objectives of this study have been, (a) to investigate the roots and evolution of population pressure in Kitui district, (b) to compute carrying capacities for different administrative units of Kitui district, (c) to investigate the impact of population pressure on the environment and on human conditions, and to (d) explain the factors responsible for the high population growth in the study area. The general hypothesis is that population pressure in Kitui district cannot be explained by a single factor but by an array of attributes. Four specific hypotheses were formulated and tested.

Different sets of data have been utilised for the study. Primary data concerning household characteristics (heads and other members), household economies, and household heads' views on symptoms of population pressure were elicited through a questionnaire survey. Secondary data on ecological potential, the history of population pressure, Kenya's population policy, and general background information on the study area have been collected from different sources.

Carrying capacity modelling has been applied to estimate degrees of population pressure in the district. Principal Component Analysis (PCA) was used to summarise data and to determine the significant population pressure indices (symptoms). Multivariate Analysis of Variance (MANOVA) tested the null hypothesis which states that there is no significant difference between the three ecological zones on basis of selected population pressure indices. Descriptive statistics compared the three ecozones on basis of respondents' views and their observations on selected population pressure indices.

7.1 THE MAIN RESEARCH FINDINGS

The study demonstrates that population pressure is not a recent phenomenon in Kitui district. It is a result of a complex history of political, economic, and social changes which have engulfed Kenya over the past one hundred or so years. Directly or indirectly these changes have disturbed the stability of the ecosystems in the face of increasing human numbers and diminishing resources.

Changes associated with British colonial rule, including territorial constriction through the creation of African native reserves, the repeated imposition of quarantines, the introduction of the Hut and Poll tax, and the creation of wildlife conservation areas have all led to a reduction in land and contributed to a breakdown of the

indigenous economic and social order. After Kenya attained independence in 1963, government policy on land adjudication, the establishment of commercial ranches, the creation of forest reserves and Trustlands, as well as the maintenance of the game reserves inherited from colonial authorities together, escalated the problem.

High population growth has been by no means a minor factor in increasing hunger for land and environmental destruction. The desire among the majority of people for many children continues to frustrate government's concerted efforts to limit births. This desire for many children emanates from a complex cultural background and the economic setting of the local people. Kenya's population policy also has many flaws and weaknesses and has thus been unable to influence the entrenched custom favouring many children. Unless female emancipation is promoted, it will be difficult for Kenya to achieve demographic transition.

If progress towards reduced births is to be realised, the population policy may have to develop a reward and penalty system, such as those introduced by some of the more successful programmes in China and Southeast Asia. As indicated earlier, in the one-child population policy of China, for instance, the first child has access to free schooling and medicare. But parents who produce a second child have to pay heavily for their children to gain access to these services (Tien, 1984:393).

The results of the carrying capacity analysis demonstrates that many parts of Kitui have now reached a critical level of population pressure. Overall, the district exceeds its carrying capacity by more than 60,000 people. The worst affected areas are Kitui Central and Mwingi divisions where locations like Changwithya, Matinyani, Kisasi, Mulango, and Mutonguni exceed their carrying capacities by more than 100 per cent. However, in the south and east, there exists some land with room for more people. These results are based on the presupposition that the existing levels of technology will be maintained for the next couple of decades.

The results of the analysis of symptoms of population pressure provide a spatial picture of the problems across ecological zones within the district. On the basis of respondents' views and observations regarding population pressure indicators, ecological zone III appears to be the most seriously affected, followed by ecological zone IV. The two ecological zones extent mainly across Central and Mwingi divisions. Both zones rank high in land fragmentation and subdivision, soil erosion, food insufficiency, and reduced land fallowing. In addition, increased use of marginal lands is reported by the majority of respondents in these two ecozones. As has been already indicated, due to the vagaries of weather and high demand for land, local people are forced by circumstances to utilize all parts of their

individual land parcels in order to produce adequate subsistence.

Many areas in ecological zone V in Southern and Eastern divisions are not currently suffering from population pressure. These areas will be able to absorb more people for at least the next decade. But the ability of the areas to support more people will depend largely on levels of technology adopted. Should increased cultivation under existing technology take place, then population redistribution from high potential zones will not alleviate the problem. Unless improved methods of farming are undertaken, population pressure in these fragile ecosystems will threaten to further pauperize any people likely to move into these areas.

In summary, this study has demonstrated that population pressure in Kitui district dates back to the advent of British colonial rule in Kenya in the late 19th century. Many events in both the colonial era and following Kenya's independence have been identified as major causes of population pressure in the area. The results of the Principal Component Analysis indicate that only nine of the eighteen indices of population pressure derived initially from literature review for the field investigation are of significance in the study area.

Results from the Multivariate Analysis of Variance, from the carrying capacity analysis, and from the descriptive statistics, suggest that there are disparities in population pressure between different administrative units and ecological divisions in Kitui district. Hence, the second and the third hypotheses of the study, which proposed that there are no significant differences between the administrative units and ecozones in terms of population pressure, must be rejected. In addition, this study has made a significant finding, namely, that population pressure is most severe in the more arable lands of the study area, contrary to the general literature which suggests that population pressure is most intense in more fragile ecosystems where overall population densities are lower.

7.2 POLICY IMPLICATIONS

This study has demonstrated that population pressure is an important factor influencing the nature, the pace, and the direction of future rural development in Kitui district. Lack of access to basic social amenities is a factor exacerbating population pressure. The majority of people still live more than ten kilometers from basic amenities; often access to utilities is totally lacking. For instance, at the time of the field survey, only three per cent of population had access to piped water from the gravity-fed water supply system from Yatta furrow to Kitui town (Kenya, 1988).

Often the pipes transmitting water along this system are broken, causing a loss of millions of litres of water. This water system is essential for rural development in Kitui district. Complete overhaul of the system, including the replacement of existing low-quality pipes with better-quality ones, is required. Similar projects should be initiated elsewhere in the district to ensure that water reaches more people. Unless water supply can be guaranteed, crop failure and food shortage will be ever chronic problems in the area. It will also be difficult to stop the utilization of marginal lands as people will continue farming along steep slopes of river valleys in their desperate efforts to capture retreating moisture. Soil erosion and general environmental deterioration will inevitably escalate and will become more difficult to reverse.

Besides the lack of water, the present road network is also very poor in Kitui district. There are only two graded roads connecting Kitui and Mwingi towns to Nairobi. All remaining roads are of murram and the majority become impassable during the rainy season. In such circumstances, people find it difficult to market their agricultural produce. Without an improved road network, there is little incentive for farmers to produce surplus. It is also difficult to modernize cropping systems and animal husbandry in the absence of a reliable transport network. Advice on

better farming techniques and improved veterinary services has difficulty in reaching areas where it is most needed.

Many scholars predict a series of crises for regions in which population and resources have become imbalanced (Osborn, 1958 and 1963; Vogt, 1960; Meadows et al, 1971). For example, Commoner (1971:201) stated that:

> we are in a grave danger of a dual worldwide catastrophe which threatens to destroy the stability of the ecosystems on which we depend for food, oxygen, pure water and suitable temperatures, while a rapidly growing population places increasing demands on the earth's dwindling and degraded resources.

Such doomsday predictions may be inappropriate philosophies for geographers seeking solutions. Maddox (1972) argued that doomsday predictions are a defeatist and over-reactionary statements in any context. However, his contentions seem unjustifiably optimistic, for it is certain that land in developing countries has never before been subjected to such stress, and never before have the lives of millions of citizens been so impoverished. The issues raised in this research require immediate attention. For instance, there is need for population redistribution, environmental education, and more dedicated population control programmes which address the issue of culture vis-a-vis fertility. Otherwise the damage to human conditions and to the environment created by population pressure may be difficult to repair.

7.3 DIRECTIONS FOR FURTHER RESEARCH

The carrying capacity estimates suggest that the methodology can be refined to yield higher levels of confidence for Kitui district and other areas. Multiple modelling, encompassing varying levels of technology, income, improved crops and animals, and better land use strategies can provide an improved data base for planning this region. Further research in multiple modelling to assess the potential carrying capacities with improved technology is therefore required. For instance, it is important to investigate the implications upon carrying capacity of changing the livestock management system in ecozone III to stall feeding of cross-bred animals with cultivated hectarage of bana or nepier grass. It is also necessary to find out how this change from grazing to stall-feeding would reduce soil erosion and improve conservation of water sources. These are fruitful avenues for further research.

Ester Boserup (1965), among others, believes that increased population densities leads to spontaneous agricultural change and the intensification of production. This notion is quite important for Kitui district, because it would be essential to know whether specific levels of population pressure are stimulating spontaneous intensification in the agricultural systems or are causing family size limitation. Such knowledge would be valuable in conceiving development strategies which would encourage specific levels of population pressure for this area.

This study has shown that ecozones III and IV are most affected by population pressure. This is because of diminishing resource availability in the face of growing population. Life has become particularly difficult during the dry season, and future research should be directed at a detailed inquiry into farmers' coping strategies for survival during the dry seasons. Such research is necessary to better gauge the coping mechanisms used by local people in the face of diminishing resources and worsening droughts.

Another area requiring further research is Akamba views about population pressure. Although the study has shown clearly that Kitui district is suffering from population pressure, when asked directly about this issue, respondents do not openly accept that there is population pressure in their area. As was indicated in Chapter Six, this reaction may be explained by Akamba taboos against counting people. Thus, surrogate evidence used by this study to determine levels of population pressure was drawn from respondents' views on changing size of land holdings and general resource deterioration, the calculation of carrying capacity estimates, and data from the historical records. It is therefore suggested that an intense field research schedule involving participant observation would provide better insights into Akamba perceptions of population pressure. Unlike survey research methods, which take prepared questionnaires to the field, such participant observation

would have the advantage of requiring long-term residence in an area enabling researchers to understand peoples' traditions, thought patterns, and their general attitude levels. Such knowledge can provide a pointer for handling questions which may be culturally sensitive.

Further, the impact of the various government development policies in Kitui district such as wildlife conservation, land tenure reforms, and the creation of ranching schemes need to be investigated in detail. The study has shown that these programmes have exacerbated rather than ameliorated population pressure in Kitui district. Greater insights can be gained from an inquiry into individual policies in the context of local environmental perceptions and resource base.

In summary, this study has clearly demonstrated that population pressure is a serious problem affecting rural development especially in Kenya's arid and semi-arid areas and should therefore be addressed without further delay. Research is required to determine the kinds of crops and livestock which are more suitable for these areas. To meet this challenge the Kenya Government must treat science and technology more seriously than appears to be the case at present. As indicated ealier, the agricultural and ecological management of the arid and semi-arid areas is a much more difficult task than that of managing arable lands. Competent and highly dedicated people are required to

support the farmers who are, as well as those likely to move into these fragile ecosystems. The Kenya Government should therefore focus attention to training such experts.

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APPENDIX A

RECORDING SCHEDULE

Symptoms of Population Pressure in Kitui District, Kenya.

Name of Interviewer_____

Date of Interview_____

Household Number_____

Village Name_____

Sub-location_____

Location_____

Division_____

Ecological Zone_____

A. HOUSEHOLD CHARACTERISTICS

1. Household head (enumerate)

   Name_____

   Sex_____

   Age_____

   Occupation_____

   Tribe_____

   Level of Education_____
   (highest class attained)

2. Number of wives_____

3. Number of children aged 0-15_____

4. Number of adults other than wives aged 16-65_____

5. Number of adults other than wives aged above 65_____

6. Number of persons who are employed for wages_____

7. Number of persons who are unemployed_____

8. How many members of this household are away, excluding married daughters_____

9. If any members are away, enumerate them as follows, excluding married daughters:

Number	Age	Sex	Relationship to Household Head	Highest Level of Education	Destination	Terms of absence Permanent/ Temporary	Reason for Being away
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							

B. **LANDLESSNESS/DISPUTE/SUBDIVISIONS/FRAGMENTATION/TENURE**

10. **How much land do you have access to for your use at any given time? (Estimate the acreage in each of the following categories).**

a) Owned by you (ha)_____

b) Communally owned (ha)_____

c) Hired by you (ha)_____

d) Other (specify) (ha)_____

11. How much of this land is for?

a) Pastoral use (ha)_____

b) Cultivation (ha)_____

12. How many land pieces/fragments do you have_____

13. Please state approximate distance between the two furthest pieces. (tick off).

    a) 0-3 km_____

    b) 4-7 km_____

    c) 8-11 km_____

    d) More than 12 km_____

14. For the land you own, do you have a title deed for it? (yes, no)_____

15. If you do not have a land title deed to the farm, what is the status of the land owndership?

    a) Not surveyed_____

    b) Recently surveyed_____

    c) In dispute_____

    d) Squatting_____

    e) Others (specify)_____

16. Compared to five years ago, is your land now smaller (yes, no)_____

17. If the farm is smaller, what is the reason? (tick off).

    a) Subdivision among sons_____

    b) Deteriorated production_____

    c) Sold a part of land_____

    d) More animals_____

    e) Others (specify)_____

18. If subdivided among sons, how many subdivisions are there and what is their average size?

    Number_____

    Size (ha)_____

19. How much more land will you need to subdivide among other sons in the next five years?

ha_____

20. Does the land you use for cultivation produce enough crops for food and cash?

(yes, no)_____

21. Is the rainfall in this area sufficient for crop cultivation each year?

(yes, no)_____

22. If there are times of rainfall insufficiency, how do you supplement your water requirements?

a) By irrigation_____

b) Abandon cultivation for pastoralism_____

c) Others (specify)_____

23. Compared to five years ago, has crop production on your farm:

a) Declined_____

b) Remained the same_____

c) Improved_____

24. Compared to 5 years ago do you fallow?

a) More land_____

b) Less land_____

c) No land_____

25. If you still fallow land, for how long do you fallow it?

a) ½ - 1 year_____

b) 1½ - 2 years_____

c) 2½ - 3 years_____

d) More than 3 years_____

26. If you don't fallow or you fallow less land. what are the reasons?

a) Shortage of land_____

b) Increased use of fertilizers_____

c) Others (specify)_____

27. Besides subsistence production. what other land uses do you practise?

a) Poultry keeping_____

b) Livestock keeping_____

c) Real estate development_____

d) Others (specify)_____

28. For how long have you lived on this farm? (years)_____

29. Are you a migrant to this place? (yes. no)_____

30. Where were you living before?

District_____ Division_____

Location_____ Sub-location_____

31. What attracted you most to this area?

a) Availability of land_____

b) Employment_____

c) Social amenities (schools. hospitals. etc.)_____

d) Others (specify)_____

32. What reasons made you leave your former place of residence?

a) Landlessness_____

b) Lack of employment_____

c) Overcrowding on land_____

d) Others (specify)_____

33. Have you been involved in any land dispute in the last 5 years?

a) Yes_____

b) No_____

34. Has the frequency of land disputes in this area in the last 5 years?

a) Increased_____

b) Remained the same_____

c) Declined_____

d) Non-existent_____

C. USE OF MARGINAL LANDS/SOIL EROSION

35. Please state whether you regularly cultivate/graze on each of the following:

a) Along river channels_____

b) Around swamps_____

c) Along roadsides_____

d) On steep slopes_____

36. Has soil erosion on your land in the last 5 years:

a) Increased_____

b) Declined_____

c) Remained the same_____

37. If soil erosion on your land has increased, what measures do you take to prevent it (tick off)?

a) Gabions_____

b) Terracing_____

c) Re-afforestation_____

d) Others (specify)_____

38. Over the last 5 years have you cleared any bush?

(yes, no)_____

39. If the answer to 38 is yes. how much land have you cleared?

(ha)_____

40. Is the general tendency to clear bush in this area?

a) Severe_____

b) Moderately severe_____

c) Low_____

d) Non-existent_____

D. FOOD SUFFICIENCY AND MALNUTRITION

41. How many days a week do members of your household eat?

a) Morning meal_____

b) Mid-day meal_____

c) Evening meal_____

42. What minimum number of times a week. does any member of your household consume the following foods at any meal? (Circle appropriate number).

a) Milk	0	1	2	3	4	5	6	7
b) Ugali	0	1	2	3	4	5	6	7
c) Rice	0	1	2	3	4	5	6	7
d) Bread	0	1	2	3	4	5	6	7
e) Green Vegetables	0	1	2	3	4	5	6	7
f) Beans	0	1	2	3	4	5	6	7
g) Fish	0	1	2	3	4	5	6	7
h) Meat/poultry	0	1	2	3	4	5	6	7
i) Fruits	0	1	2	3	4	5	6	7

43. Was food raised on your farm last year for feeding all resident members of your household?

a) Totally sufficient_____

b) Just sufficient_____

c) Barely sufficient_____

d) Insufficient_____

e) Very insufficient_____

44. If food was sufficient last year did you sell some of it? (yes, no)_____

45. If you sold some of the food, why did you sell it?

a) Needed cash_____

b) There was surplus_____

46. If food was insufficient last year, state the sources of additional food.

a) Purchased_____

b) Famine relief_____

c) Exchange (barter)_____

d) Others (specify)_____

47. Has any member of your household suffered from the following diseases in the last five years?

a) Pellagra_____

b) Kwashiokor_____

c) Rickets_____

E. ACCESSIBILITY

48. How is your village served, in terms of a good road network?

a) Very well served_____

b) Well served_____

c) Barley well served_____

d) Poorly served_____

e) Very poorly served_____

49. If your village is very poorly served with road network, how do you transport your farm produce to the market?

a) By human portage_____

b) Handcarts_____

c) "Matatu"_____

d) Others (specify)_____

50. How easily accessible are you to the market?

a) Very easily_____

b) Moderatlev easily_____

c) Just easily_____

d) Poorly_____

e) Very poorly_____

51. If you are not easily accessible to the market, what are the reasons?

a) Physical distance_____

b) Transport cost too high_____

c) Others (specify)_____

52. How far in km is your present residence from each of the following:

a) Dispensary _____

b) Rural health centre _____

c) Government hospital _____

d) Family planning clinic _____

e) Primary school _____

f) Secondary school _____

g) Market _____

h) Chiefs camp _____

i) Water source (e.g. river) _____

j) Tap water/bore hole _____

k) Seasonal road _____

l) All weather road _____

F. INCOME

53. Estimate your gross income for last year in each category.

Item	Price Per Unit	Income (Ksh.)
Food crops	_____	_____
Cash crops	_____	_____
Livestock	_____	_____
Business	_____	_____
Others (specify)	_____	_____

54. Was any off-farm income earned last year by any member of your household? (yes, no) _____

55. If off-farm income was earned last year, what was the source and how much was it?

a) Urban wage employment (Ksh) _____

b) Rural wage employment (Ksh) _____

c) Own business (Ksh) _____

d) Others (specify) (Ksh) _____

Total = (Ksh) _____

56. How often is off-farm income earned in your household?

a) Irregularly _____

b) Monthly _____

c) Rarely _____

d) Never _____

57. Who earns off-farm income for this household?

a) Male head of household _____

b) Wife/wives _____

c) Grown-up children _____

58. What was your total expenditure last year on the following items?

Item	Approximate Cost
Food	_____
Seeds	_____
Ploughing/weeding	_____
Farm inputs (fertilizers, etc.)	_____
Farm labour	_____
Fuel (paraffin, charcoal, etc.)	_____
Clothing	_____
Education	_____
Transport	_____
Health (medicines/drugs & health care)	_____

59. Has your farm income in the last five years:

a) Declined_____

b) Remained the same_____

c) Improved_____

G. POPULATION PRESSURE PERCEPTION

60. What is your desired maximum number of children?

a) None at all_____

b) 1-2_____

c) 3-4_____

d) 5-6_____

e) 7-8_____

f) More than 8_____

61. What in your opinion is the desired maximum number of children for most people in your village?

a) None at all_____

b) 1-2_____

c) 3-4_____

d) 5-6_____

e) 7-8_____

f) More than 8_____

62. If most people in your village desire smaller than the traditional size families. what do you think is their main reason?

a) Land scarcity_____

b) Food inadequacy_____

c) High education costs_____

d) Others (specify)_____

63. If most people in your village desire large families what do you think is their main reason?

a) Fear that some may die_____

b) There is plenty of food and land_____

c) So that some children will take care of their old parents_____

d) Others (specify)_____

64. What would be your advice to any couple in your village about the number of children they should have?

a) No children at all_____

b) 1-2 children_____

c) 3-4 children_____

d) 5-6 children_____

e) 7-8 children_____

f) More than 8 children_____

65. What is your opinion about the number of people in this village in comparison to the amount of land?

a) Too few_____

b) Alright_____

c) Too many_____

d) Others (specify)_____

66. If you feel that there are too many people in this village, what do you think should be done?

a) Resettlement by government_____

b) Migrate to other areas_____

c) Move to town to look for job_____

d) Use family planning_____

e) Others (specify)_____

APPENDIX B

REPUBLIC OF KENYA

RESEARCH CLEARANCE PERMIT

PAGE 2

THIS IS TO CERTIFY THAT;

~~Person~~/Mr./~~Mrs~~/~~Miss~~ Leonard Musyoka Kisovi

of (Address) Dept. of Geography University of Manitoba

has been permitted to conduct research in

Location, Kitui

District, Eastern

Province,

on the topic "Population pressure in Kitui District, Kenya"

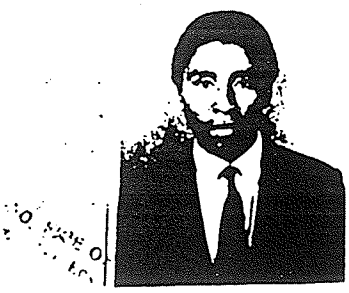
for a period ending January 19 89

PAGE 3

Research permit No. 17

Date of issue

Fee received



Applicant's Signature

J.W. Wangoni (Ms)
Permanent Secretary,
Office of the President

OFFICE OF THE PRESIDENT
P.O. Box 30510, NAIROBI

NOTES

1. Government Officers will not be interviewed without prior appointment.
2. No questionnaire will be used unless it has been approved.
3. You must report to the District Commissioner of the area before embarking on your research.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice.

GPK 302—2m—2/86

APPENDIX C

Potential Crop Yields by Ecological Zones Using Traditional Technology.

Crops	Potential Yields (Kg/Ha.)	Calories/Kg.	Millions of Calories/Ha.
	ECOZONE III		
Maize	1000	3200	3.2
Cow Peas	400	3200	1.28
Beans	400	3200	1.28
Grams	350	3200	1.12
	ECOZONE IV		
Sorghum	700	3200	2.24
Millet	330	3200	1.06
Pigeon Peas	300	3200	0.96
Grams	300	3200	0.96
Lab Lab (Mbumbu)	310	3500	1.09
Maize	500	3200	1.6
	ECOZONE V		
Sorghum	350	3200	1.12
Millet	200	3200	0.64
Grams	200	3200	0.64

Source: Ministry of Agriculture (1977:161). Marginal Lands Pre-Investment Study. Nairobi: Government Printer.

Upper percentage points of the F_{ν_1,ν_2} distribution†

$1-\alpha$	ν_2	ν_1: 1	2	3	4	5	6	7	8	9	10	12	15	20	30	60	120	∞
0.90		39.9	49.5	53.6	55.8	57.2	58.2	58.9	59.4	59.9	60.2	60.7	61.2	61.7	62.3	62.8	63.1	63.3
0.95		161	200	216	225	230	234	237	239	241	242	244	246	248	250	252	253	254
0.975	1	648	800	864	900	922	937	948	957	963	969	977	985	993	1,000	1,010	1,010	1,020
0.99		4,050	5,000	5,400	5,620	5,760	5,860	5,930	5,980	6,020	6,060	6,110	6,160	6,210	6,260	6,310	6,340	6,370
0.90		8.53	9.00	9.16	9.24	9.29	9.33	9.35	9.37	9.38	9.39	9.41	9.42	9.44	9.46	9.47	9.48	9.49
0.95		18.5	19.0	19.2	19.2	19.3	19.3	19.4	19.4	19.4	19.4	19.4	19.4	19.5	19.5	19.5	19.5	19.5
0.975	2	38.5	39.0	39.2	39.2	39.3	39.3	39.4	39.4	39.4	39.4	39.4	39.4	39.4	39.5	39.5	39.5	39.5
0.99		98.5	99.0	99.2	99.2	99.3	99.3	99.4	99.4	99.4	99.4	99.4	99.4	99.4	99.5	99.5	99.5	99.5
0.90		5.54	5.46	5.39	5.34	5.31	5.28	5.27	5.25	5.24	5.23	5.22	5.20	5.18	5.17	5.15	5.14	5.13
0.95		10.1	9.55	9.28	9.12	9.01	8.94	8.89	8.85	8.81	8.79	8.74	8.70	8.66	8.62	8.57	8.55	8.53
0.975	3	17.4	16.0	15.4	15.1	14.9	14.7	14.6	14.5	14.5	14.4	14.3	14.3	14.2	14.1	14.0	13.9	13.9
0.99		34.1	30.8	29.5	28.7	28.2	27.9	27.7	27.5	27.3	27.2	27.1	26.9	26.7	26.5	26.3	26.2	26.1
0.90		4.54	4.32	4.19	4.11	4.05	4.01	3.98	3.95	3.93	3.92	3.90	3.87	3.84	3.82	3.79	3.78	3.76
0.95		7.71	6.94	6.59	6.39	6.26	6.16	6.09	6.04	6.00	5.96	5.91	5.86	5.80	5.75	5.69	5.66	5.63
0.975	4	12.2	10.6	9.98	9.60	9.36	9.20	9.07	8.98	8.90	8.84	8.75	8.66	8.56	8.46	8.36	8.31	8.26
0.99		21.2	18.0	16.7	16.0	15.5	15.2	15.0	14.8	14.7	14.5	14.4	14.2	14.0	13.8	13.7	13.6	13.5
0.90		4.06	3.78	3.62	3.52	3.45	3.40	3.37	3.34	3.32	3.30	3.27	3.24	3.21	3.17	3.14	3.12	3.11
0.95		6.61	5.79	5.41	5.19	5.05	4.95	4.88	1.82	4.77	4.74	4.68	4.62	4.56	4.50	4.43	4.40	4.37
0.975	5	10.0	8.43	7.76	7.39	7.15	6.98	6.85	6.76	6.68	6.62	6.52	6.43	6.33	6.23	6.12	6.07	6.02
0.99		16.3	13.3	12.1	11.4	11.0	10.7	10.5	10.3	10.2	10.1	9.89	9.72	9.55	9.38	9.20	9.11	9.02
0.90		3.78	3.46	3.29	3.18	3.11	3.05	3.01	2.98	2.96	2.94	2.90	2.87	2.84	2.80	2.76	2.74	2.72
0.95		5.99	5.14	4.76	4.53	4.39	4.28	4.21	4.15	4.10	4.06	4.00	3.94	3.87	3.81	3.74	3.70	3.67
0.975	6	8.81	7.26	6.60	6.23	5.99	5.82	5.70	5.60	5.52	5.46	5.37	5.27	5.17	5.07	4.96	4.90	4.85
0.99		13.7	10.9	9.78	9.15	8.75	8.47	8.26	8.10	7.98	7.87	7.72	7.56	7.40	7.23	7.06	6.97	6.88
0.90		3.59	3.26	3.07	2.96	2.88	2.83	2.78	2.75	2.72	2.70	2.67	2.63	2.59	2.56	2.51	2.49	2.47
0.95		5.59	4.74	4.35	4.12	3.97	3.87	3.79	3.73	3.68	3.64	3.57	3.51	3.44	3.38	3.30	3.27	3.23
0.975	7	8.07	6.54	5.89	5.52	5.29	5.12	4.99	4.90	4.82	4.76	4.67	4.57	4.47	4.36	4.25	4.20	4.14
0.99		12.2	9.55	8.45	7.85	7.46	7.19	6.99	6.84	6.72	6.62	6.47	6.31	6.16	5.99	5.82	5.74	5.65
0.90		3.46	3.11	2.92	2.81	2.73	2.67	2.62	2.59	2.56	2.54	2.50	2.46	2.42	2.38	2.34	2.31	2.29
0.95		5.32	4.46	4.07	3.84	3.69	3.58	3.50	3.44	3.39	3.35	3.28	3.22	3.15	3.08	3.01	2.97	2.93
0.975	8	7.57	6.06	5.42	5.05	4.82	4.65	4.53	4.43	4.36	4.30	4.20	4.10	4.00	3.89	3.78	3.73	3.67
0.99		11.3	8.65	7.59	7.01	6.63	6.37	6.18	6.03	5.91	5.81	5.67	5.52	5.36	5.20	5.03	4.95	4.86
0.90		3.36	3.01	2.81	2.69	2.61	2.55	2.51	2.47	2.44	2.42	2.38	2.34	2.30	2.25	2.21	2.18	2.16
0.95		5.12	4.26	3.86	3.63	3.48	3.37	3.29	3.23	3.18	3.14	3.07	3.01	2.94	2.86	2.79	2.75	2.71
0.975	9	7.21	5.71	5.08	4.72	4.48	4.32	4.20	4.10	4.03	3.96	3.87	3.77	3.67	3.56	3.45	3.39	3.33
0.99		10.6	8.02	6.99	6.42	6.06	5.80	5.61	5.47	5.35	5.26	5.11	4.96	4.81	4.65	4.48	4.40	4.31
0.90		3.29	2.92	2.73	2.61	2.52	2.46	2.41	2.38	2.35	2.32	2.28	2.24	2.20	2.15	2.11	2.08	2.06
0.95		4.96	4.10	3.71	3.48	3.33	3.22	3.14	3.07	3.02	2.98	2.91	2.84	2.77	2.70	2.62	2.58	2.54
0.975	10	6.94	5.46	4.83	4.47	4.24	4.07	3.95	3.85	3.78	3.72	3.62	3.52	3.42	3.31	3.20	3.14	3.08
0.99		10.0	7.56	6.55	5.99	5.64	5.39	5.20	5.06	4.94	4.85	4.71	4.56	4.41	4.25	4.08	4.00	3.91
0.90		3.18	2.81	2.61	2.48	2.39	2.33	2.28	2.24	2.21	2.19	2.15	2.10	2.06	2.01	1.96	1.93	1.90
0.95		4.75	3.89	3.49	3.26	3.11	3.00	2.91	2.85	2.80	2.75	2.69	2.62	2.54	2.47	2.38	2.34	2.30
0.975	12	6.55	5.10	4.47	4.12	3.89	3.73	3.61	3.51	3.44	3.37	3.28	3.18	3.07	2.96	2.85	2.79	2.72
0.99		9.33	6.93	5.95	5.41	5.06	4.82	4.64	4.50	4.39	4.30	4.16	4.01	3.86	3.70	3.54	3.45	3.36
0.90		3.07	2.70	2.49	2.36	2.27	2.21	2.16	2.12	2.09	2.06	2.02	1.97	1.92	1.87	1.82	1.79	1.76
0.95		4.54	3.68	3.29	3.06	2.90	2.79	2.71	2.64	2.59	2.54	2.48	2.40	2.33	2.25	2.16	2.11	2.07
0.975	15	6.20	4.77	4.15	3.80	3.58	3.41	3.29	3.20	3.12	3.06	2.96	2.86	2.76	2.64	2.52	2.46	2.40
0.99		8.68	6.36	5.42	4.89	4.56	4.32	4.14	4.00	3.89	3.80	3.67	3.52	3.37	3.21	3.05	2.96	2.87
0.90		2.97	2.59	2.38	2.25	2.16	2.09	2.04	2.00	1.96	1.94	1.89	1.84	1.79	1.74	1.68	1.64	1.61
0.95		4.35	3.49	3.10	2.87	2.71	2.60	2.51	2.45	2.39	2.35	2.28	2.20	2.12	2.04	1.95	1.90	1.84
0.975	20	5.87	4.46	3.86	3.51	3.29	3.13	3.01	2.91	2.84	2.77	2.68	2.57	2.46	2.35	2.22	2.16	2.09
0.99		8.10	5.85	4.94	4.43	4.10	3.87	3.70	3.56	3.46	3.37	3.23	3.09	2.94	2.78	2.61	2.52	2.42
0.90		2.88	2.49	2.28	2.14	2.05	1.98	1.93	1.88	1.85	1.82	1.77	1.72	1.67	1.61	1.54	1.50	1.46
0.95		4.17	3.32	2.92	2.69	2.53	2.42	2.33	2.27	2.21	2.16	2.09	2.01	1.93	1.84	1.74	1.68	1.62
0.975	30	5.57	4.18	3.59	3.25	3.03	2.87	2.75	2.65	2.57	2.51	2.41	2.31	2.20	2.07	1.94	1.87	1.79
0.99		7.56	5.39	4.51	4.02	3.70	3.47	3.30	3.17	3.07	2.98	2.84	2.70	2.55	2.39	2.21	2.11	2.01
0.90		2.79	2.39	2.18	2.04	1.95	1.87	1.82	1.77	1.74	1.71	1.66	1.60	1.54	1.48	1.40	1.35	1.29
0.95		4.00	3.15	2.76	2.53	2.37	2.25	2.17	2.10	2.04	1.99	1.92	1.84	1.75	1.65	1.53	1.47	1.39
0.975	60	5.29	3.93	3.34	3.01	2.79	2.63	2.51	2.41	2.33	2.27	2.17	2.06	1.94	1.82	1.67	1.58	1.48
0.99		7.08	4.98	4.13	3.65	3.34	3.12	2.95	2.82	2.72	2.63	2.50	2.35	2.20	2.03	1.84	1.73	1.60
0.90		2.75	2.35	2.13	1.99	1.90	1.82	1.77	1.72	1.68	1.65	1.60	1.54	1.48	1.41	1.32	1.26	1.19
0.95		3.92	3.07	2.68	2.45	2.29	2.18	2.09	2.02	1.96	1.91	1.83	1.75	1.66	1.55	1.43	1.35	1.25
0.975	120	5.15	3.80	3.23	2.89	2.67	2.52	2.39	2.30	2.22	2.16	2.05	1.94	1.82	1.69	1.53	1.43	1.31
0.99		6.85	4.79	3.95	3.48	3.17	2.96	2.79	2.66	2.56	2.47	2.34	2.19	2.03	1.86	1.66	1.53	1.38
0.90		2.71	2.30	2.08	1.94	1.85	1.77	1.72	1.67	1.63	1.60	1.55	1.49	1.42	1.34	1.24	1.17	1.00
0.95		3.84	3.00	2.60	2.37	2.21	2.10	2.01	1.94	1.88	1.83	1.75	1.67	1.57	1.46	1.32	1.22	1.00
0.975	∞	5.02	3.69	3.12	2.79	2.57	2.41	2.29	2.19	2.11	2.05	1.94	1.83	1.71	1.57	1.39	1.27	1.00
0.99		6.63	4.61	3.78	3.32	3.02	2.80	2.64	2.51	2.41	2.32	2.18	2.04	1.88	1.70	1.47	1.32	1.00

† Abridged from Merrington and Thompson (1943) and published here with the kind permission of the author and the editor of *Biometrika*.

Source: Mardia, et al (1982:492-3). Multivariate Analysis, London: Academic Press.