AIR TRANSPORT IN KENYA:

AN ANALYSIS OF DOMESTIC AND INTERNATIONAL AIRLINE NETWORKS

BY

EVARISTUS MAKUNYI IRANDU
B.Ed (Hons.), M.A. (Econ. Geog.)

A Thesis submitted to the University of Nairobi (Faculty of Arts) in fulfilment for the Degree of Doctor of Philosophy in Transport Geography

1995

DECLARATION

This Thesis is my original work and has not been presented for Degree work in any other University

EVARISTUS M. IRANDU
(Candidate)

This Thesis has been submitted for examination with my approval as the University Supervisor

PROFESSOR (DR.) REUBEN B.OGENDO

DEDICATION

This Thesis is dedicated to my parents, who died before the Thesis was completed, yet, they had been a tremendous source of inspiration to me in the early stages of the work.

CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The main objective of this study is to describe, analyse and explain the networks of both domestic and international airlines in Kenya and to examine the relationship between domestic air transport and national development. Four main lines of investigation are pursued in the study. These are: (a) The spatial structure of air transport networks in Kenya. This involves a detailed historical survey of the evolution of domestic and international air transportation networks from as far back in time as possible. The main stages identified are compared with the "ideal-typical sequence model" developed by Holsman and Crawford in 1975. (b) The causal factors that have influenced the evolution of air transport network in Kenya. The main physical and socio-economic factors influencing the evolution of the domestic air transport in the country are identified and discussed. (c) The patterns of air passengers and commodity flows. (d) The relationship between air transport growth and spatial pattern of development in Kenya. An index of development status is constructed to measure the spatial variation in human welfare in all the districts of Kenya. The index is used as a basis for ranking, comparing and classifying districts according to their development status. The relationship between Composite Index of Development Status (CIDS) and indicators of air transport growth is examined.

In the present study, four Null Hypotheses were formulated and tested. They are that: (a) there is no significant difference between the stages of growth of the Kenyan air transport network and the ones predicted by the Holsman-Crawford "ideal typical sequence model" of air transport growth. (b) the volume of air passenger traffic does not vary with sizes of places and the distance between them. (c) the volume of cargo freight does not vary with sizes of places and the distances between them. (d) there is no significant relationship between the development of air transport and the spatial patterns of development.

The Null Hypotheses were explored using several statistical techniques, namely, the graph theoretical techniques, multiple linear regression and correlation analysis and the Common Factor Analysis (CFA). Graph theoretical indices were computed for the Kenyan domestic air transport network for a period of over fifty years, since 1938. The graph theoretical indices showed whether the country's domestic air transport system has been growing over time or not. A "Matrix Powering Technique" of the graph theoretical approach was used to show whether the accessibility surface of the domestic air transport network was becoming highly peaked or polarised over time.

Multiple Linear Regression and Correlation Analysis was applied to both international air passenger and commodity flow traffic data. Bivariate correlation analysis was used to measure the strength of the relationship between air transport growth and the spatial patterns of development. Stepwise multiple regression and correlation analysis was used to corroborate the results of the bivariate correlation analysis, confirming that there is a significant relationship between air transport growth and the spatial pattern of development.

The main findings of the study are also discussed. Some of these are: (a) that the general trends of Kenya's domestic air transport growth correspond to those proposed in the Holsman- Crawford "ideal-typical sequence model" of air transport growth. The present study has established that the domestic air transportation network has evolved through three main stages comparable to the first, second and third phases of the Holsman-Crawford Model. This is the first time this theoretical model has been tested anywhere in the world outside north western Australia where it was first developed. This finding would seem to confirm that the model could apply to other areas too. (b) the application of multiple linear regression and correlation analysis to the international air passenger and commodity flow data revealed that: (i) distance was a very important explanatory factor accounting for 30% of the total variation in the volume of air passenger traffic between Nairobi and other international air hubs. (ii) GDP was the most important explanatory factor accounting for 14% of the total variation in the volume of commodity shipment.

The study has made some important contributions to transport geography. Some of these include: (a) the application of a variant of Nystuen and Dacey's technique of Dominant Flow Analysis, called simple linkage analysis. The application of simple linkage analysis to Kenya's domestic air passenger flow data in order to identify the dominance-dependency nodal regions of air passenger interaction is an important contribution to the methodology in flow analysis. Most of the previous studies have used the original version of Nystuen and Dacey's Dominant Flow Analysis. Simple linkage analysis is a much better method of portraying the nodal structures of a network than Nystuen and Dacey's Dominant Flow Analysis. (b) the construction of a new composite index for measuring spatial variation in human welfare at the sub-national (district) level. This is one of the most important contributions made by the study. The new composite index of development status (CIDS) is a robust and versatile measure that provides multi-dimensional insights about spatial variation of development at the sub-national (district) level.

Finally, this study recommends that, to promote a balanced development in the country, an integrated transport network should be established. This can be achieved through strategic planning of domestic air services with special emphasis on their integration with surface transportation modes such as roads and railways.

ACKNOWLEDGEMENTS

I would like to record my appreciation for the assistance I got from all individuals and/or Institutions while preparing this work. More specifically, I would like to express my most profound thanks to my main University supervisor, Prof. (Dr.) Reuben B. Ogendo, who made this research project a very stimulating learning process. Through his invaluable advice and constructive criticisms, I was able to complete this most challenging task. I also take this opportunity to express my most sincere gratitude to Dr. Oyuko O. Mbeche of the Department of Civil Engineering, University of Nairobi for his valuable guidance during the final stages of the preparation of this thesis. His probing questions stimulated my thinking and helped me to understand the nature of the research problem being investigated much better.

Special thanks go to the two previous Chairmen of the Department of Geography, University of Nairobi, namely, Prof. (Dr.) E.H.O. Ayiemba for approving my local study leave and Prof. (Dr.) D.A. Obara for approving my study visit to Heidelberg University in Germany. The local study leave enabled me to complete my field research. While in Heidelberg University, I was able to do preliminary data analysis and also held very fruitful discussions with the academic staff at the Institute of Geography pertaining to my research work. My thanks also go to other members of the academic staff in the Department of Geography of the University of Nairobi for their useful suggestions especially with regard to the quantitative aspects of the thesis.

I am most grateful to the German Academic Exchange Programme (DAAD) for its generous funding. DAAD provided sufficient funds without which this work would not have been completed. DAAD also financed my study visit to Heidelberg University in Germany.

These acknowledgements would be incomplete without thanking Prof. (Dr.) Fricke and his staff at the Institute of Geography of the University of Heidelberg, for their warm hospitality during my three-month stay there. During this period, the staff at the Institute assisted me in many ways including data analysis and interpretation. Through Prof.(Dr.) Fricke's own initiative, I was able to procure some relevant bibliographic material from within and outside Germany. Such assistance enabled me to complete my work on schedule.

I am grateful to Mr. M. Mugizi of International Civil Aviation Organisation (ICAO), Mr. Konate Gaoussou of African Airlines Association (AFRAA), Mr. Charles W. Omondi of Aerodromes Department, Mr. Kimemia of Ministry of Transport and Communications, and Mr. C. Njenga of Aviation Luxeken Ltd. for providing valuable secondary data on air transport. I would also like to thank Dr. P.M. Ngau, Mr. F. Mwangi Karema, Mr. Omondi Ndege and T.O. Owambo for assisting in data analysis; and Messrs. Joseph Kirema, Simon M. Kinga and Mr. I.O. Ayuyo for their cartographic work. Dr. W.N. Wamicha is warmly thanked for translating some relevant German literature to English for my use. I also owe much gratitude to Mrs. Dorice Khaduli and Mrs. B. Ndung'u for typing the work.

Finally, I would like to acknowledge with thanks the tender love and care as well as the encouragement I got from both my wife Esther and children. Sometimes, the demands of research work made me stay away from home for many months. Yet, my family bore all this with ease. Their endurance, patience and understanding enabled me to complete my project without much difficulty.

However, I bear the ultimate responsibility for all the errors and omissions, if any, in the thesis.

E.M. Irandu

CHAPTER ONE

INTRODUCTION

1.0 STATEMENT OF THE RESEARCH PROBLEM

Geographers have long been interested in the role that the development of transport plays in opening up new territory and in the more general relationship between transport and economic development. However, few studies have examined the role of transport over a long period and built, from this, models of transport development. The models that have been developed are concerned primarily with surface transport modes such as roads and railways. Studies on the role of air transport are more scanty (Holsman and Crawford, 1975). Yet, global air traffic, in terms of the number of passengers and volume of cargo carried by airlines, has been growing steadily in recent years. Air transport today has emerged as the most used form of public transport for long-distance passenger movement and its role in international transport is likely to increase significantly in the future. Despite the growing importance of air transport, no detailed and systematic geographical study has been undertaken on it, so far. The present study is intended to fill this gap.

In this study, an attempts is made to identify, describe and explain the spatial structure of both domestic and international air transport networks in Kenya. The main purpose of the study is to examine critically the role of air transport on development. The study raises four basic questions. These are:-

a) What is the spatial structure of air transport network in Kenya?

b) How has this spatial structure evolved over time and space?

c) What factors have influenced this structure?

d) What is the relationship between air transport growth and economic development?

The study of transport growth in an individual country provides insights into the actual role played by transport and a comparison of a number of such studies may enable us to abstract from them trends and phases evident in all such studies. Such work can then be made more widely applicable by the integration of such trends and phases into a model of transport development.

Holsman and Crawford (1975) developed a model of air transport growth. However, this model has only been applied in Australia. Its suitability for developing countries has not been tested. The present study attempts to ascertain the applicability of this model. In the past, economic geographers have tended to follow too closely the Eurocentric approach of economists whose elegant models fit very uneasily when applied outside Euro-America (Chapman, 1969). In the future, economic geographers would contribute far more to development research if they became even less Eurocentric in orientation and set their sights firmly in developing countries. Thus, when applying Eurocentric models such as the "Holsman - Crawford" air transport growth model in developing countries, modifications should be made to suit local environments.

In Kenya, as in other parts of the developing world, the introduction and improvement of modern transport is frequently seen as a means of encouraging more rapid economic development, of fostering social progress and of assisting political cohesion. Yet there has often been disagreement about the role of transport, and many different views have been expressed about the relationship between transport and development (Gauthier, 1970, Hoyle, 1988). Today there is a widespread awareness of the complexity of the relationships between transport and development. Transport is now seen as one element among many in the varied infrastructure needed for economic development.

The available literature suggests that there are three possible effects of transport investment. These effects may be positive, neutral or negative. The introduction of new transport facilities or the improvement of the existing ones, may yield positive and beneficial effects. The expansion in directly productive activities such as agricultural or industrial production may be a direct result of providing improved transportation facilities. Sometimes transportation may have a neutral or permissive effect on the development process, because it does not independently produce directly productive activities. A negative effect occurs when an overinvestment in transportation facilities reduces potential growth in directly productive activity.

The argument that economic development should be viewed as an unbalanced process raises the companion problem that it be viewed as an unbalanced process in geographic space (Gauthier, 1970, 615). Perroux in his well-known article on growth poles argues that a fundamental fact of sectorial development is that growth does not appear everywhere nor simultaneously. Rather it appears at points or development poles with varying intensities and spreads along diverse channels with varying terminal effects for the whole economy (Perroux, 1971). As conceived by Perroux, growth poles develop in an economic space which is defined without reference to geographic space. To overcome this weakness the original growth pole concepts have been broadened to include geographic space (Boudeville, 1966).

In the same way transport investment may have positive or negative sectorial consequences, it also may have positive or negative spatial consequences. Transport improvements may lead to new opportunities being created in new locations, as they improve accessibility and change the relative location of places and phenomena (Barke and O'Hare, 1984). This, in turn, has serious implications for regional development planning because a changing pattern of accessibility poses the problem of determining whether or not the changes in the spatial structure of the economy are those desired. Is there a possibility that heavy investment in air transportation in Kenya would create a polarized space economy? This is a pertinent issue investigated in this study.

Air transport is the most recent development in man's efforts to reduce the friction of distance (Knowles and Wareing, 1981). It is by far the fastest of all the modes of transportation. Today, supersonic transport air craft such as the Concorde can reach any part of the world in a matter of hours. New-York is now only three and half hours travel time from London. Here in Kenya, the travel time between Nairobi and Mombasa is under one hour by air while the same journey takes about twelve hours by rail and about six hours by road. Thus, the development of air transportation has played a key role in spatial re-organization.

Air transportation has distinctive advantages that make it ideal for developing countries. It is especially suited for the islandic nature of economic development. Airlines can overfly those extensive areas of low population densities and low economic productivity that separate the islands of development and do not warrant immediate road and rail development (Altschul, 1980). In many developing countries, distances are vast and competitive modes of transport such as road and railway are poorly developed and seasonally difficult to operate.

In Kenya, air transportation has expanded rapidly after World War II. This is indicated by the increase in the number of passengers handled in Nairobi Airport in the last thirty years. Nairobi Airport[1] handled 180,000 passengers in 1955 and 2,186,600 passenger in 1990. Rapid increase in international air traffic has been associated largely with the development of Kenya's tourist industry. Further expansion in the tourist industry will mainly depend on the development of an efficient air transport system. The export of horticultural crops and other processed agricultural products will become increasingly important in coming years. This will lead to greater demand for more air cargo space.

---

[1] Nairobi Airport is now referred to as Jomo Kenyatta International Airport (J.K.I.A.)

1.1 LITERATURE REVIEW

1.1.1 INTRODUCTION

This section provides a summary of both theoretical and empirical studies that are relevant to this study. The existing literature is critically examined in order to evaluate the contributions made by other scholars in the area of study. The major findings of the previous studies are reviewed, pointing out as clearly as possible, areas of agreements and disagreements among researchers in this important topic of transport studies. The weaknesses and limitations of these studies are identified with a view to rectifying them for purposes of the current research topic. More importantly, the literature review is undertaken in order to unearth gaps existing in the previous studies which are then filled in the present study.

Before the 1950's, the classical treatment of transport involved regional descriptions of transport facilities and their historical development, accompanied by descriptive mapping of route location, route classification and where data were available, traffic flow. The emphasis was laid on the comparative role of transport modes in different parts of the world. The influence of the physical environment on route lay out, the role of political decisions and cultural attitudes and patterns of commodity flow in international trade were all common concerns of transport studies of the time.

The 1950's saw growing interest in generalization and theory development in transportation geography. Some of the work by non-geographers played a key role in the development and direction of transportation geography. Research in Economics, Traffic and Highway engineering, Mathematics, Sociology, Transport Planning and Regional Science has aided invaluably in providing concepts, tools and data for transportation geographers. The application of the systems analysis approach to transportation research has helped geographers to avoid a "narrow and rigid disciplinary myopia" (Wheeler, 1971, 5).

Transportation geography has been closely tied to location theory, which in the main holds transport as a constant (uniform accessibility) or treats it as an independent variable (McCarty and Lindberg, 1966). In classical location theory, locations of nodes or land uses may be viewed as the dependent variables; transportation with other factors being the independent variables. In transportation geography, networks and flows, in a simplified sense, are the dependent variables, and locations and their attributes may be relevant, along with transport variables, in explaining characteristics of the transport system. Studies of the impact of transport tend to be structured such that transport is an independent variable. Increasingly, however, with the recognition of the interdependence of transport and location, transport variables are regarded as parts of an interdependent system, no longer though of as dependent or independent (Isard, 1956).

The ultimate aims of geographical studies of transport are therefore to provide concepts, principles, and theories, preferably in a temporal framework of network location and structure, of interaction and network flows, and of the associations of these variables with the economic and social system. These are some of the major aims of the present study. The theoretical and empirical studies relevant to this study are reviewed below.

1.1.2 THEORETICAL BASES RELEVANT TO THIS RESEARCH TOPIC

TRANSPORT DEVELOPMENT MODELS

The first Transport Development Model to discuss is: Ullman's Three Factor Typology Model. The existence of geographical space, and the unequal distribution of economic activities in space, affect the demand for movement by introducing locational relationships between the interacting spatial units. Ullman (1956) revolutionized transport geography by developing a simple model to show the factors that affect the development of transport systems. He identified three basic factors that influence spatial interaction between regions, namely, complementarity, intervening opportunity and transferability. Economic movements between areas are a function of the specific complementarity between them. By specific complementarity, Ullman means a supply in one area which satisfies a demand in another (Smith, 1964, Hodder and Lee, 1974). Complementarity is a function of natural and cultural areal differentiation and the locational specialization of economic activities. Complementarity is the basis of spatial interaction because it makes possible the establishments of transport routes, air routes, railway routes and waterways as examples of transport routes.

Complementarity can generate interchange between two areas only if no intervening source of supply is available. There may be perfect complementarity between two places but the existence of an intervening opportunity may prevent significant interaction from taking place. Interaction patterns change constantly because intervening opportunities appear or disappear.

The third factor required in an interaction system is transferability or friction of distance, measured in real terms of transfer and time costs. Even if perfect complementarity exists between two places and if there are no intervening opportunities, interaction will not take place if the cost and effort of movement is too great. At the simplest level, the degree of transferability may be related to transport costs (Barke, 1986). It is obvious that different commodities have very different transport costs and therefore the extent to which they are transferable or worth while transporting, varies considerably. The concept of transferability may be interpreted as relating to the "supply-demand relationship." There may be a plentiful supply of a commodity in one region, but if no other region wishes to purchase such a commodity, then its transfer will not take place.

Interaction between complementary regions will also only take place if the commodity can be moved. To some extent this depends on the nature of the product. For example, although there is a demand for Kenyan sunshine among German holiday makers, it (sunshine) is not transferable. As such, Germans have to come to Kenya to enjoy the sunshine. It would appear that transferability decreases as economic distance increases and any intervening opportunity will be taken if it reduces this distance. Transferability changes considerably from time to time.

Ullman's model of spatial interaction is a very useful tool for analysing linkages and flows. But the model has some serious shortcomings that reduce its usefulness. The concepts used, such as complementarity, intervening opportunity and transferability, are difficult to quantify. These concepts do not always apply in most real world interaction systems (Ogonda, 1986). Ullman explained that complementarity is a function of both cultural and areal differentiation. Although to some extent this is correct, mere areal differentiation by itself does not always generate the flow of traffic or ideas between places. Many parts of the world do not have any spatial interaction although they are culturally and areally different and complementary. The system proposed applies primarily to interaction based on physical movement, principally of goods but also, to a large extent, of people. It does not apply to the spread of ideas or to most other forms of communication except where they accompany the flow of goods or people. Thus, Ullman's three-factor typology, model of spatial interaction should be applied cautiously, because of the different operations of economic, social and political systems in different parts of the world.

TRANSPORT DEVELOPMENT MODELS

TAAFFE-MORRILL-GOULD MODEL

Taaffe, Morrill and Gould (1963) devised a model to illustrate the ideal typical sequence of transport development. The ideas contained in the model came originally from research undertaken in West Africa, but they have been applied to several other developing countries in Tropical Africa and elsewhere. The series of diagrams (Fig 1.1) suggests how, in a hypothetical developing country, a transport network may gradually emerge from small and simple beginnings to become a complex element in a mature economy. The model is based on the assumption that transport networks in developing countries are rooted historically and geographically in sea ports.

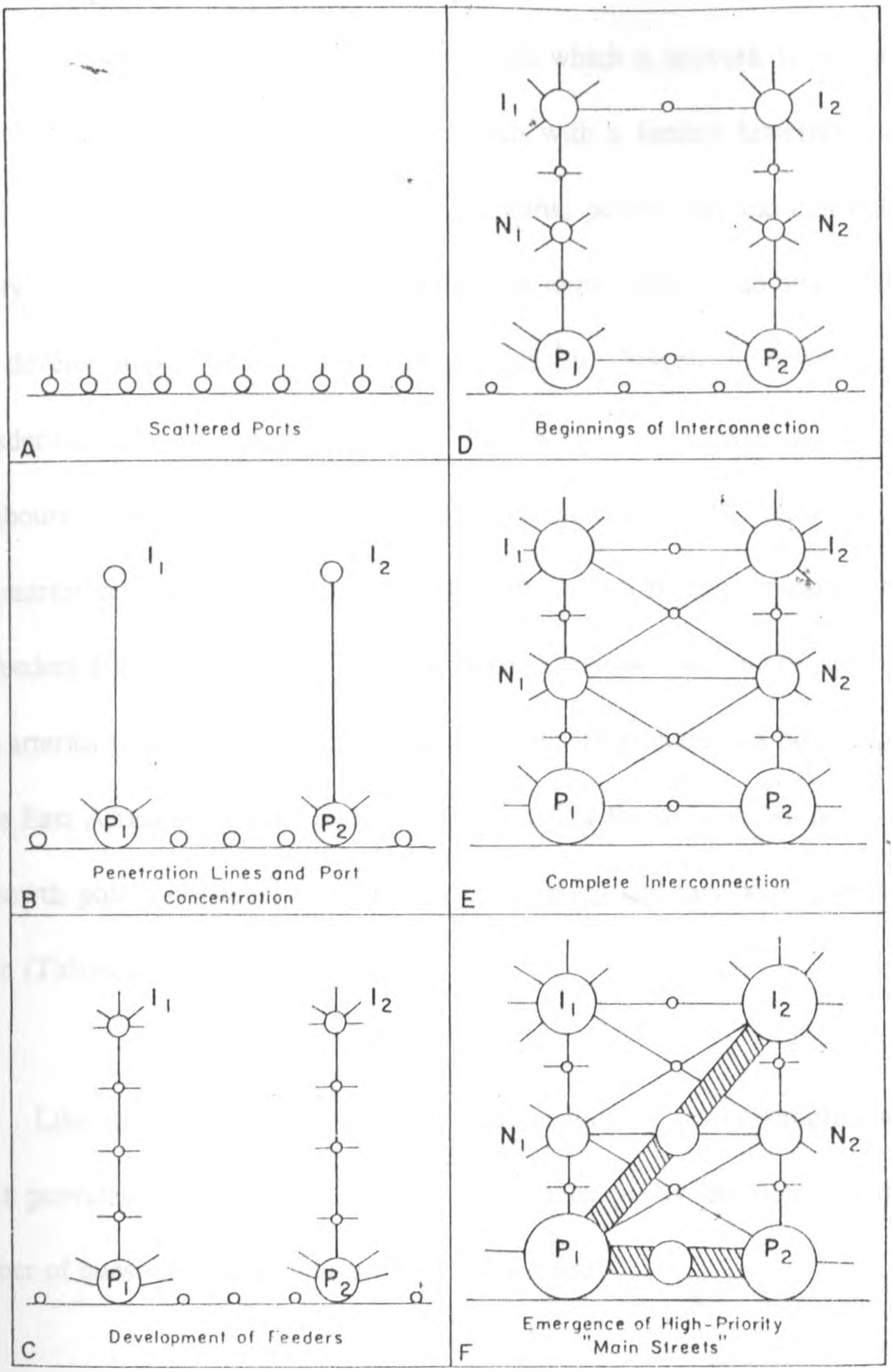


Figure 1:1 Ideal-Typical Sequence of Transport Develoment.

Source: Taaffe, E J., Morrill R.L. and Gould P R. (1963) pp 504.

The model identifies six stages through which a network is presumed to pass. Stage 1 consists of small scattered ports each with a limited hinterland and with little lateral interconnection. In stage 2, there is initial penetration and concentration of port activity. In this stage, one or two ports develop more rapidly than others and these major ports develop longer lines of inland communication. Stage 3 witnesses the development of feeder routes and intermediate centres. Major sea ports expand at the expense of their neighbours. Stage 4 is the beginning of interconnections both between coastal centres and interior centres respectively as shown. In stage 5 there is complex interconnection and feeders gradually link up. The final stage experiences the emergence of high priority main arteries resulting from a particular demand. This model has been applied by Hoyle to the East Africa situation (Hoyle, 1970). Implicit throughout the model is the concept of growth pole consistent with the idea of city-rich and city-poor sectors advanced by Lösch (Tidswell, 1978).

Like all models, Taaffe-Morrill-Gould's Model is an oversimplification of reality, but it provides a useful point of view and leaves plenty of room for discussion. A number of questions remain unanswered. These are:-

a) How does a developing country such as Kenya move from one stage of the model to the next?

b) What factors affect a country's progress through the various stages?

c) How relevant is the model to an understanding of present demands?

SEALY'S AIR TRANSPORT GROWTH MODEL

Sealy (1966) developed a model of air transport growth involving three phases. In the first, or Pioneer Phase, aircraft are used for surveys of all kinds, such as topographical, forest, geological or mineral surveys. If the development of the resources seems justified, aircraft are used to establish the first camps and to aid in the construction of surface links. In the second phase, primary road and rail links are established. Exploitation begins on a large scale, while air craft still play a vital role for both passengers and freight. The final phase is characterised by the growth of industry and dense settlement if physical and economic conditions are suitable. Air transport then assumes a more normal role, deriving most of its revenue from passengers, mail and specialized freight operations.

Sealy was the first geographer to propose a model of air transport growth in underdeveloped regions. However, he did not offer spatial pattern of idealized network growth and his model is too concerned with describing one specific case of air transport development to be universally acceptable.

HOLSMAN - CRAWFORD MODEL

Holsman and Crawford (1975) offered a more elaborate model of air transport growth in an underdeveloped region. Holsman and Crawford (1975) made the first attempt to develop a conceptual model of air transport growth (Fig. 1.2). The model was applied in the underdeveloped regions of Australia. According to this model, air transport growth involves four phases.

a) Phase 1: Exploration period of space covering activities:

Development proceeds from one or a series of major peripheral foci scattered adjacent to the underdeveloped regions. The air craft are used for surveys of all kinds such as geological, geophysical and government exploratory expeditions. Such activities are referred to as "space covering" activities. During this phase, there is no scheduled air traffic between the peripheral nodes.

b) Phase II: Establishment of major lines of penetration.

Deep lines of penetration of inland mining centres and settlements are established with the major peripheral nodes acting as origin - destination points. Resources discovered are exploited if deemed economic. Initially, volume of traffic to these mining centres is very great, possibly leading to the upgrading of air craft used in the network. Lateral interconnections between the peripheral nodes become established and traffic increases rapidly.

c) Phase III: Introduction of intermediate nodes and trunk routes

This phase is characterised by continued extension and expansion of the main penetration links in both frequency and capacity of services. Thus as the region's economy grows, so traffic demand in the region increases. Intermediate nodes in the network begin to appear. This is due to greater regional significance through the establishments of surface links to them. Trunk routes develop as links between successively higher-order nodes become shorter and more direct as small centres are bypassed.

d) Phase IV: Integration of the network

In this final phase, the network becomes fully integrated as lateral connections between intermediate nodes extend. Air transport now assumes a more nominal role, deriving most of its revenue from passengers, mail and specialized freight.

This model provides a very useful summary of certain trends or regularities in the growth of air transportation. But, the phases discussed are an "ideal sequence". Any stage - of - growth approach to model building has its own inherent flaws. The phases of air transport growth are not distinct historical periods, rather they form a continuous process. The model is Euro-centric. It stresses the exploitation of resources of a given region by outsiders. The model assumes that interaction is a one-way process instead of a two-way process. Holsman and Crawford have applied their "ideal-typical - sequence model only in Australia. It is difficult to tell how realistic the four phases identified are in the real world. One would ask: Is the model applicable outside Australia?

This study applies the model in the Kenyan situation in order to test its validity. The growth of air transport system in Kenya is compared with the phases identified in Holsman-Crawford model in order to show whether the transport system conforms to the postulates of the model.

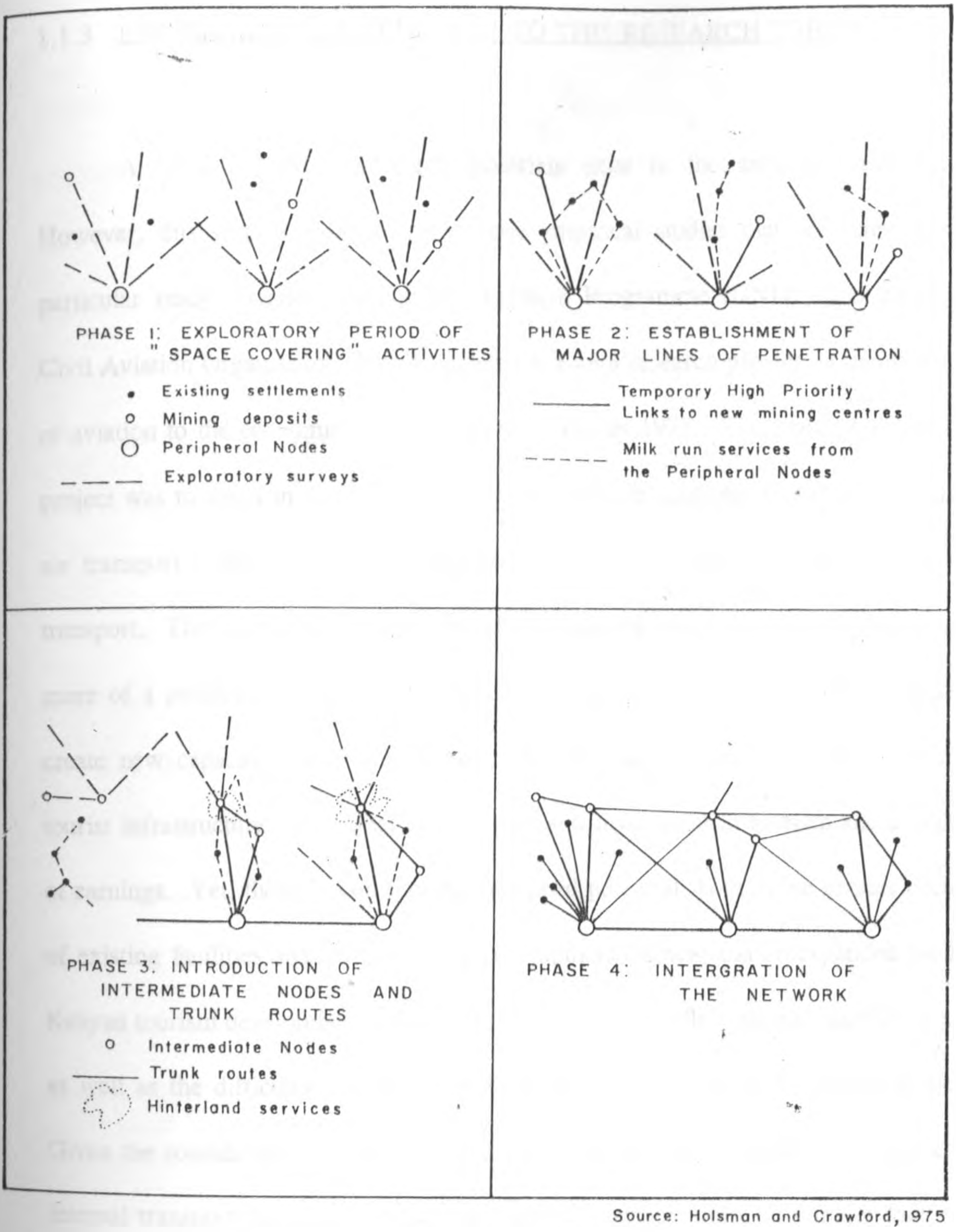


Figure 1·2 AN IDEAL SEQUENCE OF PHASES OF AIR NETWORK GROWTH IN AN UNDER-DEVELOPED REGION

1.1.3 EMPIRICAL BASES RELEVANT TO THIS RESEARCH TOPIC

A lot of important research materials exist in the area of transportation. However, this section examines only those empirical studies that are relevant to this particular study. United Nations Development Programme (UNDP) and International Civil Aviation Organisation (ICAO) undertook a joint research project on the contribution of aviation to the economic development of Kenya in 1975. The main objective of this project was to assist in the development of the Kenyan economy by taking advantage of air transport's lesser need for capital investment and greater flexibility than surface transport. The study notes that in agriculture, manufacturing industry and tourism, it is more of a problem of effectively utilizing existing capacity than a problem needing to create new capacity. The study further observes that Kenya has a highly developed tourist infrastructure, substantial employment and investment in tourism and a high level of earnings. Yet, there is considerable untapped potential, both in the greater occupancy of existing facilities and in the further development of new and/or expanded facilities. Kenyan tourism development is constrained by the generally high and increasing airfares as well as the difficulties in visitor accessibility, particularly in peripheral properties. Given the considerable spatial diversification of the tourist infrastructure in the country, internal transport involving both air and surface transport must be a major factor in the planning of the tourist industry.

Agricultural produce for which the duration of transportation is of critical importance is most relevant to this UNDP/ICAO project. The export of horticultural produce by air, (such as cut flowers, vegetables and fruits), has been growing rapidly since 1968. The study indicates that the further development of such exports by air will depend primarily on air freight capacity availability, airfreight rates and improved market intelligence and quality competitiveness between Kenya and other sources of supply. This is an important study on air transport with some useful findings. However, the study is now out of date and some of these findings need to be updated.

Studies carried out by Mwenge International (1982) found out that air transport more than any other mode enables access to remote areas. This is an important advantage to a developing country such as Kenya. Compared with other transport modes, air transport demands very limited infrastructural development and does not involve the expenditure of much financial resource to the extent that roads or railways would. All that is required is an air strip of sufficient size to accommodate light aircraft. This aspect of accessibility is of particular importance for Kenya's tourist industry which centres heavily on the country's National Parks and Game Reserves. Domestic air transport has made such areas readily accessible.

It has created an opportunity for short term tourists to broaden their tourism experience in Kenya at a very little cost in terms of time. However, this report is not exhaustive, as it does not examine the spatial structure of air transport services. Since the report is limited to domestic transportation, it fails to consider international air transport. The present study examines both domestic and international air transport in Kenya.

King (1984) observes that due to its size and economic importance, Nairobi and its hinterland are served by numerous international airlines and by the national carrier, Kenya Airways (KA), at Jomo Kenyatta International Airport. The density of air traffic at Nairobi, in terms of the number of international air passengers, ranks it among the three busiest air centres in Africa South of the Sahara. Nairobi enjoys direct flight connections to 26 points outside Africa and its islands, a figure which exceeds that of any other city south of the Sahara.

The unusual array of air services adds to Nairobi's role as an international air passenger hub. Passengers from Israel find in Kenya a gateway to parts of Africa south of the Sahara. South Africans of Indian, African and European racial background transit at the Nairobi's Jomo Kenyatta International Airport enroute to points not served by South African Airways and Air India for political reasons. According to the study, Nairobi has greater frequency of flights as compared to neighbouring airports such as

Dar-es-Salaam and Entebbe. Nairobi's location, vis-a-vis the principal North-South alignment between Europe and Southern Africa, requires little deviation in terms of route-kilometres flown, yet it offers a convenient stopover for passengers, freight, and fuel. Despite discussing Nairobi as an airline hub, the study is limited in scope and ignores other equally important aspects of commercial air transport in Kenya.

Wanyanga (1988) provides a detailed historical account of domestic air transportation services in Kenya. He stresses the role of air transport services in economic development. He points out that aviation is necessary for provision of specialized services to distant and remote areas where accessibility is hampered for certain seasons of the year. He recognizes in the study, the significance of general aviation in promoting development in remote areas. However, he concentrates on the historical growth of domestic air transport and does not discuss the spatial pattern of domestic air transport networks. This is a major weakness in this study. The present study fills this gap by carrying out a detailed study of the spatial pattern of domestic air transport networks.

Ongaro (1989) identifies and examines the network of commercial flights in Kenya. His study is limited to the passenger, cargo and mail air transport services offered within the country by commercial operators. The study reveals that most of the aerodromes in Kenya are category C (small airstrips). This poses problems in the expansion of domestic air transport services particularly scheduled air flights. Most of these air strips lack adequate navigation aids. The study also shows that the market for domestic air transport services is growing. Although this is an important geographical study of air transport in Kenya, the study is not exhaustive. It is limited to commercial domestic air transport services, particularly those serving the needs of tourists. The study ignores general aviation.

The lack of internal road and rail communications coupled with the often vast distances to be covered in many developing countries has led to general aviation playing a key role in the framework of transport services on which development can be built. General aviation provides vital functions such as locust and other pest control, provision of medical facilities and supply of goods and services to remote areas. Finally, Ongaro's study does not consider international air transportation, hence, international air transportation needs a thorough geographical study.

Irene Van Dongen (1954) in her study of East Africa's transport system notes that domestic air transport in the region has grown at a fast rate in the distance of haulage, the number of passengers and volume of freight moved. She observes that airlines often experience under-capacity flights. There is a big difference between potential carrying capacity of the aircraft and actual traffic moved. Few routes within East Africa show a capacity utilization of more than 60%. However, the findings of this study are now obsolete and a more up-to-date research needs to be undertaken. Her study covers all the transport modes in East Africa, consequently, it is general and not detailed enough. The study also concentrates on domestic air transport services and does not examine the nature of international air transportation in Kenya.

Hogenauer (1975) assesses the pattern of air transport in the now defunct East African Community. The study identifies and discusses the implications of the various factors influencing air transport patterns in East African Community. The study examines the physical, demographic, economic and political factors that influence air transport pattern. The author observes that the physical factors such as topography and weather had little impact on air transport patterns. The demographic factors examined include population distribution and intrinsic motivation for travel. The study shows that only about 20% of the overall African population was within an hour of an airport with scheduled air services. The Asians and Europeans being largely urban are well served and form the basis for air network. About 76% of Asian population and 69% of the European population are located within one hour of an airport with a scheduled air service. The study establishes that Asians and Europeans, being wealthier, could afford the higher costs of air transport and that the return visits to the home country (for expatriates) provided the basis for frequent air travel.

The main economic factors considered by Hogenauer (1975) are the distribution of industry, tourism and competitive surface transport. The author observes that there are few industrial centres in the region and the existing few are effectively served by air. Tourism is the principal user of air transport, both internationally, and internally and charter operators offer service to a variety of game parks and other tourist attractions. According to the author, political factors are the most significant, as divergence within the community has a disruptive rather than a cohesive effect on air transport. Varying political ideologies and nationalistic approaches to airport planning and landing rights disrupts attempts at an overall community approach. The study covers the spatial pattern of air transport in the defunct East African Community. The study does not discuss the role of air transport in economic development in the region. This is a serious omission of a study purporting to cover air transport in East Africa.

In recent years, Africa and other regions of the developing World have experienced a proliferation of state owned airlines. Van Chi-Bonnardel (1973) examines the performance of African state owned airlines. He observes that air transport is not a popular mode for domestic travel in the continent because its high costs limit the number of domestic air passengers to business executives and senior civil servants. He argues that African state owned airlines should concentrate on providing inter-continental air transport service instead of intra-continental services. Van Chi-Bonnard's study is an important one. However, his study is not exhaustive. The study only considers the role of domestic air transport in serving administrative and commercial needs. His study ignores the movements of tourists who form a significant proportion of the total domestic air passengers. The study does not discuss the role of intra-continental air transportation in promoting regional economic integration. The creation of regional economic organisation in Africa such as the Preferential Trade Area (PTA), has offered tremendous opportunities for developing regional airlines which would be able to compete with foreign mega carriers and the foreign international airlines based in Europe and America. The present study examines the role of both intra-continental and inter-continental air transportation in influencing Kenya's economic development.

Altschul (1980) observes that air transport in Africa relies on international flights. Air connections between individual African countries and Europe are generally more highly developed than those between neighbouring countries. According to the author, many African countries have maintained the well travelled air routes connecting them with former colonial powers. Infrequency of direct regional (intra-continental) service between African cities is a common problem to tourists and businessmen. Direct flights between East and West Africa are less frequent and provide fewer options than direct flights via Europe. The author also notes that air transport in Africa is dominated by international passenger traffic and that Africa's airports have replaced the continent's ocean ports as the primary points of entry and departure for overseas travels.

The author has also revealed that the domestic air transport in comparison with international air transport is much less developed. It suffers from lack of traffic originating at minor airports and is heavily dependent on traffic generated at the major airports. Passenger groups consisting mainly of civil servants, businessmen and foreign tourists make the bulk of domestic traffic while military transport and delivery of emergency or relief dominate domestic traffic periodically. Although these findings are pertinent to the present study, most of them are of a general nature. The author examines the role of transport in the whole of Africa. The study is continental in coverage and is therefore, not thorough. Specific case studies of domestic and international airlines operating in a given country such as Kenya should be undertaken in order to understand fully their operations and contributions to national development.

Gaile (1988) observes that the development of the African airline network illustrates several aspects of development and the impacts of colonialism. The early network development served to link the colonial urban capitals of individual colonial powers. Using the technique of graph theory, the author shows that rather than moving towards an independent network structure, the structure based on former colonial powers has actually been strengthened since African countries have attained independence - the phenomenon of "aviation neo-colonialism". The author concludes by analysing the various problems associated with airline development in Africa. The study provides useful and up-to-date ideas on African airline connectivity. However, the study is general and broad in scope. It covers the whole of Africa.

Gaile and Hanink (1984) analyse the changing inter-island connectivity of the Caribbean airline network through the last five decades. The examination of the airline network connectivity reveals interactive adjustments among the islands in response to political and economic changes both within the region and between the region and other nations. The study shows that while the volume of air traffic over the network has increased very rapidly throughout the development of the network, connectivity has increased only marginally in the last three decades and has essentially levelled off in the current period. The authors provide a historical geographical perspective in order to gain a more in-depth view of airline connectivity in the region. The study employs graph theoretic techniques in analysing airline connectivity. This study covers the whole of the Caribbean region and is, therefore, general in nature. Further, the study does not discuss the role of air transport on economic development in detail. These are some of the glaring gaps in this study which the present study attempts to fill.

Kissling (1981) examines some of the problems of international civil aviation in the South Pacific. The author observes that there has been a proliferation and expansion of the national airlines of small south Pacific Island states established after the attainment of their independence. Moreover, there has been a re-orientation of the commercial operations of the well established carriers from the metropolitan powers partly in response to rising island nationalism and also in response to steeply rising operating costs. The smaller carriers in the region are likewise caught in the net of escalating costs, just at the time they had hoped to assume greater responsibility for their aviation needs and must now move to acquire more modern fuel-efficient equipment. The findings of Kissling's study are relevant to the present study. But, the present study is broader in scope as it discusses both the domestic and international airline networks in Kenya.

1.2 JUSTIFICATION FOR CHOICE OF TOPIC

The significance of this study is best underlined by the following considerations:-

a) O'connor (1965) and Ogonda (1986) carried out detailed systematic studies of the railway transportation in Uganda and road transportation in

Kenya, respectively. However, air transportation in Kenya has not received such a detailed and systematic study. The literature relating to air transportation is of a general and fragmentary nature. Air transportation merits a detailed geographical investigation, hence, the need for this study. Whatever literature exists does not provide the kind of data required in a major study such as this one.

b) An efficient and well equitably patterned transportation system is critical in the achievement of development goals for any country. Without such a system, development of markets for goods and services will not be fully realized and national, social and economic integration would be seriously hampered. Since the attainment of independence, the Kenya Government has paid considerable attention to the development of its transportation system. Air transportation is becoming increasingly vital to Kenya's socio-economic development. As the country develops an export-orientated economy, especially in the field of horticultural crops and other high-value agricultural products, air transport will become even more important. Given the growing importance of air transportation in the country, there is need to undertake a thorough study on it. Such a study would show the contribution air transport would make in promoting the development of export activities especially in horticulture.

c) Kenya is one of Africa's top tourist destinations. Most of the tourists come from Europe and North America and, practically, the only mode of transport for them is by air. Therefore, adequate air services and frequency are of great importance. In Kenya and in other countries of Eastern Africa, flight frequencies are often low. This makes planning of tourist itineraries difficult. Besides, the passenger load factor on some routes in the region is very high during peak periods.

International tourism in Kenya has developed primarily as a result of progress in air transport. The latter is by far the most important mode for tourists arriving from overseas and also from neighbouring countries. Transportation by sea is, currently, much less important. Air Transport has captured most of the passenger traffic from sea transport. Rail transport is also of limited significance but it may be important for domestic tourism. Due to its slowness, rail transport is less suited for international tourism in Kenya than air and road transport.

The present study examines the problems facing air transport in Kenya and suggests solutions to some of them. The data obtained from the study should enable transport planners to allocate, appropriately, scarce resources among the different transport modes in the country.

d) Nairobi has become the hub of air traffic connections for a large part of the African continent and Western Europe. Nairobi, like Johannesburg, Lagos, Dakar and Cairo, has become the primary focus of intra-continental and inter-continental air routes and is a major node of air transport in East, South, West and North Africa.

There is a need for a clear understanding of the main factors that have influenced the growth of international air transportation focusing on Nairobi and the implications of this growth to the future expansion of Jomo Kenyatta International Airport (JKIA). The study shows whether the airport will be able to cope with increasing international air passenger traffic in the future.

From all the above considerations it would appear that air transport is very important in Kenya and cannot be ignored in geographical investigations, hence, the reason(s) for choice of this topic.

1.3 OBJECTIVES OF THE STUDY

The main objective of the study is to describe, analyse and explain the networks of both domestic and international airlines and to examine the relationship between domestic air transport and national development.

The specific objectives of the study are:

a) To examine the spatial structure of air transport network in Kenya. This involves identifying and analysing the patterns of scheduled domestic and international airlines as well as chartered air services.

b) To evaluate the factors that have influenced the evolution of air transport network in Kenya. This involves identifying and analysing the socio-economic, physical and political factors that have influenced development of air transport network.

c) To analyse the volume of traffic for both domestic and international airlines. This involves determining the number of passengers for both domestic and international airlines. The amount of cargo and mail handled within and outside Kenya are also determined.

d) To discuss the relationship between air transport growth and development in Kenya. To achieve this objective, an index of development to measure the spatial variation in human welfare in all the districts of Kenya is constructed. The development index is used as a basis for ranking, comparing and classifying districts according to their development status. The role of air transport in general development is critically examined.

1.4 THE SCOPE AND LIMITS OF THE STUDY

The study examines the spatial structure of domestic and international air transport systems operating in Kenya. It analyses and discusses the scheduled domestic and international airline networks as well as those of chartered services. Both commercial air transport and general aviation are considered. However, military and police air transportation is excluded from the study because of the security implications involved. Other modes of transport such as roads and railways, in so far as they promote air transport activities, are considered in the identification and discussion of the explanatory variables of the spatial pattern of development. Their relationship with other indices of development is examined. However, a detailed study of these modes of transport, *per se*, is beyond the scope of the present study. Fortunately, such studies have been undertaken before (O'connor, 1965, Ogonda, 1986).

1.5 HYPOTHESES

Four null hypotheses have been formulated whose validity is tested and their rejections will lead to the acceptance of the alternative hypotheses:

a) There is no significant difference between the stages of growth of the Kenya air transport network and the one predicted by the Holsman - Crawford "ideal - typical sequence" model of air transport growth.

b) The volume of air passenger traffic does not vary with sizes of places and the distances between them.

c) The volume of cargo freight does not vary with sizes of places and the distances between them.

d) There is no significant relationship between the development of air transport and the spatial patterns of development.

1.6 OPERATIONAL DEFINITIONS, CONCEPTS AND CONCEPTUAL/THEORETICAL FRAMEWORK

1.6.1 OPERATIONAL DEFINITIONS:

TRANSPORT

The term transport refers to the movement of goods and people. It excludes the flow of ideas and information which constitutes communication. In the study the terms transport and transportation are used interchangeably.

TRANSPORT MODES

These refer to the means of travel or of moving goods. They include airways, roads, sea routes and pipelines.

TRANSPORT FACILITIES

These refer to the stock of transport equipment. That is, the mobile equipment such as aircraft, cars, buses, lorries, trains etc.

AIR TRANSPORT SERVICE

Air transport services include airline offices, travel agencies, terminal facilities and cargo. International airline services are those linking Kenya with the outside world. Domestic air transport services link different parts of the country such as Game Parks and Reserves.

MINOR AIRPORTS

These are often located in remote areas and serve the islands to development (Altschul, 1980, 52).

SPACE COVERING ACTIVITIES

These are activities carried out throughout extensive areas of an underdeveloped region. Such activities include aerial surveys of all kinds (Holsman and Crawford, 1975).

SCHEDULED AIR CARRIER

An air carrier is generally considered to be scheduled when its service is operated in accordance with published time table and it is open to use by members of the public.

CAPACITY

Capacity in air transport refers to the total traffic volume which an airline carries on a particular route in terms of passenger seat, kilometres and/or cargo tonne kilometres.

DEVELOPMENT

The term development has often been confused with economic growth and/or economic development. Some scholars, especially economists have defined economic development as the process whereby a country's real per capita Gross National Product (GNP) or income, increases over a sustained period of time through continuing increases in per capita productivity. But any development indicator based on monetary value of production is subject to both conceptual and technical problems. For example, GNP per capita does not show the distribution of national wealth. Developing countries are known to have highly skewed distributions of wealth, with most of it concentrated in the hands of a very small and exceptionally rich elite. At the same time, nearly all wealth may be concentrated in one small section of the country, usually in the primate capital city while the rural masses in the remainder of the country experience severe deprivation.

GNP per capita does not tell us anything about equally important dimensions of development such as socio-cultural system, political system and level of technology. In other words, the concept of development has a much wider meaning than the narrow economic development concept. In its broadest sense, development may be defined as "the process of improving the quality of all human lives" (Todaro, 1985, 580). The three equally important aspects of development are:

a) Raising people's living levels (that is, their income and consumption levels of food, medical services, education and so on, through "relevant" economic growth process.

b) Creating conditions conducive to the growth of people's self-esteem through the establishment of social, political, and economic systems and institutions which promote human dignity and respect; and

c) Increasing people's freedom to choose by enlarging the range of their choice variables (such as increasing varieties of consumer goods and services).

1.6.2 OPERATIONAL CONCEPTS IN THE MODEL

NETWORK

Network refers to the geometrical structure of route systems. This include the geometrical layout, location of routes and intersections; nodes, terminals; density and length of routes and the relative accessibility of individual points and network relative to other points.

FLOW

Flow refers to movement and its intensity. This involves movements of people, goods and messages along transport networks.

MODAL SYSTEMS

This includes mobile transport equipment such as aircraft, cars and buses and the rate at which they increase. It can also refer to growth of a given mode of transport such as rail transportation.

SYSTEMS OPERATIONS

This includes routing, scheduling, pricing, types of service and availability of new equipment.

1.6.3 CONCEPTUAL/(THEORETICAL) FRAMEWORK

The conceptual (theoretical) framework used in the present study is a "systems framework". It describes the mechanisms of air transport system and shows the relationship between air transport and development.

The conceptual (theoretical) framework used in the study is a modification of the model developed by Wheeler (1971) and elaborated by Hay (1973) and Hurst (1973). Wheeler (1971) developed a simple model for studying transportation geography. (Fig. 1.3a). The model is useful in transportation studies because it provides the basis for:

a) examining the location, structure and evolution of networks.

b) flows on networks.

c) impacts of networks and flows on development. However, the model is oversimplified and smacks of the traffic engineers' approach. It is mainly concerned with networks, flows and vehicle operation costs. The impact(s) of transportation networks on the societal system are ignored.

Hay (1973) presented a more elaborate model. This improved model consists of four main components, the demand, network facility, flows and vehicle capacity. Network facility includes route ways and terminals while vehicle capacity includes all modes of transportation such as roads, air and shipping. Collectively, demand, networks and flows determine the spatial pattern of transportation flows although there is much circular causation between these phenomena (Fig. 1.3b). Although Hay's model is better refined than Wheeler's pioneer model, it has serious shortcomings. The model is misleading because it does not show what gives rise to demand. Further, the model ignores the impact(s) of transportation on the societal system.

Hurst (1973) devised a "functional" or "systems frame work" which encompasses the socio-political setting in addition to the economic aspects of transportation (Fig. 1.3c). The model has provided the basis for probing the interrelationship between transportation system and the societal system. Hurst incorporated the core components from each of the models developed by Wheeler (1971) and Hay (1973). The main components of the model are:

a) demand

b) vehicle capacity

c) network facility

d) flows

e) systems operations

f) levels of service

Unlike the previous models, Hurst's model lays emphasis on the impact(s) of transportation on the societal system. He pays adequate attention to traffic related factors such as noise, air pollution, vibration and so on. But, the conceptual model is confusing and difficult to make operational (Rimmer, 1978, 84).

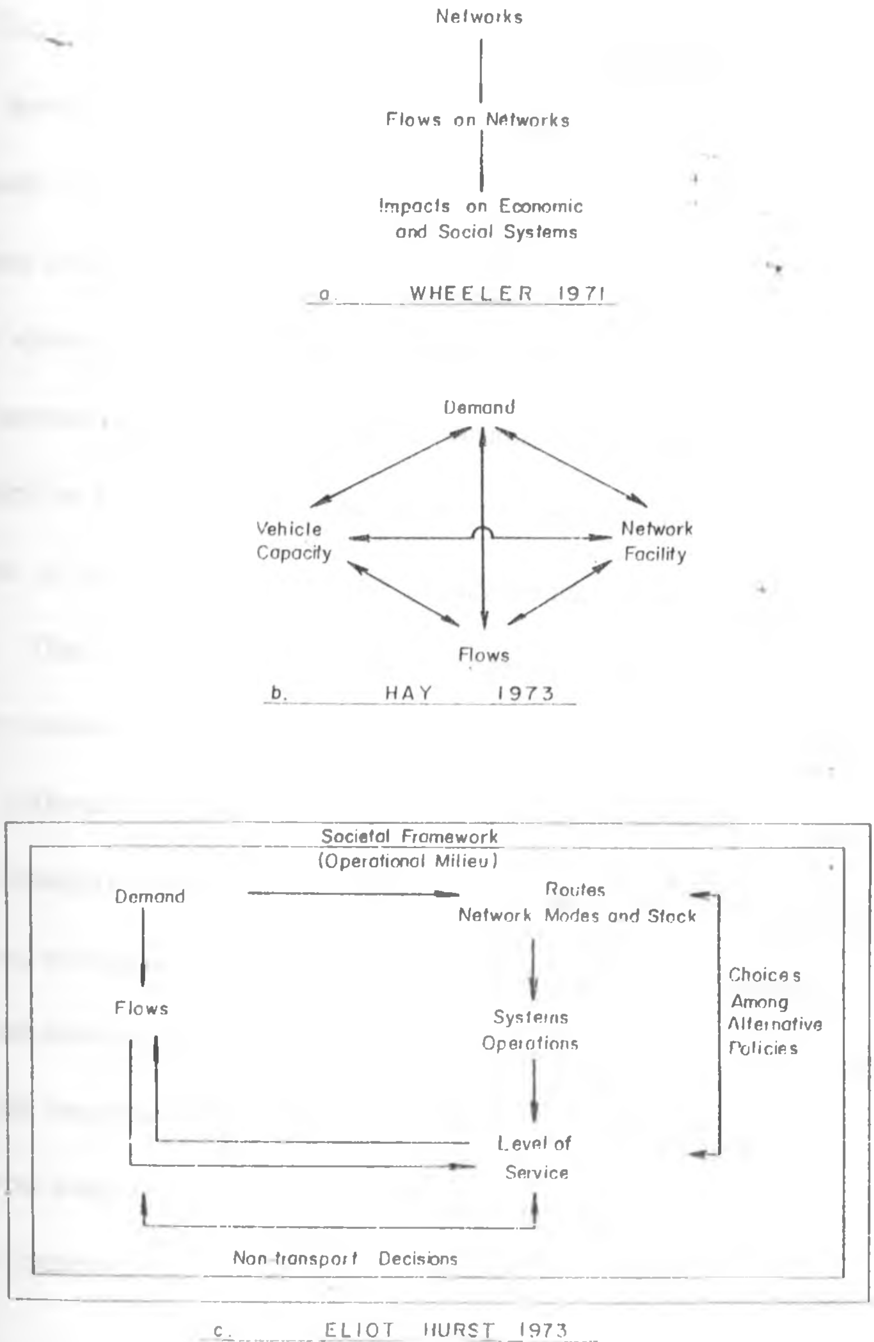


Figure 1-3 DIFFERENT CONCEPTUAL FRAMEWORKS FOR STUDYING TRANSPORT GEOGRAPHY

The current research model incorporates the core components from each of the models developed by Wheeler (1971), Hay (1973) and Hurst (1973). The main components of the model are shown in Figure 1.4. The model consists of two main parts or systems both of which are mutually interrelated. These are the societal and the transport systems. The societal system can be disaggregated into its component parts such as economic, political and social dimensions. But, transport system is meant to serve society as a unified whole. The transport system also affects society by facilitating movements of people and goods and in influencing locations of various economic activities. Thus, transport system may be regarded as a system affecting and being affected by societal system of which it is part (Ogonda, 1986, 69). Just as transport system is influenced by societal system, so does transport system influence societal system. Transport system has two major effects on societal system, namely, socio-economic and ecological effects. These effects could be positive and negative. For instance, the development of air transport system would enhance regional integration. However, this integration may lead to cultural problems such as prostitution and crimes. Such problems arise when differing cultures are brought together through travel e.g. air travel. Air transportation also leads to environmental problems such as noise and air pollution.

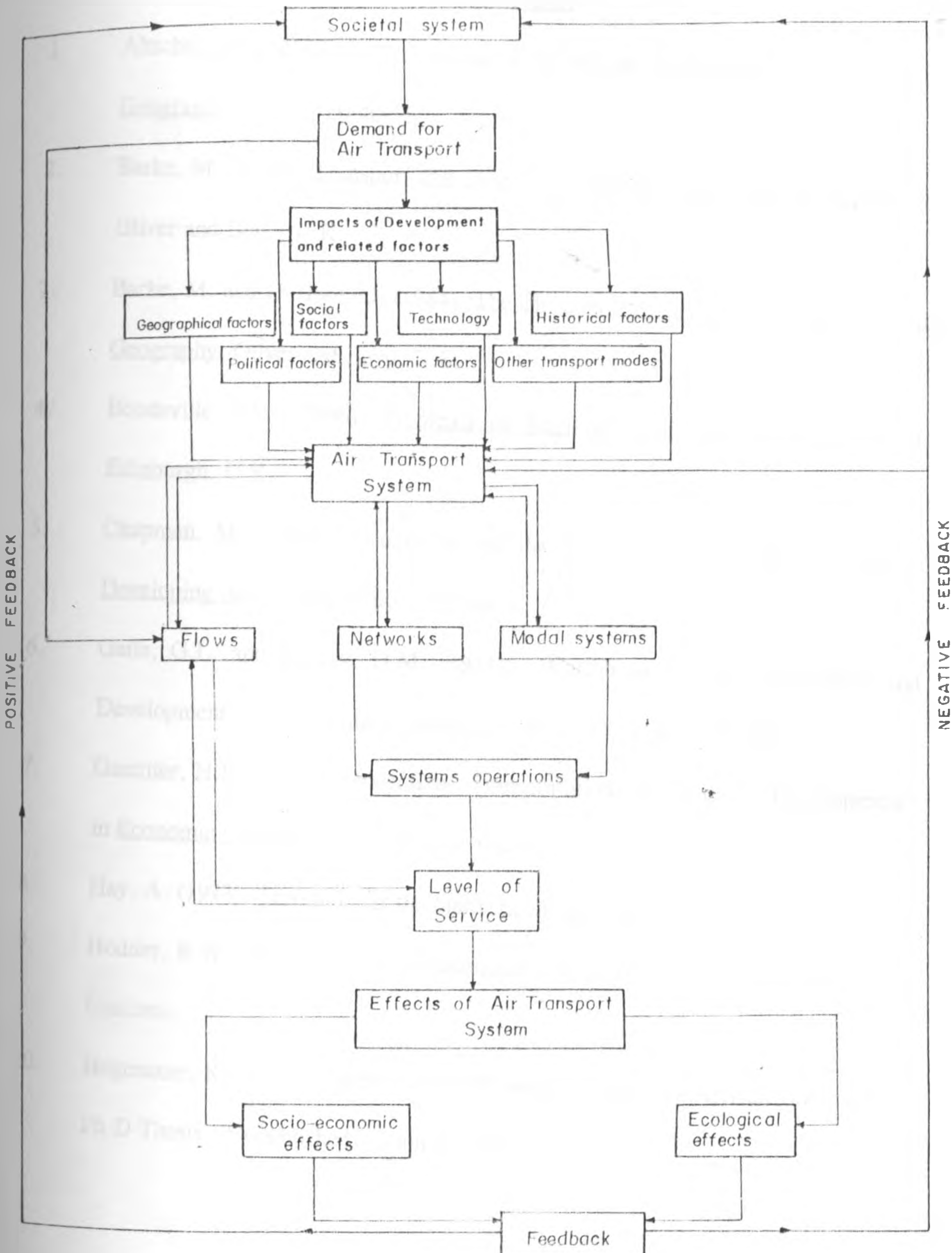


Figure I 4 CONCEPTUAL FRAMEWORK FOR STUDYING AIR TRANSPORT SYSTEM

REFERENCES

1. Altschul, D.R. (1980): "Transportation in African Development", in Journal of Geography. Vol 79, pp 40-55.

2. Barke, M. (1986): Transport and Trade. Conceptual Frameworks in Geography. Oliver and Boyd, U.K.

3. Barke, M. and O`Hare, G. (1984): The Third World. Conceptual Frameworks in Geography. Oliver and Boyd, U.K.

4. Boudeville, J.R. (1966): Problems of Regional Economic Planning. Part I, Edinburgh, U.K.

5. Chapman, M. (1969): "Geography and the study of Development", Journal of Developing Areas. Vol. 3, pp. 319-338.

6. Gaile, G.L. and Hanink, D.M. (1984): "Caribbean Airline Connectivity and Development" in Caribbean Geography. Vol. 1, No. 4, pp. 272-282.

7. Gauthier, H.L. (1970): "Geography, Transportation, and Regional Development" in Economic Geography, Vol. 46, pp. 612-19.

8. Hay, A. (1973): Transport for the Space Economy. Macmillan, London.

9. Hodder, B.W. and Lee R. (1974) Economic Geography. Methuen and Co. Ltd., London.

10. Hogenauer, K. (1975): Patterns of Air Transport in the East African Community, Ph.D Thesis, (Unpublished), Columbia State University.

11. Holsman, A.J. and Crawford, S.A. (1975) "Air Transport Growth in Under-Developed Regions", in Australian Geographer, Vol. 13, No. 2, pp. 79-90.

12. Hoyle, B.S. (1970): "Transport and Economic Growth in Developing Countries: The case of East Africa" in Essays for K.C. Edwards. Ed. by R.H. Osborne *et al.*, pp. 187-96.

13. Hoyle, B.S. (1988): Transport and Development in Tropical Africa. John Murray, London.

14. Hurst, M.E.E. (1973): "Transportation and Societal Framework", Economic Geography. Vol. 49, pp. 163-80.

15. Isard, W. (1956): Location and Space Economy. Cambridge, The M.I.T. Press.

16. King, J.W. (1984): Nairobi as an Airline Passenger Hub, Dept. of Geography, University of Utah, U.S.A.

17. Kissling, C.C. (1981): "Rationalization for Survival in South Pacific Regional Civil Aviation", in Australian Geographical Studies, Journal of the Institute of Australian Geographers. Vol. 19, pp. 205-216.

18. Knowles, R. and Wareing, J. (1981): Economic and Social Geography, Heinemann, London.

19. McCarty, H.H. and Lindberg, J.B. (1966): A Preface to Economic Geography, Englewood Cliffs, N.J., Prentice - Hall Inc.

20. Mwenge International Associates, (1982): A study of Capacity Utilization and Requirements and Generators' Fares and Rates, a Report.

21. O'Connor, A.M. ((1965b): Railway and Development in Uganda. East African Institute of Social Research Studies, Vol. 18, Nairobi.

22. Ogonda, R.T. (1986): The Development of Road Transport System in Kenya, Ph.D. Thesis (Unpublished), Dept. of Geography, University of Nairobi.

23. Ongaro, S.L. (1989): Commercial Air Transportation in Kenya: A Geographical Study of Some Aspects of Domestic Flights, B.A. Dissertation (Unpublished), Dept. of Geography, University of Nairobi.

24. Perroux, F. (1971): Note on the Concept of Growth Poles (transl. by I. Livingstone from "Note Sur la notion de Pôle de Croissance") in I. Livingstone, Ed. Economic Policy for Development: Selected Readings, Harmondswash.

25. Rimmer, P.J. (1978): "Redirections in Transport Geography", in Progress in Human Geography, Vol. 2, No. 1, pp 76-100.

26. Sealy, K.R. (1966): The Geography of Air Transport. Aldine, Publishing Co., Chicago.

27. Smith, R.H.T. (1964): "Toward a Measure of Complementarity", in Economic Geography, Vol. 40, No. 1, pp. 1-8.

28. Taaffe, E.J., Morrill, R.L. and Gould, P.R. (1963): "Transport Expansion in Underdeveloped Countries: A comparative Analysis" Geographical Review, 53, pp. 503-29.

29. Tidswell, V. (1978): Pattern and Process in Human Geography. University Tutorial Press, U.K.

30. Todaro, M.P. (1985): Economic Development in the Third World Longman, London/New York.

31. Ullman, E. (1956): "The role of transportation and the Bases for Interaction", in Thomas, W.L. (Ed.) Man"s Role in Changing the face of the Earth. pp. 862-80, Chicago.

32. UNDP/ICAO (1975): Studies to Determine the Contribution that Civil Aviation can Make to the Development of the National Economies of African States : Kenyan. Nairobi.

33. Van Chi-Bonnardel, R. (1973): The Atlas of Africa. Editions Jeunie Afrique.

34. Van Dongen, I.S. (1954): The British East Africa Transport Complex. University of Chicago, Chicago.

35. Wanyanga, (J.N. (1988): Growth of Civil Aviation in Kenya, (Unpublished), Directorate of Civil Aviation, (DCA), Nairobi.

36. Wheeler, J.O. (1971): "An Overview of Research in Transportation Geography", East Lakes Geographer. Vol. 7, pp. 3-12.

CHAPTER TWO

BACKGROUND TO THE STUDY AREA

2.0 INTRODUCTION

This chapter provides a general physical and human background to the study area. It discusses the characteristics of the study area that are relevant to the growth of air transport in Kenya. The main aspects of the study area examined include its location, size and extent, the physical background, demographic characteristics and the economic structure.

2.1 LOCATION, SIZE AND EXTENT

The sovereign state of Kenya is located on the Eastern part of the continent of Africa. It is the twenty-second largest country in the continent. It shares a common border with Ethiopia in the North, Sudan in the North-West, Somalia in the East, Tanzania in the South and Uganda in the West. It is bordered by the Indian Ocean in the South East (Fig. 2.1). The Indian Ocean serves the country as an important outlet and a means for international maritime contact. The contact is focused on the Kilindini Harbour, Mombasa, which is the country's main gateway to and from the sea. The port also serves as an outlet to and from the sea for Uganda, Rwanda and Burundi which are landlocked. It also serves Eastern Zaire and Southern Sudan.

Fig 2:1 THE LOCATION OF KENYA IN AFRICA.

The Country is located approximately between latitudes 4° 21'N and 4° 28'S and between longitudes 34° and 42°E. It covers an area of 582, 648 square kilometres. Water surfaces cover about 2.3% of the country, leaving about 97.7% of the dry land of which about four-fifth is arid or semi-arid. At the time of carrying out this research, the country was divided into 41 administrative Districts (fig. 2.2). Since then, several new districts have been created by splitting some of the larger districts[1]. An updated administrative map of Kenya is shown in appendix i.

The location of Kenya is of great strategic significance as far as international air transport is concerned. International air transport reflects Nairobi's geographical position as an intermediate point for services between Europe and South Africa and the Indian Ocean Islands of Madagascar, Mauritius and Seychelles. Nairobi airport is an important transit point because of the following two major reasons:

a) Operational constraints : Most airlines have limited possibilities of flying non-stop between Europe and Southern Africa and the Indian Ocean, and therefore have to use an intermediate point for refuelling.

b) The demand for travel between Europe and Nairobi cannot justify the service of Nairobi airport as a "turn-around" point by European carriers using wide-body aircraft at the existing level of frequencies. Most European airlines would prefer to maintain a high level of frequencies and to serve Nairobi together with another point in Africa, to consolidate

Fig 2.2 OLD ADMINISTRATIVE BOUNDARIES OF KENYA

passenger loads, rather than provide "turn-around" flights at low frequencies to and from Nairobi.

2.2 THE PHYSICAL BACKGROUND

2.2.1 TOPOGRAPHY

The physical basis of the country consists of extensive erosional plains, cut across ancient crystalline rocks of pre-cambrian age. These are gently warped, giving an imperceptible rise from the sea level towards the highlands of the interior which have their base at about 1,500 metres. The height of the Kenya Highlands has been greatly augmented by outpourings of Tertiary lavas forming plateaus at altitude of between 2,500-3,000 metres and isolated extinct volcanoes which stand at much higher elevations such as Mt. Kenya (5,200 m) and Mt. Elgon (4,320 m).

The great Rift Valley, which bisects Kenya into almost two equal parts, runs from Lake Turkana in the north to Lake Natron in the South on the Kenya/Tanzania border. The Rift Valley is most spectacular in the highlands. In the latter, the Rift Valley averages about 60 kilometres in width and is bounded by fault-scarps about 600-900 metres high. The floor of the Rift Valley is dotted with lakes and volcanoes which are at present inactive but generally associated with steam jets and hot springs, (Fig. 2.3).

Physical factors affect air transport in two ways:-

a) By their direct effect on air transport, (which is relatively limited).

b) By their indirect effect on the distribution patterns of population and economic activity, (which is substantial).

Although topography no longer seriously affects enroute flying capability, particularly for contemporary aircraft readily able to operate at higher altitudes, nevertheless, it is an important factor[2]. An aircraft starts and finishes its journey on the earth's surface (Sealy, 1966). In terms of direct influence on air transport, the most significant effect of the physical setting is the impact of combined high altitude and high temperature increasing the take-off length requirements for aircraft and/or reducing the pay load. Altitude is very important in the siting of airports and is a very important consideration in the Kenya Highlands. At an altitude greater than 60 m (200 ft) the fall-off in aircraft performance at take-off is great and could mean a reduction in the possible load carried.

Local topography can also be of concern in airfield site selection, including the construction of aircraft operating considerations. Kenya contains vast areas of the type of topography suited to aviation - vast grassy plains. (Tymns, 1929). However, some of the fairly flat lowland areas often result in poor drainage conditions. They get flooded during the wet season. Some of the air strips located in such areas get waterlogged leading to their closures.

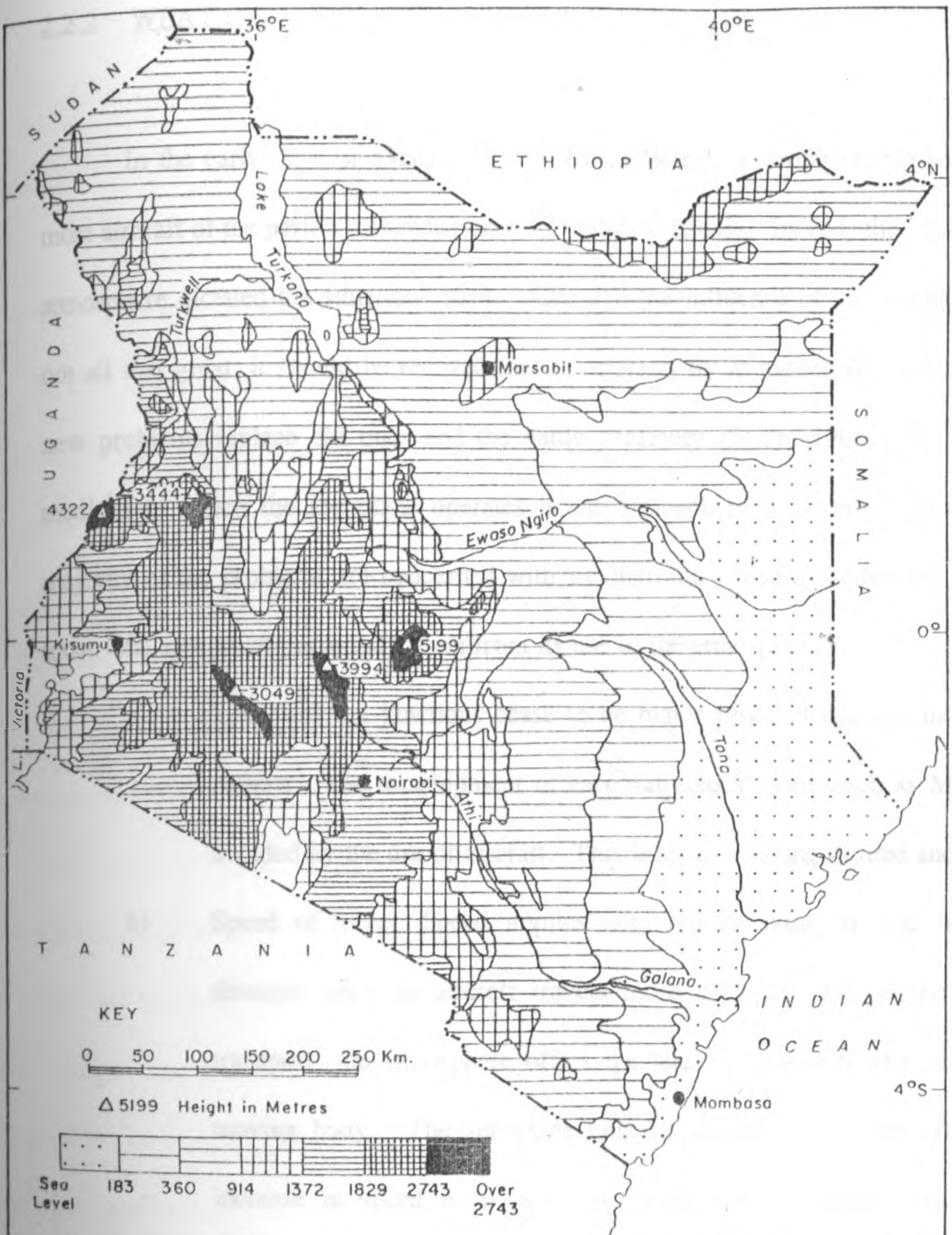


Figure 2-3: Relief of the Study Area.
Source: F.F. Ojany and Ogendo R.B., 1988.

2.2.2 WEATHER

In the early days of aviation before World War I, a strong breeze would make most aircraft of the period somewhat uncomfortable to handle. Indeed, the "moods of the atmosphere dictated the situation" then. Although the influence of the weather today is not all that great, it should be realized that as aircrafts fly at higher altitudes and faster, new problems replace old ones and the battle continues (Sealy, 1966, 30). Since the medium in which the aeroplane operates is the atmosphere it is only natural that the majority of the problems are concerned with weather and climatic conditions. The three most vital aspects of the aircraft stem from its use of the atmosphere:

a) Land and sea junctions cease to be major physical barriers in the traffic pattern. The transhipment of cargo at coastal ports such as Mombasa is avoided by the use of aircraft. This leads to a saving in time and money.

b) Speed of travel: Speed implies not only a saving in time but also in distance since an aircraft travels more directly. Of all the media of transport, the atmosphere offers the least resistance to the passage of a moving body. The aeroplane benefits accordingly. The effect of the increase in speed is to bring all points on the earth's surface closer together in time, a phenomenon known as "time-space convergence".

c) Travel in air needs no road or track. This is a big advantage especially in difficult terrain, where the construction of roads and railways could be an almost prohibitive proposition.

Weather is of far greater significance to aviation than difficulties of terrain. Strictly speaking all the elements of weather are important in the sense that each contributes to the whole weather, but, some elements are more critical to air transport than others. Overall, weather conditions in Kenya are generally conducive to flying rather than detrimental (Hogenauer, 1975). Local weather conditions of limited duration can be of concern, but no long-term difficulties are experienced. As one author observes flying is possible even in adverse weather (Walmsley, 1920). The higher operating altitudes of contemporary aircraft, technological advances in on-board instrumentation and communications, and improved meteorological forecasting techniques now minimize the effects of weather. In East Africa as a whole, it is rare for surface wind to exceed 65 kph (40 mph) for more than a minute or two, although to the North East of Lake Victoria, strong gusts are often associated with thunderstorms. Winds may facilitate a journey or delay it. Wind affects an aircraft's speed in relation to ground and hence, its range and payload. Airport lay out also must take into account the prevailing winds.

Aero-engines are sensitive to temperature change(s) and their efficiency is thus affected. Air density is a determinant of the lifting capacity of a wing. Generally the higher the density, the higher the lift generated by the wing at any given air speed. Thus to maintain lift, the aircraft must fly faster. Similarly, the lower the density the slower the take-off and landing speeds will be. Air density fluctuates according to either temperature or pressure changes. Atmospheric pressure falls with height and density will decrease with altitude. As already pointed out, temperature and altitude are very important in the siting of airfields in highland areas.

LOW STRATUS CLOUDS AND FOG

Fog occurs in Kenya in the form of "low cloud" on the mountains and highland areas. The commonest cause of low visibility is the torrential rain occurring over the country. During rainstorms, the clouds are low and the visibility is such that flying conditions within the storm would be hazardous. An important feature of climate in Kenya, particularly in the highlands, is the occurrence of two or three cloudy months following the Long Rains in March-May. During the latter part of May, June, July and part of August, while very little rain falls, an overcast sky is a common feature and may be experienced for days on end. The cloud is of the "strato-cumulus" or "cumulus" type with other clouds in the higher strata. Generally speaking, this cloud is too high to interfere with normal flying, but both during the rainy season and the consequent cloudy season, the cloud type(s) will frequently be found resting on the higher ridges of the plateaus on both sides of the Rift Valley during early hours of the morning. The air-route from Kisumu to Nairobi, therefore, may be impassable at Mau Summit and Kijabe until about 9 o'clock during some months. The Kijabe escarpment could be passable at a more southerly point than the normal direct route, which is due west of Nairobi.

Low stratus clouds and fog are the main causes of poor visibility at Nairobi airport and constitute the most serious meteorological hazards to aircraft taking off or landing in the early morning hours or at night (Fig. 2.4). The clouds form very rapidly and, in a matter of a few minutes, the sky may change from almost clear to a complete cover of stratus (Mwebesa, 1979). This may render any forecast which was made prior to such a rapid change quite unrepresentative. The period of greatest frequency of low stratus clouds is during the Long Rains (March-May) and the short rains (October-December). The frequency of low stratus clouds at Nairobi Airport is shown in table 2.1. The summary of flying conditions in cloud is provided in table 2.2.

Table 2.1 : Percentage Frequency of Low Stratus Clouds and Poor Visibility at Nairobi Airport (Jomo Kenyatta International Airport([a])

Month	Time (GMT)							
	0000	0300	0600	0900	1200	1500	1800	2100
Jan.	7	13	4	-	-	-	-	-
Feb.	4	12	6	-	-	-	-	-
March	2	14	6	-	-	-	-	1
April	17	34	2	-	-	-	-	7
May	17	20	7	-	1	-	-	10
June	4	4	4	1	-	1	-	1
July	7	6	14	1	-	1	1	3
Aug.	3	3	2	-	1	-	-	-
Sept.	7	10	3	-	-	1	-	-
Oct.	6	26	2	-	-	-	-	2
Nov.	16	40	2	1	1	-	-	3
Dec	27	47	11	1	-	-	1	9

a : The occasions shown in the table are for when visibility is equal to or below 1500 metres and/or cloud base is 150m (500 ft) or below.

Source: Mwebesa, M.M.N. (1979) : East African Weather for Aviators. Table 15, pp. 113.

THUNDERSTORMS

Thunderstorm can be defined as precipitation accompanied by thunder and lightning (Mwebesa, 1979). A thunderstorm falls only from cumulonimbus clouds. Such clouds result from warm, moist and unstable air. Under these circumstances the air rises very high and cloud forms with its top reaching as high up as the tropopause. Three stages are involved in the growth of a thundercloud.

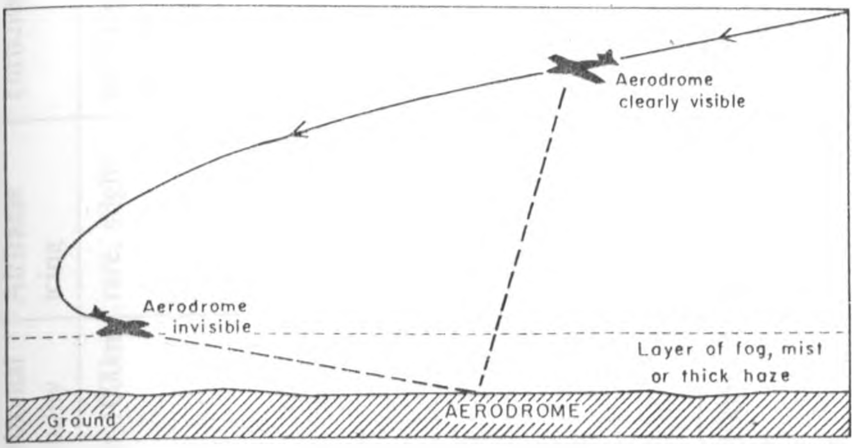


Figure 2:4a Obscuring of an aerodrome by surface fog as an aircraft descends to land.

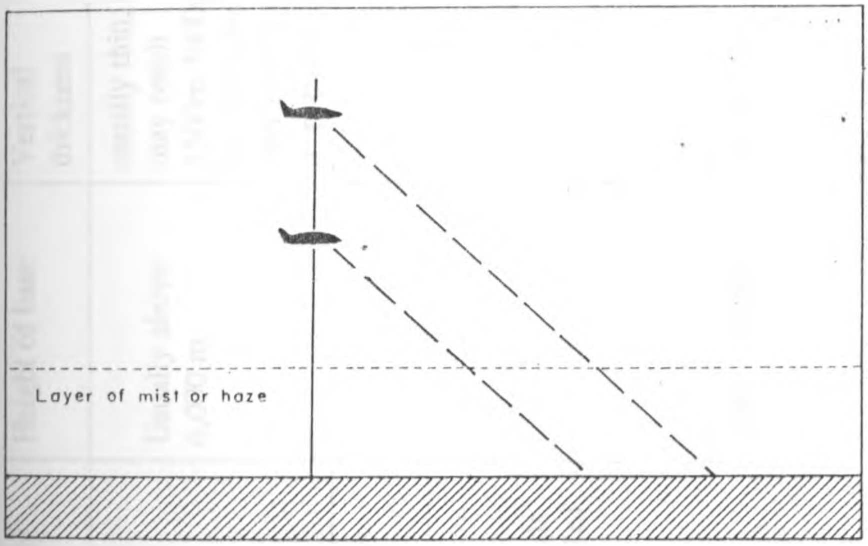


Figure 2:4b Horizontal range of visibility from an aircraft flying above a haze layer on the ground.

Source: Meteorological office, (1971), pp 128

__Table 2.2 : Summary of flying conditions in cloud__

Cloud type	Constitution	Continuity	Height of base	Vertical thickness	Horizontal visibility	Airframe icing	Turbulence	Remarks
Cirrus (Ci)	ice crystals; rarely mixed*	detached	Usually above 6,000 m	usually thin, but may reach 1500m-3000m in low latitudes; may extend to tropopause	over 1000m	rare, slight	nil, slight except when merging into Cb	may merge into Cs or Cb
Cirrostratus (Cs)		continuous						may merge into As
Cirrocumulus (Cc)	ice crystals, or water drops, or mixed*	layer clouds composed of detached globular masses						may merge into Cs
Altocumulus (Ac)	usually water drops to -10°C, mixed* at lower		1980 - 6000m	usually thin	20-100m	rime, slight to moderate		

Cloud type	Constitution	Continuity	Height of base	Vertical thickness	Horizontal visibility	Airframe icing	Turbulence	Remarks
	temperatures							
Altostratus (As)	usually ice crystals, occasionally mixed*	continuous often 8 oktas cover	1980-6000m but occasionally less than 1980	up to 4,500m				often merges below into Ns
Nimbostratus (Ns)	water drops	continuous	surface to 2400m	merges into As	10-20m	rime or moderate clear ice; possibly rain ice below cloud	severe near base, moderate elsewhere	envelopes hills
Cumulus (Cu)	water drops	isolated, but may cover 6 oktas	usually 450-1500m	up to about 4,500m	generally less than 20m, and at times less than 10m	rime or clear ice, possibly heavy; no safe lower limit to temperature	severe	large Cu may develop into Cb
Cumulo-nimbus (Cb)	mainly water drops to -15°C, mixed* at lower temperatures	usually isolated clouds 4.8-16km diameter; occasionally form a	usually 450-1500m but may be down to surface over water	4000-9000m or more, especially in low latitudes may reach tropopause			severe or very severe within 16km horizontally and 1500-3000m	risk of lighting severe `static' and hail

Cloud type	*Constitution*	Continuity	Height of base	Vertical thickness	Horizontal visibility	Airframe icing	Turbulence	Remarks
		continuous line					vertically	
Strato-cumulus (Sc)	mainly water drops	layer of globular masses or rolls, often continuous	usually 450-1200m	150-900m	10-30m	rime, moderate	moderate	sometimes penetrated by large Cu or Cb
Stratus (St)	water drops	continuous	surface to 600m	60-300m		rime, slight to moderate	nil or slight	envelops low hills

* - containing both water drops and ice particles.

Source: Meteorological office, 1971, Table 7, pp 157.

These are:

a) The cumulus or growing stage

b) The mature stage

c) The Dissipating or Decaying stage.

The initial cumulus cloud is built up by the ascent of successive bubbles of warm air rising either directly from the heated ground, especially from slopes of favourable aspect, or more usually, from the temperature of a layer in convective equilibrium, developed and deepened by surface turbulence. The cloud is usually 1-2°C warmer than its surrounding. Updraughts develop which range between 1.5-3.0 m/s in the lower part of the cloud to 5-8 m/s at the top of the cloud. By this time, the cloud is about 8 km across and about 7 km deep. The transition from the first stage to the mature stage is marked by the first few drops of precipitation. The mixture of super-cooled droplets and ice crystals in the central portion of the cloud produces rain drops. This sets of an active downdraught within and below the cloud, partly as a result of the frictional drag as it attains its terminal velocity and partly because it chills the surrounding air directly as a consequence of evaporation. Downdraughts reach a velocity of 4-8 m/s towards cloud base. Within the cloud especially in its lower layers, horizontal contrasts of temperature may reach 4-5°C so that updraught is accelerated, and in extreme cases, it may reach 30 m/s (110 km/h).

The dissipating or decaying stage is the last stage in the development of a thunderstorm and by this time, the thundercloud has grown to its maximum height and the top might have reached the tropopause at about 16 km depth in the equatorial regions (Fig 2.5). Its width may be about 14 km. The anvil can be observed at this stage and the top of the cloud will now have a clearly cirriform appearance, because it is composed of ice crystals. The heavy shower, which was experienced in stage two dies down and gives way to only light rain. Eventually all the liquid water drops are depleted and the whole of the lower part of the cloud dissipates, leaving only the ice crystal cloud above.

Thunderstorms occur regularly and widely all over Kenya, with the greatest occurrences near and around water surfaces (Fig. 2.6a-m). By international agreement, a thunderstorm day is defined as the local calender day on which thunder is heard (Chaggar, 1977). A thunderstorm day is recorded as such regardless of the actual number of thunderstorms occurring on that day. The greatest frequencies are found around the inland lakes, particularly over and around Lake Victoria.

Isobronts have been drawn at intervals of 3 days on the monthly maps whereas 30 day intervals have been used for the annual map (Fig. 2.6a-m). Frequencies of 15 or more thunderstorm days per month are regarded as high and are shaded. In January, the maximum frequency is in the Lake Victoria region, with districts such as Kisumu, Kisii, Siaya, Busia and parts of Bungoma, Kakamega and Kericho having an average of 9-12 thunderstorm days per month. The remainder of the country experiences few or no thunderstorm days per month in January (Fig. 2.6a). In February, there is little change in the pattern observed in January.

In March, the maximum frequency is concentrated in the Lake Victoria Basin as shown in Fig. 2.6c. Kisumu, Kisii, Kericho, Busia and most parts of Kakamega and Bungoma districts have 15 or more thunderstorms days per month during the month of March. The active belt extends farther east, with Trans Nzoia, Uasin Gishu, Narok and Kajiado having at least 9 thunderstorm days per month. Other parts of the country such as Nairobi, Machakos, Kitui, Embu, Meru and Tana River districts are less active.

In April, there is a slight decrease in the geographical extent of thunderstorm days. The maximum is still concentrated in the Lake Victoria Basin (Fig.2.6d). Kisumu, Kisii, Kericho, Siaya, Busia, Bungoma and Trans Nzoia districts have atleast 15 thunderstorm days per month. In May, Kisumu district records over 3 weeks (21 days) of thunder. Other districts within the Lake Basin such as Kisii, South Nyanza, Siaya, Busia and Kericho record more than 2 weeks (14 days) of thunder (Fig.2.6f). In June, the maximum frequency is concentrated in the Lake Basin. There is a notable decrease in thundery days over much of the country. About a half of Kenya, especially the eastern part shows almost a total lack of thunderstorms. In July, there is little change compared with the frequency distribution in June (Fig.2.6g).

In August, there is a slight increase in the frequency of thunderstorm days, especially, in the Lake Basin and the neighbouring highland areas of Nandi, Uasin Gishu, Bungoma and Trans Nzoia districts record more than 3 weeks of thunder (Fig.2.6h). In September, a large part of the country records atleast over 2 weeks of thunder (Fig.2.6i). The rest of the country is less active. In October, the maximum is still over western Kenya, especially in Busia, Siaya and Kisumu district which have more than 3 weeks of thunder.

A marked increase in the frequency of thunderstorm days is noticeable in November (Fig.2.6k). Although maximum frequency is still over western Kenya, the geographical distribution of thunderstorm days is more widespread. In December, most parts of the country including the Lake Basin are less active. During this period, parts of the coast such as Kwale and Kilifi districts record atleast 3 days of thunderstorm (Fig.2.6l). The mean annual conditions of thunderstorm days throughout the year are shown in Fig.2.6m.

The monthly frequency distribution patterns observed above (Fig.2.6a-l) result mainly from the association of thunderstorms with high ground and lake convergence zones. The high ground acts as a high level heat source forming early and deep convection and at the same time, by virtue of anabatic winds, it is favourable for low level convergence thereby enhancing convective development (Chaggar, 1977: 5).

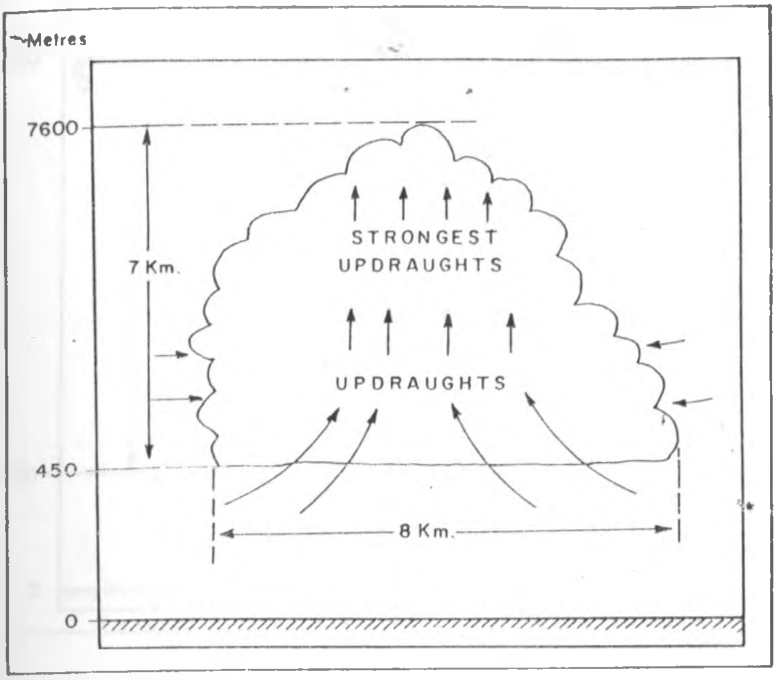


Figure 2·5a Cumulus Stage
Source: Mwebesa, M.M.N., (1979), pp 44.

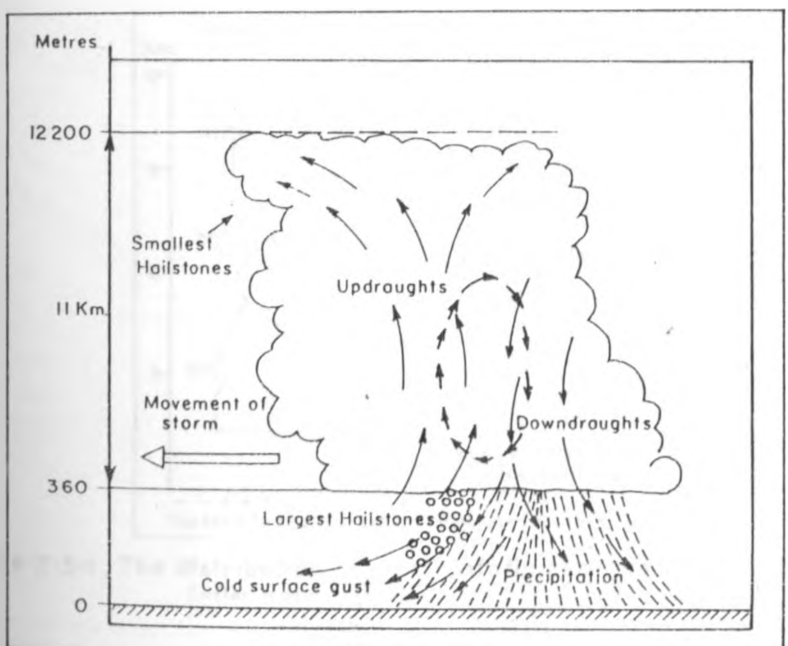


Figure 2·5b Mature Stage
Source: Mwebeso, M.M.N., (1979) pp 45.

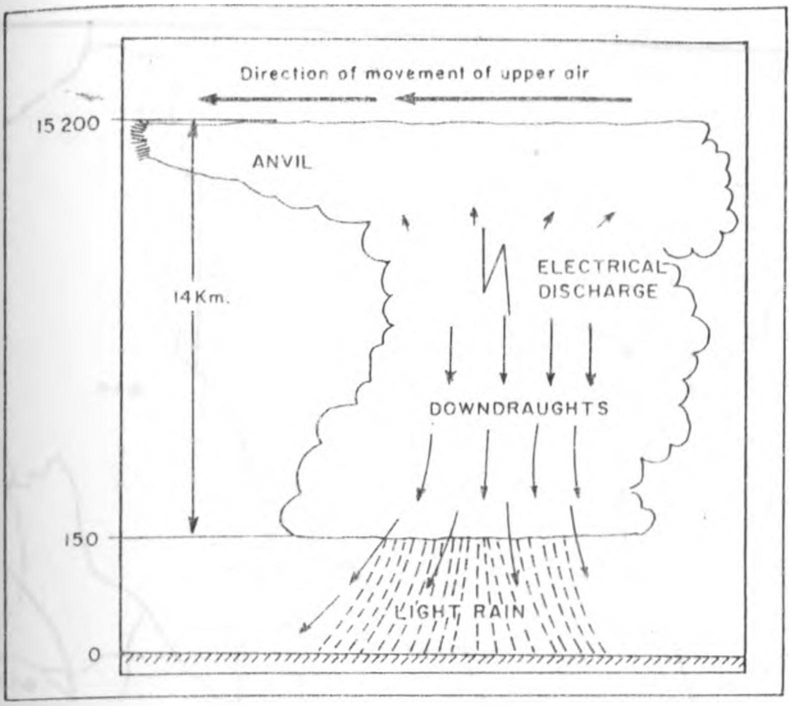


Figure 2.5c Dissipating Stage
Source: Mwebeso, M.M.N., (1979), pp 46

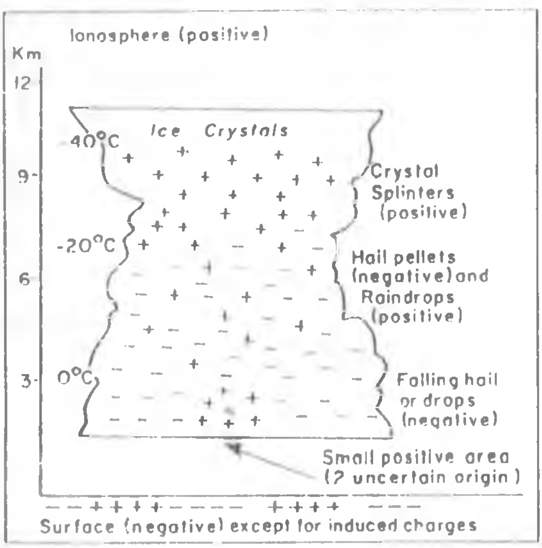


Figure 2·5d The distribution of electrostatic charges in a thunder cloud (After Mason, 1962).

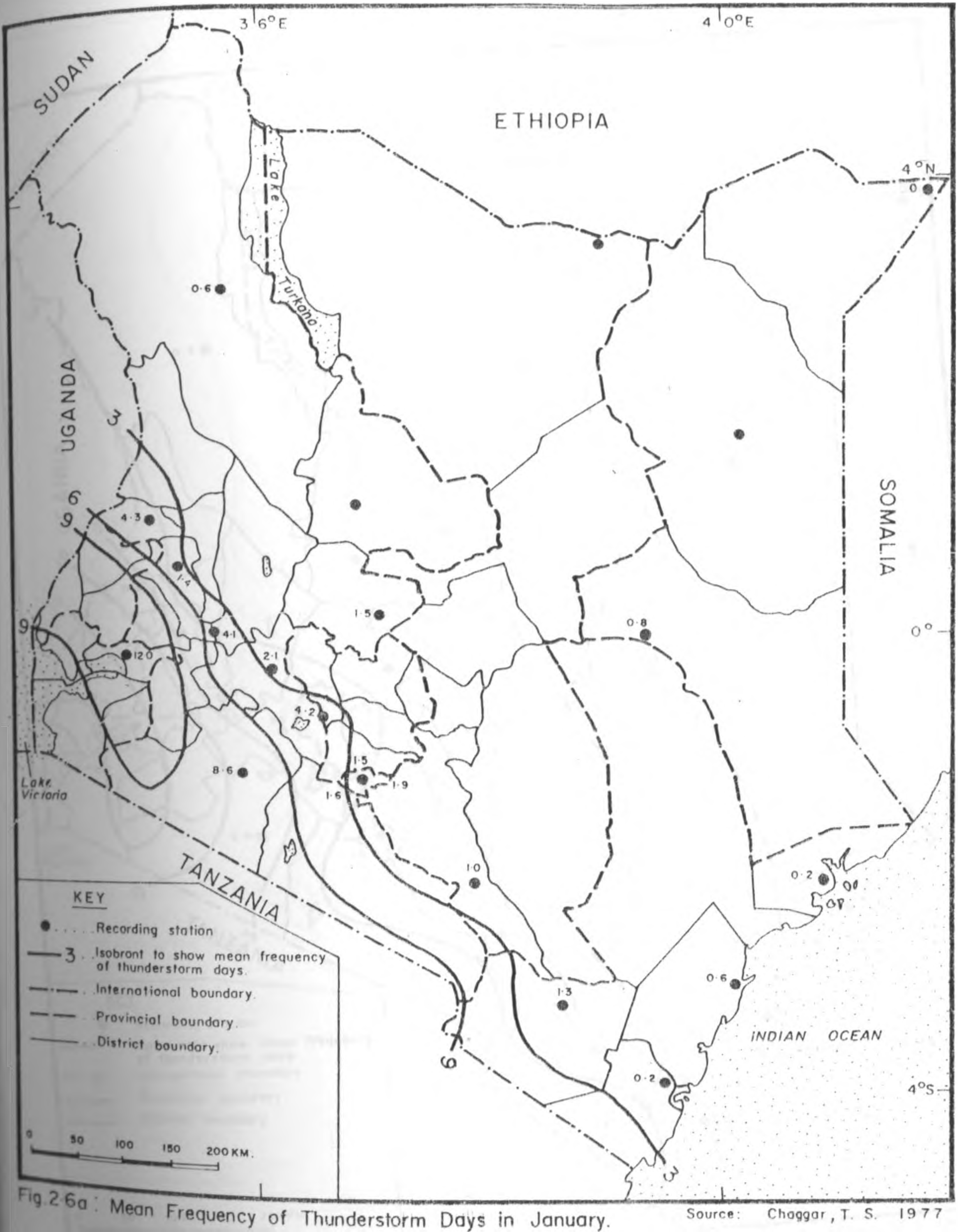


Fig.2.6a: Mean Frequency of Thunderstorm Days in January. Source: Chaggar, T. S. 1977

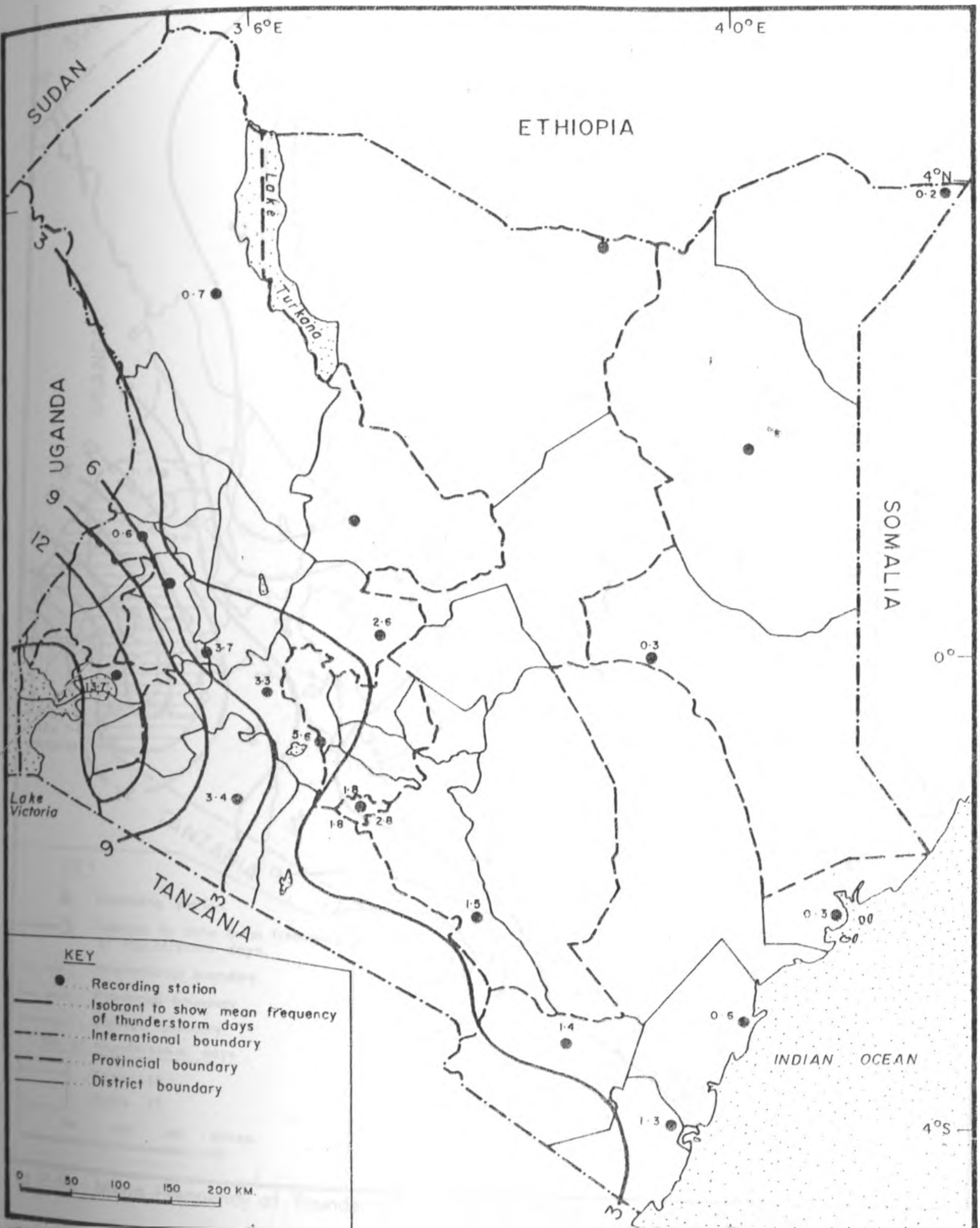


Fig 2 6b: Mean Frequency of Thunderstorm Days in February

Source Chaggar, T S 1977

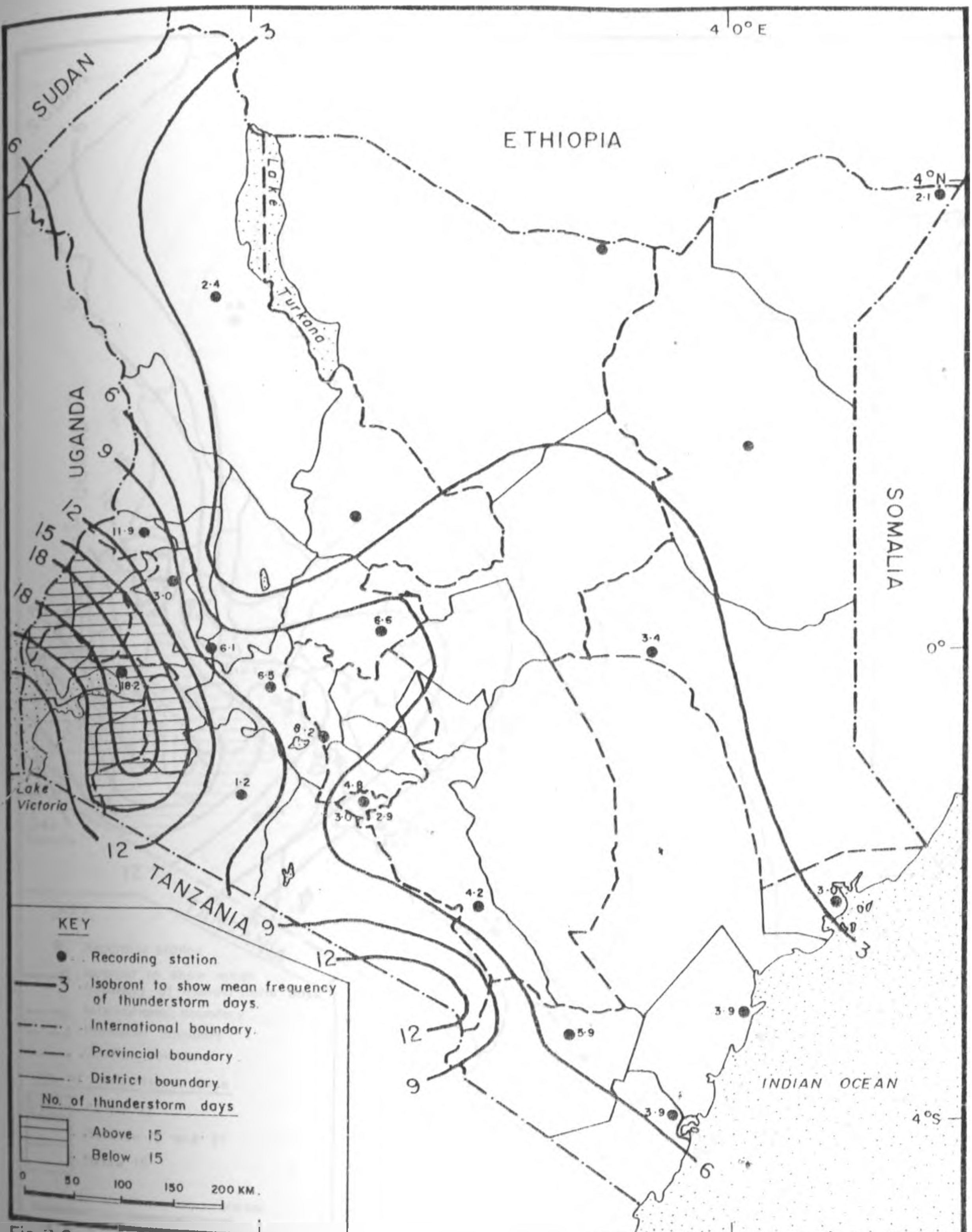


Fig 2.6c Mean Frequency of Thunderstorm Days in March

Source Chaggar, T. S. 1977

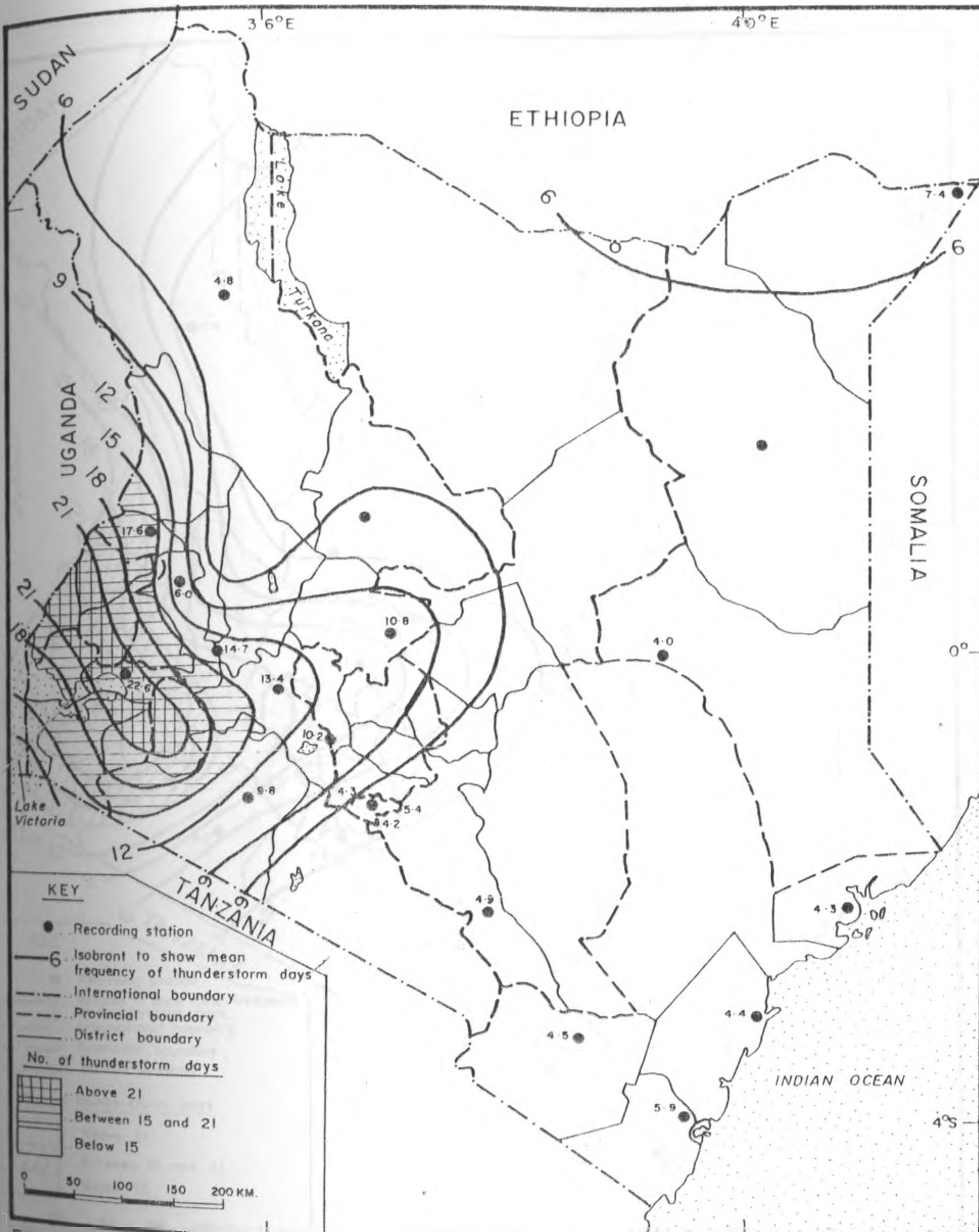


Fig 2 6d . Mean Frequency of Thunderstorm Days in April   Source Chaggar, T. S. 1977

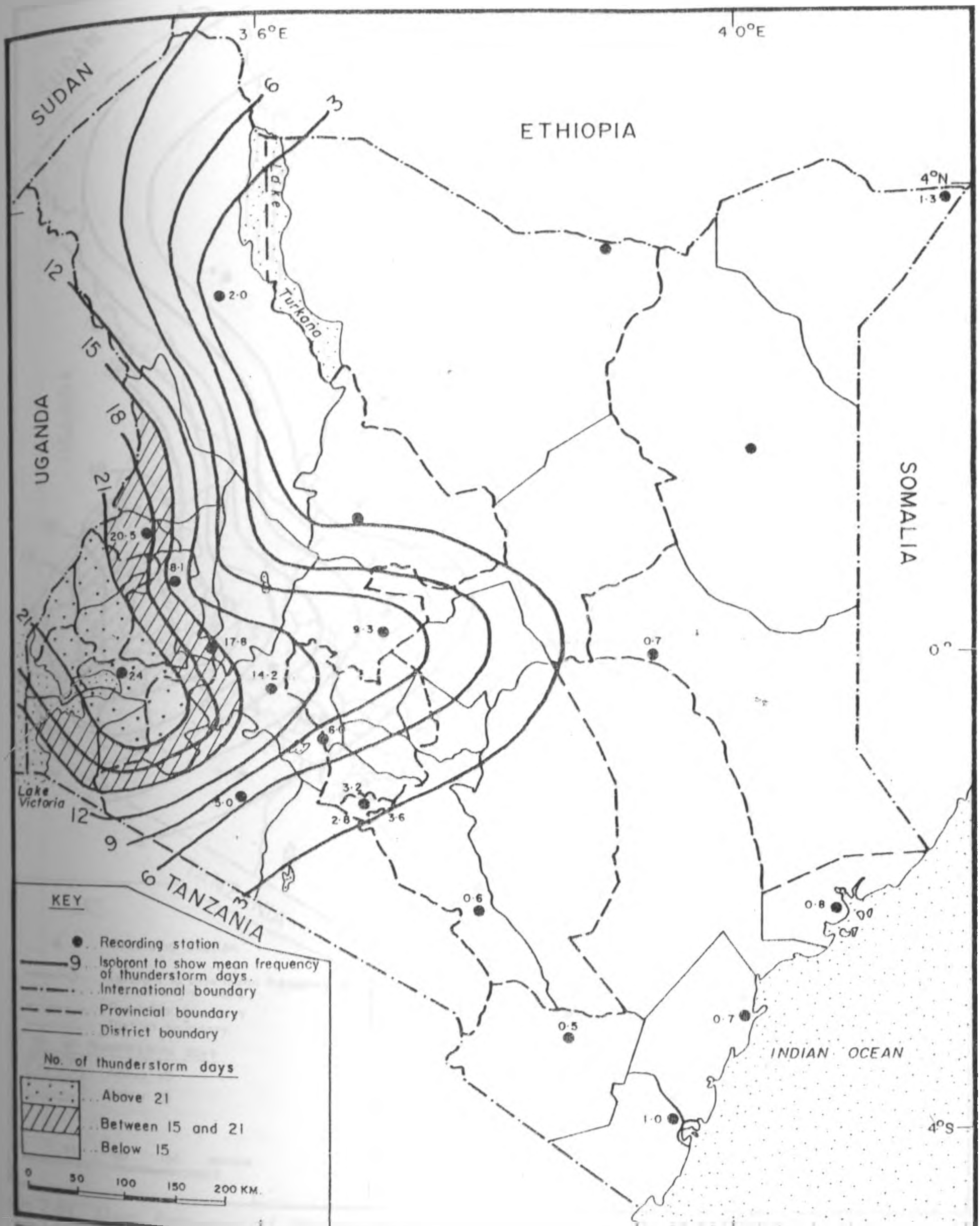


Fig.2.6e Mean Frequency of Thunderstorm Days in May. Source: Choggar, T S. 1977

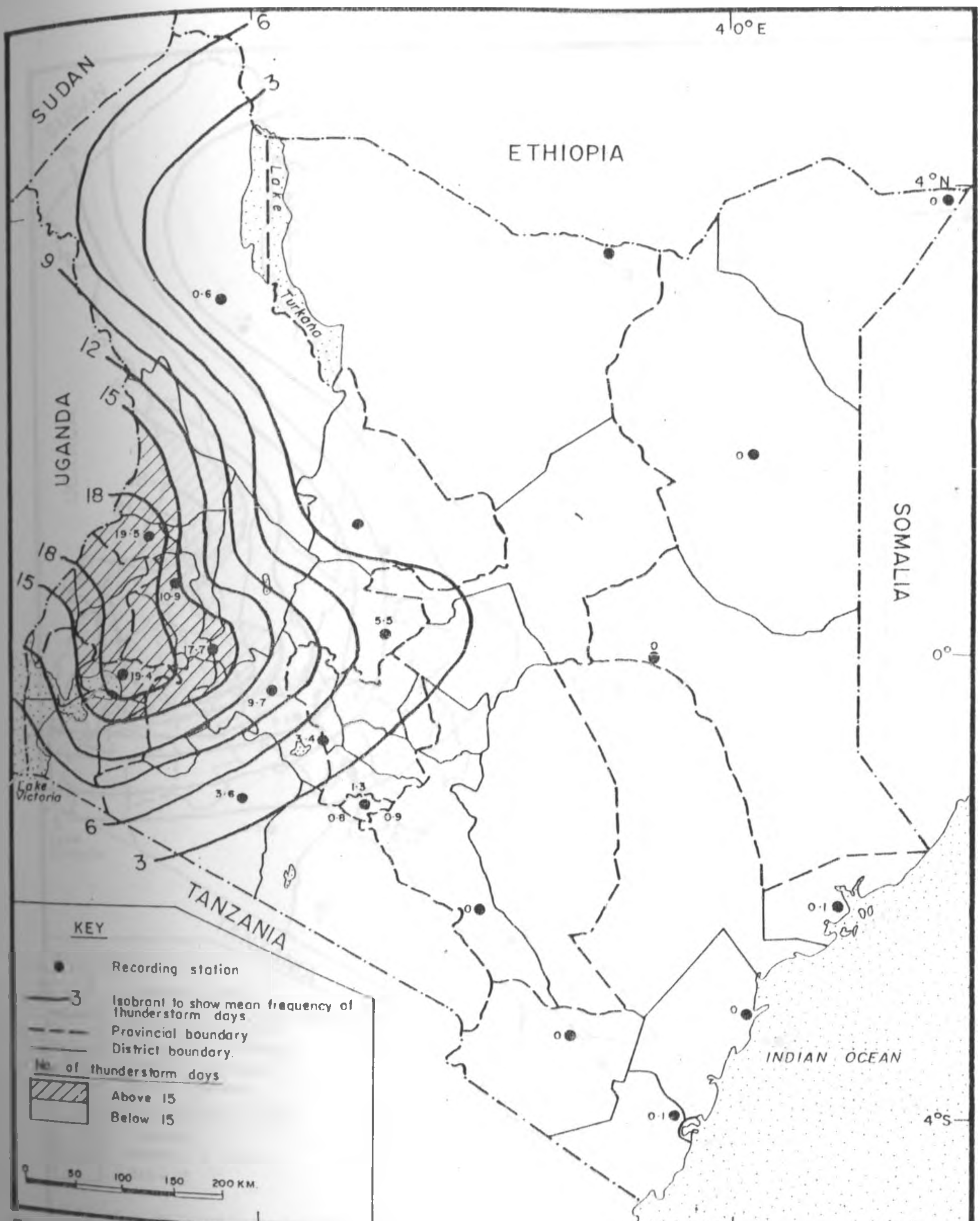


Fig 26f Mean Frequency of Thunderstorm Days in June

Source: Chaggar, T. S 1977

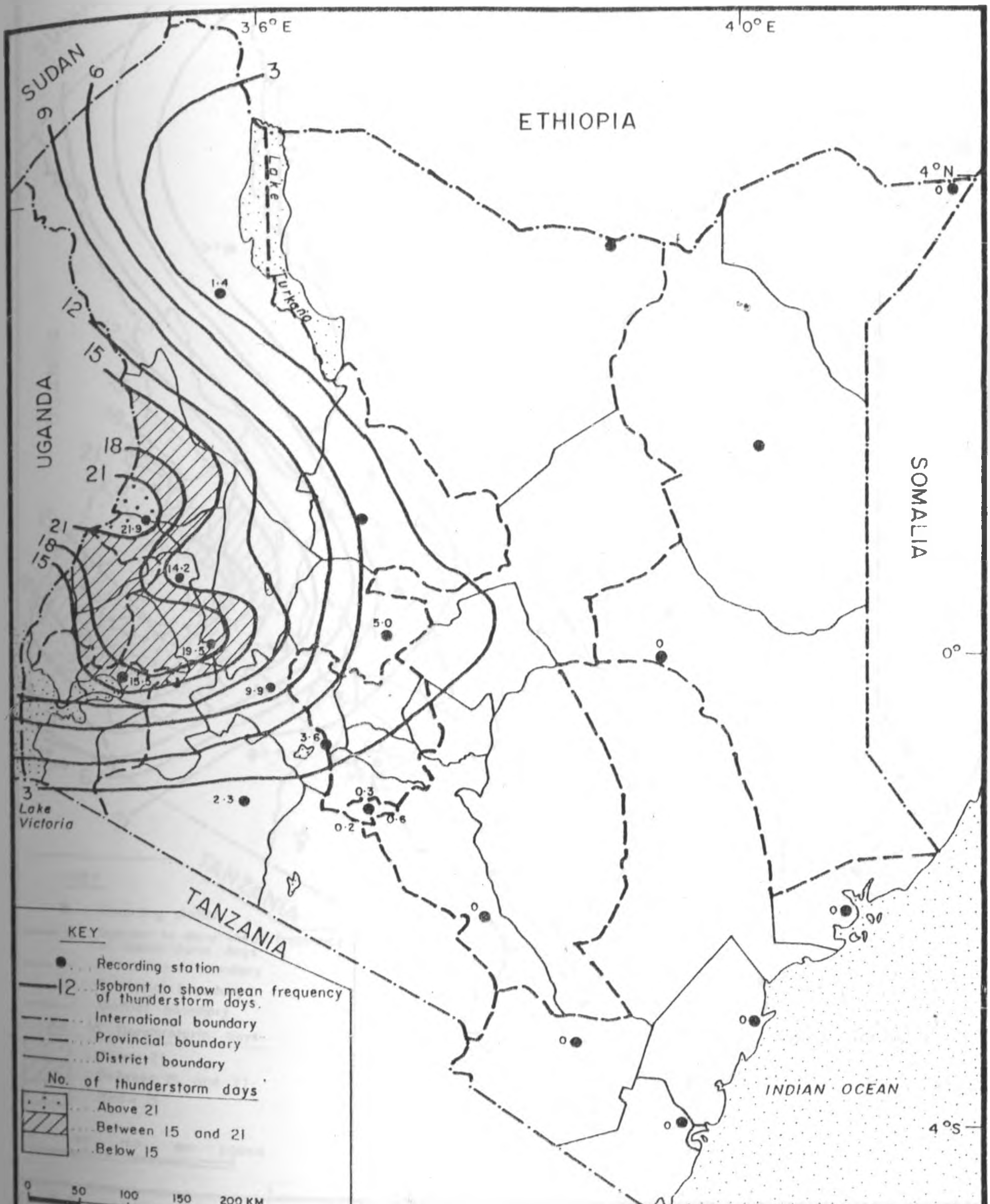


Fig 2 6g Mean Frequency of Thunderstorm Days in July   Source Chaggar, T. S. 1977

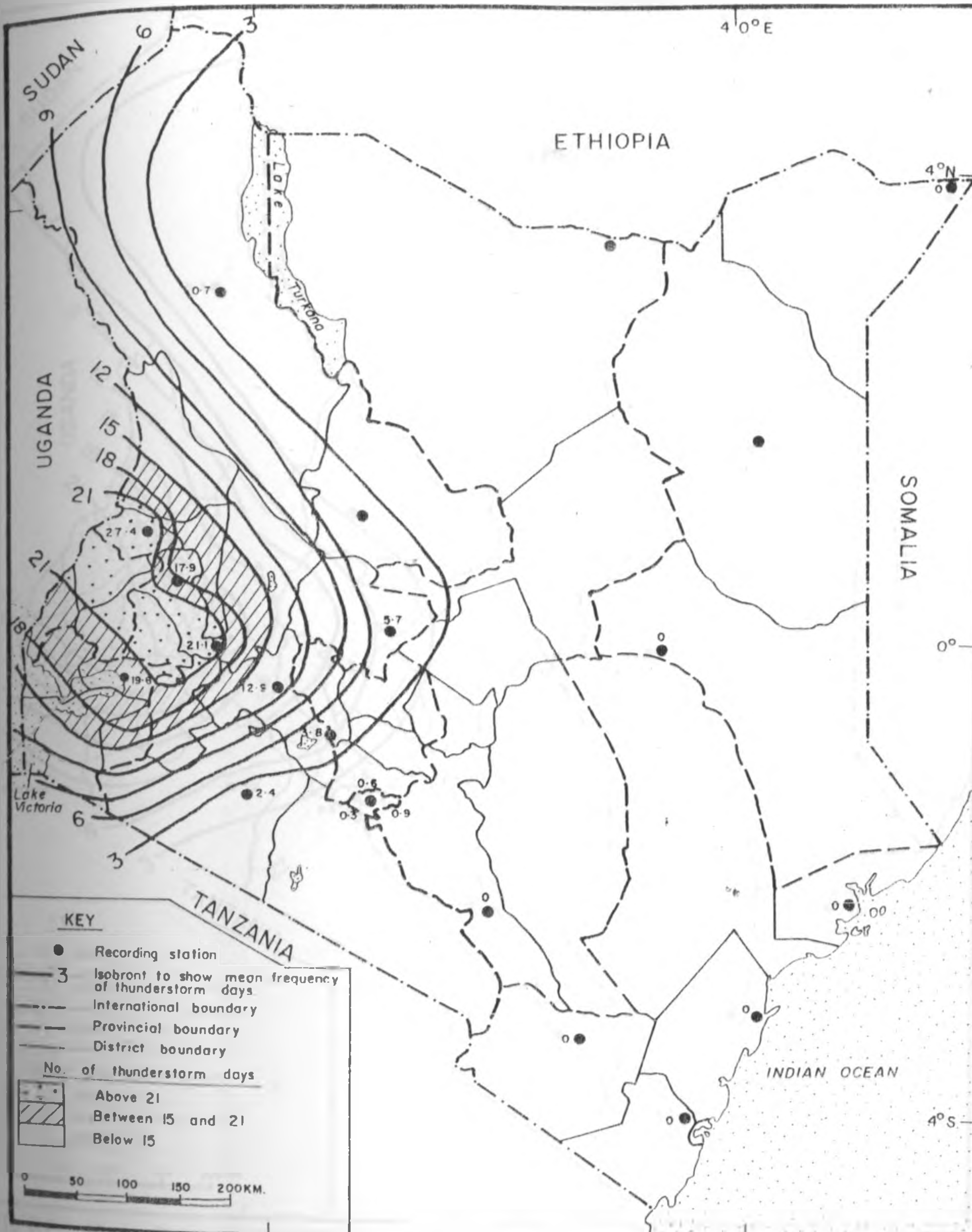


Fig.2·6h : Mean Frequency of Thunderstorm Days in August. Source : Chaggar, T. S 1977

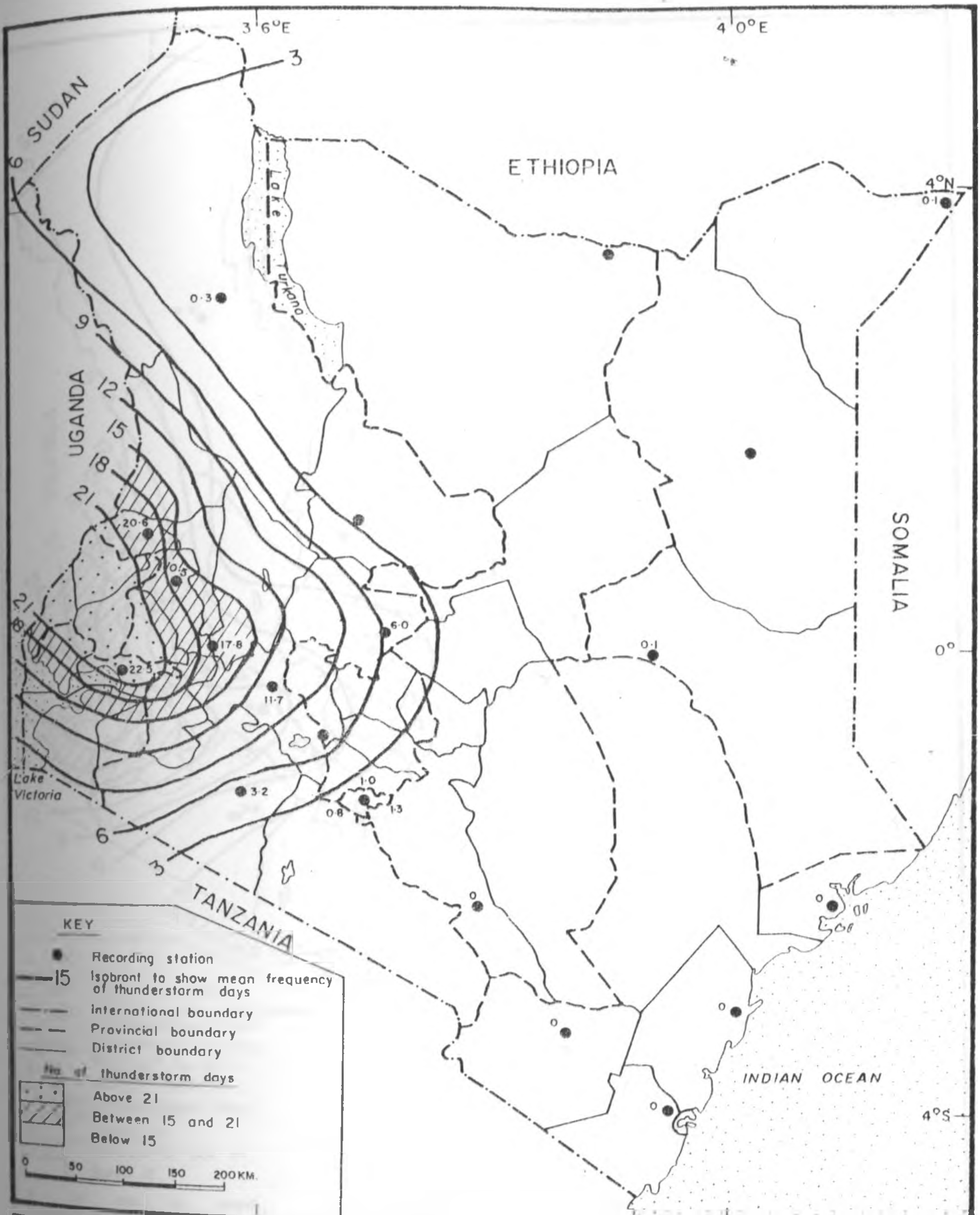


Fig 2·6i : Mean Frequency of Thunderstorm Days in September

Source Chaggar, T S 1977

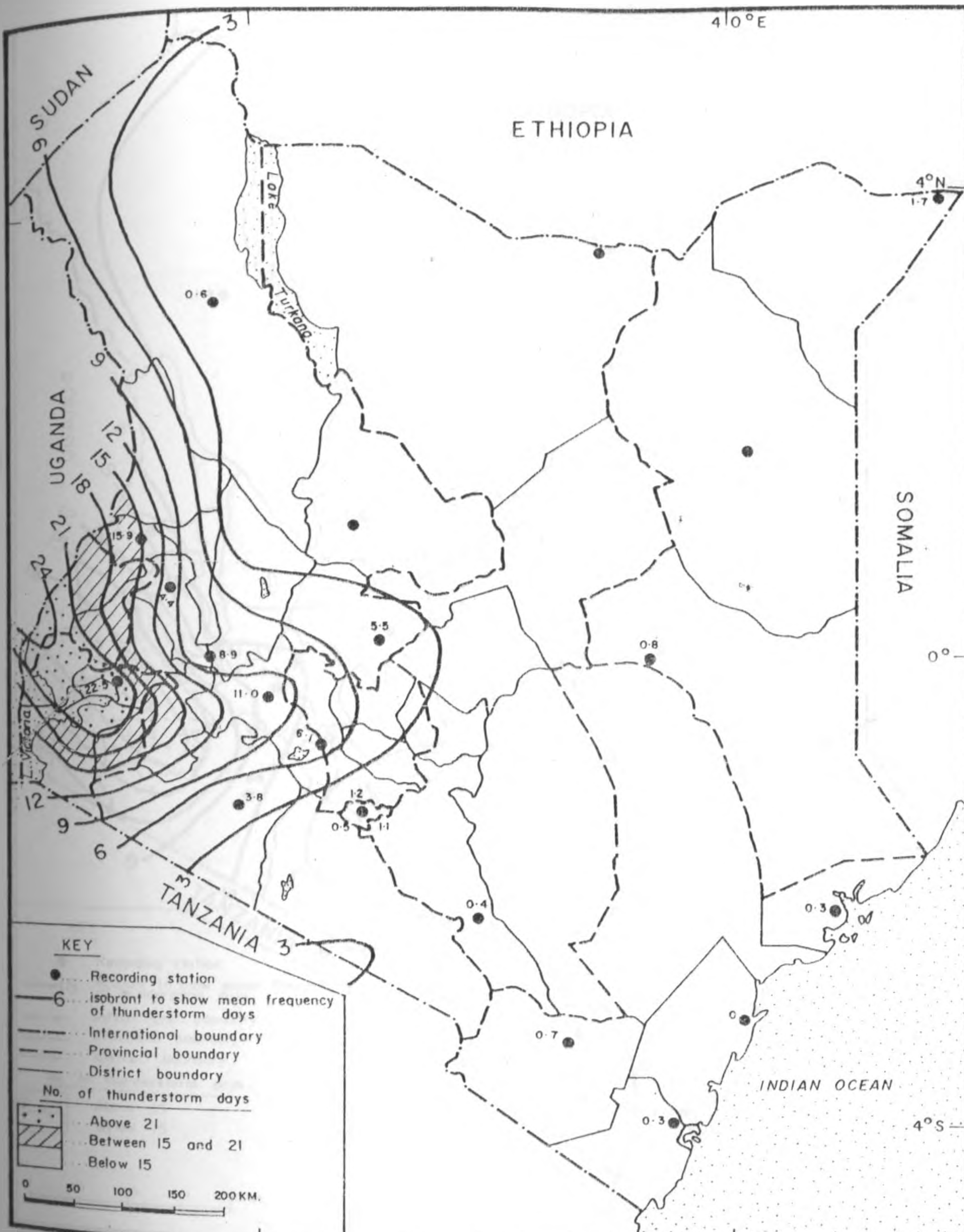


Fig 2.6j Mean Frequency of Thunderstorm Days in October

Source Chaggar, T S 1977

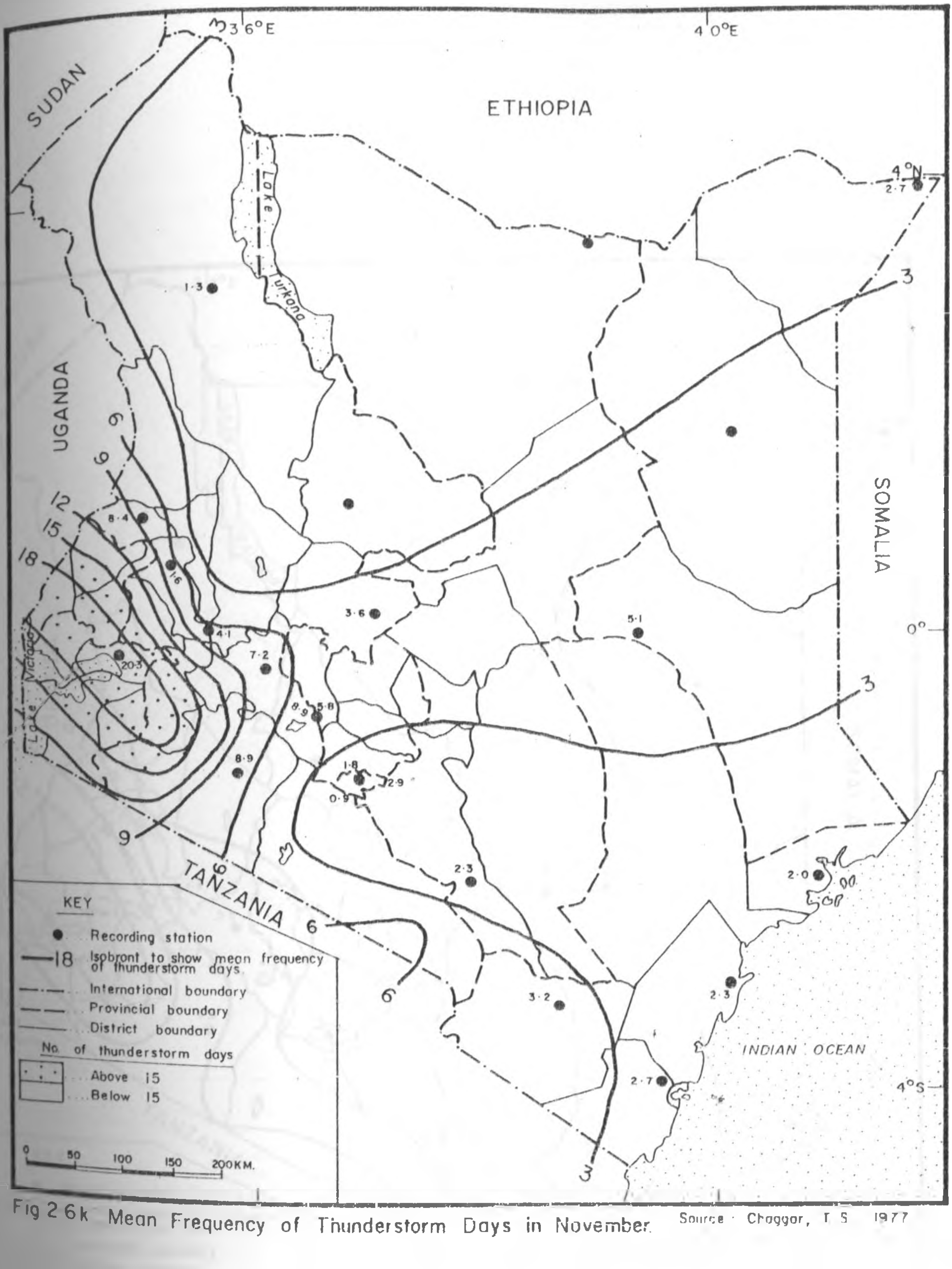


Fig 2.6k Mean Frequency of Thunderstorm Days in November. Source: Choggor, T. S. 1977

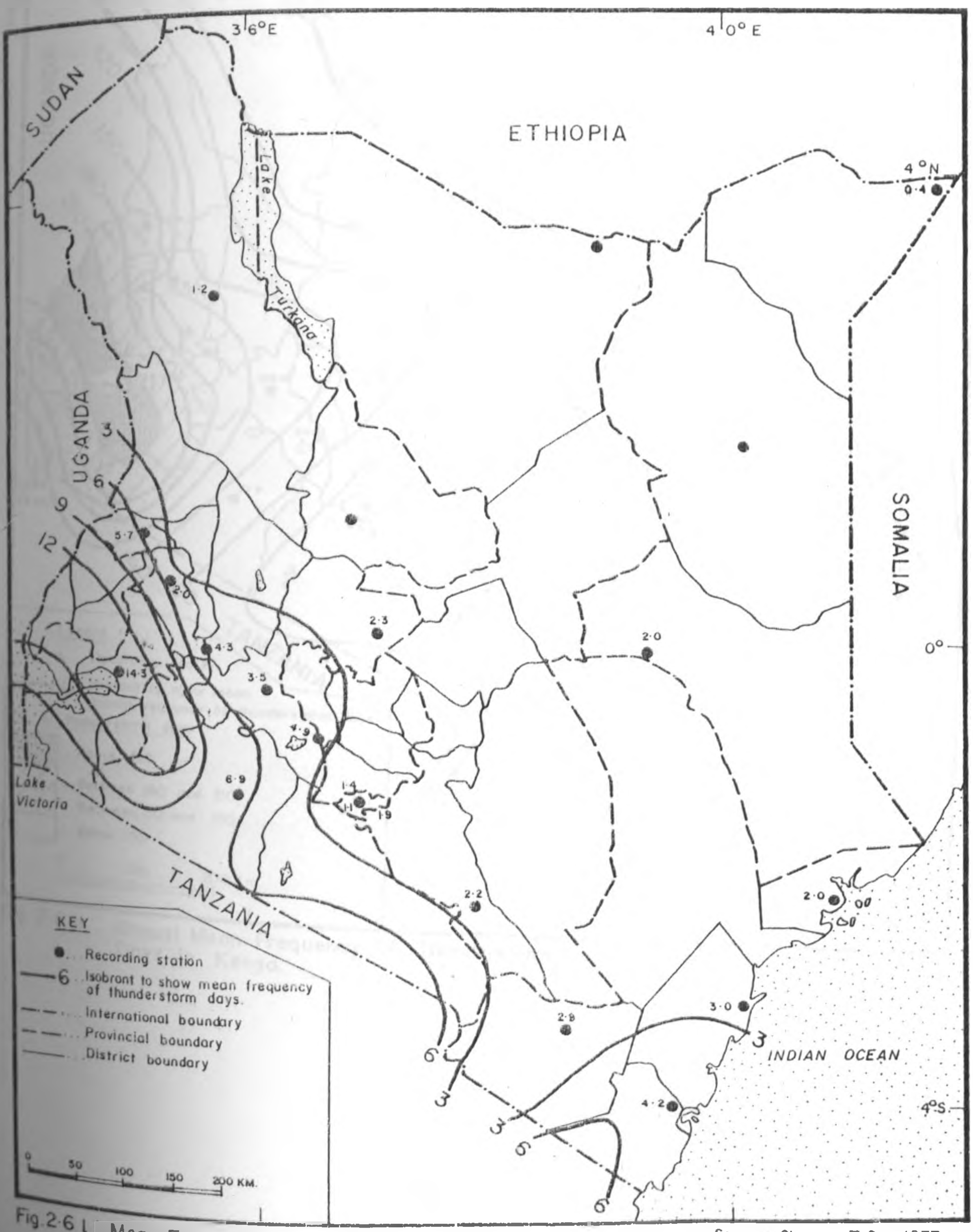


Fig.2·6 L. Mean Frequency of Thunderstorm Days in December. Source Cheggar, T.S 1977.

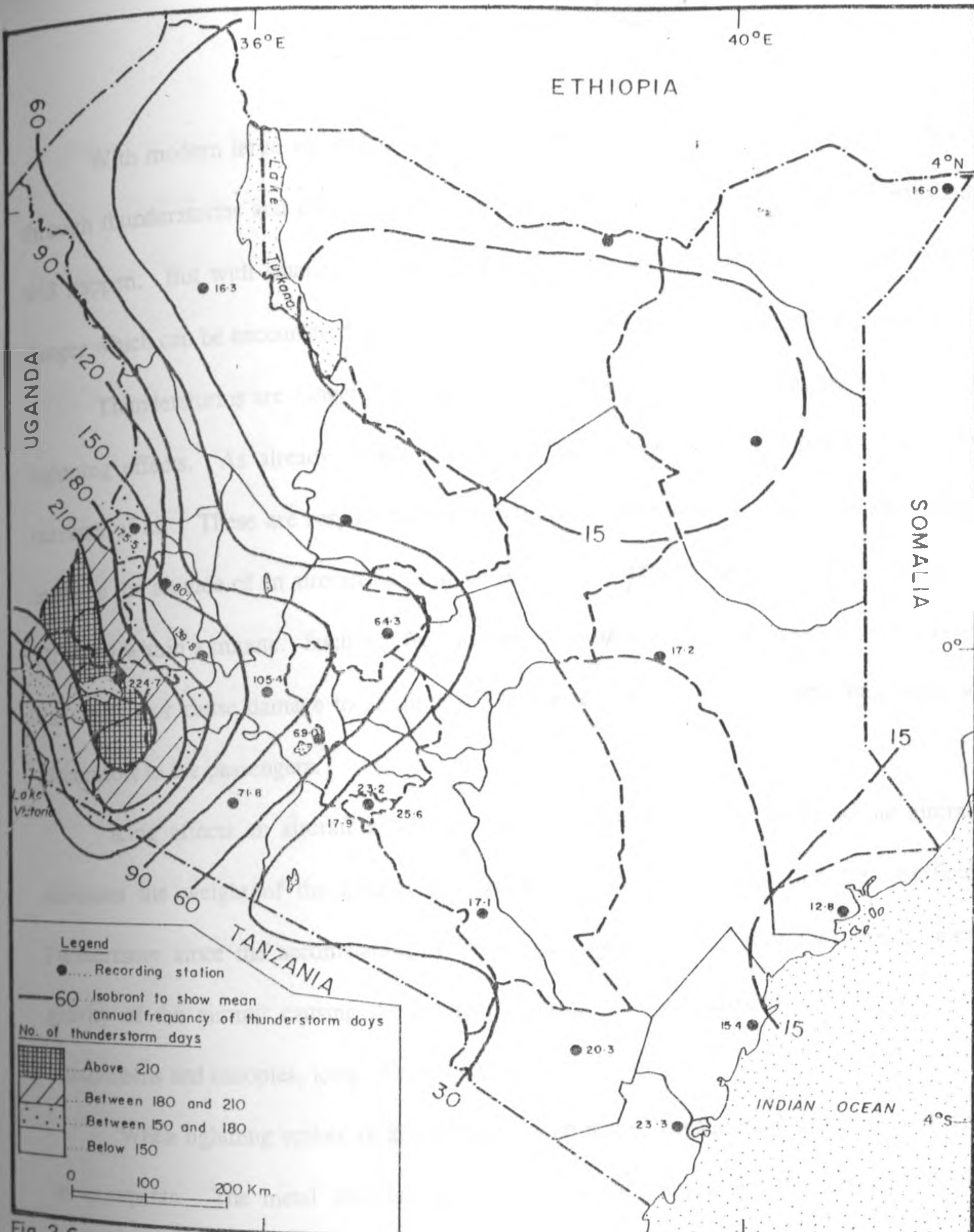


Fig. 2·6m Annual Mean Frequency of Thunderstorm Days in Kenya

Source Chaggar, T. S 1977

With modern large air craft it is no longer absolutely necessary to avoid going near or through thunderstorms and this can be done with almost complete certainty that no real danger will happen. But with smaller air craft such as the ones used by the local air operators, the danger which can be encountered in or near a thunderstorm can not be overemphasized.

Thunderstorms are dangerous to air transport in three main ways of turbulence, icing and lightning effects. As already stated in a thunder cloud there are very strong up and down currents of air. These are responsible for turbulence. Large-scale up and down currents may increase the altitude of an aircraft by as much as 1500 m (5000 ft) and reduce it by about 450 m (1500 ft) within a minute. Such an effect in extreme cases may cause the pilot to lose control of the aircraft or cause damage to an aircraft. In less severe cases, turbulence may cause some discomfort to the passengers.

Icing affects an aircraft in several ways[3]. When ice adhere to the whole aircraft, it increases the weight of the aircraft and the lift to maintain balance may be insufficient. Furthermore since the accumulation of ice is not uniform it may shift the normal centre of gravity of the aircraft causing the external controls to be unbalanced. By forming on the windscreens and canopies, icing affects visibility.

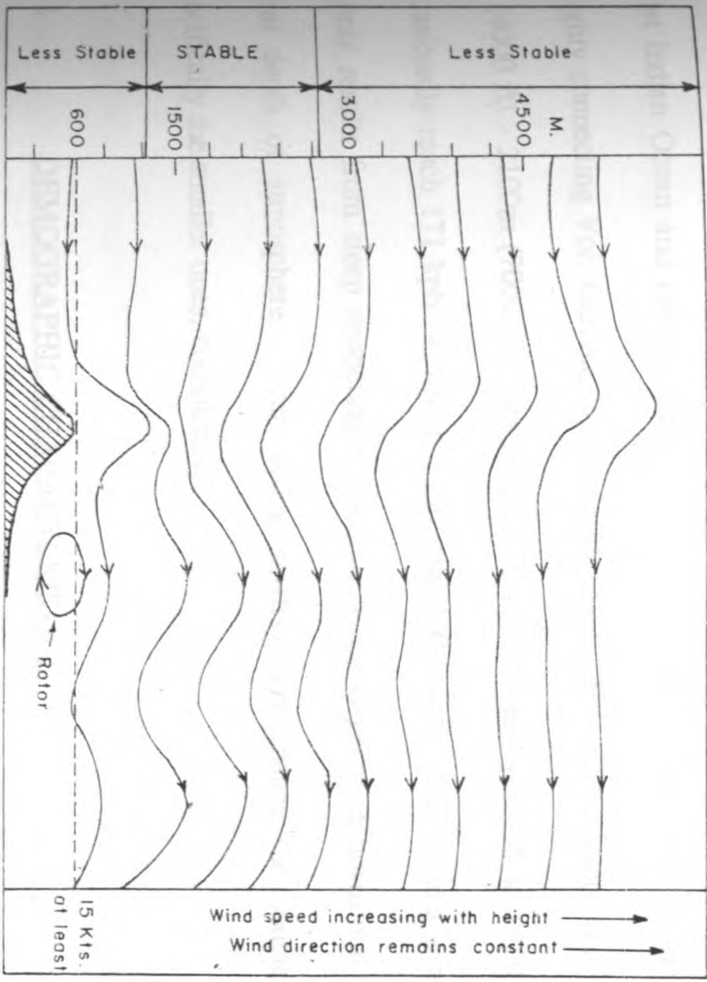
When lightning strikes an aircraft there is no major damage done to the aircraft itself or its occupants. The metal structure of modern aircraft ensures that the aircraft will not be seriously affected and the bonding requirements ensure that no electrical discharge can penetrate the interior to harm the occupants. All modern aircrafts are mounted with lightning arresters to minimise damage on them. However, lightning strikes if severe may interfere with the aircraft's communications equipment.

MOUNTAIN WAVES

Mountain waves can occur near any mountain in Kenya if the conditions are favourable. When an airstream meets a ridge of high ground at right angles and blows over it, the atmosphere is sort of bodily pushed upwards and the effect of this displacement can be transmitted to far greater heights than the high ground itself, often as high up as the tropopause. After passing over the top of the high ground the air follows a wavy path composed of "standing waves" (Fig.2.7). The waves continue to exist a long way downward, in some cases as far as 200 to 300 km away from the mountain. These lee waves may contain powerful updraughts and downdraughts with vertical speeds of 38 kph (20 knots) to 95 kph (50 knots). Such waves can be very dangerous to aircraft especially if encountered by pilots unexpectedly. Two possible dangers to aircraft flying in lee waves are due to turbulence and downdraughts. Turbulence can be very severe especially in the region of the "Rotor systems" which tend to form in the crests of the waves. Turbulence may be so severe that a pilot may lose control of aircraft and in some cases the aircraft may be destroyed. An aircraft caught up in a strong downdraught may crash if it does not have sufficient ground clearance.

Figure 2:7 Computed wind flow over a ridge about 600m. high.

Source: Mwebesa, M.M.N. (1979), pp 106.


Less Stable
STABLE
Less Stable
600
1500
3000
4500
M.
Rotor
6
4
2
0
2
4
6
8
10
12 Kms.
15 Kts.
at least
Wind speed increasing with height
Wind direction remains constant

JET STREAM

Jet streams are exceptionally fast streams of air confined to relatively narrow bands of the atmosphere. These occur during the months of April-October. Jet streams originate in the South West Indian Ocean and move northwards passing over the East coast of Africa along a path roughly connecting Voi, Garissa, Wajir and Mandera. The wind velocity at an altitude of 1200 m (4000 ft) - 2100m (7000 ft) often reaches 76 kph (40 knots) to 95 kph (50 knots) and may occasionally reach 171 kph (90 knots) - 190 kph (100 knots). Such strong winds in jet streams mainly results from steep temperature gradients which develop in horizontal bands through a great depth of atmosphere. Such strong wind(s) may change the course of an aircraft, specifically the smaller ones, completely.

2.3 DEMOGRAPHIC CHARACTERISTICS

2.3.1 POPULATION GROWTH LEVELS AND TRENDS

Kenya's population has increased fourfold from a total of 5.4 million in 1948 to a total of 21.4 million in 1989 (ROK, 1994). These figures show that, on the average, the total population has been increasing by more than 40% every decade. As a result of the widening gap between fertility and mortality, Kenya's population is growing at an accelerated rate. The current official figure of 3.5% per annum puts Kenya among the world's most rapidly growing nations. The decrease in the death rate is due to improved health services and nutrition. Population projections estimate a Kenyan total population of 37 million by the turn of the century.

2.3.2 POPULATION DENSITY AND DISTRIBUTION

In 1989, the average population density for the whole country was 37 persons/km^2, a 37% increase over the 1979 figure of 27 persons/km^2. Both averages conceal marked and long-standing variations at the sub-national level which reflect the limited distribution of arable land. Although Kenya's population density is low, only a very small percentage of it is cultivatable. Very high densities occur in the better favoured areas, where rainfall is about 857.5 mm and over per annum[4]. About 80% of the population resides in the 17% of the land which is suitable for agriculture. About 85% of the population live is rural areas. This population is concentrated in three major regions. These are the Lake Basin, the Mt. Kenya region and the coastal region stretching form Galana (Sabaki) river delta southwards towards the Tanzania border. In the Lake Region, population densities range from 300 persons per square kilometre in Kisumu District to more than 500 persons per square kilometre in Kisii and Nyamira Districts. In some parts of the Mt. Kenya region, population density ranges from 100-300 persons per square kilometre, especially in Kiambu. In the coastal region, the density ranges from 50 persons per square kilometre to about 500 persons per square kilometre, especially in Mombasa.

The dramatic growth in Kenya's population has influenced the distribution of her people in two ways:

a) It has led to the intensification of land pressure in the traditional high density areas.

b) It has also stimulated movement of the population into the less densely settled rural areas and into urban centres. Each of these trends has implications for economic and social well being.

Generally, the larger the population, the greater the demand for transport services. Sparseness and concentration of population affect the amount of passenger traffic generated. Sparsely populated areas are likely to generate less traffic for air transport.

2.4 URBANIZATION

Urbanization in Kenya is almost entirely a twentieth century phenomenon and is mainly a product of British colonization. Before the establishment of British colonial rule in the 1890s, no urban centres existed in the country beyond those that were founded in the coastal region during the pre-colonial period. At the time of the first national population census in 1948, there were 17 towns with a total population of 276,240. The urban population was proportionally small, accounting for only 5.1% of the total population. Most of the urban population was concentrated in Nairobi and Mombasa, with the majority of the urban dwellers being non-Africans. According to the 1962 population census, the number of urban centres had doubled to 34 and the urban population had increased to 670,950, with an annual urban growth rate of 6.6% per annum. The growth of urban centres, both in numbers and population accelerated after independence when Africans were allowed to migrate to urban areas without any legal or administrative restrictions (Table 2.3). The 1989 population census showed that there were 46 urban centres in Kenya with a population size of 10,000 people and above, as compared to 27 in 1979. The urban centres with a population size of 2,000 people and above constituted 18.1% of the total population in 1989.

Table 2.3 : Number of Urban Centres in Kenya, 1948-1989

Size of Urban Centre	Number of Urban Centres				
	1948	1962	1969	1979	1989
100,000+	1	2	2	3	6
20,000-99,999	1	2	2	13	17
10,000-19,999	2	3	7	11	23
5,000- 9,999	3	11	11	22	32
2,000- 4,999	10	16	25	41	61
Total	17	34	47	90	137
Total urban population	276,240	670,950	1,082,437	2,309,000	3,877,222
% of Kenya's population	5.1	7.7	9.9	15.1	18.1

Source: Population Census Records for Various Years

A majority of urban centres (85%) were small centres with a population size of less than 10,000 people. The ten major urban centres were: Nairobi, Mombasa, Kisumu, Nakuru, Machakos, Eldoret, Meru, Nyeri, Kakamega and Thika. As far as the population distribution and growth rate of the urban population are concerned, most of the population (89%) was concentrated in towns with a population size of 10,000 people and above. Apparently, the urbanization process has been accelerated since 1979. The percentage of the population classified as urban (living in centres reporting population size of 2,000 and over) increased from 15.1% (1979) to 18.1% (1989). The larger towns have continued to harbour most of the population (ROK, 1994).

Urban growth has been largely due to rural-urban migration. About two-thirds of the population enumerated in Nairobi at the time of the 1989 census were born elsewhere. Rural-urban migration has been a response to land scarcity, rural poverty, rural-urban income differentials, the urban monopoly of modern sector employment opportunities and the greater availability and quality of urban services. The doubling of the urban population between 1969-1979 was caused by natural increase, rural-urban migration and boundary extensions for most secondary towns (Table 2.4).

Table 2.4 : Urban Population and Average Annual Growth Rates(%) 1962-1989

Town					Average annual Growth Rate (%)		
	1962	1969	1979	1989	1962-1969	1969-1979	1979-1989
Nairobi	266,794	509,286	827,775	1,324,570	9.7	5.1	4.7
Mombasa	179,575	247,073	341,148	461,753	4.7	3.3	3.0
Thika	13,952	18,387	41,324	57,603	4.0	8.4	3.3
Nyeri	7,857	10,004	35,735	91,258	3.5	13.7	9.4
Murang'a	5,389	4,750	15,290	21,650	-1.8	24.0	3.5
Nyahururu	5,316	7,602	11,277	14,829	5.2	8.0	2.7
Malindi	5,818	10,757	23,275	34,047	9.0	29.6	3.8
Machakos	4,400	6,312	84,320	116,293	5.3	32.0	3.2
Meru	3,308	4,500	72,049	94,947	4.5	15.1	2.8
Embu	5,213	3,928	15,986	26,525	-4.0	16.8	5.1
Kisumu	23,526	32,431	152,643	192,753	4.7	17.2	2.3
Kisii	4,500	6,080	29,661	44,149	4.2	7.0	4.0
Nakuru	38,181	47,151	92,851	163,927	3.1	10.8	5.7
Eldoret	19,605	18,196	50,503	111,882	-1.1	11.3	8.0
Kericho	7,692	10,144	29,603	48,511	4.0	9.4	4.0
Kitale	9,342	11,573	28,327	56,218	3.1	5.0	6.9
Nanyuki	10,448	11,624	18,986	24,070	1.5	5.2	2.4
Naivasha	4,690	6,920	11,491	34,519	5.7	17.8	11.0
Kakamega	4,100	6,244	32,025	58,862	6.9	19.1	6.1
Bungoma	1,600	4,400	25,161	26,805	15.7	37.2	0.6
Busia	-	1,100	24,857	27,080	-	-	13.7
Webuye	-	-	17,963	27,758	-	10.2	4.4
Maralal	-	3,878	10,230	8,962	-	3.3	-1.3
Isiolo	5,445	8,201	11,331	16,824	6.0	-	4.0
Garissa	-	-	14,076	31,319	-	-	8.0
Mandera	-	-	13,126	22,699	-	-	5.5

Source: Population Census Records

Some of the urban centres such as Nairobi, Lamu, Mombasa and Kisumu are important air traffic generators in the country. As the population of the urban centres continues to grow, so is the demand for air travel likely to grow.

2.5 AGRICULTURE

Agriculture is the mainstay of the economy of Kenya. It is the main source of employment and income for majority of the population. Agricultural exports of coffee, tea and horticultural crops account for about 70% of foreign exchange earnings. Most of the country's agricultural exports are bulky and unsuitable for air transport. However, the development of horticultural crops such as cut flowers, fruits and vegetables has led to increased demand for air transport.

Horticulture is the intensive cultivation of vegetables, fruits and flowers either close to the market or to transport links. Horticultural products need to be transported from the farms to the markets in the shortest time possible so as sell them while fresh. The horticultural sector has expanded rapidly during the past twenty years to become a dynamic source of exports. Production increased from 1,476 metric tonnes of fresh horticultural exports worth Kshs.3.1 million in 1968 to 49,147 metric tonnes worth Kshs.1,678.6 million in 1990 (Table 2.5).

Horticulture's share of total merchandise exports has increased steadily rising from 3% in 1983 to about 10% in 1988, a dramatic increase from 0.3% in 1968. In the same year (1988), coffee and tea accounted for about 27% and 20% of the total value of merchandise exports, respectively. As a result of this rapid growth, horticulture is today the third largest source of foreign exchange among the agricultural exports and the fourth largest merchandise export, being exceeded in value only by coffee, tea and petroleum exports. The development of horticulture has helped to diversify the range of Kenya's exports. In the 1960s, the country was highly dependent on two principal export crops; coffee and to a lesser extent tea, with horticultural exports making a negligible contribution to export earnings. Even as late as 1970, horticultural exports accounted for only 0.5% of all exports. In addition to the problem of dependence on a few crops, the country was faced with a rapidly growing population, excessive rural-urban migration and widening regional inequalities.

The horticulture sector comprises an extremely wide range of export products: fruits (ranging from temperate to tropical fruits), many different types of vegetables, and an increasing variety of flower crops. Major horticultural exports by air now include French beans, avocadoes, courgettes, chillies, Asian vegetables (okra, eggplants, pepper), mangoes, pineapples, passion fruit, melons, strawberries and cut flowers (carnations, roses, orchids etc).

Commodity diversification has been particularly helpful because the country's `traditional exports' relative to the prices of imports has been downward. The index of purchasing power of exports has declined from 114 in the period 1974-1978 to 86 by 1984-1988. Several reasons have led to the development of the horticultural sector in Kenya:

a) Climatic Variety

The country has a suitable climate which makes it possible to grow tropical, semi-tropical and temperate fruit and vegetables for which there is a large demand during the European winter. The main horticultural areas in Kenya are around Thika, Limuru, Naivasha, Iveti and Mua Hills near Machakos, Eldoret, Kericho and Malindi.

b) Nairobi's central location and its use by many world airlines. Most of the horticultural crops are exported to Western Europe by air.

c) Towns are well distributed and often expanding as a result of high population growth rates. These maintain an internal demand.

d) The well developed tourist industry creates a consistent demand for high quality horticultural produce.

Table 2.5 : Exports of Fresh Horticultural Produce. 1968-1990

Year	Volume in Metric tonnes	Value in Kshs (million)
1968	1,476	3.13
1969	2,519	5.14
1970	3,224	6.48
1971	5,123	10.87
1972	7,856	17.11
1973	10,158	29.57
1974	11,335	33.85
1975	13,115	83.27
1976	14,719	102.34
1977	18,844	128.72
1978	21,007	159.76
1979	21,377	194.72
1980	22,266	227.06
1981	23,352	251.61
1982	24,597	272.68
1983	28,850	350.57
1984	31,298	415.86
1985	30,002	469.23
1986	36,211	630.37
1987	36,557	900.09
1988	58,119	1,327.93
1989	49,503	1,440.05
1990	49,147	1,678.60

Source: Horticultural Development Authority (HCDA) and CBS

Horticulture faces a number of problems one of the major ones being shortage of air cargo space. Air cargo space is limited even though the government obligates all the airlines stopping in Nairobi to reserve 20% of their holds for Kenyan horticultural exports and to charge a relatively low freight rate (Schapiro and Wainaina, 1989). If Kenya continues to rely on regularly scheduled passenger flights while the supply of horticultural exports continues to grow, air cargo space could become a critical bottleneck. If horticulture is to play a more significant role in Kenya's economy, adequate air cargo should be provided. For the continued expansion of the industry, a greater use of cargo charters is called for.

2.6 MANUFACTURING AND SERVICES

The manufacturing and tertiary sectors are also very important in the economy. The disproportionate development of manufacturing and services was bound up with early presence of a substantial number of non-African settlers whose high incomes generated demand for manufacturing and services. This enabled the economy to develop services and manufacturing industries which satisfy not only Kenya's needs but also for Uganda and Tanzania.

Manufacturing industry increased its share of GDP from 11.0% in 1965 to 13.6% in 1992 (Economic Survey, 1994). At present, the manufacturing sector employs about 140,000 people about 14% of the total formal sector employment. Most of the manufacturing industries and commercial activities are concentrated in urban areas such as Nairobi, Mombasa, Kisumu, Nakuru, Thika and Eldoret. The relative importance of each urban centre is a function of its population size. As the manufacturing sector continues to grow and become more diversified, the demand for air transport may become important for some of the finished products. The need to maintain closer business contacts by businessman in different parts of the country may become increasingly crucial.

2.7 TOURISM

Kenya firms render various services to foreigners which cannot be quantified in physical terms but have a monetary value. Some of these include financial services, clearing and forwarding, transport services, landing rights to foreign aircraft, docking facilities at Kilindini harbour and tourism. These services which earn foreign exchange for the country are referred to as "invisible exports". Tourism is Kenya's most important invisible export.

For a long time, Kenya's export earnings have heavily depended on agricultural products mainly coffee and tea. However, since 1987, tourism has become the leading foreign exchange earner having bypassed coffee and tea (Fig. 2.8). Due to the collapse of the International Coffee Agreement and the plunging of coffee and tea prices in the world markets, coupled with poor terms of trade for agricultural products, tourism has proved to be the only sector which offers prospects for a positive contribution to Kenya's economic development. Revenue from tourism has grown from 25% of the value of merchandise exports and 15% of the total exports in 1985 to 46% of the value of merchandise exports and 21% of total exports in 1990, a significant growth within a short period (1991). Such phenomenal growth would have been difficult to achieve without affordable, reliable and efficient air transport system. International and domestic air transport has been, and will remain essential to tourism development in Kenya (Irandu, 1992b).

Tourist Attractions

According to the International Union of Official Travel Organizations (IUOTO), a tourist is any traveller for a period of twenty-four hours or more in a country other than that in which he usually resides. Hence, tourists include travellers for pleasure, for domestic reasons, for health reasons, for conferences, in representative capacity of any kind (e.g. scientific, diplomatic, administrative), travellers on business, as well as students. Thus, tourists travel for a multitude of reasons or attractions. Kenya's major tourist attractions are its excellent wild life resources, captivating scenery, pleasant climate and attractive beaches. Prehistoric sites and historical monuments combined with the rich and diversified culture of the Kenya people also draw many tourists to the country.

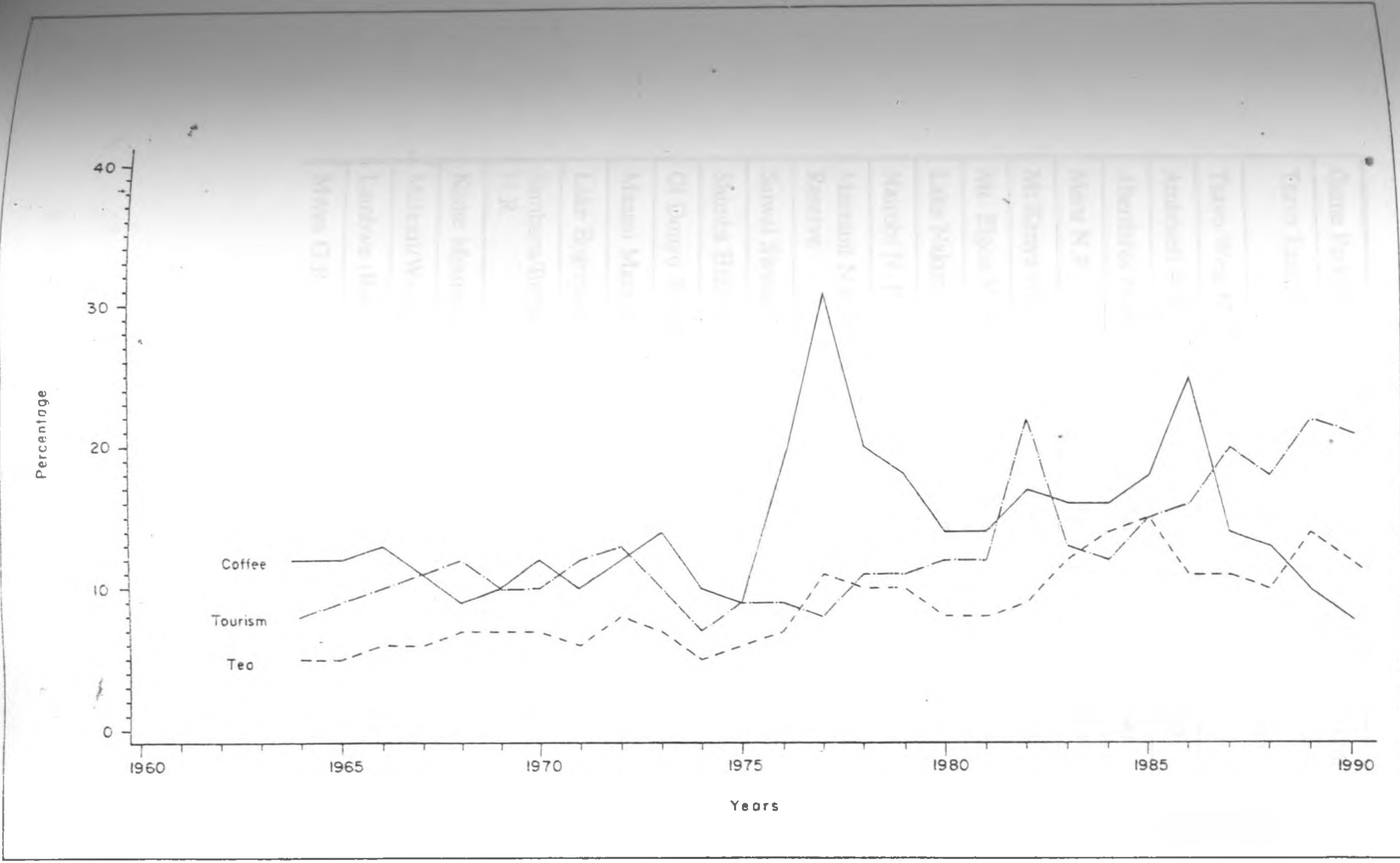


Figure 2: 8 COFFEE, TEA AND TOURISM EARNINGS as a Percentage of total Export Earnings.

Source: Rwerio, E.B.I.N. (1991): Annex I, pg 24

Table 2.6: National Parks and Game Reserves in Kenya: Date of Establishment and Size (km^2)

Game Park/Reserve	Date Established	Area (km^2)
Tsavo East N.P.	1948	21,343
Tsavo West N.P.✓		
Amboseli N.P.	1961[a]	392
Aberdares N.P.	1950	590
Meru N.P.	1966	870
Mt.Kenya N.P.	1949	588
Mt. Elgon N.P.	1968	169
Lake Nakuru N.P.	1967	57
Nairobi N. P.	1946	120
Marsabit N.P./Game Reserve	1948[b]	1944
Saiwal Swamp N.P.	1974	1.9
Shimba Hills N.R.	1968	192
Ol Donyo Sapuk N.P.	1967	18.4
Maasai Mara N.R.	1961	1672
Lake Bogoria G.R.	1974	107
Samburu/Buffalo Springs N.R.	1968	293
Kisite Mpunguti N.P.	1978[c]	39
Malindi/Watamu N.R.	1968	240
Lambwe (Ruma) G.R.	1966	194
Mwea G.R.	1976	68

Game Park/Reserve	Date Established	Area (km^2)
Tana River Primate G.R.	1976	169
Losai G.R.	1976	1806
Boni G.R.	1976	1339
Ngai Ndethya G.R.	1976	212
Arawale G.R.	1974	533
Shaba G.R.	1974	1643
Rahole G.R.	1976	1270
South Turkana N.R.	1979	1091
Bisanadi N.R.	1979	606
South Kitui N.R.	1979	1833
North Kitui	1979	745
Kerio Valley N.R.	1983	66
Kiunga Marine N.P.	1979	250
Mt. Longonot N.P.	1983	52
Sibiloi N.P.	1973	1570
Central Island N.P.[d]	1983	5
South Island N.P.	1983	39

[a] Game Park (1974)
[b] National Park (1966) covering an area of 144 Km^2
[c] National Reserve (1973)
[d] On Lake Turkana

Source: CBS, Various Years and Vorlaufer, K. (1983).

To protect wildlife, the then colonial government enacted stringent laws. These were contained in the "Kenya National Parks Ordinance" of 1945. The aims and scope of the ordinance were:

> "to provide for the establishment of National Parks and for the preservation of wild animal life, wild vegetation and objects of aesthetic, geological, prehistoric, archaeological, historical or other scientific interest therein, and for incidental matters relating thereto" (Kenya colony and Protectorate, Ordinances and Regulations, 1945, 26-33).

The policy followed, since 1945, in respect both of the protection of game and of making wildlife sanctuaries accessible to tourists was further strengthened with the advent of independence (Table 2.6).

The old National Parks such as Nairobi, Tsavo (East and West) and Aberdares have been extended and new ones have been created such as Shimba Hills, Marsabit, Ol Donyo Sapuk and Mr. Elgon. Today, there are 15 National Parks and 23 Game Reserves distributed throughout the country (Fig. 2.9). The National Parks are run by the Central Government, while Game Reserves are run by the local county councils. Most striking to international tourists to Kenya's National Parks and Game Reserves are the large concentrations and variety of wild game (Ouma, 1970).

Kenya's climate is pleasantly varied, thus providing opportunities for tourists to relax in the warmth of the coast or in the coolness of the highlands' resorts (Fig. 2.10).

Figure 2·9a Location of National Parks, Game Reserves and Tourist centres in Kenya.

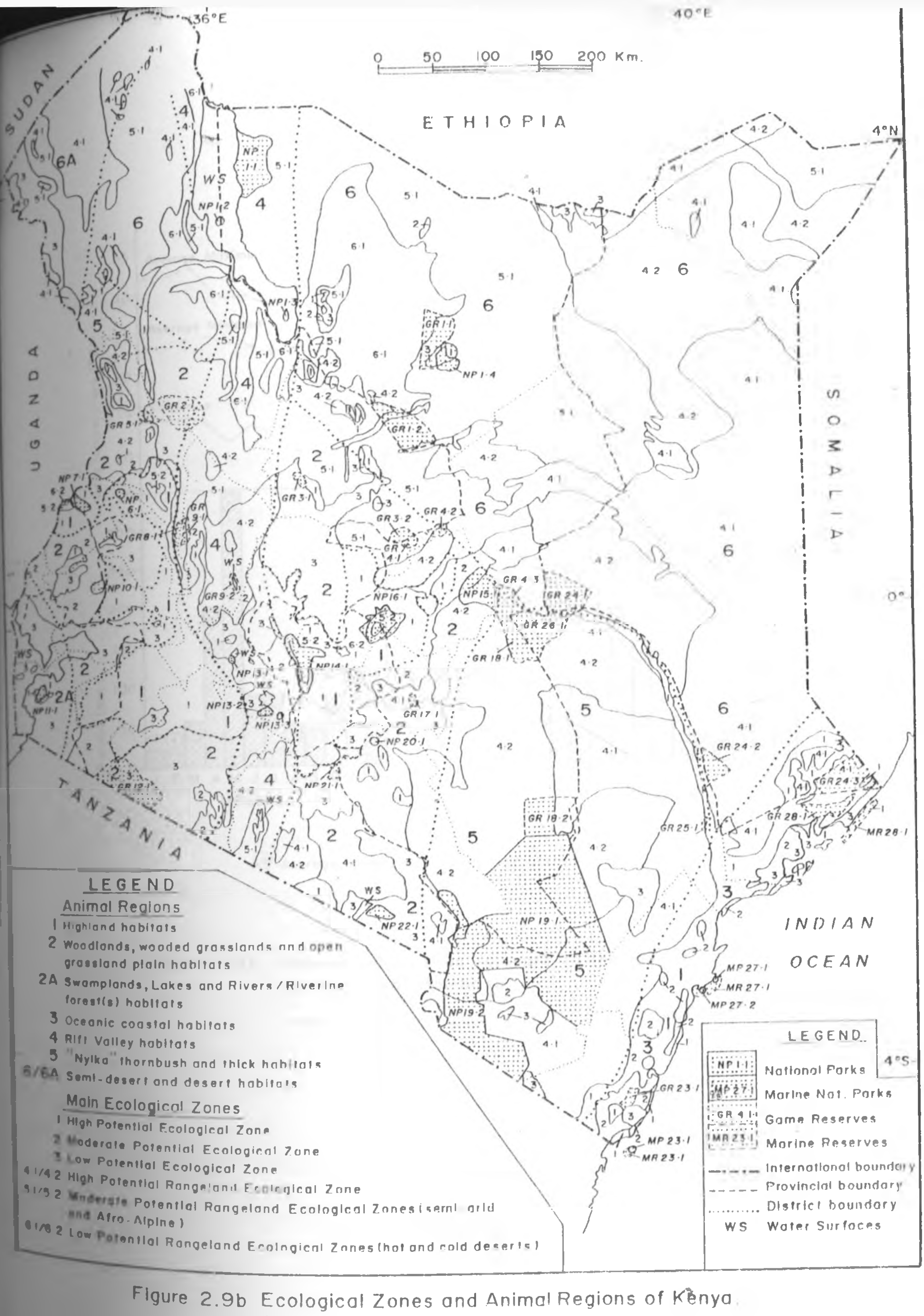
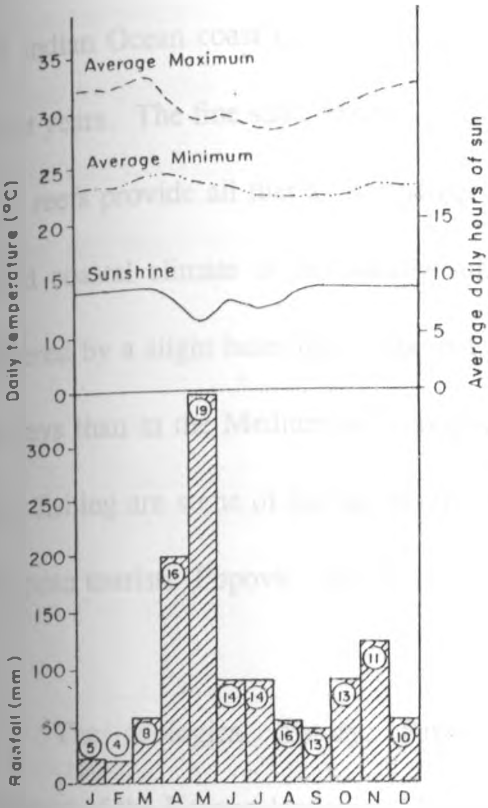


Figure 2.9b Ecological Zones and Animal Regions of Kenya
After R.B. Ogendo, 1989.

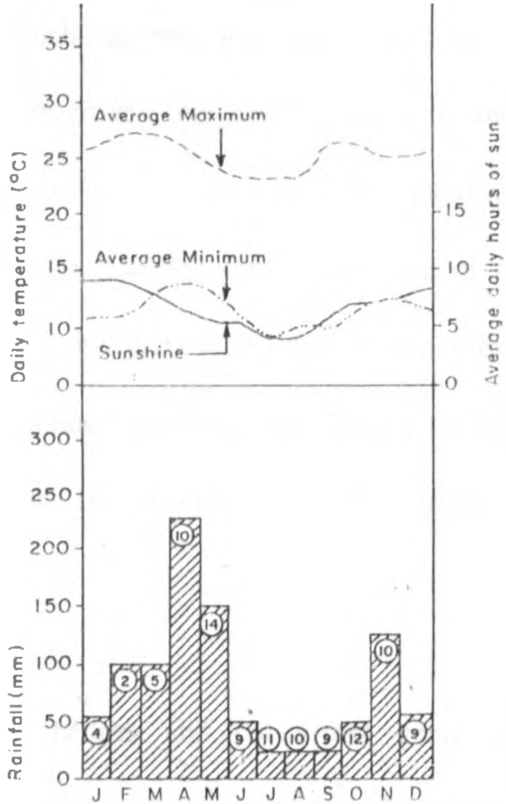
(B) Average number of days with rain each month

Figure 2:10 Climatic information relevant to the tourist, Nairobi and Mombasa.

Source: Gamble, W.P. (1989), pp 32.



MOMBASA



NAIROBI

The Indian Ocean coast is a great tourist asset which has been attracting large-scale tourism in recent years. The fine sand beaches fringed by palm groves, with emerald sea water sheltered by coral reefs provide all that a "northerner" dreams of "tropical sea". The warm and moderately humid coastal climate is just ideally suited for relaxation and rest. The glare of the sun is tempered by a slight haze and occasional cloudiness, and there is less danger of overexposure to sun rays than in the Mediterranean region. Swimming, goggling, wind surfing, skiing and big game fishing are some of the major attractions of the Indian ocean coast which greatly appeal to European tourists (Popovic, 1972).

The geological history, Palaeoclimatic changes and concurrent geomorphological evolution of the Kenyan landscape like elsewhere in East Africa, have ensured a great variety of scenes now available to the local and international tourists. The multi-coloured rift soda lakes, the snow-capped Mt. Kenya (astride the Equator) and the rift escarpments are some of the most spectacular scenes in the country. Indeed, starting from the palm fringed sandy beaches of the Indian ocean, one can make innumerable traverses across the country, all through scenes of "kaleidoscopic variety and singular grandeur" (Ouma, 1970, 59).

The rich and varied culture of the people of Kenya is also an important tourist attraction. This include music, dance, drama, literature, customs and art of the different cultural groups.

Since independence, the country has made great strides in the promotion of her cultural heritage, through the creation of the Ministry of Culture and Social Services. Today, tourists can watch with delight traditional dances being performed at the Bomas of Kenya in Nairobi or in Game Lodges and beach hotels. Table 2.7 shows the most popular Game Parks and reserves in the country.

Table 2.7 : Number of Tourists Visiting Top Ten Game Parks and Reserves in Kenya, 1984-88 (000s visitors)

Game Park/Reserve	Tourists (000s)				
	1984	1985	1986	1987	1988
Amboseli N.P.	143.9	151.5	157.0	148.5	137.7
Nairobi N.P.	126.8	110.6	91.6	99.8	125.5
Lake Nakuru N.P.	125.3	135.5	127.9	127.9	138.6
Tsavo West	118.7	96.8	82.9	80.6	85.4
Maasai Mara N.P.	109.9	110.7	94.8	95.9	118.8
Tsavo East	76.0	73.3	75.3	89.6	87.3
Aberdare	47.4	43.1	42.5	54.0	59.9
Samburu/Buffalo Springs N.R.	47.1	52.1	45.5	47.7	67.6
Malindi Marine N.P.	40.5	25.4	36.1	38.6	39.2
Lake Bogoria G.R.	24.4	23.8	25.6	31.2	32.8

Source : Central Bureau of Statistics, various years.

Kenya was already being visited by travellers during the colonial period (particularly hunters of big game), but a heavy increase in tourism did not start until 1965/66, when "charter flights" from Western Europe, especially Germany and Switzerland were introduced. Since then, the number of foreign visitors, their duration of stay and overnight stays increased drastically (Table 2.8).

Table 2.8 Number of Tourist Arrivals in Kenya for Selected Years, 1946-1990

Year	Number of Arrivals ('000s)
1946	16.1
1950	24.1
1954	33.2
1958	41.2
1962	50.0
1966	106.5
1970	343.5
1974	387.5
1978	364.8
1982	392.1
1986	614.2
1990	800.7

Source : Central Bureau of Statistics, Various Years.

The number of tourists visiting Kenya increased "fourfold" from 81,500 in 1965 to 343,500 in 1970. Since then, the number of tourists arrivals has been increasing steadily. The breakup of the East African Community (EAC) in 1977 and the World Economic Recession of the early 80's affected the volume of tourist traffic to Kenya significantly. However, in recent years, the number of tourist arrivals has picked up and in 1990, about 800,700 tourists visited Kenya.

During the earlier years of 1973-76, Africans, followed by Europeans, provided the main source of demand for tourism, with demand for North American, U.K. and German tourists being the most important non-African sources of demand. Between 1976 and 1983 there was an increase in demand by Europeans and a drop in demand by Africans mainly owing to the closure of the Kenya-Tanzania border between 1977 and 1983. By 1983, Germany had become the most important origin country (Sinclair, 1990). Germany, the U.K., Switzerland, Italy and France are particularly important origin centres for tourists from Europe (Fig. 2.11). The majority of tourists to Kenya originate from only a small number of countries, so that there is a "concentration" of demand by nationality. Kenya needs to attract new sources of demand from countries such as Japan, Australia, New Zealand and European countries such as Spain. A decrease in the concentration of demand would have the advantage of decreasing the risk associated with a fall in demand by tourists of a particular nationality; a wider spread of nationalities is advantageous in that a decrease in demand by tourists of one nationality is more likely to be offset by an increase in demand by another.

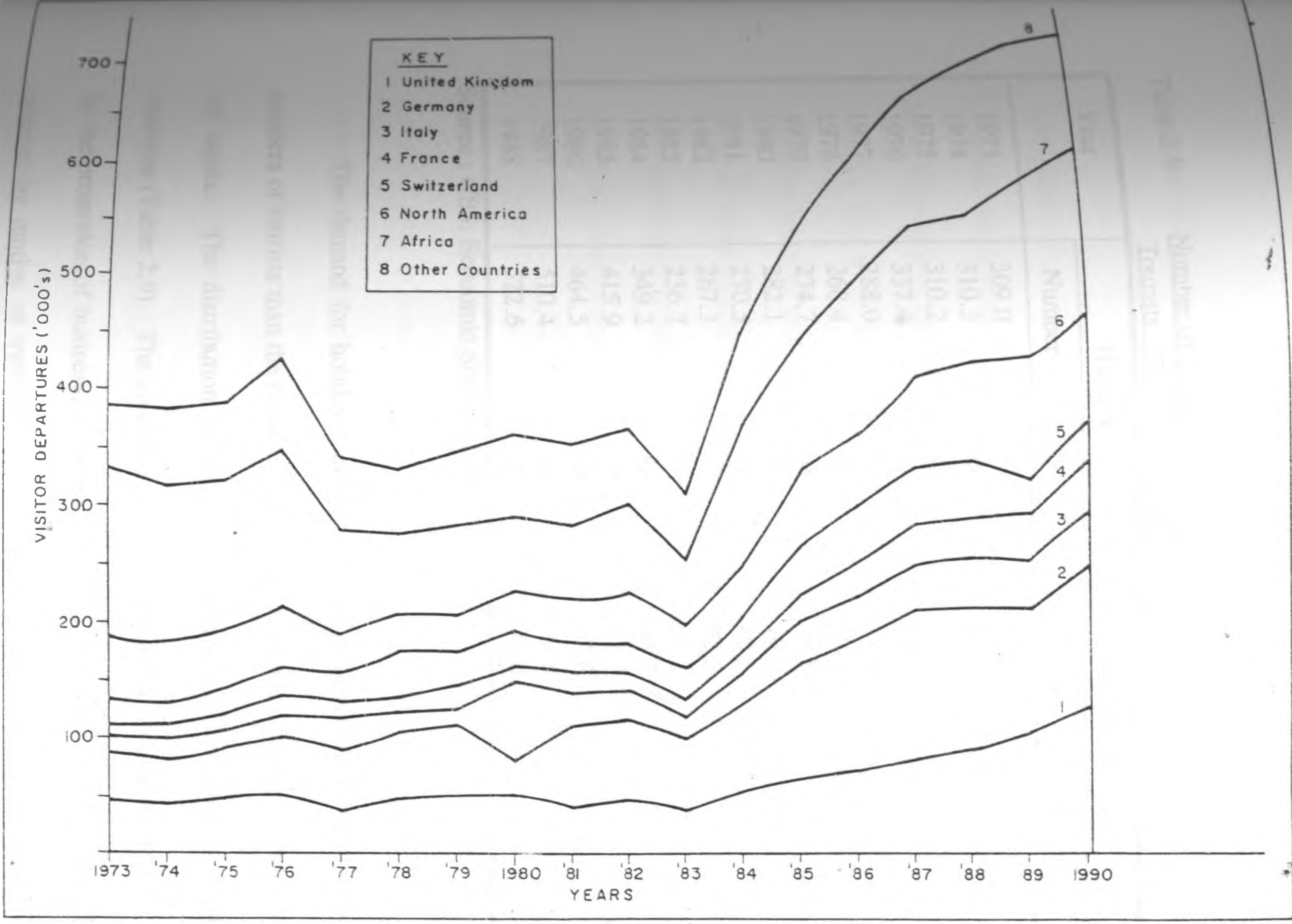


Figure 2·11 Visitor Departures by Nationality and Country of Residence, 1973–1990 (in thousands)

Table 2.9 : Number of Holiday and Business Tourists, 1973-88 ('000 Departures)

Year	Holiday		Business		Total
	Number	%	Number	%	
1973	309.0	88	43.7	12	352.7
1974	310.3	88	43.4	12	353.7
1975	310.2	87	45.9	13	356.1
1976	337.4	87	49.3	13	386.1
1977	288.0	94	19.7	6	307.7
1978	268.4	91	26.1	9	294.5
1979	274.7	88	37.8	12	312.5
1980	282.1	89	36.0	11	318.1
1981	270.5	87	40.5	13	311.0
1982	267.3	93	42.3	7	309.6
1983	236.7	88	32.2	12	268.9
1984	349.2	88	46.3	12	395.5
1985	415.9	88	57.2	12	473.1
1986	464.5	88	63.8	12	528.3
1987	510.4	88	69.8	12	580.2
1988	522.6	88	71.0	12	593.6

Source : CBS: Economic Survey, 1976-89

The demand for holiday tourism in Kenya is considerably more important in terms of numbers of tourists than the demand for business tourism, although business tourists spend more per capita. The distribution between the two types of tourism has remained fairly stable overtime (Table 2.9). The country's relative dependence on holiday tourism could be lessened by the promotion of business, conference and incentive tourism. The greater diversification of tourism by motive of visit would have the advantages of increasing Kenya's total tourism earnings and decreasing their sensitivity to changes in variables such as inflation and exchange rates.

The visitors from the different countries show very diverse demand preferences. Whereas in Nairobi, the demand for tourism by Africans, Americans and tourists from the U.K. was the most important in terms of bed-nights occupied in 1988, in coastal areas the largest source of demand was from West Germany, the share of demand by tourists from other European countries being of greater importance than in Nairobi, and tourism from Africa and the U.K. being of lower relative importance. American, German and U.K. tourists constituted the largest share of demand in lodges in National parks and Game Reserves, and African demand was by far the largest share of demand in the remaining areas of the country.

The main change in the distribution of demand by area between different time periods occurred prior to 1980 and consisted of an increase in the share of the coast from 36.2% of total bed-nights in 1973 to 52.8% in 1989. This was due, in part, to the growth of long haul inclusive tour "package" tourism and charter flights to Kenya. The share of bed-nights in lodges increased slightly from 8.6% to 11.3%, Nairobi's share fell from 46.8% to 27.7% and the share of other areas remained approximately constant. The spatial demand for tourism is highly concentrated in the coastal areas which constitute only a small fraction of the country.

There is scope for diversifying tourism into those National Parks and Reserves which are underutilized, including arid and semi-arid lands which provide grazing for much of the wildlife in Kenya. There is also potential for increasing "town tourism" in Nairobi by tapping the business and conference market and for encouraging the further promotion of "town-safari" and "town-beach" holiday packages by tour operators. (Sinclair, 1990).

2.8 THE GROWTH AND DEVELOPMENT OF THE ROAD NETWORK SYSTEM

Apparently, the Kenya road system, has gone through a series of changes from an initial lines of trails, passing through a system of old tracks and earth roads to a complex network of gravel and bitumen highways (Ogonda, 1986). In 1906 there were only 818 kilometres of public earth roads, in 1914 the length was 2334 kilometres, by 1920 the kilometrage had increased to 5760 and today there are over 53,000 kilometres of national classified roads and over 100,000 kilometres of unclassified tracks and roads. Of the classified network system, over 6,000 kilometres are bitumenized. The development and expansion of the road transport system in Kenya since World War II has been revolutionary. This is because of the important part roads play in effecting fast travel from place to place. Road transportation has facilitated the efficient and quick exchange of produce and manufactured goods between distant places which would not be accessible by use of other modes of transport.

Historically the development of road network was subsidiary to that of railway networks. However, since restrictive measures to protect the railway system were lifted in 1959 a major programme to upgrade the system of roads was started. Since that time, the expansion of road systems has been rapid. At independence the highway system, although extensive was of very poor standard. The roads were mainly of gravel and earth roads. Immediately after independence the first priority was given to the upgrading of roads and especially the main trunk roads. This was followed by improvement of the primary network through selective bitumenization of heavily used segments and realignment of critical bottleneck sections.

Early development programmes concentrated on upgrading the heavily used trunk and primary roads. It was at this time that important links were bitumenized such as the Nairobi-Mombasa road, Eldoret - Tororo (Uganda), Sagana-Embu roads etc. A special purpose roads programme was initiated to support development efforts in tea, sugar and tourist areas. In the early 1970s emphasis was directed towards feeder roads and minor roads with a view to opening up areas where road communications did not exist earlier. A number of major roads such as Ahero-Isebania, Athi River - Namanga and Kakamega-Webuye roads were completed (Fig 2.12). Road transportation competes with, as well as complements, air transport services in the country, especially in the ferrying of passengers. The relationship between the two important modes is examined in a later chapter (Chapter seven).

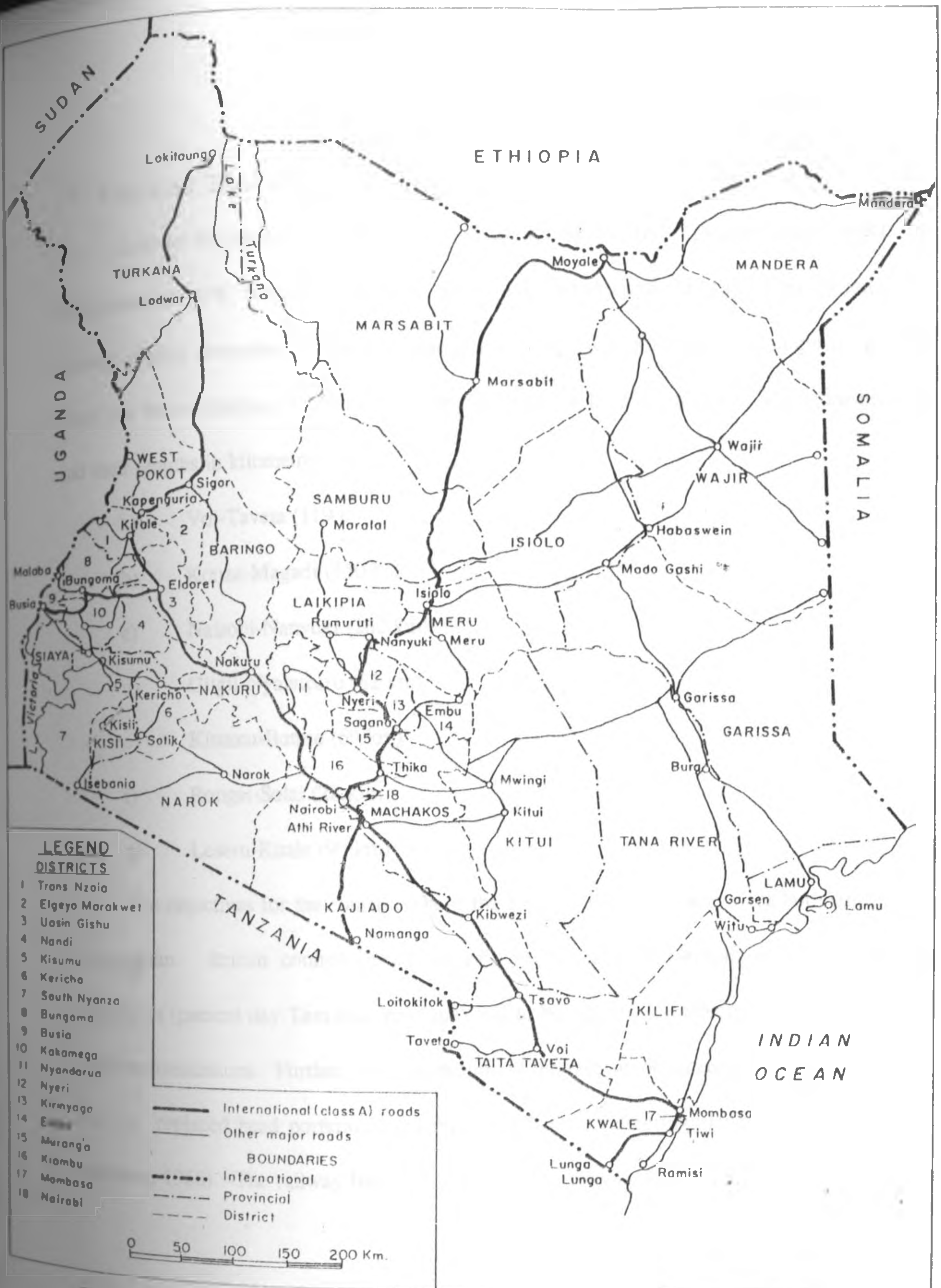


Figure 2-12 Kenya's Major Roads
Source: Modified from R.B. Ogendo, 1989.

2.9 RAILWAY TRANSPORTATION

Railway transportation in Kenya is run by the Kenya Railways corporation which was established in 1978, following the break up of the East African Railways Corporation. The railway system comprises a network expanding to over 2,733 kilometres of single track. The main line from Mombasa to Malaba covers a distance of 1085 kilometres. The main branches and their lengths in kilometres are:

a) Voi-Taveta (119 km)

b) Konza-Magadi (150 km)

c) Nairobi-Nanyuki (262 km)

d) Gilgil-Nyahururu (82 km)

e) Kisumu-Butere (69 km)

f) Rongai-Solai (28 km)

g) Leseru-Kitale (90 km)

The objectives for the construction of the Kenya-Uganda Railway were both strategic and humanitarian. British control of the interior in the face of German activity in the then Tanganyika (present day Tanzania mainland) had to be made more effective and depended upon good communications. Further, the construction of the railway obviated the carriage of goods by man (i.e. replaced head porterage) and put an end to the lingering slave trade (Mountjoy and Embleton, 1966). The railway line was constructed to pass through some of the richest farming areas in the country. As the only reliable medium of land transport in the early part of the 20th century, the railway system controlled the development of the road pattern for a considerable period. At this early stage, the road network pattern was to feed the railway network and not to compete with it. Roads running parallel to the railway network such as the Mombasa-Nairobi road were considered competitive and therefore unfavourable to the profitable performance of the railway system. After independence, this pattern changed. The railway system has increasingly suffered losses at the expense of the expanding and improving road patterns, including amongst others the tarmacking of the Mombasa to Nairobi Highway.

A further factor which has favoured the recent road network is the fact that the railway system was mainly designed to serve the former "White Highlands" rather than the African areas. This imbalance has now been rectified. There has been no addition to the railway network since independence. There is a proposal to construct a new 240 km railway line from Kampi ya Moto to Marich Pass on the Kenya-Sudan border. Other possible extensions are: Butere-Bungoma, Sagana-Embu and Kericho-Sotik-Kisii (Fig. 2.13).

In a recent study of road-rail competition for freight traffic in Kenya, the modal split between rail and road traffic was analysed in terms of journey length (Fig. 2.14). On short journeys almost all goods are moved by road, but as the journey length increases, so does the proportion of traffic moved by rail (Cundill, 1986). Table 2.10 shows the comparative characteristics of the different modal systems.

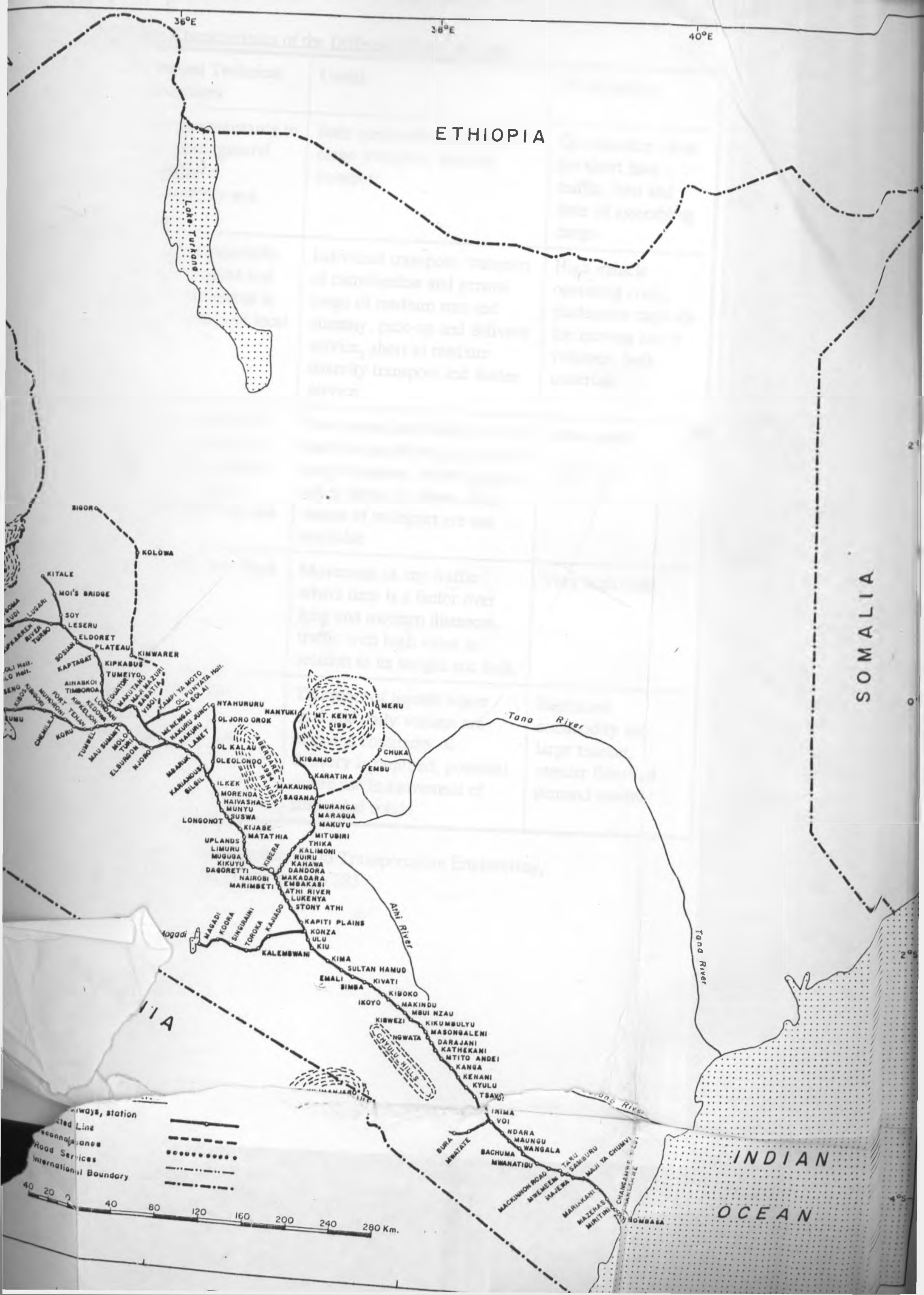

ETHIOPIA
SOMALIA
INDIAN OCEAN
Lake Turkana
36°E
38°E
40°E
2°S
4°S
KITALE
MOI'S BRIDGE
SOY
LESERU
ELDORET
PLATEAU
KIMWARER
KOLOWA
SIGORO
LUGARI
TURBO
KIPKABUS
KAPTAGAT
SOSIANI
TUMEIYO
AINABKOI
TIMBOROA
EQUATOR
MAKUTANO
MAJI MAZURI
SABATIA
VISOI
KAMPI YA MOTO
OL PUNYATA Halt.
SOLAI
LONDIANI
KEDOWA
KIPKELION
FORT TERNAN
MUHORONI
KORU
TUMBEL
MAU SUMMIT
MOLO
TURI
ELBURGON
NJORO
MENENGAI
NAKURU JUNCT.
NAKURU
LAMET
MBARUK
KARIANDUS
GILGIL
NYAHURURU
OL JORO OROK
OL KALAU
OLEOLONDO
ILKEK
MORENDA
NAIVASHA
MUNYU
SUSWA
LONGONOT
KIJABE
MATATHIA
UPLANDS
LIMURU
MUGUGA
KIKUYU
DAGORETTI
NAIROBI
MARIMBETI
KIBERA
ABERDARE RANGES
3994
NANYUKI
MT. KENYA
5199
MERU
CHUKA
EMBU
KIGANJO
KARATINA
MAKAUNG
SAGANA
MURANGA
MARAGUA
MAKUYU
MITUBIRI
THIKA
KALIMONI
RUIRU
KAHAWA
DANDORA
MAKADARA
EMBAKASI
ATHI RIVER
LUKENYA
STONY ATHI
KAPITI PLAINS
KONZA
ULU
KIU
Magadi
MAGADI
KOORA
SINGIRAINI
TOROKA
KAJIADO
KALEMBWANI
KIMA
SULTAN HAMUD
EMALI
SIMBA
KIVATI
KIBOKO
IKOYO
MAKINDU
MBUI NZAU
KIBWEZI
KIKUMBULYU
MASONGALENI
NGWATA
DARAJANI
KATHEKANI
MTITO ANDEI
KANGA
KENANI
KYULU
TSAVO
CHYULU HILLS
IRIMA
VOI
BURA
MWATATE
NDARA
MAUNGU
WANGALA
BACHUMA
MWANATIBU
TARU
SAMBURU
MACKINNON ROAD
MWEMBENI
MAJEWA
MAJI YA CHUMVI
MARIAKANI
MAZERAS
MIRITINI
CHANGAMWE
MOMBASA
Athi River
Tana River
Railways, station
Road Services
International Boundary
40 20 0 40 80 120 160 200 240 280 Km.

Table 2.10 Comparative Characteristics of the Different Modal systems

Mode of Transport	Principal Technical Advantages	Use(s)	Drawback(s)
Rail	Minimum resistance to movement, general flexibility, dependability and safety	Bulk commodity and general cargo transport, intercity transport	Of minimum value for short haul traffic, cost and time of assembling cargo
Road	Flexibility especially of routes, speed and ease of movement in intraterminal and local service	Individual transport, transport of merchandise and general cargo of medium size and quantity, pick-up and delivery service, short to medium intercity transport and feeder service	High vehicle operating costs, inadequate capacity for moving heavy volumes, bulk materials
Water	High productivity at low horse power per ton, low investment especially where natural waterways are utilized	Slow speed movement of bulk and low-grade freight, general cargo transport where speed is not a factor or where other means of transport are not available	Slow speed
Air	High speed, low fixed costs	Movement of any traffic where time is a factor over long and medium distances, traffic with high value in relation to its weight and bulk	Very high costs
Pipeline	Continuous flow, maximum dependability and safety	Transport of liquids where total and daily volume are high and continuity of delivery is required, potential future use in movement of suspended solids	Restricted commodity use, large market, regular flow and demand needed

Source : Hay, W.H. 1961 - An Introduction to Transportation Engineering, Wiley and Sons, New York, Table 8-5, pp 283.

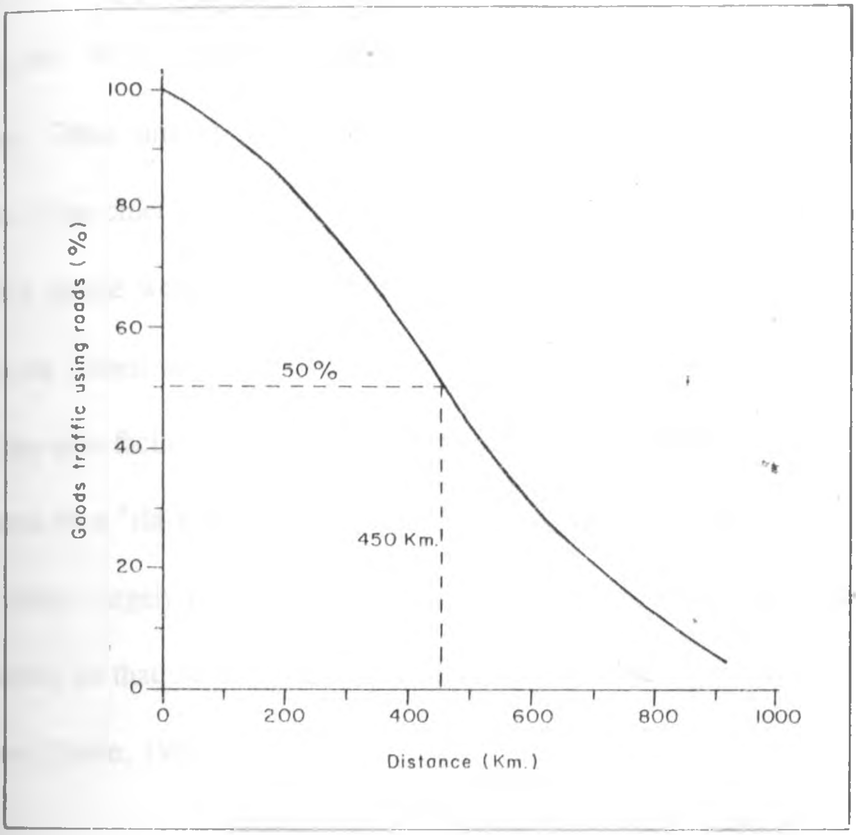


Figure 2:14 Road/rail modal split in relation to journey length.
Source: Hoyle, B (1988), pp 27.

2.10 WATER TRANSPORT

Apart from lake transport, (centred in Kisumu and other smaller lake ports such as Kendu, Karungu and Homa Bay), the main water transport focus is at the Kilindini Harbour in Mombasa. Other smaller sea ports along the coast are Lamu, Malindi, Shimoni and Mtwapa. Mombasa is the chief seaport of Kenya and the second largest urban centre in the country. The deep water on the western side of Mombasa island forms the magnificent harbour of Kilindini, reckoned the "finest on the east coast of Africa". Mombasa island on which the urban core and most of the port facilities are sited, lies between Mombasa Harbour and Kilindini Harbour, two major arms of a "ria system." Mombasa has been an important sea port in both medieval and modern times, largely because of the existence of these two harbours, (which are very different in character), so that the port has adapted successfully to the changing functions and navigational conditions (Hoyle, 1988).

The port handles a wide variety of imports and exports, including bulk and containerized cargoes. It handles a considerable tonnage of crude oil imports, agricultural export and miscellaneous cargo and is an important centre of employment and regional development (Table 2.11).

Table 2.11 : Traffic Handled at the port of Mombasa ('000 dead Weight Tonnes)

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Imports										
Dry General Cargo	1342	1216	1335	1722	1629	1729	1726	1609	1845	1675
Dry Bulk Cargo	718	270	272	250	627	340	408	371	251	518
Bulk Liquids[a]	3587	2705	2681	2502	2180	2839	2747	2887	3104	3000
Total Imports	5647	4191	4288	4474	4436	4908	4881	4867	5200	5193
Exports										
Dry General Cargo	784	870	1126	983	934	1181	1231	1095	969	1350
Dry Bulk Cargo	748	805	660	554	548	419	425	391	498	557
Bulk Liquids[a]	1274	688	410	522	396	388	356	298	529	389
Total Exports	2806	2363	2196	2059	1878	1988	2012	1784	1996	2296
Total Throughput	8453	6554	6484	6533	6314	6928	6919	6673	7239	7525

[a] petroleum and other bulk liquids

Source: Hoyle, B.S.(1988), Kenya Ports Authority, 1992

The hinterlands of the port include the agriculturally well-developed and productive Kenya Highlands, including the coffee and tea-producing areas of Western Kenya and the economic core zones of Southern Uganda. Certain core areas of production for export, together with areas of population concentration and import consumption, are particularly important elements in the hinterlands of Mombasa, but the area tributary to the port nevertheless includes virtually all of Kenya and Uganda. Traffic from Rwanda, Burundi and Eastern Zaire also passes through the port. In the past, a large proportion of tourists (41%) visiting Kenya came by sea. However, with the upgrading of Mombasa airport into an international status, most of the tourists (62%) now come to Kenya by air (Fig. 2.15). A significant proportion (36%) of tourists visiting Kenya, today, also travel by road.

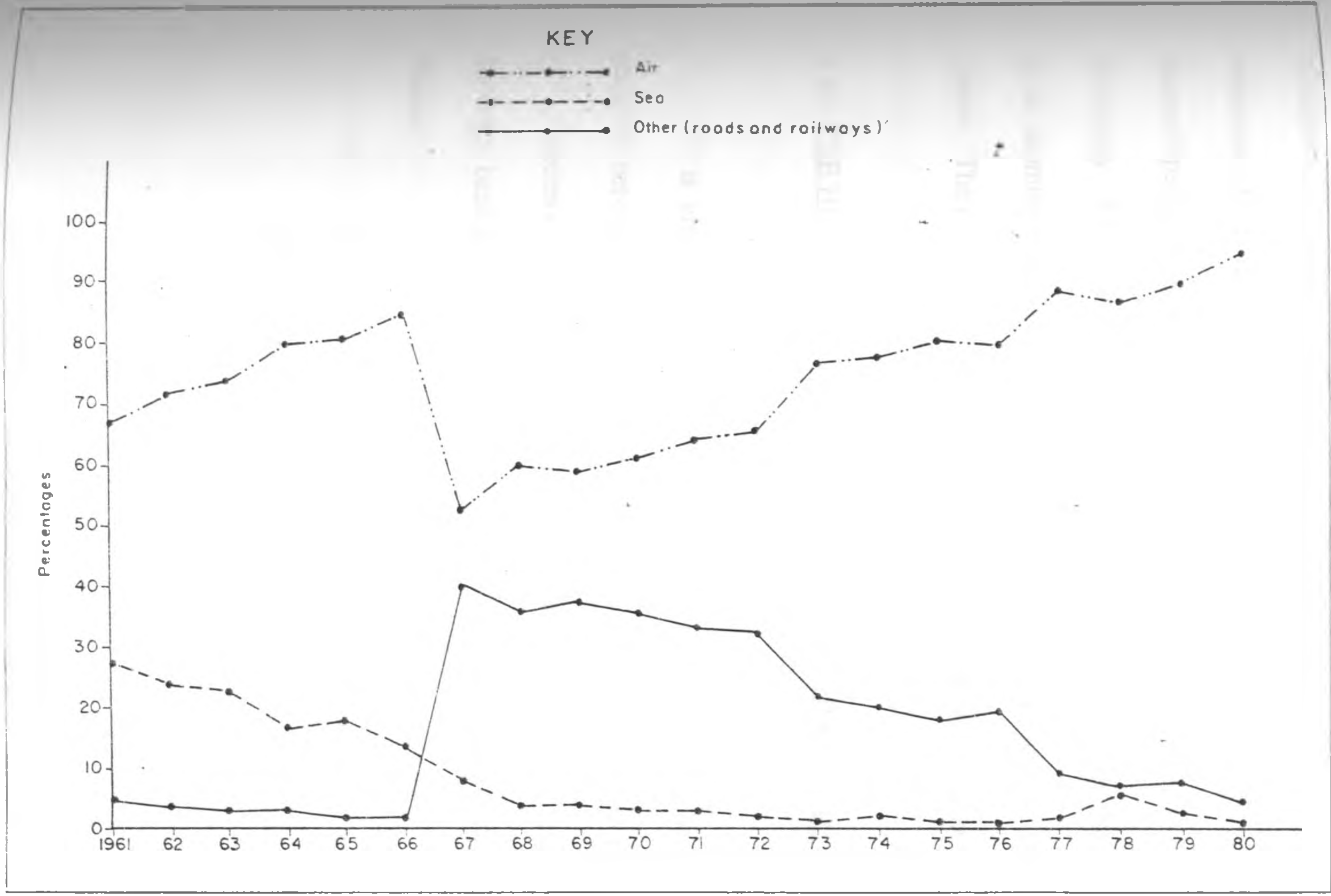


Figure 2·15 Tourists arriving in Kenya by Mode (%), 1961–1980.
Source: Central Bureau of Statistics, various years.

2.11 PIPELINE TRANSPORT

The pipeline transport which is currently confined to the transport of "white" petroleum products from the oil refinery in Changamwe, (Mombasa), to the hinterland, provides the economy with a pollution-free, reasonably safe, cheap and reliable mode of transport which contributes to the reduction of raw damage by limiting the use of oil tankers of the roads. It is managed by the Kenya Pipeline Company Limited (KPC) a wholly government hold parastatal under the Ministry of Energy. KPC started its commercial operations in 1978 with the construction of the pipeline from Mombasa to Nairobi. The company's annual throughput stands at 1.9 million cubic metres. The pipeline has been extended to Eldoret in western Kenya.

2.12 THE HISTORICAL DEVELOPMENT OF AIR TRANSPORT

It is important to include a discussion of the historical background in a study of air transport network in Kenya in order to stress the continuing impact of past actions and

decisions on the present air transport network (Hogenauer, 1975). The knowledge of the historical basis for the aviation pattern in the country is essential to its understanding for several reasons:

a) The development of air transport coincided with the British colonial administration, not only in its infancy but in its critical post-war expansion.

b) As in all developing countries air transport was more than any other transportation mode imposed wholly from outside the country.

c) The pattern of important routes emerged early and has remained basically the same with the dominance of the air routes to Europe and Asia.

The existing spatial structure of air transport network in Kenya, like that of the rest of Africa, can be better understood by reference to the colonial origins of the international network (Gaile, 1988). The first flight in East Africa was made during World War I when the Royal Flying Corps sent an aircraft to support British army operations against the Germans in the then Tanganyika (now Tanzania mainland). This was followed from 1919 on by other experimental flights planned by the Air Ministry with the objective of forging an air route between Cairo and Cape Town (Wanyanga, 1988). Within the country, the relatively wealthy colonialists began to experiment with the construction, modification, and operation of aircraft. Soon the use of aviation as a mode of transport became fairly common. As elsewhere, the plane was seen as the solution to the "inadequate railways and indifferent roads" of the vast tracts of bush of the territory (Hill, *et al.*, 1968, 5). The principal mission of the earliest flights in Kenya was reconnaissance, although the aircraft was also used for making sketch maps of unsurveyed country and for obtaining details of topography, mainly for military purposes.

2.12.1 INTERNATIONAL AIR SERVICES

The first successful flight on the Cairo-Cape air route was made by Lt. Col. Pierre Van Ryeneveld and captain C.J.Q. Brand on March 20th, 1920. Kisumu lay on this Cairo-Cape air route. Soon afterwards, an experimental flying service by a "flying boat" between Khartoum and Kisumu was inaugurated which brought Kenya within 12 days from Europe. A flying boat was considered because landing grounds had not been established for land planes but the presence of a continuous body of water in the form of the Nile river and Lake Victoria presented the best landing facility at the time. The first aeroplane was a De Havilland DH 50 Gypsy Moth fitted with floats. The aircraft was nicknamed the "Pelican" and was delivered in November 1926 to commence the experimental flights. The decade of the 1930's saw the establishment of both international and domestic passenger services in the country. Imperial Airways provided international passenger services while internal (domestic) air services were provided by Wilson Airways.

IMPERIAL AIRWAYS

During these pioneering years, the Imperial Airways, the forerunner of British Overseas Airways Corporation (BOAC) arranged for an experimental airline to leave Croydon (England) for Nairobi in January 1929. It carried a limited number of passengers. This is often regarded as the "First commercial flight" from England to the colonies. In January 1932, the London-Cape Town Services were initiated and the route was changed, passing through Nairobi instead of through Mwanza. The journey was reduced to seven (7) days from the original ten (10) days on a once weekly frequency. Initially passengers were carried up to Nairobi, being the only sector which had been adequately surveyed until 27th April, 1932, when they were allowed on the Nairobi-Cape section . In 1933, there was a considerable increase in the number of air passengers carried by Imperial Airways as a result of the need for haste in the journey to Kakamega. Engineers, businessmen and fortune seekers were booking through Kisumu, from where they could rush to Kakamega, about 60 kilometres away, to try their luck in gold prospecting. Flying was seen as the fastest means of transport. In July 1933, the Imperial Airways introduced a "shuttle" service between Nairobi and Kisumu. 17 passengers were ferried at a time. A route through Marseilles, Alexandria, Kisumu, Mombasa and Durban was developed to serve the coastal towns of Mombasa, Dar es salaam, Beira and Durban. On 1st April 1940, Imperial Airways merged with BOAC.

2.12.2 DOMESTIC AIR SERVICES

WILSON AIRWAYS

As already indicated, domestic air passenger services in Kenya were offered by Wilson Airways. Wilson Airways was the first air transportation company in East Africa. The airline was established in July 1929 and was named after its founder, Mrs. Florence Kerr Wilson. The airlines' headquarters was at Mombasa. The airline had offices in Nairobi near the present Phoenix House on Kenyatta Avenue. Inaugural flight was undertaken in November 1929. Trial runs were conducted thus pioneering what would eventually become the first network of air service routes on the continent. The operations of Wilson Airways were based at an airfield at Dagoretti Corner consisting of a strip of land at the junction of the main roads to Naivasha and Ngong, now occupied by the Dagoretti Corner shopping centre. The area was chosen because it was flat and free of obstructive objects such as trees. The grass in the field was kept level by goats and sheep (Wanyanga, 1988). Wilson Airways used the airfield for one year before moving to Nairobi West (now Wilson Airport).

By June 1930, the airline had flown about 160,000 kilometres (100,000 miles) over a period of ten months thus proving how important an air service would be to Kenya. Settlements were far between and road communication was still poor and seasonal. The speed and independence of air transport from surface infrastructure, except for landing and take-off, proved their worth. Travel was faster and seasonal roads did not interfere.

In August 1932, Wilson Airways introduced a regular scheduled airmail service and passenger service between Nairobi and Dar-es-Salaam through Zanzibar, Tanga and Mombasa on a weekly basis, with a Thursday departure from Nairobi and a return flight leaving Dar-es-Salaam on Saturday. The inauguration of this service operated the first inter-territorial communication linking East African towns with the main Imperial Airways Trans-Africa Air route.

On 17th October 1932, Wilson Airways launched another Weekly service this time to Entebbe through Nakuru, Kisumu and Jinja. Both services quickly became popular so that by the end of October, the frequency of their operations had to be increased to twice weekly so as to accommodate all the passengers. This marked the development of the first domestic (internal) air routes in East Africa.

Although air transportation was gaining in popularity at this time, still the railway was a `great rival' in many ways leaving air travel to those in a hurry. Nevertheless, it was gradually replacing the `safari-on-foot' and `ox-wagon' on many routes. By 1938, Wilson Airways had expanded its services and was then operating a variety of scheduled feeder air services connecting directly to the Imperial Airways Trans-African Flying Boat Service at Kisumu (Fig. 2.16).

Apart from the scheduled services operated by Wilson Airways many special charters were also operated by the domestic airline. In 1938, Wilson Airways carried 4,794 passengers, flew more than 1.6 million kilometres (one million miles), a third of which were charters. The airline was forced into voluntary liquidation following the outbreak of the Second World War in 1939. Its assets were acquired by the Kenya Auxiliary Air Unit. The airline represented a major step in the development of aviation in East Africa and especially in Kenya.

AERODROMES

When experimental flights were made to establish the Cairo-Cape Town air route, there were no known aerodromes or landing grounds in Kenya at all. Many of the inaugural landings were made on grass stretches selected by pilots while in the air. In order to facilitate and control the development of aerodromes and landing grounds the government, by authority derived from the Air Navigation Colonies, Protectorates and Mandated Territories) Order in Council, of 1927, issued a circular in June 1928 detailing the procedure for selection, preparation and maintenance of landing grounds. The circular classified the landing grounds in three (3) categories:

a) Government owned and managed civil aerodromes

b) Private civil aerodromes licensed for use by all or particular type of aircraft.

c) Private unlicensed aerodromes which were not open to general public use and which would not be used for regular carriage of passengers for hire or reward.

The earliest aerodromes and landing grounds in Kenya are shown in Fig. 2.16. As flying became more popular and widespread in the country more landing grounds were constructed by private individuals, the Royal Air force, Air Charter operators and especially Wilson Airways, the Air Ministry and the colonial government. By 1933, the Nairobi West aerodrome (now Wilson Airport) had already become the "busiest airport in Africa" a position it holds even today. Between January 9th and January 13th, 1933, 23 aircraft were handled in only 5 days at the airport (Wanyanga, 1988, 162). By 1938, there were about 31 airfields in Kenya. These are shown in table 2.12.

Many early landing grounds and aerodromes were difficult to use for several reasons. The main ones were:-

a) Undergrowth in some cases covered the airfields sooner than was expected.

b) Anthills sprung out before airfields could even be used.

c) Wild animals used the runways more often than aircraft.

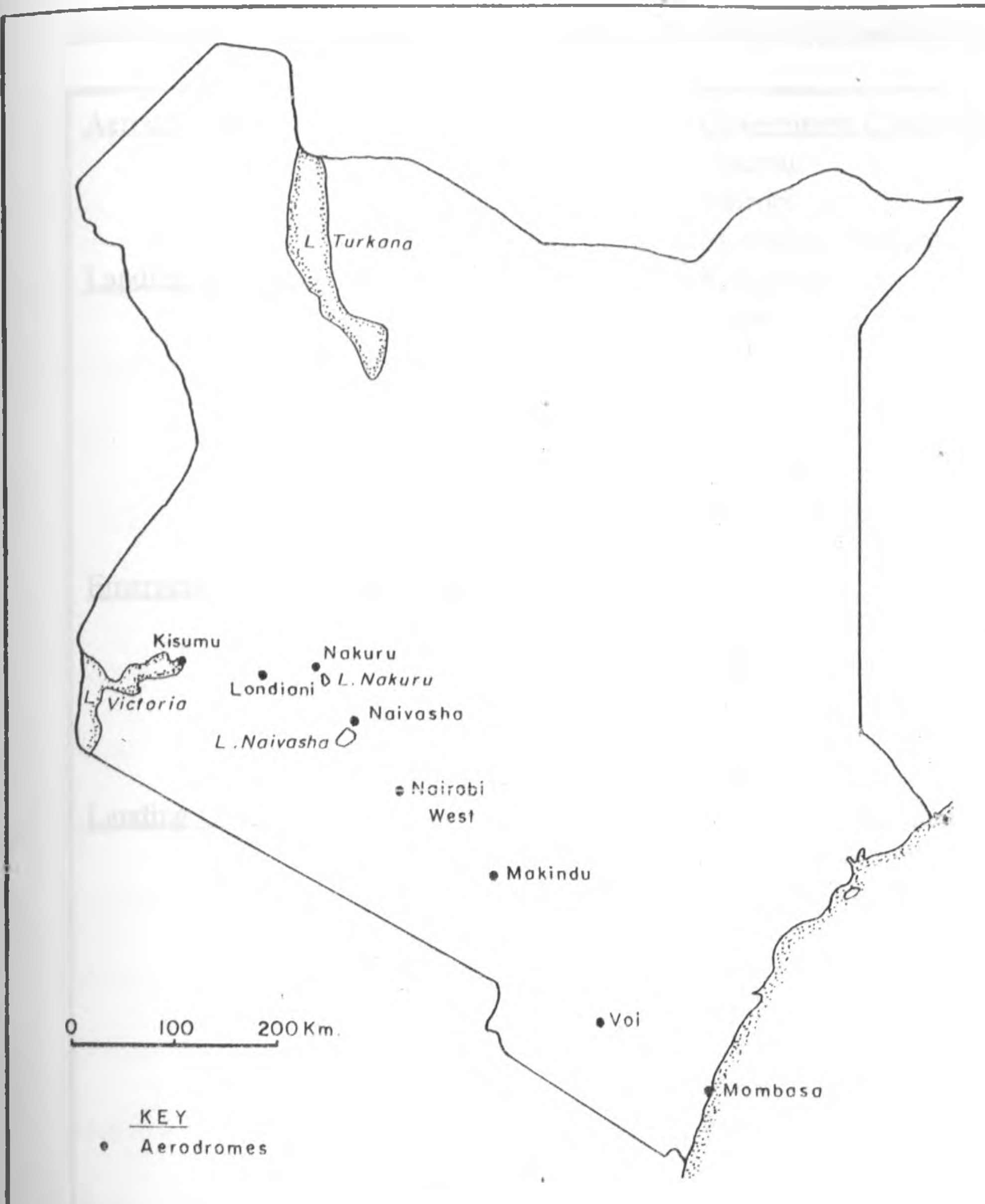


Figure 2.16 Earliest Aerodromes in Kenya, 1930.
Source: Fieldwork.

Table 2.12 : Aerodromes, Landing Grounds and Emergency Landing Grounds in Kenya, 1938.

Aerodromes	Government Controlled Kisumu Nairobi Mombasa (Shimanzi)
Landing Grounds	Kakamega Lamu Naivasha Nanyuki Nyeri Rumuruti Masara (Kisii) Isiolo
Emergency Landing Grounds	Kitui Mackinnon Road Makindu Narok Tsavo Voi
Landing Grounds	Privately Controlled Eldoret (Licensed) Harris' Farm, Athi River (Unlicensed) Kilifi (Unlicensed) Kima (Unlicensed) Kitale (Licensed) Malcader Mines (Licensed) Magadi (Unlicensed) Malindi (Unlicensed) Nakuru (Licensed) Njoro (Licensed) Sotik (unlicensed) Taveta (Unlicensed) Timau (Unlicensed) S.N. Turner's (Nyeri) - (Unlicensed)

Source: Kenya Colony and Protectorate, Blue Book for the year ended 31st December,1938.

The outbreak of World War II interrupted the development of air transportation in Kenya. Civil Aviation activities in the country ceased, and the aircraft, aerodromes, personnel and general aviation facilities were taken over for military purposes. The Air Navigation (Air Restrictions) Order of 1939, prohibited the flight or surface movement of all aircraft other than military or state aircraft. The Order remained in force until November 1945.

2.12.3 POST-WAR DEVELOPMENT

After the war, the British government embarked on a determined programme of economic rationalization among public services: civil aviation sector, railways, harbours, postal services and telecommunications. At this time, civil aviation world wide, but particularly in the British Empire, was foreseen as having a key role to play in interconnecting remote locations (Hogenauer, 1975). The British, using B.O.A.C., divided Africa into geographical groupings of airlines into:- a) East b) West and c) Central African Airways: East African Airways Corporation (E.A.A.C.) in 1945, Central African Airways (C.A.A.) in 1946, and West African Airways Corporation (W.A.A.C.) also in 1946. In retrospect, it appears that, in Africa, the British were reasonably foresighted, establishing, considerably ahead, of the day of independence, airlines, which could act as regional feeders to the international airline of the colonial power. In this way, they may have hoped to retain some economic influence in the new states, leading to some sort of aviation neocolonialism (Thornton, 1970, 118-119).

INTERNATIONAL AIR SERVICES

The British dependencies in East Africa formed a natural corridor through which aviation routes from North and South Africa were destined to pass. Several regular scheduled International Air Services operated into and out of Kenya by 1947. These were:-

a) Spring Bok Services employing "York" Aircraft operated by B.O.A.C. between England and South Africa calling at Nairobi only, in East Africa. Its frequency of service was thrice weekly in both directions.

b) Spring Bok service employing "Skymaster" aircraft operated by South African Airways (S.A.A.) between South Africa and England calling Kisumu only, in East Africa. It frequency of service was thrice weekly in both directions.

c) The B.O.A.C. Regional service between Cairo and Nairobi via Kisumu. Its frequency of service was thrice weekly both ways.

d) Central Africa Corporation (C.A.A.) service employing Vickers Viking aircraft between Salisbury (now Harare) and Nairobi through Zambia (the Northern Rhodesia). This service operated twice weekly in either direction.

Table 2.13 : Scheduled International and Regional Air Services in Kenya, 1955.

Scheduled Trunk Route Services	
B.O.A.C:	London-Rome-Cairo-Khartoum-Entebbe-and/or Nairobi (Standard Service) London-Rome-Cairo-Khartoum-Entebbe (Optional) - Nairobi (tourist service) London-Rome-Cairo (Optional) - Khartoum-Nairobi-Livingstone-Johannesburg (tourist service) London-Rome-Cairo (Optional) - Khartoum-Nairobi-Livingstone-Johannesburg (standard service)
S.A.A:	Johannesburg-Livingstone (Optional)-Lusaka (Optional) - Lusaka (Optional) - Nairobi-Khartoum-Cairo-Athens-Rome-Frankfurt (Optional) - Paris (Optional) - London Johannesburg-Nairobi-Cairo-Rome-London (standard service)
Air France:	Paris-Rome-Cairo-Khartoum-Nairobi-Tananarive
Air India:	Karachi (Optional) - Aden-Nairobi
Scandinavian Air System (S.A.S):	Points in Sweden-Copenhagen-Hamburg-or Amsterdam-Frankfurt-Zurich-Rome-Athens-Lydda or Cairo-Khartoum-Nairobi-Durban or Johannesburg
El Al: (Israel Airline)	Lydda-Nairobi-Johannesburg-Tel Aviv
Regional Scheduled Services	
Aden Airways:	Aden-Hargeisha-Mogadishu-Nairobi
E.A.A.C:	Nairobi-Mombasa-Dar es Salaam-Lindi-Mozambique-Quilimane-Beira (Optional) -Maputo-Durban Nairobi-Dar es Salaam-Blantyre-Salisbury (Harare)-Durban Nairobi-Tabora-(Optional)-Abercorn-Lusaka-Salisbury (Harare)
C.A.A:	Salisbury (Harare)-Lusaka-Ndola-Tabora-Nairobi Salisbury (Harare)-Blantyre-Dar es Salaam-Nairobi
Ethiopian Airlines:	Addis Ababa-Nairobi
Sabena:	Bukavu-Bujumbura-Entebbe-Nairobi

Source: Kenya Annual Report: Aviation Section (1955) pp 1-2

e) Air France Service between Paris and Madagascar via Nairobi employing Douglas D.C. 4 Aircraft. Its frequency was once weekly either way.

f) Ethiopian Airlines service between Addis Ababa and Nairobi employing Dakota Aircraft. It operated once weekly in either direction.

By 1955 the number of scheduled International Air services into and out of Kenya increased considerably (Table 2.13). Fig. 2.18 shows regular domestic air routes in Kenya in 1947.

DOMESTIC AIR SERVICES

An Advisory Committee to the conference of East African Governors concluded that public support for civil aviation was essential and that private ownership was infeasible. This was not unlike the pattern in other countries of Africa and elsewhere. The proposed airways system for East Africa was to be primarily a feeder operation for the long-haul routes of the B.O.A.C. (the Imperial Airways post-war successor). The Committee concluded that: "It is indeed manifest that for the purpose of development and controlling Air transport in East Africa the four governments must act as one and constitute for themselves central authority for this purpose" (Hill, *et al.*, 1968, 2).

The East African Territories (Air transport) Order in Council, approved in Britain on October 30th, 1945, established an East African Air Authority consisting of the officers administering Kenya, Uganda, Tanzania mainland (then Tanganyika) and the British resident at Zanzibar and for the formation of the region's airline - the East African Airways Corporation (E.A.A.C.). The functions of the E.A.A.C. were:-

a) To secure fullest development consistent with the economy of efficient air transport services within the East African Territories.

b) To ensure that such services were operated at reasonable charges.

c) To acquire aircraft, aerodromes and to operate air services.

East African Airways Corporation (E.A.A.C.) was run by a Board of Directors consisting of a Chairman appointed by the authority, and five members, three of whom were non-civil servants. The Corporation was inaugurated in January 1946. It operated six new DH 85 "Dominie" aircraft and four old "Rapid" aircraft. It took over all the internal air services including the BOAC services into and through East Africa. The initial route pattern originated at the Lake Victoria ports of Entebbe and Kisumu and extended in a broad area through Nairobi, Mombasa to Moshi and Dar es Salaam via Tanga and Zanzibar.

The internal regular scheduled services within Kenya and in other parts of East Africa were:

a) Nairobi-Mombasa and return (daily)

b) Nairobi-Moshi-Dar es Salaam (thrice weekly)

c) Nairobi-Kisumu-Entebbe and return (thrice weekly)

d) Dar-Zanzibar-Tanga-Mombasa and return (thrice weekly)

e) Dar-Moshi-Nairobi (thrice weekly)

The operations of the airline were initially handicapped by a shortage of qualified pilots to serve all the service routes, aircraft maintenance problems, delays in operating certain routes and adverse publicity of early air crash.

In April 1948, E.A.A.C. introduced a new service- "the businessmen's express" between the various urban centres in East Africa. The service was operated by Lockheed Lodestars[2] and Doves, which were new comers in the service of the airways. The new service took a businessman to Mombasa in one and half hours (1.5 hrs) and Kisumu in one hour (1 hr). This enabled a businessman to make his return trip on the same day. The Lodestars were equipped with the latest navigation aids; including high frequency (HF) radio telephone, direction finding loops and long range wireless. Both aircraft carried radio operators and could maintain communication with Nairobi from any point in East Africa.

By 1953, economic development in the post-war colonial era had continued to result in considerable airline growth. The initial arc changed and shifted from Lake Victoria ports to Nairobi. E.A.A.C. replaced Lodestar with Dakota. In March 1957, the airline began international air services to Europe and Asia. It operated scheduled service once a week to UK, twice a week to India and Pakistan via Aden and once a week to Rhodesia (currently Zimbabwe). As the colonial era drew to an end, the airline became more concerned with international services.

AIR CHARTERS

Many aircraft operators became established in the country during 1947 and, with some slight improvement in the supply of aircraft, they undertook a considerable and increasing volume of air charters and instructional flying. Table 2.14 shows the air charter companies based in Nairobi. Although these air charters were based in Nairobi, they operated throughout East Africa.

Air survey, photography and crop spraying were catered for by charter operators. In 1956, aircrafts flew a total of 1,250 hours and sprayed 20,000 hectares (50,000 acres) of crop land. Aerial prospecting was being carried out with rudimentary equipment for the detection of radio-active and other precious minerals.

Table 2.14 : Air Charter Operators Based in Nairobi, 1947

Operators	Services
Caspair Air Charters and Agencies Ltd.	Instructional Flying
Campling and Brothers and Vanderwal Ltd.	Charter and Instructional Flying
Uganda Co. Ltd.	Charter and Instructional Flying
Noon and Pearce Air Charters	Charter and Instructional Flying
Clairways Ltd.	Charter
E.A.A.C.	Charter
African Air Cars	Charter
Aero Club of East Africa	Charter and Instructional Flying
Write and Hayter	Charter
H.D. Hooper	Charter and Instructional flying
Air Work Ltd.	Freight Charter only

Source: Fieldwork, 1991

Table 2.15 : Aerodromes, Landing Grounds and Emergency Landing Grounds in Kenya, 1955.

Airfield	Elevation (m)	Dimensions (m)	Class[3]
Amboseli	1050	1350	P
Banya	372	900	GM
Buna	750	900	GM
Derkali	900	810	GM
Eldoret	2100	1350	G
El Wak	390	810	GM
Fort Ternan	1410	1440	P
Garissa	120	900	G
Hogitcho(Marsabit)	900	1350	G
Ileret	510	1584	G
Isiolo	1000	1000	G
Kagio	1200	900	E
Kericho	1900	900	G
Maralal	1770	1100	G
Kisumu	1100	1800	G
Kitale	1875	1620	G
Kitui	1137	810	GM
Loitokitok	1350	900	GM
Lamu	7.5	810	GM
Lodwar	510	1080	G
Lokitaung	540	900	G
Narok	1875	810	GM
Macalder	1200	1050	LP
Mackinnon Road	353	1350	G
Magadi	653	1710	P
Makindu	983	900	GM
Manda Island	6	675	E
Malindi	15	900	P
Mandera	360	1170	G
Mweiga	1950	900	EP
Marsabit	1260	1080	G
Mombasa	56	1800	GC
Moyale	825	1170	G
Mtito Andei	729	1350	G
Muddo Gashi	180	1125	GM
Murka Hill	1050	1440	LP
Mwatate	750	990	LP
Nairobi(Eastleigh)	1600	2400	RAF, C
Nairobi West	1660	1440	GC
Nakuru	1860	1710	G
Nanyuki	1842	1350	G
Nginyang	825	900	GM
Njoro	2130	1440	P
North Horr	420	1800	G
Nyeri	1750	1170	G
Rumuruti	1800	1350	G
Subukia	1935	1170	LP
Taveta	750	1170	G
Thompson's Falls[6]	2220	1530	G
Toidenyany	360	1350	G
Voi	510	1125	G
Wajir	300	1350	G

Source: Kenya Annual report, 1955.

AERODROMES

The gradual multiplication of aerodromes and landing grounds was part of the overall growth of civil aviation in the country. As the number of aircrafts grew, so did the number of aerodromes and landing grounds in Kenya. The number of aerodromes and landing ground increased rapidly so that 52 aerodromes and landing grounds were in use by 1955.

Many landing grounds in North Eastern Kenya were constructed or rehabilitated for Desert Locust Control or administrative purposes. Table 2.13 shows the main aerodromes, landing grounds and emergency landing grounds in Kenya in 1955. In the 1950s, Eastleigh Airport (Nairobi) and Nairobi West had become very important aerodromes in Kenya due to the volume of traffic they were handling. For example, in 1954, Eastleigh Airport handled 784 aircraft movements, 18,900 passengers and 323 kilogrammes of freight. In the same year, Nairobi West handled 1148 aircraft movements, 8,200 passengers and 204 kg of freight. In the following year, Eastleigh Airport handled 887 aircraft movements, 21,700 passengers and 353 kilogrammes of freight while Nairobi West handled 1293 aircraft movements, 8,200 passengers and about 286 kilogrammes of freight (Kenya Annual Report, 1955).

Eastleigh Airport had served air traffic since 1943. As a result of great demand in air travel and the great technological development in the size and speed of aircraft, Eastleigh Airport became inadequate. The airport had inadequate passenger reception facility, the waiting room would only sit 30 passengers, which was smaller than the seating accommodation of some of the big airlines. In 1951, Sir Alexander Gibb and Partners (Africa) were commissioned as consultants to proceed with a preliminary project report on a new airport at Embakasi. This report was presented to the Kenya Government in January 1952. The proposals contained in the report were subjected to a detailed examination by the Ministry of Transport and Communications and Civil Aviation and the Kenya Government Department of Public Works between June 1952 and April 1953. The Kenya Legislative Council gave authority to proceed with the project in May 1953 at an estimated cost of £1,500,000. Construction work began at the new Nairobi Airport Site at Embakasi on the Athi Plains in 1954. It was situated 16 kilometres from the city centre. The new airport consisted of a modern terminal building with a wide variety of amenities such as restaurants, bars, a shop and a bank. It had a 15 m (50 ft) high air Traffic Control Tower. The runaway was 3,000 metres (10,000 ft) long and 600 m (2,000 ft) m wide. It was laid on a line 54° East of North to avoid the Ngong Hills and Ol Donyo Sabuk and to take maximum advantage of the prevailing winds. The new airport was opened on March 7th 1958. In 1958, 168,000 passengers were handled at the new airport. The volume of passenger traffic continued to grow and in 1961, 391,000 passengers were handled at the airport. About 15 international airlines were operating through the airport. By 1962, Nairobi airport had become one of the most modern airports on the African routes. The runway was extended to 4,000 metres (13,500 ft) in order to facilitate the operation of the large jet aircraft. During this time, it handled the largest volume of air cargo in Africa South of the Sahara. The handling of this air cargo provided a considerable export outlet for Kenya's primary produce. Regular consignments of dairy produce, eggs, fruits and fresh vegetables were air

freighted to Aden, whilst during the seven (7) month period covering the European late Autumn, winter and early spring, an average of nine (9) tons of tropical fruits, fresh beans and strawberries and two (2) tons of vegetables used in the preparation of Eastern and special dishes were consigned each week to the U.K. The airport also handled a variety of imports including urgently needed mechanical spares, industrial equipment, pedigree livestock, vaccines, newspaper, domestic pets and beginning of season supplies of grapes.

2.12.4 POST-INDEPENDENCE DEVELOPMENT

INTERNATIONAL FLIGHTS

With the attainment of independence, it became necessary for the East African countries to renegotiate all the agreements previously entered into on behalf by the government of United Kingdom. This involved the review of traffic rights for all the scheduled foreign airlines operating into and out of East Africa. The operations of scheduled services over or into the territory of a contracting state depends upon the special permission or other authorization of that state as stipulated expressly in Article 6 of the Chicago convention (1944). The privileges of transporting passengers, cargo and mail through or into or beyond the territory of a given state were categorized by Chicago Conference into five (5) Freedoms of the Air. These traffic rights or Freedoms of the Air are summarised in Fig 2.17

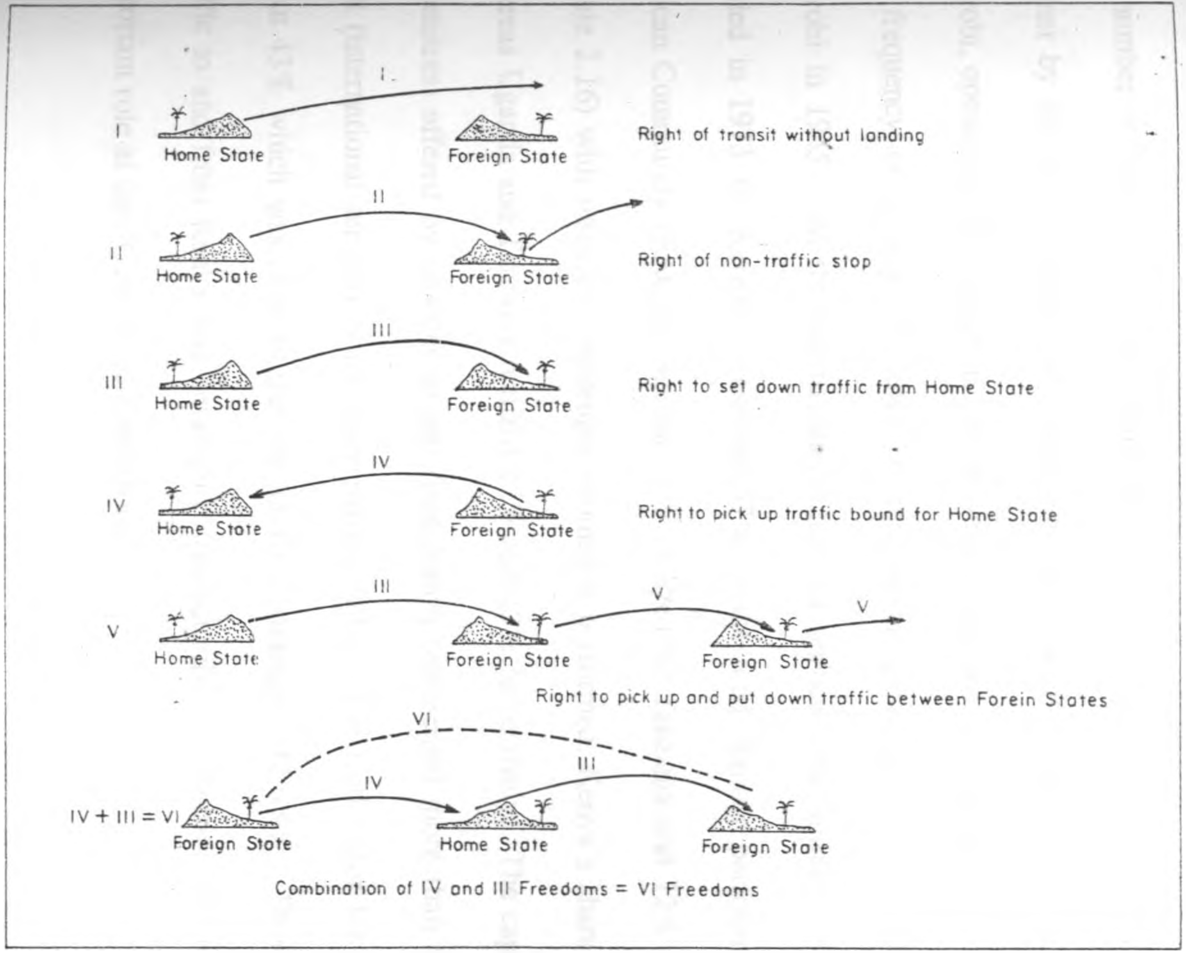


Figure 2.17 Freedoms of the Air.
Source: Kissling, C.C. (1981), pp 208.

During 1963, negotiations were completed with the government of U.K. and Germany. The main objective of these negotiations was to protect the interest of East Africa's national airline, the East African Airways Corporation (EAAC). In 1965, one more international airline, the Pan American World Airways (PAN-AM) was added to the number of heavy jet operators using Nairobi airport. The introduction of a DC8 jet airliner by this new company, providing non-stop scheduled flights between Lagos and Nairobi, opened the first direct air link between Kenya and West Africa. Fig 2.18 shows the frequency of weekly scheduled commercial air passenger services to and from Nairobi in 1965. On the international scheduled services, the number of passengers carried in 1973 for Kenya represented 57% of the total number performed by East African Community (EAC) as against 31% realized by Tanzania and 12% by Uganda (Table 2.16) with respect to passenger-kilometres performed, Kenya's share was 70%, whereas Uganda and Tanzania realized 17% and 13% respectively. The capacity (seat-kilometres) offered by services to and from Kenya represented more than 69% of the total (international service) of the three partner states. The load factor for Kenya was about 43% which was close to the one for the community (42.6%)[4]. Thus, passenger traffic to and from Kenya was developing satisfactorily and Nairobi airport played an important role as the "Gateway to East Africa".

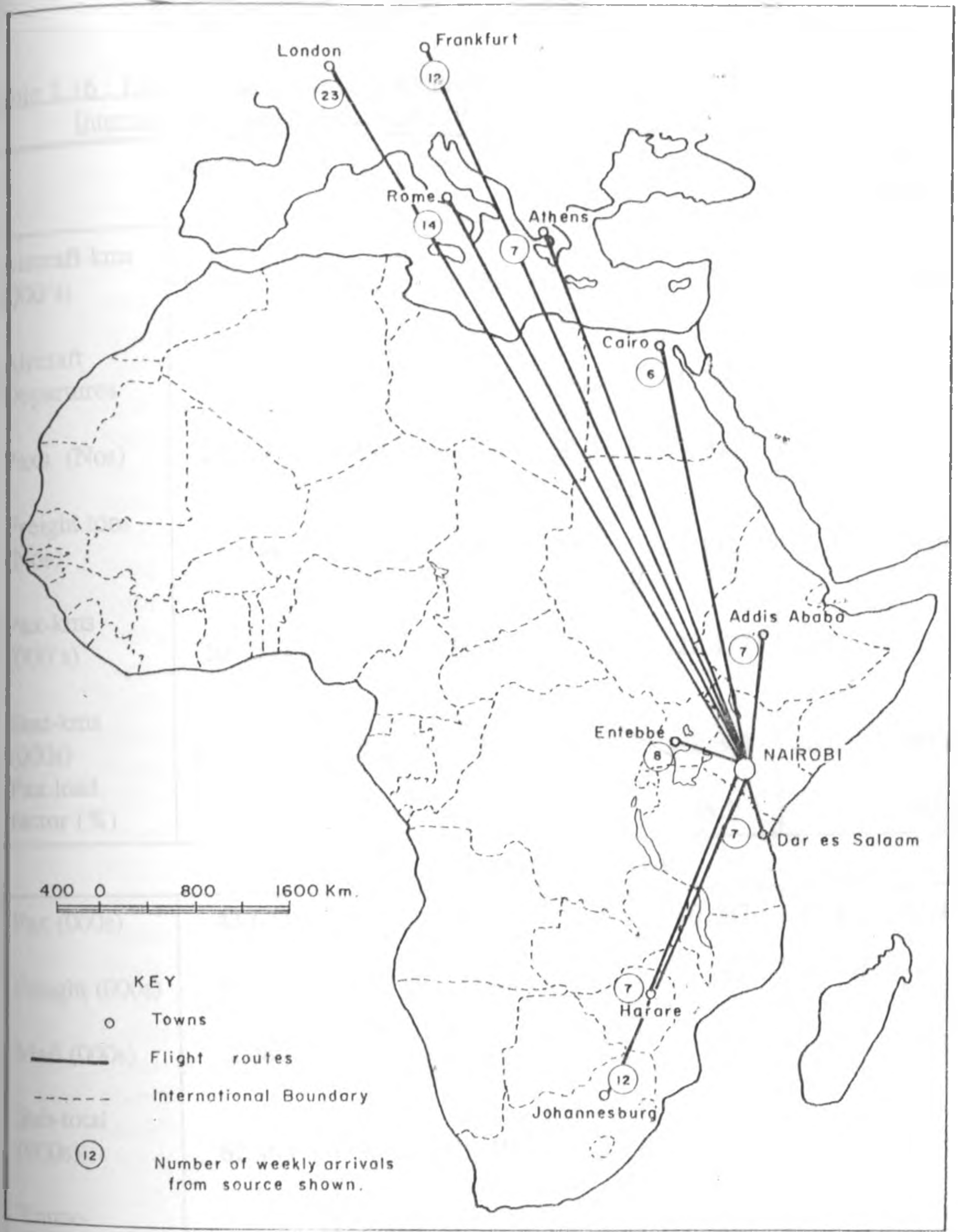


Figure 2.18 TEN CHIEF SOURCES OF DIRECT SCHEDULED COMMERCIAL AIR PASSENGER SERVICE TO NAIROBI, 1965.

Number of weekly arrivals from sources shown.

Source: Fieldwork

Table 2.16 : East African Airways Corporation Traffic : International Scheduled Services, 1973

	Kenya	%	Tanzania	%	Uganda	%	East Africa	%
Aircraft-kms (000's)	8,548	66.0	1,580	12.2	2,826	21.8	12,954	100
Aircraft Departures	6,281	55.2	3,369	29.6	1,734	15.2	11,384	100
Paxs (Nos)	245,142	57.0	130,874	30.5	52,417	12.5	428,434	100
Freight tons (Nos)	6,044	57.3	2,362	22.5	2,141	20.3	10,547	100
Pax-kms (000's)	507,544	70.3	92,099	12.8	122,477	16.9	722,120	100
Seat-kms (000s)	1,179,546	69.6	175,538	10.4	338,604	20.0	1,693,688	100
Pax load factor (%)	43.0	-	52.5	-	36.2	-	42.6	-
Tonne-kms (Performed)								
Pax (000s)	43,623	69.8	8,000	12.8	10,487	17.4	62,470	100
Freight (000s)	16,754	63.7	2,094	8.0	7,438	28.3	26,286	100
Mail (000s)	2,086	68.8	401	13.2	544	18.0	3,031	100
Sub-total (000s)	62,463	68.0	10,495	11.5	18,829	20.5	91,787	100
Tonne-kms(Av.)	143,543	67.8	22,614	10.7	45,439	21.5	211,596	100
Wt. Load(%)	43.5	-	46.4	-	41.4	-	43.4	100

Source: East African Statistical Department, 1973.

Table 2.17: List of Commercial Air Carriers Registered in Kenya,1980

	Country	Designated Airline	Place and Date air service agreement was initiated
1	Belgium	Sabena	Brussels, 14/6/78
2	Denmark	Scandinavian Airlines System	Nairobi, 23/11/78
3	Egypt	Egypt air	Nairobi, 24/6/78
4	Ethiopia	Ethiopian Airlines	Addis Ababa, 18/3/78
5	France	Air France	Nairobi, 28/10/77
6	Greece	Olympic Airways	Athens, 19/5/78
7	India	Air India	New Delhi, 3/11/77
8	Italy	Alitalia	Rome, 3/8/78
9	Mauritius	Air Mauritius	Port Louis, 18/1/78
10	Netherlands	KLM Royal Dutch Airlines	Nairobi, 13/8/78
11	Nigeria	Nigerian Airways	Nairobi, 29/9/78
12	Rwanda	Air Rwanda	Nairobi, 4/2/79
13	Seychelles	Air Seychelles	Victoria, 4/7/78
14	Sudan	Sudan Airlines	Nairobi, 23/9/78
15	Switzerland	Swiss Air	Nairobi, 27/8/77
16	Spain	Iberia	Nairobi, 14/6/78
17	Uganda	Uganda Airlines	Nairobi, 25/10/78
18	United Kingdom	British Airways	London, 7/3/78
19	West Germany	Lufthansa	Nairobi, 11/11/77
20	Zambia	Zambia Airways	Nairobi, 12/11/77
21	Pakistan	Pakistan International Airlines	Karachi, 1/11/78
22	North Yemen	Yemen Airways	Sansa, 1/10/79
23	Djibouti	Air Djibouti	Nairobi, 8/11/79
24	Ireland	Air Lingus	Nairobi, 31/10/79
25	South Korea	Korean Airlines	Nairobi, 25/10/79
26	Singapore	Singapore Airlines	Singapore, 24/11/79
27	Madagascar	Air Madagascar	Nairobi, 25/9/79
28	South Yemen	Alyemda	Nairobi, 3/1/78
29	Saudi Arabia	Saudi Arabian Airlines	Nairobi, 18/3/80
30	Cameroon	Cameroon Airlines	Negotiations pending
31	Israel	El Al (Israel) Airlines)	Negotiations pending
32	Malawi	Air Malawi	Negotiations pending
33	Somalia	Somalia Airlines	Negotiations pending
34	USA	Pan American	Negotiations pending
35	USSR	Aeroflot	Negotiations pending
36	Zaire	Air Zaire	Negotiations pending

Source: Fieldwork, 1991

By 1980, there had been established a reasonably high level of international air services, both scheduled and non-scheduled. 36 international scheduled and 10 non-scheduled airlines operated services to and from Kenya. Table 2.17 shows the international commercial air carriers registered in Kenya in 1980.

Today (1993), there are about 34 international scheduled airlines operating services to and from Kenya. The Air Canada, American Airlines, Japan Airlines, Transworld Airlines, Varig and Royal Zwazi Airways are the new Airlines registered in Kenya. Alyemda, Air Lingus, Air Djibouti, Korean, Pan-Am, Singapore, Yemen and the Scandinavian Airlines System (SAS) do not currently operate air services in and out of Kenya.

International air services have penetrated the Kenyan tourist market and have contributed to the rapid development of tourism in the country. For example, the introduction of charter flights from Europe to Kenya (especially West Germany and Switzerland) in 1965, increased steeply the air tourists visiting Kenya. Table 2.18 shows the main International air charters operating in Kenya.

Table 2.18 : International Air Charters Operating in Kenya, 1980

Air Condor
African Safari Airways
Trans-Meridian Air Cargo
Trans International Airways
Cargo Lux
Air Charter International
Flying Tiger
Nomads
Balair Limited
Air Comoro

Source: Fieldwork, 1991

DOMESTIC AIR SERVICES

On the domestic scheduled services, the number of passengers carried in 1973 for Kenya represented 43% of the total number carried in the East African Community as against 57% of Tanzania. With respect to passenger-kilometres performed, Kenya's shares 55%, whereas Tanzania realized 45%. The capacity (seat-kilometres) offered by services to and from Kenya represents 55% of the total domestic scheduled services of the three former East African Community States. The load factor is slightly higher than the one for the East African Community (Table 2.19)

Table 2.19 : East African Airways Traffic, 1973: Domestic Scheduled Services

	Kenya	%	Tanzania	%	Uganda	%	East Africa	
Aircraft Kms (000s)	1,468	41	2,109	59	-	-	3,577	100
Aircraft Depart. (Nos)	3,624	31	8,174	69	-	-	11,798	100
Pax (Nos)	95,612	43	125,970	57	-	-	221,582	100
Freight tonnes	584	32	1,235	68	-	-	1,819	100
Pax Kms (000s)	42,225	55	35,101	45	-	-	76,326	100
Seat Kms (Av.No)	64,994	55	53,579	45	-	-	118,573	100
Pax Load factor (%)	65	-	65.5	-	-	-	64.4	100
Tonne-Kms Performed (000s)								
Pax	3,518	54.0	2,996	46.0	-	-	6,514	100
Freight	255	35.0	473	65.0	-	-	728	100
Mail	53	27.5	140	72.5	-	-	193	100
Sub Total	3,826	52.0	3,579	48.0	-	-	7,406	100
Tonne-Km (Av 000s)	7,334	57.0	5,542	43.0	-	-	12,876	100
Wt. Load factor (%)	52.2	-	64.6	-	-	-	57.5	

Source: East African Statistical Department, 1973.

The East African Airways Corporation (E.A.A.C.) faced financial problems in 1972 and 1973. By 1976 politics had penetrated the management of the airline. Uganda and Tanzania were unable to remit cash to the airline's headquarters in Nairobi due to lack of foreign exchange. As a result, the airline was forced to suspend some of its international, regional and domestic flights. By 1977, it became apparent that the airline would collapse. The collapse of the East African Airways Corporation led to the development of individual national airlines in East Africa.

THE KENYA AIRWAYS

On 4th February, 1977, Kenya established her own airline, the Kenya Airways (KA). The following day a chartered Kenya Airways Boeing 707 hired from Midlands Airways arrived in Nairobi to provide both domestic and international scheduled services. The objectives of the airline were:

a) To run a safe, profitable and reliable airline.

b) To provide airline related services including cargo handling and engineering services.

c) To provide air services within Kenya and on international routes.

d) To play a significant role in related industries of tourism, trade and commerce of Kenya.

e) To develop skills of Kenyans with the aim of Kenyanising the running of the airline.

Its fleet comprised 3 Airbus A310-300, each offering 12 first, 39 club and 144 economy class seats, 1 Boeing 720, offering 10 first and 114 economy class seats, 1 DC 8, offering 8 first and 88 economy class seats, 2 Fokker friendship each offering 43 economy class seats and 2 Fokker 50 each offering 54 economy class seats.

On the domestic services, Kenya Airways operates 65 flights a week between Nairobi and Mombasa, 24 flights a week between Nairobi and Malindi and 22 flights a week between Nairobi and Kisumu. The flights between Nairobi and Mombasa/Malindi cater for travel requirement by residents as well as providing connections to the Kenya coast for international services. The Kenya Airways Domestic air routes are shown in Fig.2.19a. Kenya Airways also provides international air services to Europe, Asia, Middle East and the Indian Ocean islands and Africa. It offers 8 flights a week to London, 3 flights a week to Rome, 2 flights a week to Frankfurt and once weekly to Paris, Athens and Zurich. On the African continent, the airline provides 2 flights weekly to Bujumbura, Dar es Salaam, Harare, Khartoum, Kigali, Lusaka and Zanzibar (Fig.2.19b).

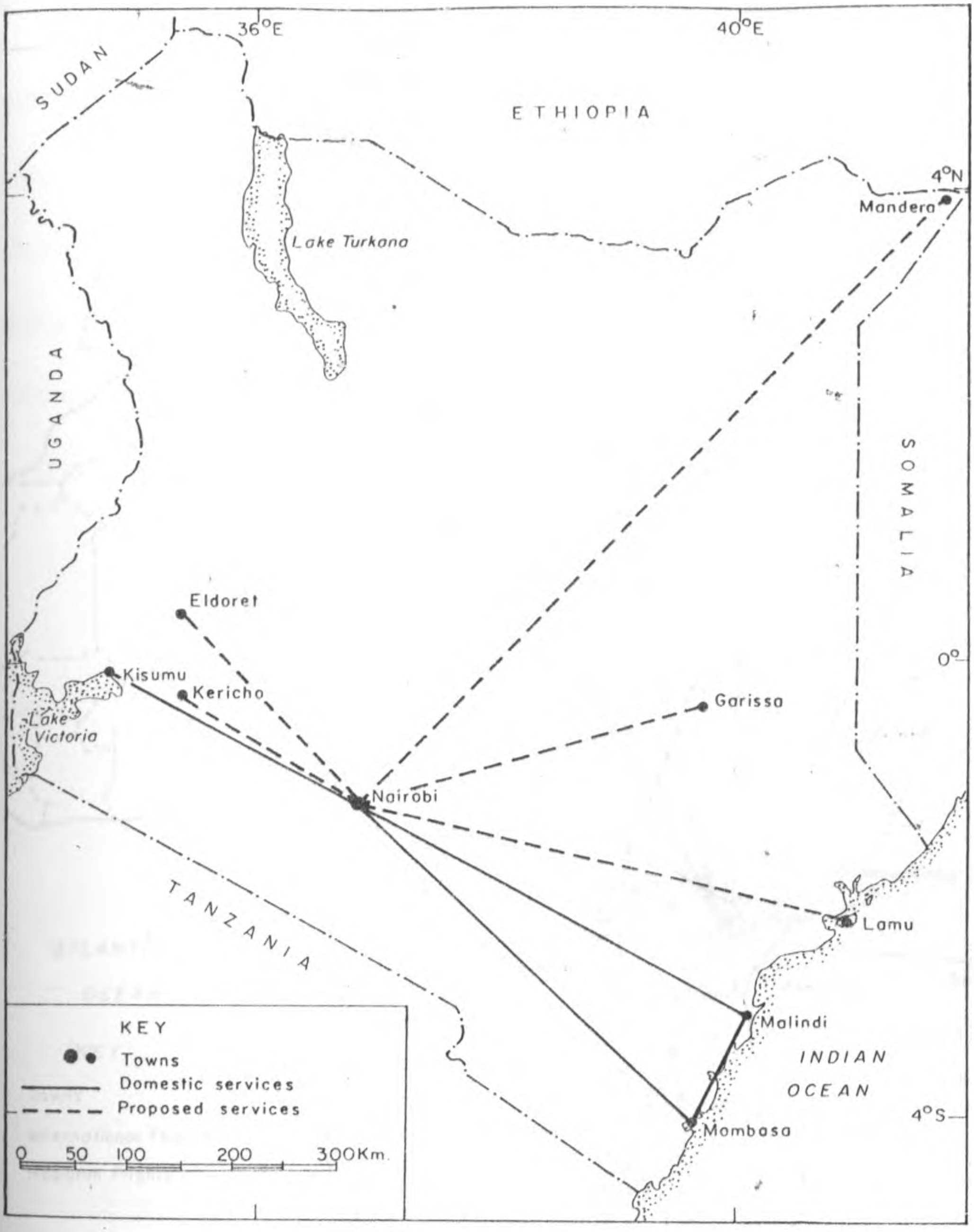


Fig. 2. 19a Kenya Airways Domestic Scheduled Services.
Source: Kenya Airways

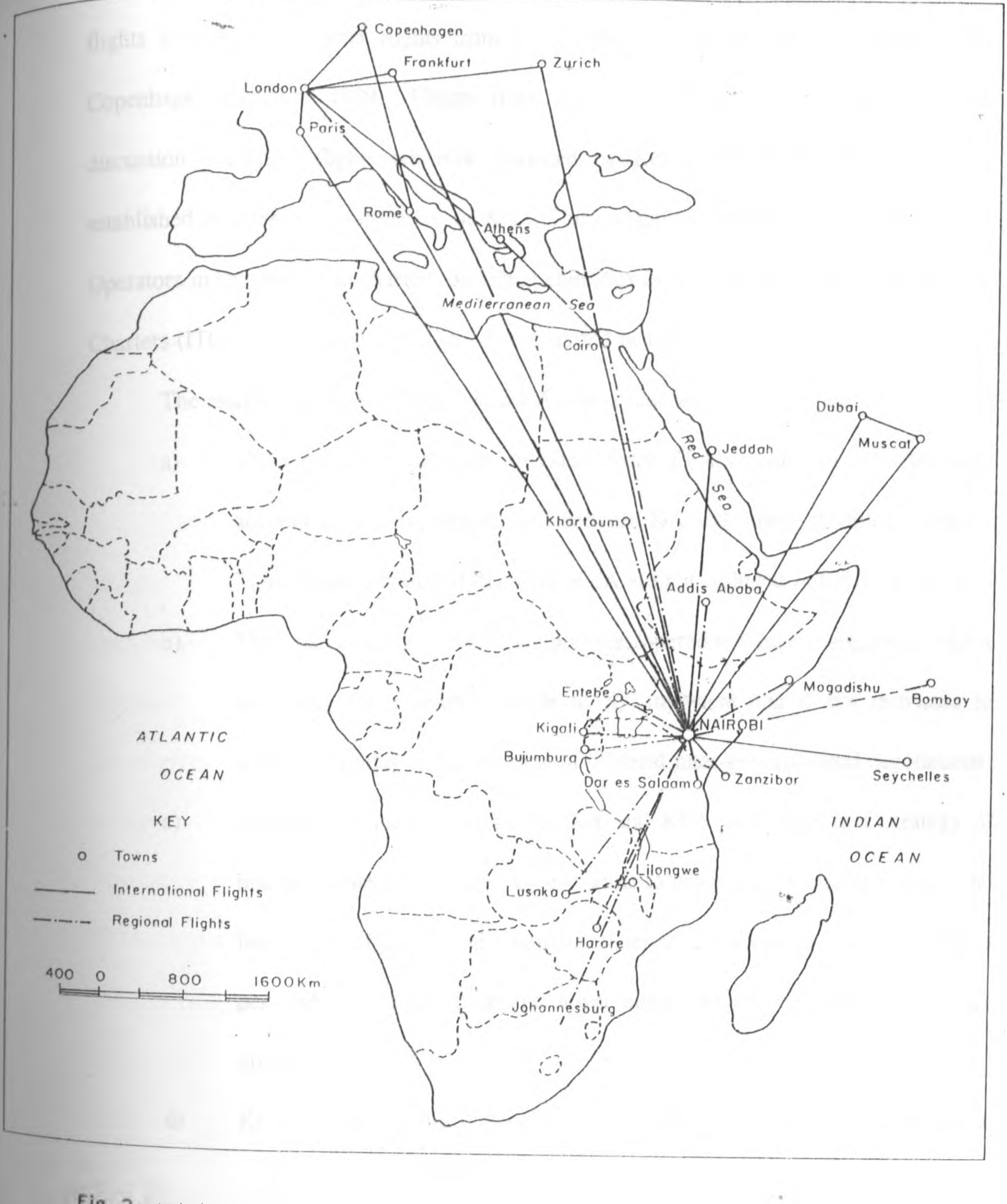


Fig. 2. 19b Kenya Airways Regional and International Scheduled Services.
Source: Kenya Airways.

Kenya Airways has provided charter flights since 1987, when it commenced charter flights from Italy. Charter flights from Paris were provided in 1988 and flights from Copenhagen started in 1989. Flights from Zurich, Edinburgh and London are under discussion. Charter flights are now provided by Kenya Flamingo Airways (KFA), established in 1988 as a subsidiary of KA. The company negotiated with leading Tour Operators in key European charter generating countries in order to generate Inclusive Tour Charters (ITC) from Europe to Kenya. These started in July, 1988.

The establishment of KFA provides KA with a number of advantages:

a) Charter flights which are provided under KFA's name are not taken into account in bilateral negotiations between KA and other scheduled airlines. Thus passengers of and flights by KFA are not included in KA's allocation.

b) The establishment of KFA also provides operational convenience since KFA can apply for a charter license to fly anywhere and is not restricted to scheduled routes or the outcome of bilateral inter-governmental negotiations.

c) Another advantage is to permit KA and KFA to engage in a strategy of market segmentation, whereby KA aims to provide high quality service and facilities to higher income tourists, whereas KFA carries more passengers per unit of aircraft space and fewer additional services and facilities are provided.

d) KFA has the flexibility of being able to cancel flights for which demand is low, subject to adequate notice.

With the introduction of the Airbus, KA is able to increase cargo space to well over 10 tons on the Nairobi-London route which is double the capability of boeing 707. In order to support the country's export drive in horticultural produce, the two Airbuses offer over 80 tons per week of cargo space. KA has a wholly owned subsidiary, Kenya Airfreight Handling Limited, that handles fresh produce and general cargo on behalf of all the airlines using Nairobi Airport. It handles 7 tons of outbound cargo every evening.

LOCAL AIR CHARTER OPERATORS

Local Air charter operators constitute what is referred to as the third-level aviation sector. This sector embraces all commercial aviation in the country apart from the operation of foreign airlines and the national carrier, the Kenya Airways (KA). It operates scheduled, coach and charter passenger services throughout the country and to airports in the neighbouring countries such as Tanzania, Sudan and Zaire (appendix ii). These Air services cater for a variety of needs such as crop spraying, aerial photography and missionary work, but focus on tourist demand to scattered game parks and the coast. By 1975, 14 airline companies provided charter services within Kenya and to other points in the East African community and elsewhere in Africa.

Table 2.20 : Current Local Air Charter Operators in Kenya, 1990

Wilson Airport Base, Nairobi
Air Kenya
Z. Boskovic
Equator Airlines
Prestige Air Services
Safari Air
Western Airways
Skymaster
CMC Aviation
Rent-a-Plane
Superior Aviation
United Airlines
A.D. Aviation
Trans World Safaris
Aero Club of East Africa
Ibis Aviation
Dolphin Airways
C.H.S. Aviation
Wing Safaris Limited
Autair Helicopter
Roy Damerall Ndisi
Missionary Aviation Fellowship (MAF)
African Medical Research Foundation (AMREF)
International Christian Aid

Moi International Airport Base, Mombasa

Skytrails
Eagle Aviation
Wise Air Safaris Limited
Skyways, (Kenya Limited)
Coast Aviation Limited
Ukunda Airways
Musiara Limited
Ultra Light Machines

Source: Civil Aviation Board (CAB) 1991.

During this time, Caspair air services provided scheduled services to Game parks, Kericho, Kisumu, Kitale, and Nakuru. Caspair air services operated light aircraft. Today, about 30 local airline companies operate chartered services in the country. These are shown in table 2.20.

NOTES

1. New Districts have been created by splitting some of the larger districts as shown:

   Meru District : Meru, Tharaka-Nithi, Nyambene Districts

   Machakos District : Machakos, Makueni Districts

   Kakamega District : Kakamega, Vihiga Districts

   Bungoma District : Bungoma, Mt. Elgon Districts

   Kericho District : Kericho, Bomett Districts

   Kisii District : Kisii, Nyamira Districts

   South Nyanza District : Homa Bay, Migori Districts

   Kitui District : Kitui, Mwingi Districts

2. From the point of view of aviation, topography refers to the earth's surface configuration, a feature which varies with the type of soil, altitude, rainfall and cultivation.

3. Airframe icing is a coating of ice on various parts of the aircraft. There are different types of airframe icing:

   a) Clear ice

Is a smooth clear coating of ice which usually forms rapidly

b) Rime ice

Is a white opaque coating of ice which forms mainly on the forward facing surfaces.

4. High potential agricultural land receives an annual rainfall of about 857.5mm and above (or over 980mm in coast province). Medium potential land receives annual rainfall ranging between 735mm-857.5mm (or 735mm-980mm in Coast province and 612.5mm-858.5mm in Eastern province).

REFERENCES

1. Central Bureau of Statistics : Economic Survey. Ministry of Planning and National Development, Government Printer, 1976-89, 1994.

2. Chaggar, T.S. (1977) : Geographical Distribution of Monthly and Annual Mean Frequency of Thunderstorm Days over Eastern Africa Technical Memorandum No. 26 E.A. Met. Dept. E.A.C, Dagoretti Nairobi.

3. Colony and Protectorate of Kenya, Blue Book for the year ending 31st December, 1938.

4. Cundill, M.A. (1986) : Road-Rail Competition for Freight Traffic in Kenya. Transport and Road Research laboratory.

5. East African Statistical Department, 1973.

6. Gaile, G.L. (1988): "African Airline Connectivity: South African Sanctions, Neocolonialism and Development" in African Urban Quarterly, Vol 3 Nos. 3 and 4, pp 177-195.

7. Gamble, W.P. (1989) : Tourism and Development in Africa. John Murray, London.

8. Hay. W.H. (1961) : An Introduction to Transportation Engineering, Wiley and Sons, New York.

9. Hill, F.M., Hill, S. and D.A. Wilson (1968): The elusive Horizon: The story of East Africa's Airline, Nakuru (unpublished).

10. Hogenauer, A.K. (1975) : Patterns of Air Transport in the East African Community, Ph.D Thesis (unpubl.), Columbia State University.

11. Hoyle, B.S. (1988) : Transport and Development in Tropical Africa. John Murray, London.

12. Horticultural Crop Development Authority (HCDA), Ministry of Agriculture, Republic of Kenya Government Printer, (various years)

13. Irandu, E.M. (1992b) : Air Transport and the Growth of Tourism in Kenya, A seminar paper presented at the Institute of Geography, Heidelberg University, Germany, 26th June, 1992.

14. Kenya Annual Report. (1955), Government Printer, Nairobi.

15. Kenya Colony and Protectorate (1945) : National Parks Ordinance, 1945, Kenya Laws, pp 26-33.

16. Mason, B.J. (1962) : "Charge Generation in Thunderstorms", Endeavour, Vol.21, pp. 156-163.

17. Meteorological Office (1971) : A Handbook of Aviation Meteorology. HMSO, London.

18. Mountjoy, A.B. and Embleton, C. (1966) : Africa. A Geographical Study. Hutchinson Educational, London, U.K.

19. Mwebesa, M.M.N. (1979) : East African Weather for Aviators. Kenya Literature Bureau, Nairobi.

20. Nairobi Airport Annual Report. 1965.

21. Ogonda, R.T. (1986) : The Development of Road system in Kenya, Ph.D Thesis (unpubl.), University of Nairobi.

22. Ouma, J.P.B.M. (1970) : Evolution of Tourism in East Africa. East Africa Literature Bureau, Nairobi.

23. Popovic, V. (1972) : Tourism in Eastern Africa. Welt forum Verlag, München

24. Republic of Kenya, Population Census Records. 1948-1979, Government Printer, Nairobi.

25. Republic of Kenya, (1994): Kenya Population Census, 1989, Vol. 1, Government Printer, Nairobi.

26. Schapiro, M.O. and Wainaina, S. (1989) : "Kenya : A case study of the production and export of Horticultural commodities", in Successful Development in Africa.

case studies of projects, programmes and policies. Economic Development Institute of the World Bank, IBRD, The World Bank, Washington DC, USA.

27. Sealy, K.R. (1966) : The Geography of Air Transport. Hutchinson, London

28. Sinclair, T.M. (1990) : Tourism Development in Kenya. A World Bank sector study, Washington D.C.

29. Tymms, F. (1929) : Prospects of Civil Aviation in East Africa. The Royal Aeronautical Society, London.

30. Vorlaufer, K. (1983) : "Der Tourismus in Kenya", Zeitschrift für Wirtschaftgeographie. Vol 27, pp 33-58.

31. Walmsley, L. (1920) : Flying and Sport in East Africa. William Blackwood and Sons, Edinburgh.

32. Wanyanga, J.N. (1988): Growth of Civil Aviation in Kenya, Directorate of civil Aviation (DCA), (unpublished).

CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

This chapter examines the research methods that have been used to collect the necessary data with which to test the main assumptions (hypotheses) of the study. Emphasis is laid on the various sources of data utilized, methods of data collection, techniques of data analysis, interpretation, presentation and applications as well as the limitations of the techniques adopted. The quality and, in some circumstances, the quantity of data determine(s), not only, which statistical tests should be used, but also the relevance of the results.

3.1 METHODS OF DATA COLLECTION

In a scientific enquiry such as this one, an investigator may have a choice of collecting the relevant data himself/herself or may rely on existing data collected by someone else. In other words, data may be gathered from primary or secondary sources. The two main types of data source were used in this study.

3.1.1 PRIMARY DATA

Primary data were gathered from direct personal field observations, oral interviews and questionnaires (recording schedules). Direct personal field observations were made by the researcher on randomly selected airports and airstrips in the country. This was useful and enabled the researcher to have insights into their locational situation, general country-wide location pattern and frequency of use. It was not possible to visit all the airports and airstrips in the country due to lack of time and financial constraints. In all, there are 15 sectors operated by domestic scheduled and charter air companies in Kenya[1]. At least one airport/airstrip was randomly selected from each sector. The more important airports such as class A airports were among those visited[2]. A total of 22 airports and airstrips were visited. These are Jomo Kenyatta International Airport (JKIA), Wilson Airport, Kisumu, Malindi, Moi International Airport (Mombasa), Ukunda, Sultan Hamud, Makindu, Mtito Andei, Manyani, Lamu, Nanyuki, Nyeri, Mandera, Wajir, Keekorok, Lodwar, Eldoret, Garissa, Samburu, Amboseli and Marsabit. The location of these airports and airstrips is shown in chapter four.

Observations made in the airports and airstrips visited were recorded in field notes and field sketch maps. This is an important data source as it helps in reducing inaccuracies in information obtained from oral interviews and questionnaires (Shaw and Wheeler, 1985).

Oral interviews of key informants were also conducted. Such informants included:

a) Operators of Third Level Aviation[3]

b) Aerodrome officials at Wilson airport and both Jomo Kenyatta and Moi International airports.

c) Officials of Kenya Airways, Civil Aviation Board (CAB), Directorate of Civil Aviation (DCA) and the Ministry of Transport and Communications (MOTC).

d) Officials of International Agencies, based in Nairobi, dealing with aviation, such as International Civil Aviation Organisation (ICAO) and African Airlines Association (AFRAA).

By means of oral interviews, it was possible to obtain information on the most important domestic sectors operated by local air charter companies, and the problems faced by the local air operators. Interviews with officials at Wilson airport, Jomo Kenyatta and Moi International airports yielded vital information on the operations of their respective airports, airport layout, traffic statistics, future expansion programmes etc. Officials of Kenya Airways, Civil Aviation Board, Directorate of Civil Aviation, and ICAO provided vital statistics on air traffic into and out of the country as well as within the country.

Questionnaires (recording schedules) were used to obtain both qualitative and quantitative data. Four sets of questionnaires were employed. The first set of questionnaires was administered to Domestic Air operators. The second set of questionnaires was administered to International Air operators based in Nairobi. The third set of questionnaires was for domestic air passengers, and the last set for International air passengers (Appendix iii-vi). Before the four sets of the questionnaire were administered, they were "pre-tested." That is, a pilot study was done in order to improve on the quality of the questionnaires. Through such an exercise, new ideas, not already formulated in the problem, were included. The pre-testing also threw some light onto the kind of variations in the responses to be expected in the population.

A complete survey for all the domestic and international airlines was carried out by sending questionnaires to all of them. All the air operators were expected to duly fill in the questionnaires and return them to the researcher. The purpose of the survey was to investigate the flow patterns of both domestic and international air passengers' travel purposes, individual attributes and to understand passengers' thoughts on air transport. However, the response was not very good. Although there were 31 domestic airlines in Kenya at the time of the field survey, only 12 (38.7%) completely filled in copies of the questionnaires were returned to the researcher. Out of a total of 32 international airlines operate in Nairobi at the time of research, only 15 (46.9%) returned completely filled in copies of the questionnaires.

In order to collect views and responses from air passengers, sampling was necessary. It was difficult to interview the entire population of domestic and international air passengers. In the following section, a review of the sampling procedures used to collect primary data from air passengers is provided. The available resources could not stretch to collect data about all the elements in the population and inferences had to be made about the whole population of air passengers by studying only some of them. But, even if the resources were adequate, a more economical way of carrying out the study would be to draw a sample from the population. Clearly, a sample would only approximately represent the characteristics of the parent population, since it only contains part of it. However, sampling theory enables us to estimate the likelihood of our sample being a good representation of the population provided we follow certain rules in choosing elements for the samples (Dixon and Leach, 1978).

3.1.2 PARENT POPULATION AND SAMPLE FRAME

The 31 domestic airlines based at Wilson airport (Nairobi) and 32 international airlines based at JKIA (Nairobi) and their passenger traffic formed the universe of the study. On the average, 127,000 air passengers are handled at JKIA per month while about 12,000 air passengers are handled per month at Wilson airport (ICAO, 1989). Two samples each of 200 passengers was drawn at JKIA and Wilson airport. It was felt that a sample of 200 air passengers was large enough to use for estimating the parameters of the parent population.

It should be emphasised that it is the size of the sample, not the proportion of the parent population which it represents, that affects the confidence limits. Usually, the larger the sample taken, the greater is the probability that it accurately reflects the distribution from which it was drawn; as size increases, confidence limits get closer to the sample mean. However, taking large samples may be time-consuming, or may be costly.

The essence of sampling lies in the fact that a large number of individuals may, within specified limits of statistical probability, be represented by a smaller group of items (samples) selected from the larger group (parent population). To ensure the success of sampling, the researcher adopted a procedure which would permit him to draw satisfactory conclusions about a parent population from a sample of minimum size.

SAMPLING PROCEDURE

In this survey, four research assistants distributed and collected questionnaires to and from a carefully selected sample of domestic and international air passengers. The survey was conducted for 31 days during the month of March, 1992 when flights normally carry an average number of air passengers (ICAO, 1989). At the time of the field survey, about 4000 air passengers were handled by international airlines per day at JKIA. At Wilson airport, the average number of air passengers per day during the low season was 1863.

The 200 samples drawn accounted for 4.7% and 10.7% of air passengers handled at JKIA and Wilson airport respectively. Moi International Airport (MIA) accounts for a about 10% of the total international air passenger traffic handled per annum. Out of 200 samples, only 20 international air passengers were selected and interviewed in Mombasa.

Interviewing was done on week days as well as weekends. This was in order to reflect the weekly patterns of air traffic at the three airports. There is a peak of air craft and air passenger movements during the weekend. This is because the demand for tourist travel is principally oriented towards the weekend. However, domestic as well as international airlines would like to optimise their aircraft utilisation and schedule their flights in such a way that a more even distribution of traffic throughout the week occurs. The peak of scheduled passenger aircraft hourly movements at the time of the field survey at JKIA occurred at 9.00 a.m., comprising 14 aircraft movements (7 arrivals and 7 departures). The departures were operated mostly by European carriers and were bound for South Africa having arrived from Europe one hour earlier. Aircraft movements at JKIA are governed by the pattern of operations whereby most of the long-haul flights are night flights. These flights leave Nairobi in late evening (9.00 p.m. - 11.00 p.m.) and arrive at Nairobi in the early morning (5 a.m. - 9.00 a.m.). The time for interviewing (7.00 a.m. - 11.00 p.m.), was expected to take care of the scheduled passenger aircraft hourly movements throughout the week.

SYSTEMATIC RANDOM SAMPLING

When people are passing at a point, such as an airport, systematic random sampling is the most appropriate technique to use. This is done by taking every k^{th} element, or every $(k \pm r)^{th}$, element where r is a small random number. This method incorporated the advantages of coverage through time, representing early and late departures equally. The idea here is to combine systematic sampling with a greater random component. Air passengers interviewed at Wilson airport, Jomo Kenyatta International airport and Moi International airport were selected using systematic random sampling. There are a number of ways of doing this. The method used in this study involved a "randomly varying interval" instead of a fixed one. The interval was varied each time by a small random number, r, added or subtracted, so that the elements are chosen at intervals of $k \pm r$, from a start between 1 and k. Whether r is to be added or subtracted each time was randomly decided. This was done by reading an extra random digit, an odd number indicating plus (+) and an even one or zero a minus (-). The desired k (interval) and the limits of r were decided first and the random start made between 1 and k. With $k = 10$ and r between 0-5, a starting point of 10 was made. The next sample was chosen by a random number (r), when $r = 5$, the interval was $10 + 5$, and the element chosen was 25. If the next random number (r) was 2, the interval was $10 - 2 = 8$, giving the element chosen as $25 + 8$, which is 33 etc. This continued until the required number of samples for both domestic and international air passengers was drawn.

Although systematic random sampling has its advantages already pointed out, it does have problems too. The processing of individuals in the sample may hinder the counting of others. Counting and interviewing every $(k \pm r)^{th}$ person to pass through the departure lounge is a difficult task. A large number of research assistants was required so that while some were counting, others were interviewing. It was much more difficult to interview air passengers on busy days.

3.1.3 SECONDARY DATA

A substantial amount of data used in this study was also derived from secondary (archival) sources, mainly published and unpublished sources. Secondary sources can be classified in terms of whether they are "spatial or non-spatial" in form. Some of the secondary sources that are "spatial" in form include maps, aerial photographs and satellite images. Maps showing the location of the major airports and airstrips in Kenya were utilized in this study. Other maps used in the study included those showing domestic as well as international air services in Kenya.

The "non-areal" data used in this study cover a wide variety of sources, but most share the characteristic of being readily transformed to a map or converted into some form of "spatial index" (Shaw and Wheeler, 1985).

DATA ON AIR TRANSPORT

An attempt has been made in this study to synthesize diverse data on air transport. The development of domestic and international air transport in Kenya has been traced from as early as the 1920s to the present time. Data on the historical growth of air transport in the country came from a variety of sources, notably the Blue Book, the Kenya Colony and Protectorate Annual Reports and correspondence of the Air Ministry preserved in the Kenya National Archives in Nairobi. The Blue Book was an Annual statistical compendium published by the Kenya colony and protectorate between 1901 and 1946. The Kenya colony and protectorate Annual Reports were published between 1921 and 1962.

Some published and unpublished individual articles and manuscripts were also consulted. Data on domestic air transport were also obtained from publications of the East African High Commission (later East African Common Services and East African Community), Kenya Airways, Civil Aviation Board and Directorate of Civil Aviation. Most published statistical data on international air transport were collected from ICAO and AFRAA. Data on air Traffic were derived from Central Bureau of Statistics (particularly from Statistical Abstracts and Economic Surveys) and Kenya Airfreight Handling Limited, a subsidiary of the Kenya Airways dealing with air cargo. Data on exports and imports by air were obtained from the Department of Customs and Excise of the Ministry of Finance.

DATA ON DEVELOPMENT INDICATORS

An attempt has also been made to identify the main indicators of development in Kenya and to construct a composite index of development. In order to be able to do this data were gathered on a number of indices at district level. Such data came from sources such as the District Development plans, Statistical Abstracts and Economic Surveys published by the Central Bureau of Statistics. Data on wage employment in agriculture, manufacturing and whole sale and retail trade came from Employment and Earnings in the modern sector published by Central Bureau of Statistics in 1988. Details on the various explanatory variables (indicators) and how they are combined to produce a composite index of development are provided in chapter 7.

3 2 DATA ANALYSIS. INTERPRETATION AND PRESENTATION

Before embarking on detailed statistical analysis, the field note books and questionnaires were cross-checked for errors, inconsistencies and incompleteness. The analysis of both qualitative and quantitative data require the use of a variety of analytical techniques. The main analytical techniques utilized in the study are:

a) Network analysis (Graph-Theoretic Techniques)

b) Gravity and potential models

c) Multiple regression and correlation analysis

d) Factor analysis.

3.2.1 NETWORK ANALYSIS

Network analysis involves the use of graph theory in the analysis of the spatial structure of a transport network. Graph Theory is a branch of topology which is concerned with the analysis of abstract configurations consisting of points and lines (Chapman, 1979, 205). Geographical problems frequently deal with a finite number of places, and with interrelationships between them. As such, graph theory has much to offer in elucidating the form and structure of geographical space. Methods based on graph theory enable one to represent the basic structure of the flows within a network. This is attained by means of reducing flow matrices to graphs, considering spatial units as nodes and the most important flow as linkages between spatial units and others (Puebla, 1987). Graph theory is used to analyse the spatial structure of air transport in Kenya. The graph theoretic technique used is a variant of Nystuen and Dacey's method. The method is known as "Simple Linkage Analysis". It is different from the "Dominant Flow Analysis" or "Multiple Linkage Analysis", of Nystuen and Dacey (1961)[4]. In the "Simple Linkage Analysis", we start with an origin - destination matrix with zeros on its main diagonal. Each unit of analysis is considered as a node. The hierarchic order of the nodes (rank) is determined by the sum of the columns (attracted flows), so that rank 1 will be given to the node which attracts most flows. The rank 1 node is the network's central node. Initially only the largest flow issued by each node is taken into consideration and this is represented by a straight line that joins its places of origin and destination, with an arrow to indicate the direction of the flow. Should several clusters be formed, the node of highest rank in each cluster is the central cluster node: hence there would be as many central cluster nodes as clusters. The remaining nodes are satellites of the corresponding central cluster nodes.

Once the initial clusters have been set up, the flows sent out by central cluster nodes are disregarded. Then the largest flow issued by the central cluster nodes (with the exception of the central node) of the network to another node that does not belong to the same cluster is represented. Thus, one single cluster is obtained in the last instance maintaining the ideals given on hierarchic order. In order not to lose sight of the initially formed clusters, the central cluster nodes are marked in the final cluster.

"Simple Linkage Analysis" is similar to Nystuen and Dacey's "Dominant Flow Analysis", but gives greater emphasis to those aspects concerning the spatial structure of the flows. Nystuen and Dacey do not represent the largest flow of a node when it is directed to another of inferior rank, which encourages the formation of several clusters to the detriment of the number of flows thus represented. A comparison of Nystuen and Dacey's method (Multiple Linkage Analysis) and "Simple Linkage Analysis" is made by means of the hypothetical matrix given below (Table 3.1).

Table 3.1 - Matrix of Flow Between Pairs of Centres

To / From	a	b	c	d	e	f	g	h	i	j	k	l
a	0	72*	12	18	30	1	4	1	3	40	3	0
b	68*	0	48*	52*	60*	11	18	2	5	26*	4	2
c	4	50*	0	14	32*	0	2	1	2	5	0	4
d	17	51*	12	0	26*	6	5	1	13	7	2	3
e	7	40*	58*	22*	0	6	12	3	40*	38*	12	6
f	2	4	2	2	2	0	30*	3	3	4	2	0
g	4	19*	4	4	15*	40*	0	4	26*	8	3	1
h	0	3	0	1	4	4	5	0	11	28*	4	0
i	3	24	4	5	40	6	18	10	0	86*	11	3
j	5	40*	11	9	38	6	12	28	100*	0	30	11
k	2	11	3	1	16*	0	7	6	11*	40*	0	11*
l	0	1	0	0	9*	0	2	0	2	8*	14*	0
Total	112	315	154	127	272	80	115	59	216	304	83	40
Rank Order	8	1	5	6	3	10	7	11	4	2	9	12

_ Largest flow issued by each node

* Significant flows issued by each node according to the multiple linkage analysis.

According to Nystuen and Dacey's method, only the large flow of each node is taken into consideration when it is directed towards another of a higher rank (nodal flow). Those nodes which issue their greater flow towards another of inferior rank are dominant and make up the terminal points of the graph (Fig.3.1). Although there are 12 nodes, only 8 flows are represented.

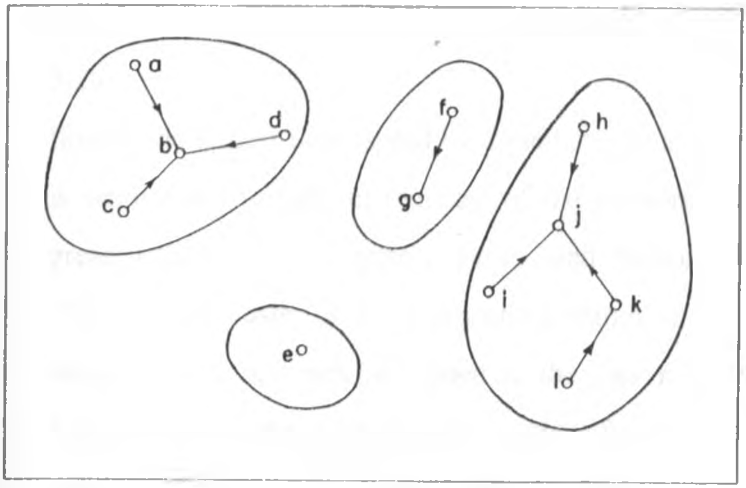


Figure 3.1: Dominant flow Analysis.
Source: Nystuen and Dacey, 1961.

In the "Simple Linkage Analysis" adopted in this study, the following procedure should be followed:

a) the largest flow issued by each node is represented, independently of whether it is directed to another of higher or lower rank (fig. 3.2a)

b) the flows sent out by the central cluster nodes are disregarded (b, g, and j) (fig. 3.2b).

c) finally, the largest flow issued by these latter to another node of a different cluster is represented (except in the case of the network's central node). The second greatest flow of g is directed towards i and the second of j towards b. (fig. 3.2c). The smaller cluster of g-f is subsumed within j-h-i-k-l thus forming an ensemble which in turn becomes integrated in the cluster b-a-c-d. The final cluster (fig 3.2c) offers a wider view than the graph of fig 3.1 as to the spatial structure of the main flows within the region studied. The final cluster displays a hierarchic structure in which one does not lose sight of the idea of relative independence suggested by the initial clusters (Puebla, 1987, 491). It is now widely accepted that the non-metric or topologic characteristics of any transport network can be represented as a finite "planar or non-planar graph[5]. The transport network or system is abstracted to a set of points or nodes, linked by a set of lines or edges. Several indices (measures) of connectivity have been suggested in the literature (Table 3.2). By connectivity is meant the relationship between the number of nodes and number of edges in a network. The measures most frequently used are cyclomatic number (μ), alpha index ($\propto$), beta index (β), diameter (δ) and gamma index (γ).

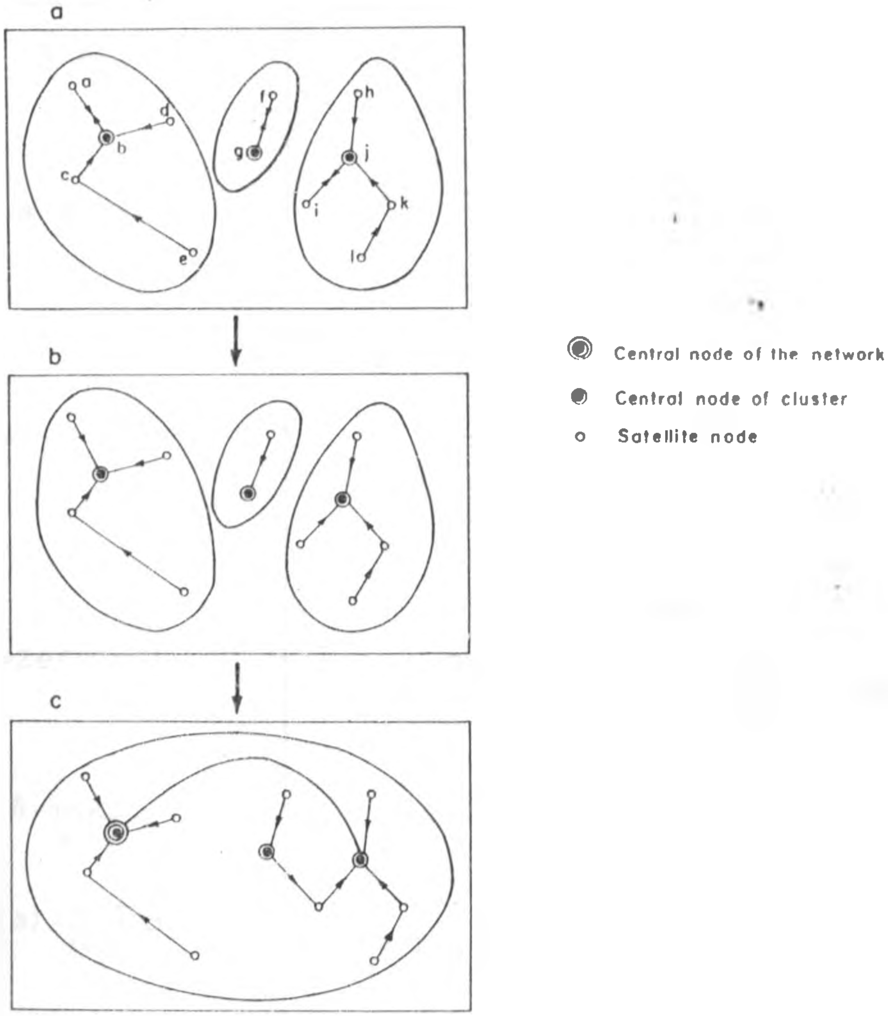


Figure 3.2 Simple Linkage Analysis.
Source: Puebla J. G., 1987, pp 492.

Table 3.2 : Some Conventional Indices of Graph Structure

Index and Identity Number	Bounds	Interpretation
$\beta = e/v$	$0 \leq \beta \leq (v-1)/2$	Ratio of edges to vertices.
$\mu = e - v + p$	$0 \leq \mu \leq \frac{(v-1)(v-2)}{2}$	The cyclomatic or first Betti number. It gives the number of fundamental loops within a graph.
$\alpha = 2\mu/(v-1)(v-2)$	$0 \leq \alpha \leq 1$	Ratio of the observed number of circuits to the maximum possible number.
$\gamma = 2e/v(v-1)$	$0 \leq Y \leq 1$	Ratio of actual number of edges to maximum possible (degree of connectivity).
$\delta = \max_{i,j} d_{ij}$	$1 \leq \delta \leq v-1$	Diameter of graph (measure of connectivity)
$D(a) = \sum_{i=j} \sum_{j=1} d_{ij}$	$v(v-1) \leq D < \frac{v^2(v-1)}{2}$	Dispersion of graph.
$A(G) = D(G)/V(V-1)$	$1 \leq A < v/2$	Average path length.

Source: James G.A. *et al.* (1970), Table 1, pp 14

These graph theoretic indices have been computed for the Kenyan domestic air transport network for several time periods. Such indices would indicate whether the domestic air transport system has been growing, stagnant or declining. It is felt that these indices (Table 3.2) are adequate to describe the Kenyan domestic air transport network over time. These measures do not only help comparisons between networks but are also useful indicators of the connectivity and complexity of transport networks. As we might expect, the degree of connectivity of a transport network in an individual country tends to increase with the extent of economic development.

THE MATRIX POWERING TECHNIQUE OF GRAPH THEORY

To examine the changing patterns of node accessibility as Kenya's domestic air transport network grows, a "matrix powering technique" of the graph theoretic approach was used. Accessibility indices were obtained for several air transport networks covering the period 1938 to 1993. The objective here is to show whether the accessibility surface has become highly peaked and highly polarized. In the terminology used by Haggett (1969, pp 261), one is dealing with a growth process of networks identified as "node connecting sequences". The underlying problem in the study of node connecting sequences is to provide insight into the process which results in the connection of nodes of the entire system and to provide interpretation of the process (Hebert and Murphy, 1970). Taaffe, Morrill and Gould (1963) and Holsman and Crawford (1975) have attempted to impose a theoretical set of discrete stages upon an observed sequence of transport networks.

As a concept, accessibility has a long history in geographical thought, not only as a descriptive variable to be measured and explained but also as a causal variable in various studies (Ingram, 1971, Pirie, 1979). It is generally recognized that accessibility is partly a function of relative location in the sense that Ceteris Paribus a central location is more accessible to (and from) an area than is a peripheral location. But accessibility is also determined by the form of permanent transport networks and the pattern of scheduled services, especially scheduled passenger services. Accessibility has been defined in many ways (Jefferson, 1929, Harris, 1954, Forbes, 1964, Johnston, 1966, Tinkler, 1977). Within the context of this study, accessibility is defined as a "function of the topological structure of the network". It is a function of the transport links of the domestic air transport.

Various techniques are available for assessing accessibility of nodes. The simplest of such networks involves the use of the binary matrix (connectivity or connection matrix) and so given the symbol C; we have the mathematical expression:

$$\sum_{j=1}^{j=n} C_{ij} \ldots\ldots\ldots\ldots\ldots\ldots (3.6)$$

This binary matrix gives the number of links incident at a node, sometimes called the degree of the node. It is seldom a very useful measure for large and complex networks (Hay, 1982). A more sophisticated method which takes into account the indirect connectivity of indices is the "matrix multiplication approach". In this method, the domestic air transport network is abstracted as a graph and converted into a "square matrix". The matrix represents the direct connectivity of nodes in the system. This matrix is then powered until the "solution time" (solution matrix) is reached. The solution time is equivalent to the diameter of the systems, while the diameter represents the shortest distance path between the two most distant nodes in the system. The figures in the cells represent the total number of alternative paths between the two points (nodes). To obtain the total number of alternative paths for a place, we add across the diameter power array. It is this sum which is the "connectivity" measure (accessibility) for each place in the network. The results of this matrix powering technique are presented in form of maps in chapter 4. Pitts (1965) used a similar method in analysing the "river trade network" in the 12th-13th century Russia. The same approach has been used by Carter (1969), Rimmer (1971) and Funnell (1972). Where the solution matrix was not possible, the matrix was multiplied by itself to power n-1, where n is the number of nodes in the graph. This ensures that, if the graph is strongly connected, the two most separated points (nodes) are connected by at least one route.

The author is also aware of other methods of accessibility analysis such as summing the powered matrices to yield a matrix T (accessibility matrix). That is:

$$T_n = C + C^2 + C^3 + \ldots C^{n=d} \ldots\ldots. (3.2)$$

where T_n = accessibility matrix, d = diameter of the network. A summation across any row or down any column will produce a vector of numbers which can be thought of as the accessibility of each node on the network. This method has been used by Gauthier (1968), Herbert and Murphy (1971) and Cates (1978). In other instances, a weighted expansion of C can also be used:

$$T_n = aC + a^2C + a^3C^3 \ldots a^nC^n = d \ldots\ldots (3.3)$$

where T_n = accessibility matrix, d = diameter

a = scalar $o<a<1$.

The summing of powered matrices to obtain an accessibility matrix has some disadvantages. Firstly, computation becomes increasingly complex with large matrices and secondly, the higher powers contain much larger numbers than the smaller powers and so consequently dominate the total sum (Tinkler, 1977).

3.2.2 MULTIPLE LINEAR REGRESSION AND CORRELATION ANALYSIS

Many of the problems studied by geographers are of a complex nature, often involving a consideration of a number of interacting variables. In such circumstances, bivariate statistics are rather inadequate tools of analysis and multivariate techniques need to be used (King, 1969, Shaw and Wheeler, 1985). One such multivariate technique is the multiple Linear Regression and Correlation analysis.

MULTIPLE LINEAR REGRESSION MODEL

An important step in modelling for both intra-urban and inter-urban traffic generation and attraction is the identification of a satisfactory basis on which to estimate the volume of traffic that may be generated or attracted (Ogunsanya, 1984). This calls for the identification of factors that can be used as possible explanatory variables. Once such factors are identified, it will be possible to establish a relationship between volume of traffic and these variables, the result of which, can be used to predict the effects of changes in the independent variables upon the pattern of passenger and goods traffic. Multiple regression analysis can do this very effectively. The technique is more suitable to use than the gravity model that has been used in most previous studies to demonstrate the connection between origins and destinations. The gravity model can not explain which factors and which functions contribute to the connection between origin and destination and in what way these factors interact (Ida, 1993).

In most regional and interregional passenger and commodity flow studies, a number of factors are regarded as important factors in traffic generation and attraction. Some of these factors are population, GNP and distance (Chisholm and O'Sullivan, 1973). From the foregoing, it can be conceptualised that there is a set of variables:

$X_1, X_2, X_3 \ldots X_n$ .... (3.4)

These factors help to explain the total volume of traffic generated or attracted. This indicates that:

$Y = f(X_1, X_2, X_3 \ldots X_n)$ .... (3.5)

Where: Y is dependent variable (volume of passenger traffic),

$X_1, X_2, X_3 \ldots X_n$ are independent variables (population, GNP, distance).

Equation 3.5 above is made operational in the form of a multiple regression equation:

$$Y = a \pm b_1X_1 \pm b_2X_2 \pm \ldots b_nX_n + \epsilon \text{ .... (3.6).}$$

Where: Y is dependent variable, $X_1, X_2, X_3 \ldots X_n$ are independent variables,

$a, b_1, b_2, \ldots b_n$ are partial regression constants

ϵ - error (disturbance) term which explains the effects of unspecified variables.

There are preconditions concerning "residual behaviour" that need to be fulfilled before the multiple linear regression equation can be finally regarded as both unbiased and the best possible estimate of the population parameters. In other words, the multiple linear regression model is based on a number of assumptions. These assumptions have been discussed in detail by Draper and Smith (1966) and Poole and O'Farrell (1971). Only a summary of these assumptions is provided below:

a) The probability distribution of Y should for any value of X, be normally distributed about the regression line.

b) There should be no multicollinearity. That is, the independent variables should not be highly correlated.

c) The observed Y values should have a zero mean and a constant variance about the regression line. The latter is the requirement of homoscedasticity. If the scatter of the residuals is not constant about the regression line the data are said to be heteroscedastic.

d) The residuals must not be serially correlated (i.e. no autocorrelation). Gould (1970) and other geographers have singled out this assumption as being "dubious" on the ground that almost all geographical phenomena show positive "spatial autocorrelation", with nearby places more alike (Ferguson, 1977).

In using multiple regression analysis technique it is assumed that the relationship between dependent and independent variables is linear. But, the relationships in passenger and commodity flow analyses may not be linear. Thus, the variables identified in the present study are transformed using the logarithmic-transformation procedure. The regression equation (3.6) above then becomes:

$$\text{Log } Y = a \pm b_1 \log X_1 \pm b_2 \log X_2 \ldots b_n \log X_n \pm \in \quad \ldots\ldots\ldots\ldots\ldots (3.7)$$

MULTIPLE CORRELATION ANALYSIS

The notion of correlation can be generalized in two ways. The term "partial correlation" refers to the correlation between any two variables when the effects of the other variables have been controlled. Multiple correlation is used to indicate how much of the total variation in dependent variable can be explained by all of the independent variables acting together (Blalock, 1972). Multiple correlation analysis is a continuation of the multiple linear regression model. We can make use of the multiple linear regression model to obtain measures of the degree of relationship between a dependent variable Y and any of the independent variables (partial correlation). Partial correlation provides a single measure summarizing the degree of relationship between two variables, controlling for a third variable. The general partial correlation equation is of the form:

$$r_{ij\cdot k} = \frac{r_{ij} - (r_{ik})(r_{jk})}{\sqrt{1 - r_{ik}^2}\sqrt{1 - r_{jk}^2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.8)$$

The multiple correlation coefficient (R^2) is a measure of the strength of the linear relationships between the dependent and independent variables of a multiple linear regression model by augmenting the deviation(s) of the independent and dependent variable from their means and standard deviations. It shows how much each individual independent variable influences the dependent variable (Y) in the multiple linear regression model. The multiple linear regression and correlation analyses were carried out with the aid of the powerful SPSS computer statistical package. The multiple linear regression and correlation analyses have been used in this study as analytical frameworks to examine the factors influencing the patterns of passenger and commodity flows (chapters 5 & 6).

The regression procedure selected for the analysis is the stepwise multiple regression. The stepwise regression is a statistical method for selecting the most significant independent variables from any set of variables. One of the most important features of stepwise regression is that a significant variable and which has been added at an earlier stage, is examined along with other variables at a later stage and may then be considered insignificant and consequently deleted. At the end of the analysis, only the most significant variables which make the greatest improvement to goodness of fit are retained. By goodness of fit is meant accounting for a larger proportion of the total variance in the dependent variable (Ogunsanya, 1984). An inherent advantage of the step-wise regression is its ability to overcome the problem of multicollinearity since it will select only those variables that make the greatest contribution to the dependent variable.

3.2.3 POTENTIAL MODELS

The potential model is an index of the intensity of possible interaction between social or economic groups at different locations. Potential models have been used in a number of ways:

(a) To fulfil a descriptive or illustrative function - maps of potential values have been used to illustrate the broad spatial distributions of phenomena such as total population.

(b) They have been used to provide explanatory variables in statistical analyses of the spatial distribution of phenomena such as per capita incomes or industrial location.

In the present study, one type of potential model - the "population potential model" is used (chapter 5). At a given location i, the potential influence, or the possibility of interaction, with respect to an individual at i, which is generated by the population of any given area j, will be greater as the population of j is larger and will be less as the distance between i and j increases. The equation which shows the potential at i, of the population area j takes the form:

$$ {}_iV_j = k\frac{P_j}{D_{ij}} \qquad (3.9)^6 $$

where ${}_iV_j$ = potential at i of the population area j.

The total possibility of interaction between an individual at i and the population of all other areas in the study area i.e. the total population potential at i would be:

$$ {}_iV = k\sum_{j=1}^{n} \frac{P_j}{D_{ij}} \qquad (3.10) $$

where ${}_iV$ = total population potential at i and the summation is over all n points (1,2, ... j .. n). K: represent constant of proportionality; it helps to describe empirical relationships exactly.

In calculating the total potential at a given location, it is important to include also a measure of the population potential of the given location with respect to an individual at that location. To do this, the distance of the given area from itself (D_{ii}) is taken as the average of the distance from the centre of the area to its periphery (Carrothers, 1956, 96).

The total population potential for the whole country has been computed using equation (3.10). When the total population potential was worked out for all the points (district headquarters), its spatial variation was mapped using "isopleths or equipotential lines". This produces a potential surface" map of Kenya (chapter 5). The advantage of the potential concept over other methods of deriving surfaces is that by measuring at a large number of points the influence of every other point, a set of discrete observations can be turned into a truly continuous variable. From such population potential maps, areas of different potential are readily discernible and interrelationships between areas are easily visualized (Smith, 1975).

3.2.4 FACTOR ANALYSIS

One of the main analytical techniques used in this study is the "Common Factor Analysis" model. (Factor analysis is a broad term referring to a group of techniques used for data description and hypothesis testing. Its most important feature is the ability to reduce a large data set to a smaller number of factors. The model may be used to produce new combinations of the original data, which may then be used as new variables in further analysis or for exploratory purposes - to detect and identify groups of inte-related variables.

Common factor analysis and principal components analysis are the two variations of "Factorial" analysis techniques that have received widest application, but preference is given to common factor solution. Their major difference lies in their treatment of the variance components of the variables. Principal components analysis (PCA) assumes that all the variation of a variable can be explained by the M-1 variables of the observation data matrix. Hence, the dimensions (components) are supposed to summarize the total variation of data. In common factor analysis, the assumption is that only part of the variation in a variable can be explained by other M-1 variables. The part of the variation that can be explained is called the "common variance". The dimensions (factors) summarize the common sources of variation in data (Ngau, 1979). The general factor analysis model is given by the equation:

$X_i = f(F_1, F_{11}, F_{111} \ldots F_n) + U_1$ .... (3.11)

where X_i = dependent variable, F_1 --- F_n are the set factor,

U_i = unique variance for each variable

The general Principal Components Analysis model is given by the equation:

$X_i = f(C_1, C_{11}, C_{111} \ldots C_n)$ .... (3.12)

where X_i = dependent variable, $C_1 \ldots C_n$ are the set of components representing n variables.

The main difference between Principal Component analysis (PCA) and Factor analysis are summarized in Table 3.3 below.

Table 3.3 : Basic Characteristics of Principal Components and Common Factor Analysis

	Principal Components Analysis	Factor Analysis
Character	Assumes a closed system, with no assumptions about underlying structure of variables; identifies only the common variance between variables	Realistic assumption concerning measurement error: allows search for variable structure; identifies common and unique variance between variables
Best conditions	Usually, if high correlations between variables, there should be a large number of variables, and only simple data reduction is required	As for principal components, but it will also deal with a smaller variable matrix and allow a wider range of analysis other than simple data reduction
Package Programmes	SPSS (sub-programme PA_1) principal factoring without iteration, PCA option	SPSS (sub-programme PA_2) principal factoring with iteration, principal factor analysis option

Source: Shaw, G; and Wheeler, D. (1985), table 15.4, pp 279

The exclusion of the unique variance in principal components analysis is a major source of its criticism. It is argued that the components should reflect the interrelationships existing in a group of variables (common variances) and not the uniqueness of variable. The common factor Analysis too, does have problems relating to the estimation of communalities, but unlike principal components analysis it does not assume a closed system. It is this feature which makes it attractive to geographers who often deal with situations where it would be unrealistic to assume a closed model. In most geographical studies it is likely that all the variables are not collected and that some degree of measurement error exists. Common factor analysis enables such problems to be considered and any variable which is not explained by the factors can be described by a residual error term. Common factor analysis provides a more comprehensive model for the needs of most lines of geographical enquiry (Shaw and Wheeler, 1985, 279).

Variables to be used in factor analysis should be carefully selected. The selection depends on the type of study being undertaken and the availability of data. It should be borne in mind that the structure of the final factors would be determined by quality and type of variables used. Usually, the practice has been to include those attributes that have been indicated as significant in previous studies and have had some theoretical support. One should avoid using a large number of variables that are highly correlated.

The variables selected form an observation data matrix. The entire data observation matrix is transformed in order to overcome the limitations of comparing the data when expressed not only in different units but also in different measurement scales.

All the cases are transformed into standard scores in order to reduce them to common units and to make them comparable.

The data are transformed using the formula:

$$Z_{ij} = \frac{X_{ij} - \bar{X}_j}{S_j} \quad \ldots\ldots\ldots\ldots (3.13)$$

where Z_{ij} = standard score for i^{th} observation on j^{th} variable

X_{ij} = raw data of the i^{th} observation on jth variable

$\bar{X}_j$ = mean of j^{th} variable

S_j = standard deviation of j^{th} variable.

A computer programme can be designed to carry out data transformation. But data transformed has its own shortcomings:

a) transformation gives equal weight to each variable

b) transformation is time consuming

c) such transformation obscures and complicates interpretation

Common factor analysis model begins with a "correlation matrix" showing intercorrelations between all the variables included in the analysis. A close examination of correlation matrix reveals important characteristics in the data set. Some variables exhibit high positive correlation coefficients, others show high negative correlation coefficients and others low correlation coefficients.

Once the correlation matrix is obtained, principal factors are extracted. The initial factor solution is a matrix of factor loadings. The factor loadings can be interpreted as "correlation coefficients" between variables. They are (factor loadings) the basis for interpretation and identification of factors. The square of any factor loading indicates the proportion of the variance in the variable which is accounted for by the factor. Variables that are highly associated with a factor will also load highly on it. The initial factor loadings matrix is rotated by means of "varimax rotation". This is done in order to maximize the variance of the loadings from only some of the variables of each factor.

The first few factors normally account for most of the common variance. Factors are extracted in order of their decreasing magnitude of contribution to the total variance. The last factors are insignificant or "trivial factors" Interest in most geographical studies is on the major factors. The cut off point for the number of factors required is based on a number of criteria:

a) To select those factors with eigenvalues greater than unity (1).

b) Each factor should account for at least 5% of the total variance

c) Scree test: when the number of extracted factors is plotted against the population of the variance it gives a negatively sloping curve which tends to level off when "trivial factors" are reached. Usually, at the point of levelling off, there is a relatively sharp drop in the eigenvalues. The portion of the curve consisting of the "trivial factors" is called a "scree line".

One important part of the output of factor analysis is the matrix of factor scores, which provides a measurement of the relationships between each observation and the new factor. The matrix of factor scores is of great interest to geographers. The factor scores are used for comparing the observation units (e.g. districts) and for regionalisation. The factor scores are usually standardized.

Like most other multivariate statistical techniques applied to geographical problems, factor analysis has attracted its share of criticisms:

a) Some geographers have questioned the appropriateness of factor analysis techniques (Clark, *et al.* 1974). Common factor analysis is a flexible technique, a feature that has made many geographers use the technique without any clear reasons for doing so.

b) There has also been a problem of interpretation. There is a danger of identifying a factor by two variables which are only slightly correlated.

Nevertheless, despite some of these problems, factor analysis still remains a very useful statistical technique.

In order to construct an index to measure the spatial variation of development at district level in Kenya as well as to show the relationship between air transport and development, factor analysis with varimax rotation was used. A country's physical,

Table 3.4 : Variables Used in Factor Analysis to construct composite index of development status

	Number	Variable Name
I		Physical Factors (Dimension)
	1	Persons per square kilometre of arable land
	2	Total value of primary industry output per capita (£)
II		Economic Factors (Dimension)
	3	percentage wage employment in agriculture
	4	percentage wage employment in tourism
	5	percentage wage employment in manufacturing
	6	percentage wage employment in whole sale and retail
	7	percentage share of GDP
	8	Manufacturing value added per capita (Kshs)
III		Social Factors (Dimension)
	9	Total population (Numbers)
	10	Population density (persons/km^2)
	11	percentage urban population
	12	Infant mortality rate (Number of deaths/1000 live births)
	13	Enrolment ratios in primary schools (%)
IV		Political Factors (Dimension)
	14	Government expenditure per capita (£)
	15	Voter participation rate (%)
V		Technological Factors (Dimension)
	16	Energy consumption per capita (tonnes)
	17	Road Density (km/km^2)
	18	Length of railway/1000 population
	19	Number of Nodes in Domestic air network
	20	Air passengers generated (Numbers)

economic, social and political systems should provide resources, institutions and cultural environments that foster human welfare. These resources, institutions and cultural environments vary from one place to another so that the spatial pattern of development varies too. In constructing the composite index of development status (CIDS), 20 variables were used (Table 3.4).

Based on factor scores, 41 districts were arrayed according to the sum of the quintile ranks from most developed to the least developed. The theoretical background of development and the development status for each district are discussed in chapter 7.

3.3 SIGNIFICANCE TESTING

In order to test the significance of the differences between sample data sets, it is essential to establish whether the differences between them could have occurred purely by chance or whether the differences in the samples really do reflect differences in populations from which they have drawn (Mowforth, 1979). Analysis of variance (F-ratio test) is used to test the null hypothesis of "no differences between samples hypothesised true means". The analysis involved making two estimates of the variance of the hypothesised common population, that is: the within·samples variance estimate and the between samples variance estimate. These were computed using SPSS statistical package. The level of statistical significance was set at 99% (p=.01) and a decision was made whether to reject or accept the null hypothesis (H_0). If the calculated value of F was less than the critical value at the stated level of significance, then the null hypothesis was to be rejected.

3.4 DATA PRESENTATION

Data are presented in this study by means of numerous quantitative and non-quantitative maps and diagrams as well as statistical tables. Some of the qualitative (non-quantitative) maps and diagrams are:

a) A map to show the location of Kenya (Study area) in Africa.

b) A map to show Kenya districts including Nairobi Province.

c) A map to show the location of earliest aerodromes in Kenya.

d) A map to show the route of the Imperial Airways (forerunner of British overseas Airways Corporation), from London, via Cairo to Nairobi and Johannesburg.

e) A map to show direct (non-stop) flights between Nairobi and other international airports of the world.

f) A conceptual model of the development of air transport system in Kenya.

g) A map to show all the 15 domestic air transport sectors in Kenya

h) A map to show the location of National Parks and Game Reserves in Kenya.

Some of the quantitative (statistical) maps and diagrams employed in the study are:

a) Diagrams to demonstrate dominant flows in Kenya's domestic air network.

b) Population potential map of Kenya.

c) Flow line maps to show interregional flow of air passenger volume.

d) Proportional circles to show volume of passengers handled at different airports in Kenya.

The various cartographic and diagrammatic illustrations used in this study are shown in the relevant chapter.

3.5 RESEARCH LIMITATIONS

In this section, the major difficulties encountered in carrying out field work are discussed. These are namely: data sources, data availability, the unco-operative attitude of air passengers and airline officials, lack of time and limited financial resources. The means of overcoming some of these difficulties in order to ensure that the data collected were as accurate as possible are also outlined.

3.5.1 DATA SOURCES AND AVAILABILITY

The secondary data sources used in this study were not originally compiled for geographical purposes and, therefore, a number of problems were encountered:

a) Many of the units of observation within which data were collected were unsatisfactory for geographical analysis, mainly because such areas vary in size and shape. In Kenya, most of the planning regions, the "districts" are usually small,, rural (except for Nairobi and Mombasa), non-economic spatial planning entities and are often delimited on political boundary criteria (King'oriah, 1984). Development data that have been available for national accounts are not available on a disaggregative district basis. Similarly, a number of large private and public organizations have had operations that span many districts. Their records cannot be easily assigned to any particular district. Districts have no data base to identify productive activities, nor do they have border-control points to register imports and exports (Kituuka and King'oriah, 1991).

b) The overall accuracy of the secondary data sources was beyond the control of the researcher. Data in some official publications were incomplete and/or not available in the form desired. This was particularly the case with data pertaining to evolution of domestic air transport network and "development indicators".

Data were needed on the type of aircraft operating on each domestic route, load factor, time and cost distance on each route for as far back in time as possible (e.g. from 1920s). But, such data were either lacking or had missing gaps. In some cases, it was difficult to get access to some information even when it was available. This was particularly so in Kenya National Archives where there was a lot of information available on the growth of air transport in Kenya. However, according to the regulations governing the operations of Kenya National Archives, only information which was about 30 years old at the time of research was availed. It was not possible to get access to data for the period 1962 to the present. This meant that most of the information availed was either out of date or irrelevant. It is likely that information on some aspects of air transport growth which could have been important for this study were missed. Attempts were made to bridge the missing gaps by interviewing relevant senior government officers in the Ministry of Transport and Communications and some were very co-operative, and availed more up-to-date and relevant data.

(c) Paucity of conventional economic data led to difficulty in the computation of aggregates for Gross Domestic Product (GDP) and Gross National Product per capita (GNP per capita). Whereas regional growth in

Developed countries is linked to more easily measurable economic aggregates such as income, savings, investment, production, consumption, labour and volume of trade, all of which can be summed up in GDP, development for sub-national areas such as districts in Developing countries cannot be easily quantified using classical and neo-classical economic indicators. The socio-economic process in Developing countries, traditional ways of life, lack of consumption and expenditure patterns and so on, all combine to complicate the quantification of development (Kituuka and King'oriah, 1991). In these circumstances, this research had to rely to some extent on "proxy indicators" such as percentage share of GDP and vote participation rate (%) for each district in Kenya.

3.5.2 UNCO-OPERATIVE ATTITUDE OF RESPONDENTS

Another difficulty encountered in the study was the unco-operative attitude of air passengers and airline officials. Many potential respondents were unwilling to be interviewed or refused to fill in and return the questionnaire. Many air passengers felt that filling in the questionnaire was a mere waste of time. Some local airline operators based at Wilson and Mombasa were suspicious that they were being probed by officials from Civil Aviation Board of Kenya (CAB). Repeated assurances to them did not seem to allay their fears. Some of the respondents filled only part of the questionnaire leaving the rest of it blank. This incompleteness of the questionnaire necessitated the selection of new samples which was both time consuming and costly.

3.5.3 FINANCIAL RESOURCES

Shortage of funds for field work and other related research activities was one of the most significant limitations. It is doubtful whether even with sufficient time, much could have been accomplished with limited financial resources. This kind of research involved extensive and expensive air travel throughout the country.

NOTES

1. The 15 domestic sectors in Kenya operated by local air charter companies are:

   Sector 1: Wilson - Maasai Mara (important air fields here include Keekorok, Governor's camp, Kichwa Tembo, Fig Tree and Mara Serena).

   Sector 2: Wilson - Garissa.

   Sector 3: Wilson - Turkana (important air fields here include Lodwar, Kalokol, and Loiyangalani)

   Sector 4: Wilson - Eldoret

Sector 5: Wilson - Samburu

Sector 6: Wilson - Amboseli

Sector 7: Wilson - Wajir

Sector 8: Wilson - Northern (important air fields are Nyeri, Mweiga, Eliye springs, Turkwell Gorge, Lokichogio)

Sector 9: Wilson - Eastern and North Eastern (important air field are Marsabit, Liboi, Embu, North Horr, Isiolo, Wamba, Moyale and Meru-Mulika lodge).

Sector 10: Wilson - Western (important air fields are Kisumu, Kitale, Kericho, Nakuru, Busia, Kakamega and Homa Bay).

Sector 11: Wilson - Coast (important air fields are Moi International airport, Malindi, Voi, Kilaguni, Makindu, Mtito Andei, Hola, Kitui, Kiwayu)

Sector 12: Wilson - Ukunda

Sector 13: Wilson - Lamu

Sector 14: Wilson - Nanyuki

Sector 15: Wilson - Mandera

2. There are 5 class A airports in Kenya. These are airports whose runways are bitumenized and have fire fighting equipment. They are inspected on a daily

basis. They are Jomo Kenyatta International airport, Moi International airport, Kisumu, Malindi and Wilson airport.

3. Local air charter operators constitute what is referred to as the third-level aviation sector. This sector embraces all commercial aviation in the country apart from the operation of foreign airlines and the national carrier, the Kenya Airways (KA). The sector operates scheduled, coach and charter passenger services throughout the country and to airports in the neighbouring countries such as Tanzania, Sudan and Zaire. These air services cater for a variety of needs such as crop spraying, aerial photography and missionary work, but focus on tourist demand to the scattered game parks and the coast.

4. Dominant flow (Multiple Linkage) Analysis is a technique that makes it possible to identify from a complex system, a flow structure which may correspond more closely with the expected nodal organisation of a country airline. The technique was developed by Nystuen and Dacey (1961) in their study of intercity telephone calls in Washington State, USA. The method is capable of quantifying the degree of association between city or regional pairs in a manner that allows the identification of the network of strongest associations and provides a quantitative basis for grouping towns or regions. When the largest flow is from a larger to a smaller centre, the larger centre is said to be "dominant". A centre is

"subordinate" if its largest flow is to a larger centre. The largest flow from every subordinate centre is called the "nodal" flow.

5. A planar graph is a two-dimensional network with all routes actually joining up in real space such as road junction. A non-planar graph is a three-dimensional network with one or more routes which cross over but do not actually join up with the routes in space. Airline network graphs are non-planar since they intersect to points that are not vertices.

6. Conversely, the potential at j of the population of area i would be:

$$_{j}V_{i} = k \frac{P_i}{D_{ji}}$$

REFERENCES

1. Blalock, H.M. (1972): Social Statistics. 2nd Edition, McGraw-Hill, Kokagusha Ltd, Tokyo.

2. Cates, D.B. (1978): "Short-run Structural change in an active network of declining connectivity", in Professional Geographer. Vol. 30, pp 9-13.

3. Carrothers, G.A.P. (1956): "An historical review of the gravity and potential concepts of human interaction", in the Journal of the American Institute of Planners. Vol. 22, pp 94-102.

4. Carter, F.W. (1969): "An Analysis of the Medieval Serbian Oecumene: A theoretical approach" in Geografiska Annaler. Vol. 51 B, pp 39

5. Chapman, K. (1979): People. Pattern and Process. An Introduction to Human Geography. Edward Arnold Publishers, London.

6. Chisholm, M. and O'Sullivan, P. (1973): Freight flows and spatial aspects of the British economy, Cambridge University Press.

7. Clark, D., Davies, W.K.D. and Johnston, R.J. (1974) "The application of factor analysis in human geography", in the Statistician. Vol. 23, pp 259-81.

8. Dixon, C. and Leach, B. (1978): "Sampling methods for Geographical Research", in Concepts and Techniques in Modern Geography (CATMOG). No. 17, Geo-Abstracts, University of East Anglia, Norwich, London.

9. Draper, N.R. and Smith, H (1966)s Applied Regression Analysis. Wiley, New York.

10. Ferguson, R. (1977): "Linear Regression in Geography", in Concepts and Techniques in Modern Geography. (CATMOG). No. 15, Geo Abstracts, University of East Anglia, London.

11. Forbes, J. (1964): "Mapping accessibility" in the Scottish Geographical Magazine. Vol. 80, pp 12-21.

12. Funnell, D.C. (1972): Service Centres in Teso, Department of Geography, Makerere University, occasional paper No. 46.

13. Gauthier, H.L., (1968): "Least-cost flows in a capacitated network: A Brazilian example" in Geographic Studies of Urban Transportation and Network Analysis. Horton, F. (ed.) Northwestern University Studies in Geography, No. 16.

14. Haggett, P. and Chorley, R.J. (1969): Network Analysis in Geography. Arnold, London.

15. Harris, O.D., (1954): "The market as a factor in the localisation of industry in the United States", Annals of the association of American Geographers. Vol. 44, pp 315-48.

16. Hay, A.M. (1982): "Transport Geography", in Wrigley, N. and Bennett, R.J. Quantitative Geography, a British View, Routledge and Kegan Paul, London.

17. Hebert, B. and Murphy, E. (1971): Evolution of an accessibility surface: the case of the domestic United States Air transport network", Proceedings of the Association of American Geographers, Vol. 3, pp 75-80.

18. Holsman, A.J. and Crawford, S.A. (1975): "Air Transport Growth in underdeveloped regions" Australian Geographer. Vol. 13, pp 79-90.

19. ICAO (1989): Airport Traffic. Series A.T-No.30, pp.102-103.

20. Ida, Y. (1993): "The pattern of air passenger flows in Japan", in Geographical review of Japan, vol. 66, ser. B, No.1, pp. 18-34.

21. Ingram, D.R. (1971): "The concept of accessibility: the search for an operational form" in Regional Studies, Vol. 4, pp 61-67.

22. James, G.A., Cliff, A.D. Hagget, P. and Ord, J.K.(1970): "Some discrete distributions for graphs with applications to Regional Transport Networks", in Geografiska Annaler. Vol.52B, No. 1, pp 14-21

23. Jefferson, M. (1929): "The civilising rails", in Economic Geography. Vol. 4, pp 217-31.

24. Johnston, R.J. (1966): "An Index of accessibility and its use in the study of bus services and settlement patterns", Tijdschrift Voor Economische en sociale Geografie. Vol 57, pp 33-8.

25. King, L.J. (1969): Statistical Analysis in Geography Prentice-Hall Inc. Englewood Cliffs, N.J.

26. King'oriah, G.K. (1984): "Regions and Regional Delimitation as Aids for Urban and Rural Development in Kenya", in Ekistics, 304, January/February.

27. Kituuka, S.E. and King'oriah, G.K. (1991): "Evaluating Development in Small Subnational Areas of Developing Countries", in the Review of Urban and Regional Development Studies, Vol. 3, pp 194-205.

28. Ngau, P.M. (1979): The Internal Structure of Residential Areas in Nairobi, M.A. Thesis (unpublished), Department of Geography, University of Nairobi.

29. Nystuen, J.D. and Dacey, M.F. (1961): A graph theory interpretation of nodal regions", in the Papers and Proceedings. Regional Science Association. Vol. 7, pp 25-42.

30. Ogunsanya, A. A. (1984): "Estimating intra-urban freight generation and attraction" In Transportation Research, vol. 18A, pp.181-189.

31. Pirie, G.H. (1979): "Measuring accessibility: a review and proposal", in Environment and Planning A. Vol. 11, pp 299-312.

32. Poole, M.A. and O'Farrel, P.N. (1971): "The assumption of the Linear Regression Model", in the Transactions of the Institute of British Geographers. Vol. 52, pp 145-158.

33. Pitts, F.R. (1965): A graph theoretical approach to historical geography", in Professional Geographer. Vol. 17, pp 15-20.

34. Puebla, J.G. (1987): "Spatial Structures of Network Flows: a graph theoretical approach" in Transportation Research, B Vol. 21B, No. 6, pp 489-502.

35. Rimmer, P.J. (1971): Transport in Thailand: The Railway decision, Canberra: Australian National University.

36. Shaw, G. and Wheeler, D. (1985): Statistical Techniques in Geographical Analysis. John Wiley and Sons, Chichester

37. Taaffe, E., Morrill, R. and Gould, P.; (1963): "Transport Expansion in underdeveloped countries: a Comparative Analysis", in the Geographical Review. Vol. 53, pp 503-529.

38. Tinkler, K.J. (1977): "An Introduction to Graph Theoretical Methods in Geography", in Concepts and Techniques in Modern Geography (CATMOG). No. 14, Geo-Abstracts, University of East Anglia, London.

CHAPTER FOUR

THE SPATIAL STRUCTURE OF DOMESTIC AIR TRANSPORT NETWORK IN KENYA

4.0 INTRODUCTION

The main objective of this chapter is to describe, analyse and explain the networks of both domestic and international airlines in Kenya. Both qualitative and quantitative techniques are used in the analysis of the spatial structure of air transport network in the country. A comparison is made between the Kenyan air transport network and the ideal-typical sequence model proposed by Holsman-Crawford in 1975. The suitability of the model in explaining the growth of air transport network in a developing country such as Kenya is critically examined. In this chapter the hypothesis that: "there is no significant difference between the stages of growth of the Kenya air transport network and the one predicted by the Holsman-Crawford ideal-typical sequence model of air transport growth" is tested.

Table 4.1 : Number of Civil aerodromes in African States, 1990

Country	Land	Water	Private Use Only	Total
Algeria	49	0	19	68
Angola	26	0	20	46
Benin	8	0	0	8
Botswana	28	0	112	140
Burkina Faso	51	0	21	72
Burundi	4	0	0	4
Cameroon	43	0	21	64
Congo	43	0	0	43
Cote d'Ivoire	27	0	59	86
Djibouti	3	0	0	3
Egypt	17	0	4	21
Equatorial Guinea	2	0	1	3
Ethiopia	40	0	50	90
Gabon	39	0	44	83
Gambia	1	0	0	1
Ghana	3	0	0	3
Guinea	11	0	3	14
Guinea-Bissau	10	0	0	10
Kenya	152	0	231	383
Lesotho	33	0	0	33
Liberia	10	0	5	15
Libyan Arab Jamahirya	45	0	0	45
Malawi	27	0	16	43
Mali	29	0	16	45
Mauritania	20	0	45	65
Mauritius	1	0	0	1
Morocco	29	0	5	34
Mozambique	18	0	72	90
Niger	20	0	17	37
Nigeria	46	0	40	86
Rwanda	7	0	1	8
Senegal	16	0	29	45
Seychelles	11	0	2	13
Sierra Leone	13	0	1	14
Somalia	15	0	0	15
South Africa	156	14	108	278
Sudan	25	0	26	51
Swaziland	4	0	10	14
Togo	8	0	0	8
Tunisia	12	0	6	18
Uganda	10	0	32	42
Tanzania	62	0	9	71
Zaire	100	0	160	260
Zambia	70	0	60	130
Zimbabwe	33	0	446	479

Source: ICAO, 1991, pp 43

4.1 SCHEDULED AIRPORTS

The continued rapid growth of air traffic in post-independence Kenya has led to a rapid development of civil aerodromes. By 1990, there were 383 civil aerodromes in the country (Table 4.1). The table reveals that Kenya ranks second to Zimbabwe in the number of civil aerodromes in use. The geographical distribution of the main civil aerodromes is shown in Fig 4.1. Today, there are two international airports in the country: Jomo Kenyatta International Airport (JKIA) and Moi International Airport (MIA), Mombasa. The main aim for the construction of Jomo Kenyatta International Airport was to provide Nairobi with an airport capable of catering for the latest aircraft. This would attract tourists, business executives and other visitors to the country. Moi International Airport is the second international airport in the country. The old airport at Port Reitz was unable to cope with increasing volume of touristic traffic. The airport was not well equipped to handle modern, heavy and wide-body aircraft flying between Europe and Mombasa. Before the expansion of the airport, tourists had to fly directly to Nairobi and then get connected to Mombasa and other important tourist results such as Malindi and Lamu by smaller aircraft. In order to promote tourism at the Kenyan coast, the old airport had to be developed to International standards. Traffic at the two international airports has been growing steadily since 1970 (Appendix viii and Fig 4.2).

Figure 4.1 MAIN AERODROMES IN KENYA
Source: Aerodromes Department and Ongaro S.L., 1989.

The pattern of domestic air transport in Kenya is dominated by Nairobi, which acts as a hub for services to provincial points. The domestic air transport network to and from Nairobi consists of two categories:

a) Domestic scheduled services provided by the national airline between Jomo Kenyatta International Airport (JKIA) and Mombasa, Malindi and Kisumu.

b) Third Level Aviation sector which takes place in and out of Wilson Airport, a general aviation airport located in the Nairobi area.

4.2 MAIN DOMESTIC AIR ROUTES

As already indicated in chapter two, there are 15 sectors operated on a regular, scheduled basis, although charter services are provided to any point in the country (Table 4.3). Air charter companies cater for a variety of needs, but their main forms is on tourist demand to scattered game parks and reserves and the coast. The base for charter flights to the whole country is Wilson Airport in Nairobi, with Moi International Airport, Mombasa being the base for charter flights for coastal resorts, especially the Malindi-Lamu sector. The demand for domestic air services from Mombasa particularly to the Game Parks has increased substantially after the expansion of the airport. Without these services, "same day" visits to the game parks/or longer stays including overnight stops would be difficult.

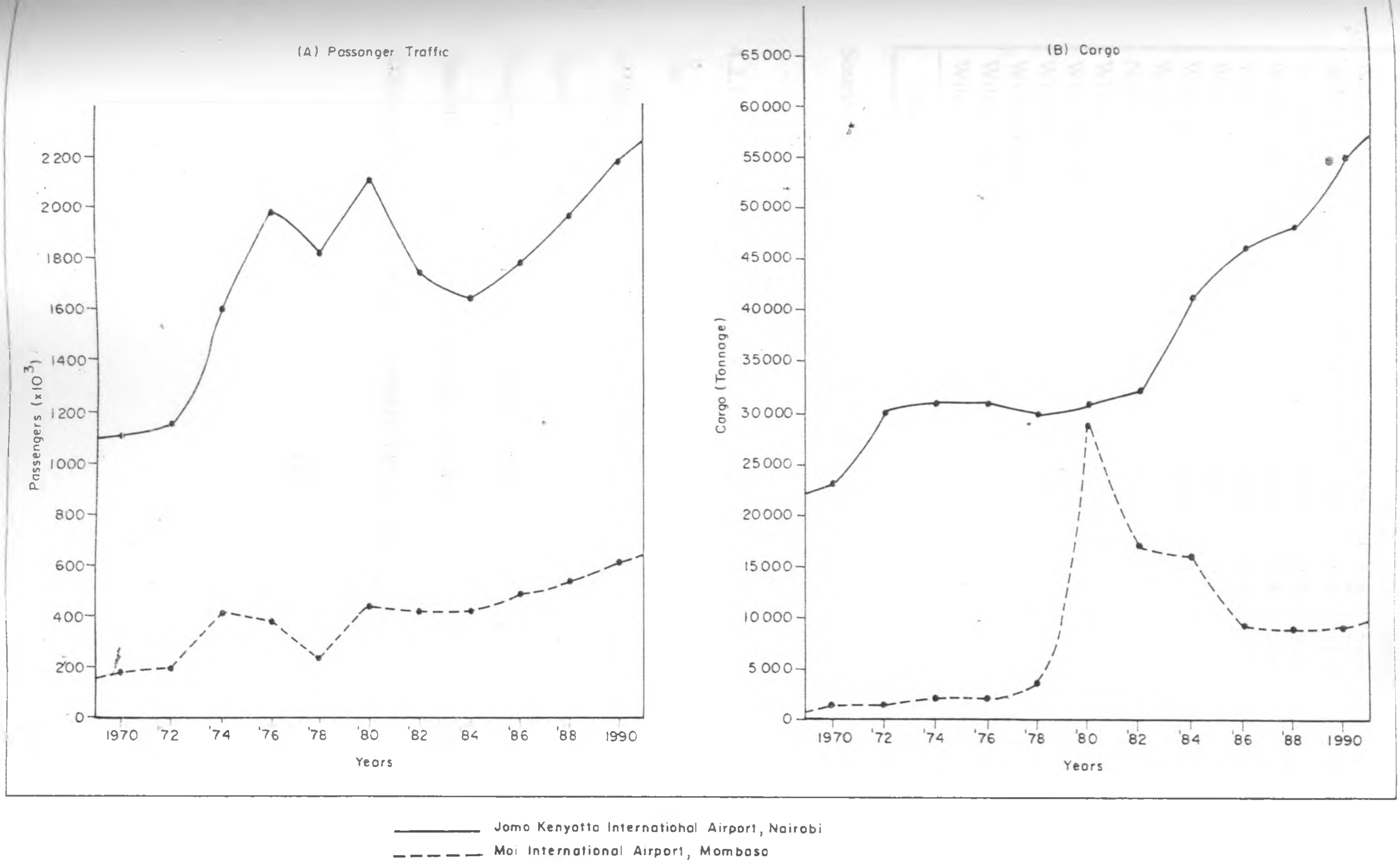


Figure 4·2 Growth of air traffic volume at Jomo Kenyatta and Moi International Airports, 1970–1990.

Table 4.2 : Wilson Airport: Sector Analysis Based on Individual Routes

Sector	1987	%	1988	%	1989	%	1990	%
Wilson-Maasai-Mara	73924	48.0	73952	47.0	78424	44.8	85685	42.9
Wilson-Garissa	8097	5.2	2416	1.5	2557	1.5	1908	1.0
Wilson-Turkana	4185	2.7	2634	1.7	3118	1.8	2697	1.4
Wilson-Eldoret	4638	3.0	3654	2.3	3690	2.1	3504	1.8
Wilson-Samburu	7621	4.9	4314	2.8	3657	2.1	3920	2.0
Wilson-Amboseli	8380	5.4	12647	8.1	13037	7.5	1846	9.2
Wilson-Wajir	1281	0.8	444	0.3	257	0.1	611	0.3
Wilson-Northern	7028	4.6	8969	5.7	9651	5.5	13335	6.7
Wilson-Eastern/ North-Eastern	4946	3.2	4881	3.1	6190	3.5	5646	2.8
Wilson-Western	11964	7.8	11074	7.1	10339	5.9	13624	6.8
Wilson-Coast	21968	14.3	18178	11.6	21039	12.0	23669	11.9
Wilson-Ukunda	-	-	2912	1.9	2571	1.5	1419	0.7
Wilson-Lamu	-	-	6959	3.9	7338	4.2	8459	4.2
Wilson-Nanyuki	-	-	3633	2.3	7963	4.6	5068	2.5
Wilson-Mandera	-	-	1070	0.7	5103	2.9	11636	5.8
Total	154032	100	156837	100	174934	100	199644	100

Source : Civil Aviation Board (CAB) 1990

4.2.1 ROUTE STRUCTURE, OPERATIONS AND PERFORMANCE

The domestic route structure in terms of sectors, weekly frequency of service and fares is shown in table 4.2. The sector lengths range from 104 km (Wilson-Nyeri) to about 820 km (Wilson-Mandera). The top five (5) sectors are: Wilson-Maasai Mara - (102 weekly flights), Wilson-Western (Kisumu) - (46 weekly flights), Wilson-Coast (Mombasa) - (39 weekly flights), Wilson-Mandera -(35 weekly flights), Wilson-Northern (Nyeri) - (28 weekly flights). The least five (5) sectors are: Wilson-Garissa (<7 weekly flights), Wilson-Lodwar (<7 weekly flights), Wilson-

Wajir (<7 weekly flights), Wilson-Ukunda (<7 weekly flights) and Wilson-Samburu (9 weekly flights).

In general, air fares in Kenya like in other developing countries are high. This, perhaps, is the most important reason for the restriction of this mode of transport mainly to high income groups such as senior government officials, business executives and university functionaries (Filani, 1975). The fares on scheduled routes range from about Kshs.16.00 per passenger-kilometre on the shortest sector (Wilson-Nyeri) to about Kshs.3.50 per passenger-kilometre on the Wilson-Western (Kisumu) sector (Table 4.3).

Table 4.3 : Frequency of Service and Fares on Selected Domestic Sectors in Kenya

Sector	Weekly Flights	Distance (Km)	Fare (Kshs.per km)
Wilson-Maasai Mara	102	210	10.40
Wilson-Western	46	300	3.50
Wilson-Coast	39	430	3.60
Wilson-Lamu	12	475	6.70
Wilson-Eldoret	10	248	8.30
Wilson-Northern	28	104	16.00
Wilson-Samburu	9	228	11.30
Wilson-Nanyuki	13	142	11.70
Wilson-Turkana	7	503	7.95
Wilson-Amboseli	23	160	10.80

Source: Computed by Author

As would normally be expected, there is a general correlation between frequency of servi and traffic density. Wilson-Maasai Mara sector handles about 43% of total passenger traffic in year. Wilson-Wajir sector handles the lowest value of passenger traffic (Table 4.2).

4.2.2 LOAD FACTORS AND CAPACITY UTILISATION

The number of aircraft seats utilized at Wilson's Airport has been increasing every year The capacity offered has also been growing. Fig 4.3 shows the volume of passenger traff handled by the top five (5) air charter companies at Wilson Airport, Nairobi. From the figure, would appear that Air Kenya is the dominant air charter company in the country (Appendix ix). Fig. 4.4 shows Air Kenya's scheduled routes. There appears to be an "over-capacity" problem i the Kenya air charter industry (Appendix x and Fig. 4.5). The average load factor (utilizatio ratio) for most air charters has bee less than 50% (Table 4.4)[1]. The ideal load factor should b 65-75% to ensure profitable operations. With fewer operators, load factor could be focused, an charter services now operated haphazardly could be consolidated or even scheduled in som instances.

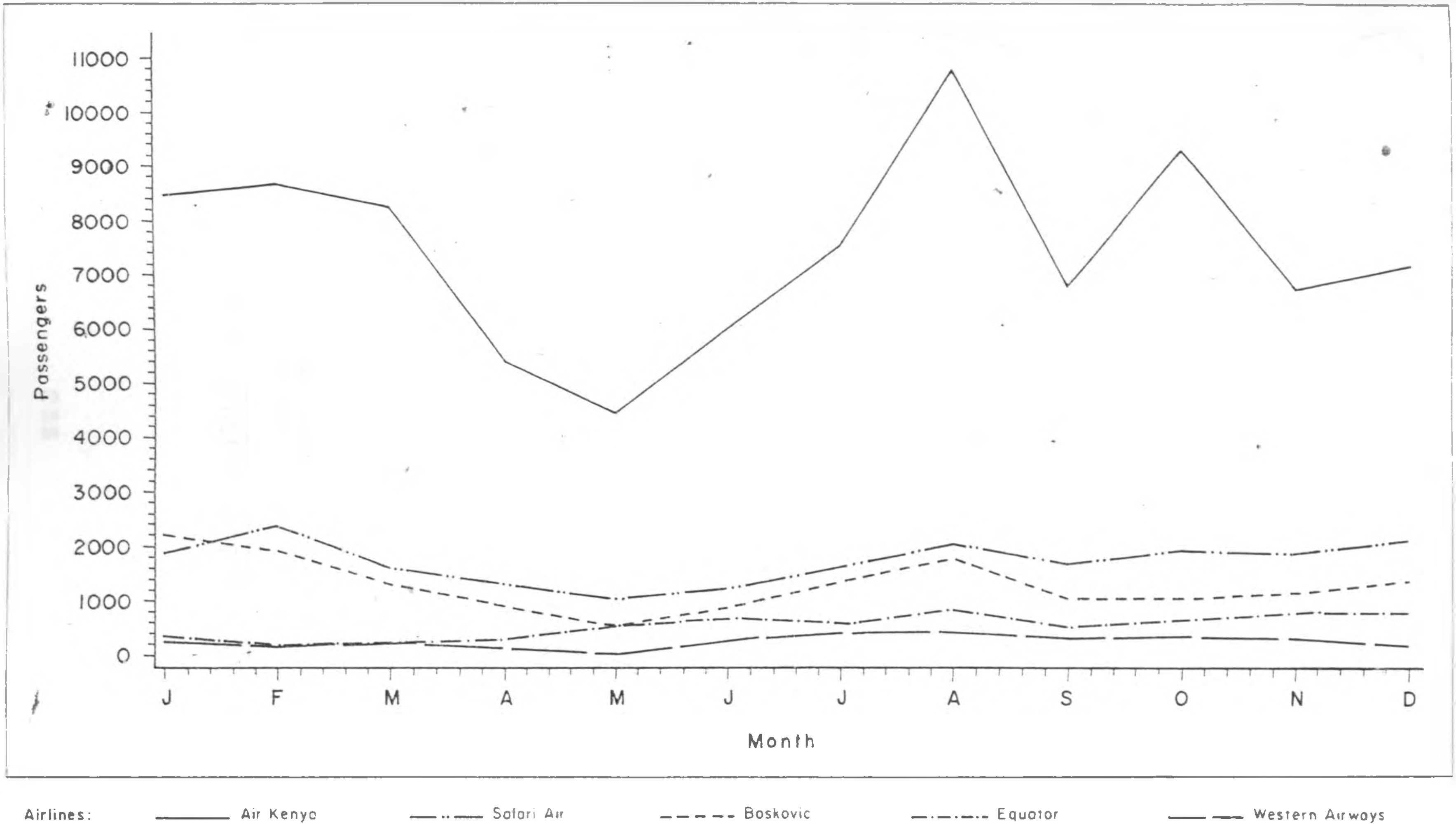


Figure 4·3 Monthly Passenger Air Traffic for Top Five Domestic Air Charter Operators.
Source Civil Aviation Board (CAB), 1990

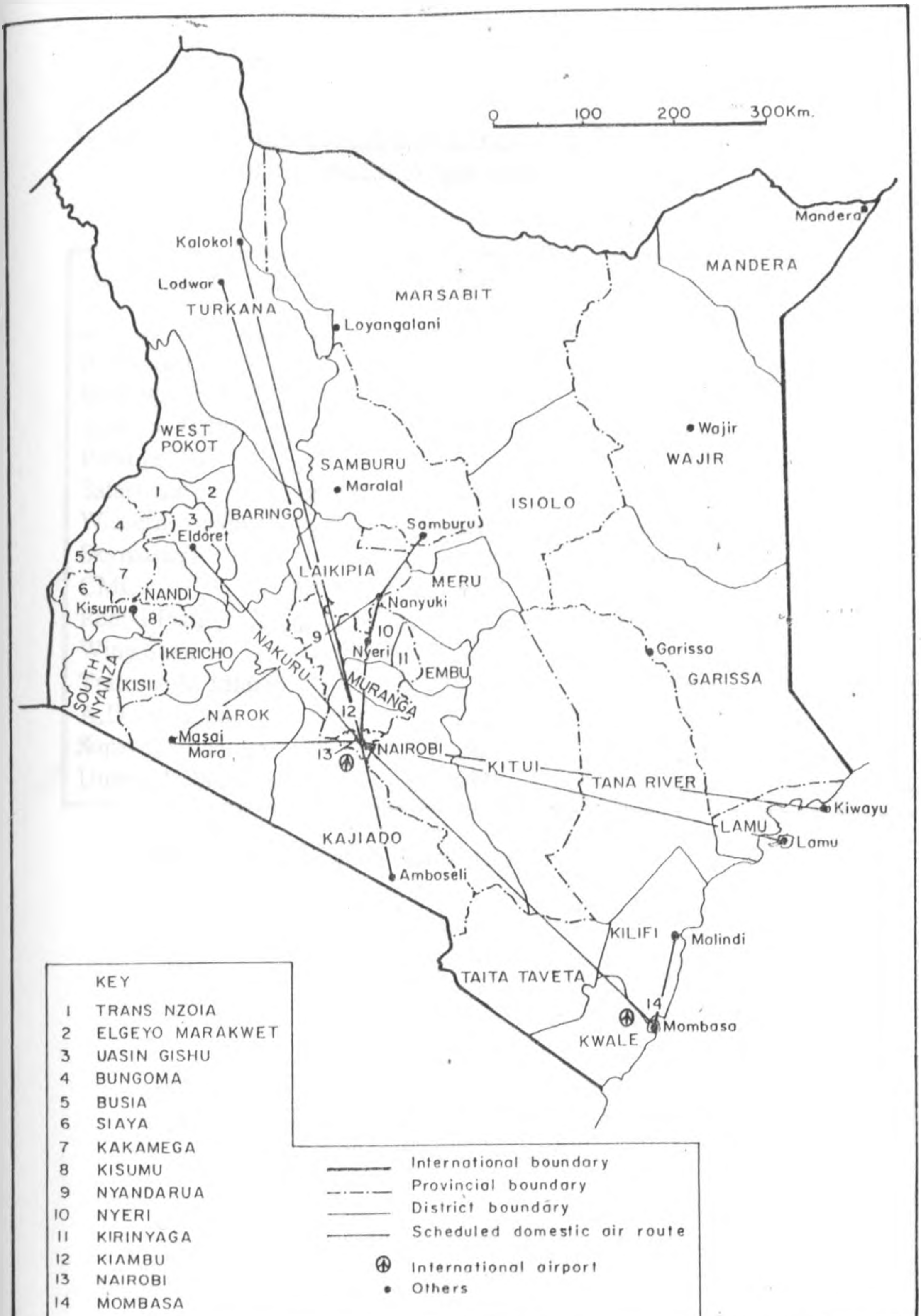


FIG. 4.4 AIR KENYA SCHEDULED DOMESTIC AIR ROUTES

Table 4.4 : Capacity Utilization of Commercial Air Charters based at Wilson Airport, Nairobi

Air Operator	Total Seats Offered	Total Seats Utilized	Load Factor (%)
Air Kenya	153450	89430	58.3
Boskovic	38455	15428	40.1
Equator Airlines	14948	6425	43.0
Prestige Air	4798	2192	45.7
Safari Air	42867	20636	48.1
Western Airways	12902	3875	22.3
Skymasters	9220	7251	78.6
CMC	8589	3582	41.2
Rent-a-Plane	11371	4682	41.2
Wing Safaris	2628	1117	42.5
Transworld Safaris	7372	2956	40.1
A.D. Aviation	2165	952	44.1
Superior Aviation	304	214	70.4
United Airlines	4822	2606	54.0

Source: Civil Aviation Board, 1990

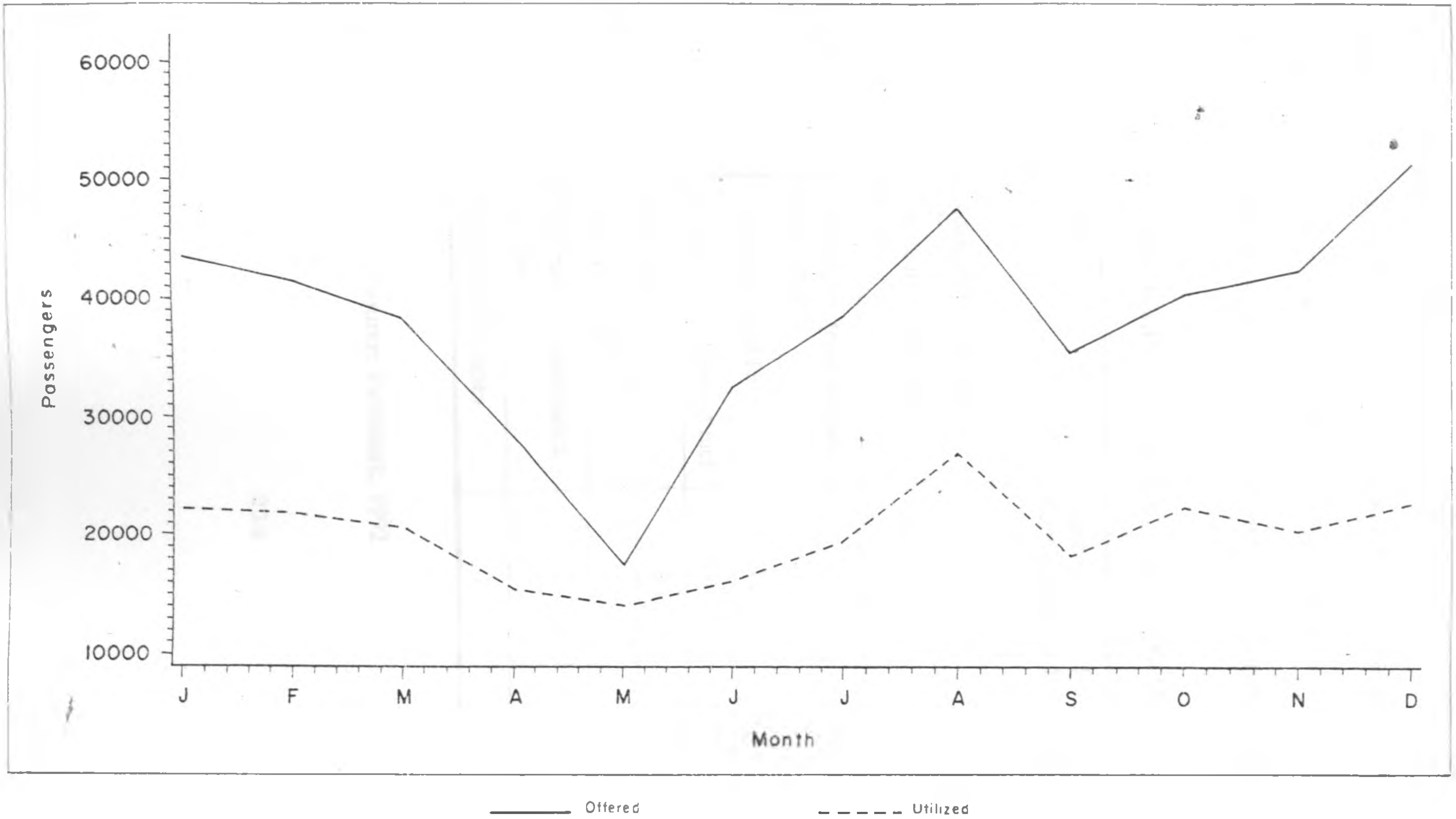


Figure 4·5 Wilson Airport: Local Operators Capacity Utilization (1990).
Source Civil Aviation Board (CAB)

4.3 PROBLEMS FACING DOMESTIC AIR TRANSPORT

Third Level Aviation sector faces a number of problems that need to be solved in order to ensure efficient, safe, reliable and comfortable air transport services (Table 4.5). The major problems include: inadequate aerodrome facilities, cost of fuel, import duties on new aircraft and spare parts, aging aircraft and discrimination in regulation.

Table 4.5: Problems faced by Domestic Air Operators

Problem	Number of Respondents (N=12)	Percentage of Respondents
Undercapacity flights	1	8.3
Competition from other airlines	6	50
Competition from surface transportation	2	16.6
Managerial problems	1	8.3
Rising cost of aviation fuel	10	83.3
Aging aircraft	4	33.3
Noise problems	2	16.6
High cost of maintenance and spares	2	16.6
Heavy import duties	1	8.3

Source: Fieldwork, 1992.

Imports of aircraft components are subjected to a wide range of duties (Table 4.13). The imports for aircraft used for transporting tourists are classified under a variety of headings rather than as imports for tourism purposes. This means that aircraft spares are very expensive and most air operators cannot afford to purchase them. As a result, many air operators are unable to replace their aging aircraft fleet.

Table 4.6 : Duties Levied on Aircraft Components

Aircraft Component	Duty Rate (%)	Sales Tax Rate (%)
Aircraft Spares	10	0
Tyres	80	17
Seal	10	0
Ring	30	17
Shaft	45	17
Plate	30	17
Key	30	17
Plug	65	17
Gasket	25	17
Stud	80	17

Source: Sinclair, M.T., 1990, pp 65.

Discrimination in the regulation of domestic air transport services occurs when different restrictions affect different operators. For example, the Kenya Airways enjoys excess protection from the government. Kenya Airways is the only domestic air carrier whose capacity is not limited and is free to offer scheduled air services on any sector in the country. One condition for a scheduled domestic air transport license is that the operator should surrender the service whenever Kenya Airways wants to operate on that route. This condition has tended to discourage local air operators from pioneering the establishment of new domestic sectors (Ongaro, 1989).

4.4 THE USE OF GRAPH THEORY IN THE ANALYSIS OF DOMESTIC AIR TRANSPORT NETWORK

Transport networks are integrated structures that link centres (nodes) such as towns or cities and each link in the network not only connects two nodes but is part of the whole system of connections between many other pairs of nodes. A useful tool for analysing transport network is the Graph Theory which has been discussed in chapter 3. The overall domestic air transport network change in the last five decades is summarized in table 4.7. The table shows that the connectivity of Kenya's domestic air transport network has increased since 1938. An examination of each graph theoretic index on the table indicates that the air transport network has been growing up to 1983. For example, the network's cyclomatic number (μ) increased from 1.0 in 1938 to 8.0 in 1983. But, in 1993, the cyclomatic number had decreased to only 4. A high value of the cyclomatic number indicates a highly connected network, while a lower value indicates poor connectivity. The beta (β) index too shows a similar trend increasing from 1.0 in 1938 to 1.5 in 1983 and declining to 1.2 in 1993. The decline in the value of each graph theoretic index is apparent in two particular years, namely: 1953 and 1993. The decline in the values of graph theoretic indices in 1953 can be attributed to the state of emergency in the country. Due to the Mau Mau uprising, civil aviation was restricted throughout the country. The decline in the values of cyclomatic number (μ), beta index (β) and gamma index (γ) in 1993 can be explained by a number of factors. These are: the closure of some missionary air fields and the adoption of unsuitable aviation policies in the country. The period 1983-1993 witnessed the closure of some missionary airfields in the northern parts of Kenya. The missionaries were distributing famine relief mainly by air to places and communities otherwise largely inaccessible by surface transportation. The closure of such airfields reduced significantly air transport network connectivity in the region. During the same period, unsuitable policies were implemented that worked against the development of civil aviation in the country. For instance, heavy import duties were imposed on new aircraft and spare parts. This meant that local air operators could not increase and/or modernise their fleet. This, coupled with the high cost of aviation fuel, forced many domestic air operators to withdraw from certain routes (sectors). Consequently, there was a decline in airline connectivity. A beta value of 0.9 indicates partial connection, a value of 1.0 indicates complete simple connection, a beta value of 1.1 or 1.2 indicates advanced or complex interconnection. Studies have shown that there exists a significant relationship between a country or region's economic development and the value of the various graph theoretic indices (Kansky, 1963, Mowforth, 1979, de Souza, (1990). Fig 4.6 shows hypothetical transport network graphs with increasing connectivity. The connectivity graphs for Kenya's domestic air transport network are shown in Fig 4.7.

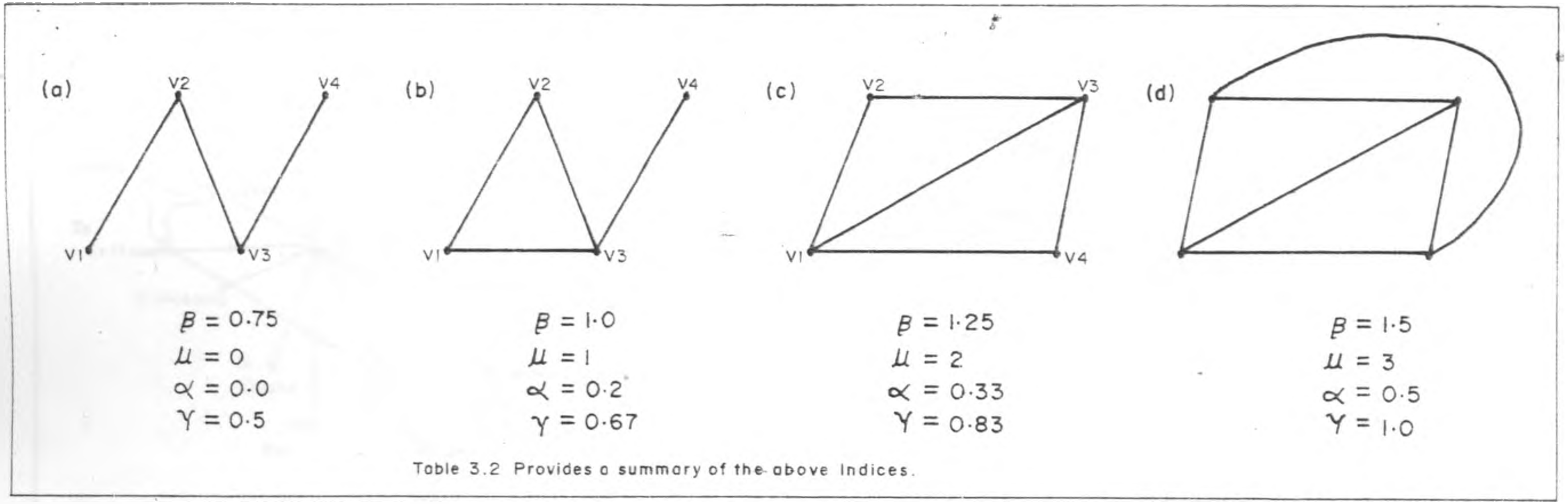
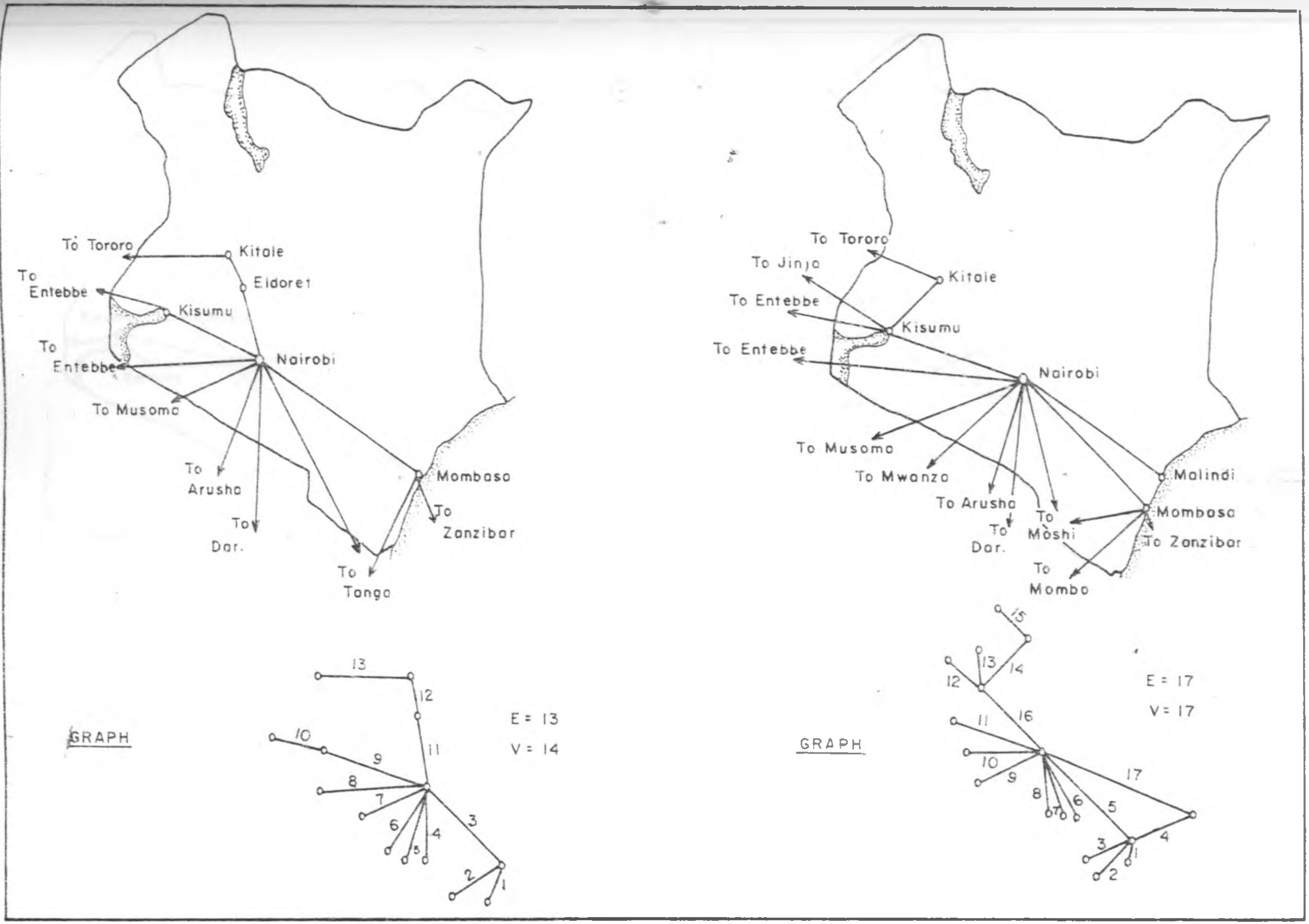


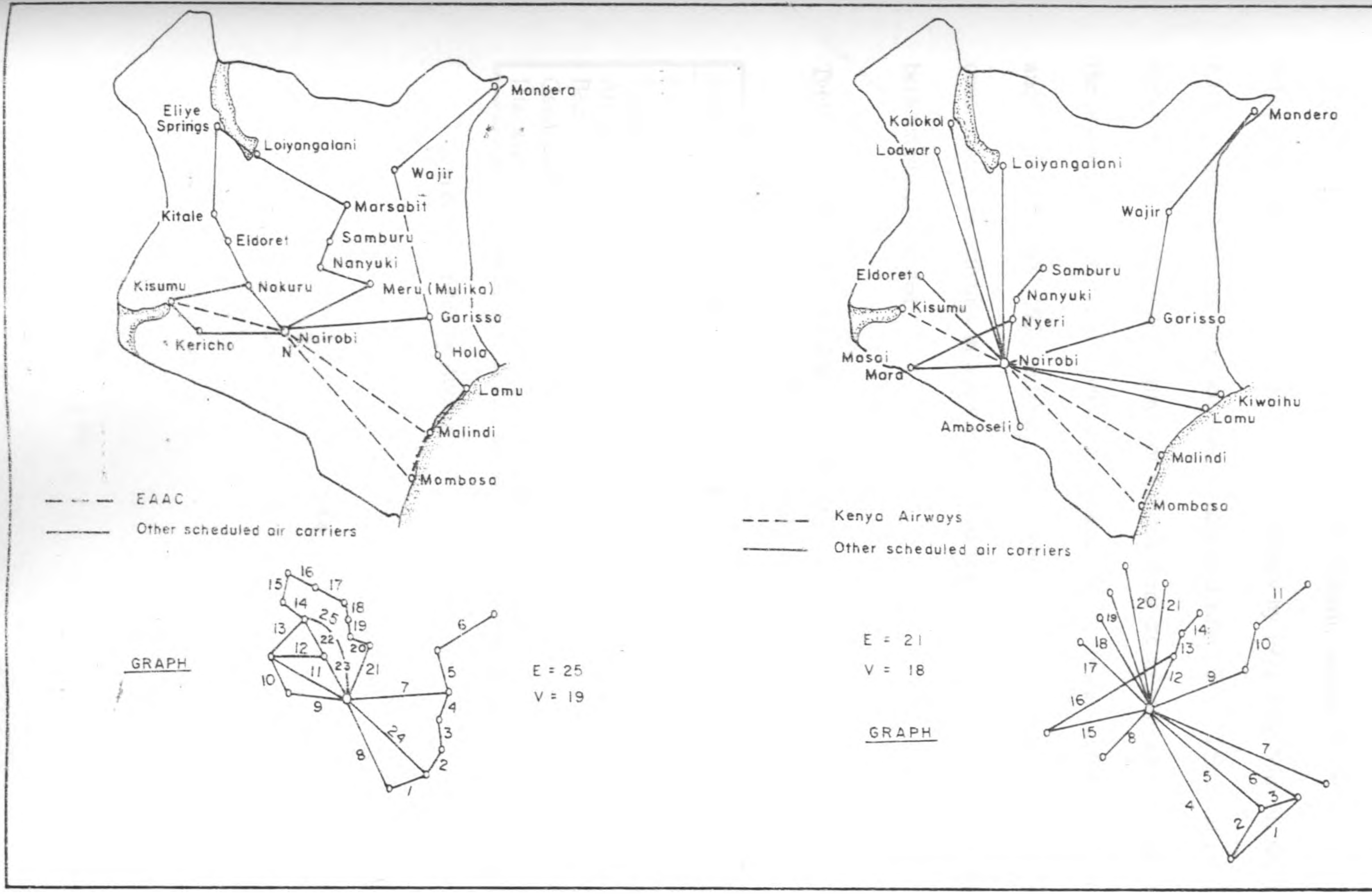
Figure 4.6 Hypothetical Network Graphs with increasing Connectivity.
Source: Prepared by Author



A) Regular Domestic Air services in Kenya, 1953.

B) Regular Domestic Air services in Kenya, 1963

Figure 4.7a Connectivity Graphs in Kenya, 1953 and 1963.
Source Fieldwork



C) Regular Domestic Air services, 1973

D) Regular Domestic Air services, 1991.

Figure 4·7b Connectivity Graphs in Kenya, 1930 and 1991.

Source Fieldwork

The evolution of accessibility surface of Kenya's domestic air transport network is shown in Fig 4.8. The accessibility surface created by drawing isolines reveals a trend from moderate peaking in 1938 to a highly peaked and highly polarized surface in 1973. The point of highest accessibility in 1938 was Nakuru, located in the heart of former White Highlands. The highest peaks of accessibility by 1973 were Nairobi, Kisumu and Lamu. This pattern has remained almost unchanged since 1973. The trend revealed by the evolution of accessibility surfaces of Kenya's domestic air transport network supports the findings of Taaffee *et al.* (1963) and Lachene (1965). In the Taaffee (1963, 504-505) and Lachene (1965, 195), models, the growth of transport networks accentuated concentration of activities in a few centres and high priority or main street connections between places emerged.

Table 4.7 : Summary of Connectivity Measures of Kenya's Domestic Air Transport Network, 1938-1993

Index	1938	1947	1953	1963	1973	1983	1993
Cyclomatic Number (μ)	1.0	2.0	0.0	1.0	8.0	8.0	4.0
Alpha (α)	0.03	0.13	0.0	0.1	0.04	0.1	0.03
Beta (β)	1.0	1.2	0.93	1.0	1.3	1.5	1.2
Gamma (γ)	0.25	0.47	0.33	0.5	0.14	0.21	0.14
Diameter(δ)	5.0	3.0	4.0	4.0	7.0	6.0	5.0

Source: Compiled by Author

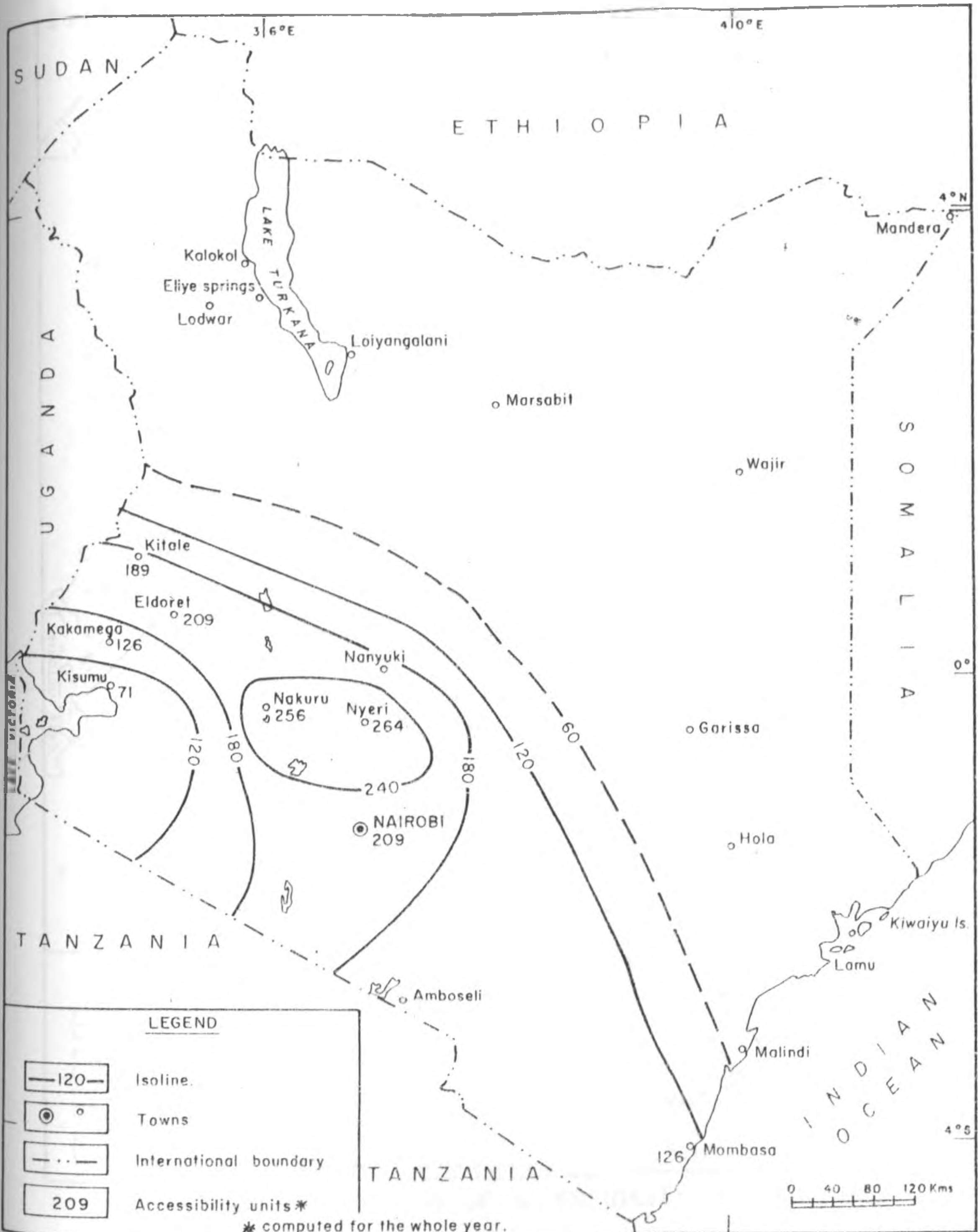


FIG. 4.8 (a) : EVOLUTION OF ACCESSIBILITY SURFACE, 1938.

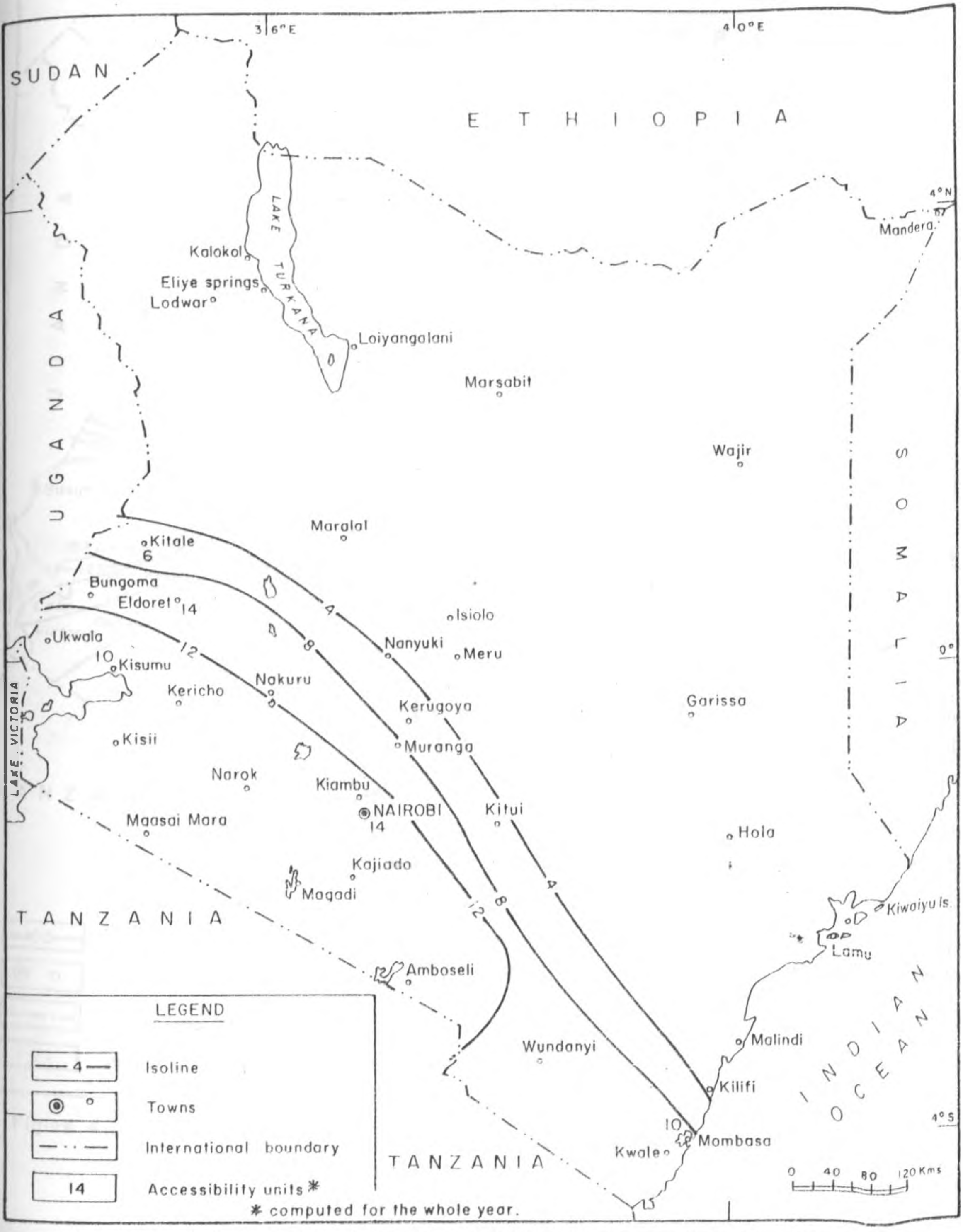


FIG. 4.8 (b) : EVOLUTION OF ACCESSIBILITY SURFACE, 1953

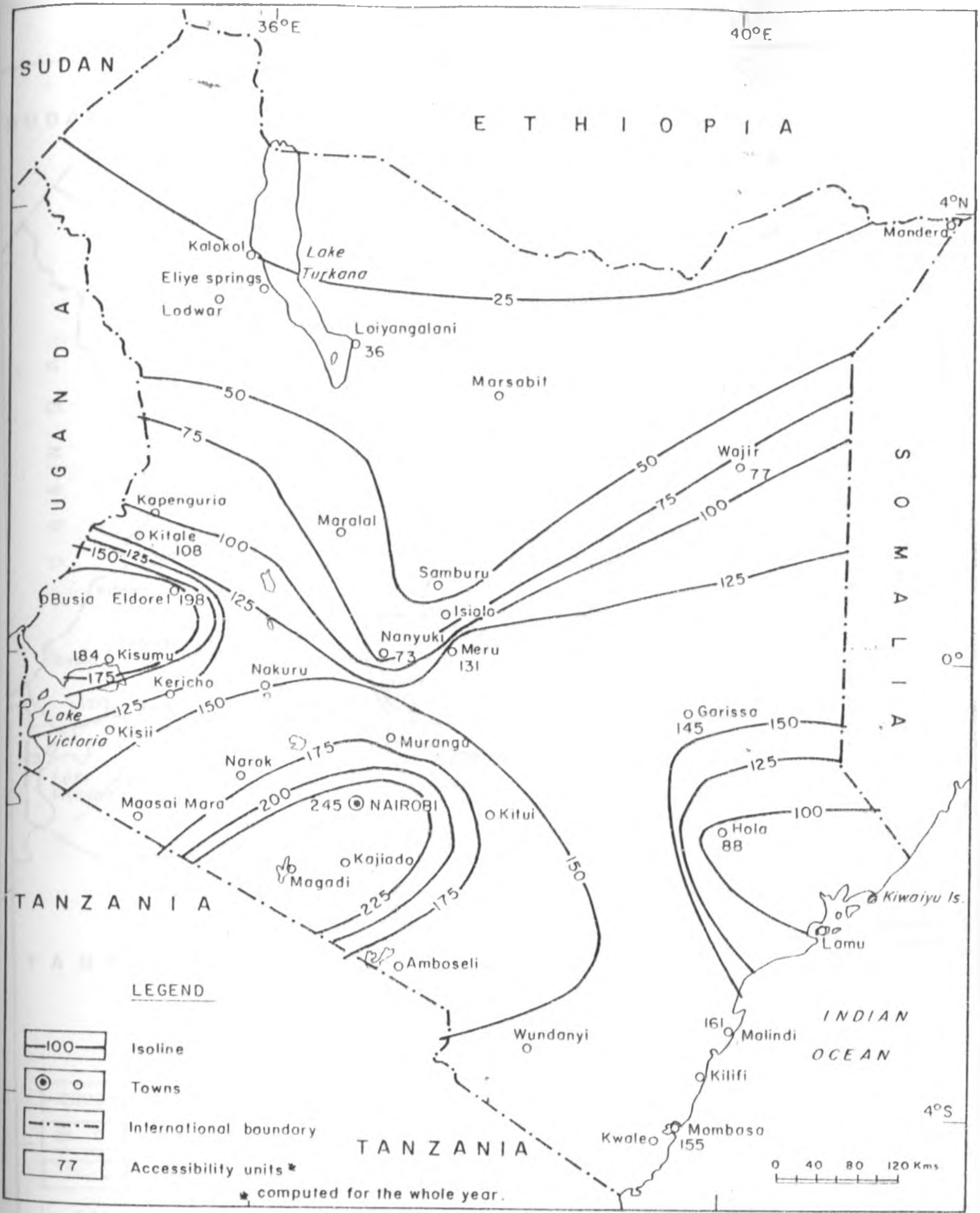


Figure 4.8 (c) EVOLUTION OF ACCESSIBILITY SURFACE, 1973.
Source Fieldwork.

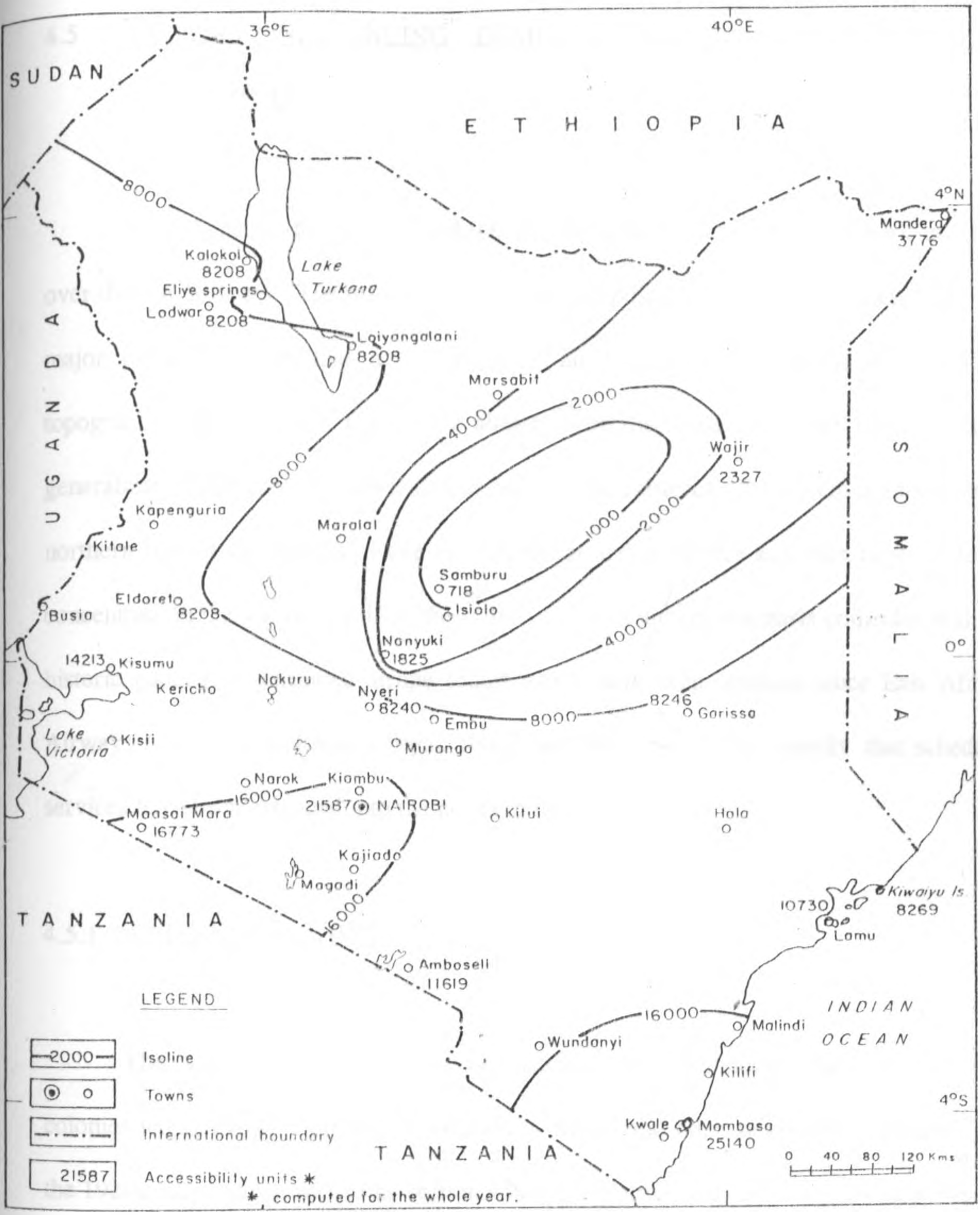


Figure 4.8 (d) EVOLUTION OF ACCESSIBILITY SURFACE, 1993.
Source Fieldwork

4.5 FACTORS INFLUENCING DOMESTIC AIR TRANSPORT NETWORK DEVELOPMENT

Several factors have influenced the development of air transport network in Kenya over the last 50 years. The main ones are: physical, political and economic factors. The major physical factors that have influenced air transport development in Kenya are topography and weather. These have already been discussed in chapter two. A broad generalization that can be made is that because of the existence of a dry environment in the northern half of the country, extensive settlement and economic activities have tended to concentrate in the southern half of the country. This southern emphasis coincides with the historic pattern of scheduled airline routes which have been operated since East African Airways Corporation (EAAC) began flying in 1946. It is only recently that scheduled services have been extended into the northern half.

4.5.1 POLITICAL FACTORS

The desire by colonial powers to maintain close communication links with their colonies led to the development of aviation in Kenya and other developing countries. By the 1920s, imperialism was being seen in a new perspective and central to this idea was the emphasis being placed on the need to improve imperial communications and transport. If empires were to be maintained, so were the thinking, then swifter, surer and more frequent communications between the colonies and the mother countries had to be developed to assure the unity so essential in imperial survival. This, to the traditional processes of empire building and colonial rule in Africa was added another dimension: Air transport. The following quotation best illustrates the colonial motive for developing air transport in Africa:

> "Air transport was assigned the critical task of giving substance to the shadow of empire ... With the introduction of the aeroplane and a new dimension of imperialism to pursue, a second scramble for Africa was under way. It was not the rush to claim territory as the first had been, but is was empire building all the same. Now the prices were prestige and influence, routes and ports of call." (McCormack, 1976, 89).

In the late 1950s and early 1960s, following political independence in various African countries, the possession of national airlines became a national prestige symbol. This tendency necessitated the subsequent proliferation of African National airlines which can only be explained only in terms of political prestige rather than economic (Filani, 1975).

4.5.2 ECONOMIC FACTORS

The major economic factor that has promoted the growth of air transport in Kenya is tourism. Tourism is the principal user of air transport both internationally to and from Kenya and domestically. Tourists have an insatiable curiosity to visit as many places of interest as possible within the shortest time interval. Appendix xi and Fig 4.9 show the seasonal variation of international air passenger and domestic air charter traffic. The resultant pattern is due to the fact that Kenya has successfully developed wild life tourism and beach tourism. each with its own seasonal rhythms. The dry seasons (January and July-September) are the best for wild life viewing as the drought draws the animals to the water holes where tourist lodges are built. The Short-rains in October-November do not deter tourists as this is the period when animals gather in vast numbers in the Maasai-Mara Game Reserve for their annual migration. The long rains period between March-May is the low-season for wild life tourism because the animals disperse from water holes (other water sources become available). The unsealed roads make the safari drives difficult and the savanna grass grows tall and hides the animals. The low-season for the beach resorts is longer as they are primarily winter sun attractions for the Northern hemisphere market (Burton, 1991, 245).

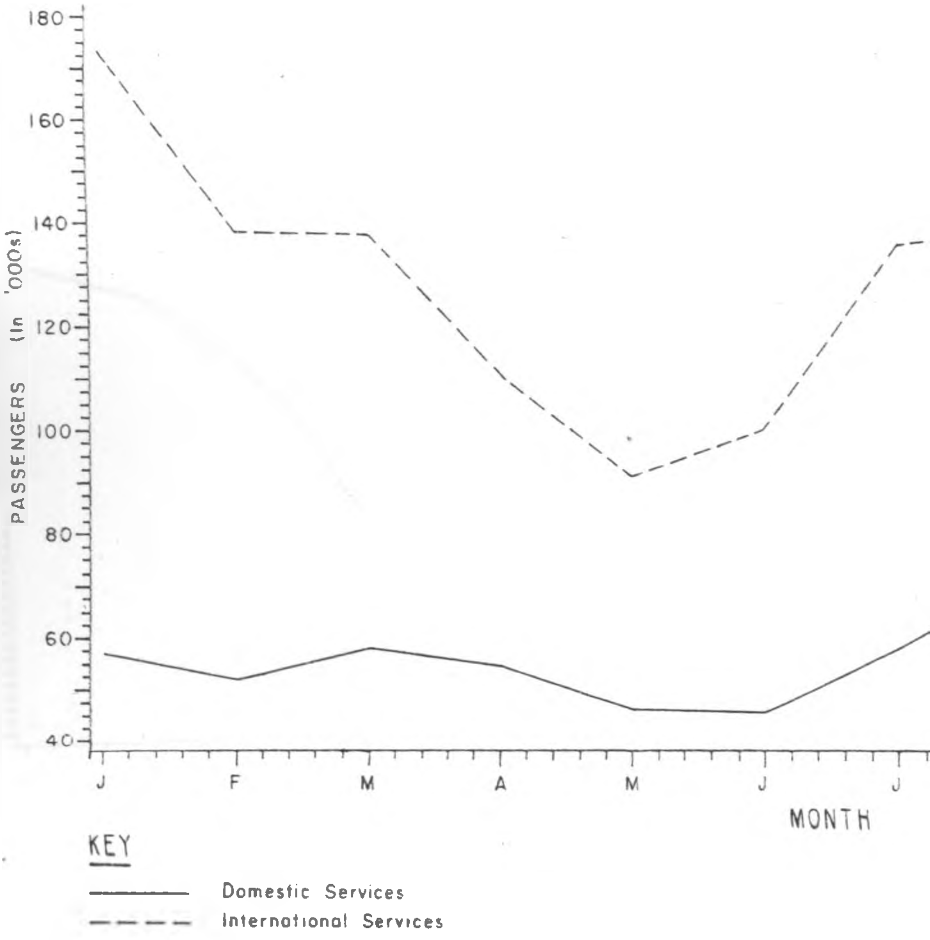
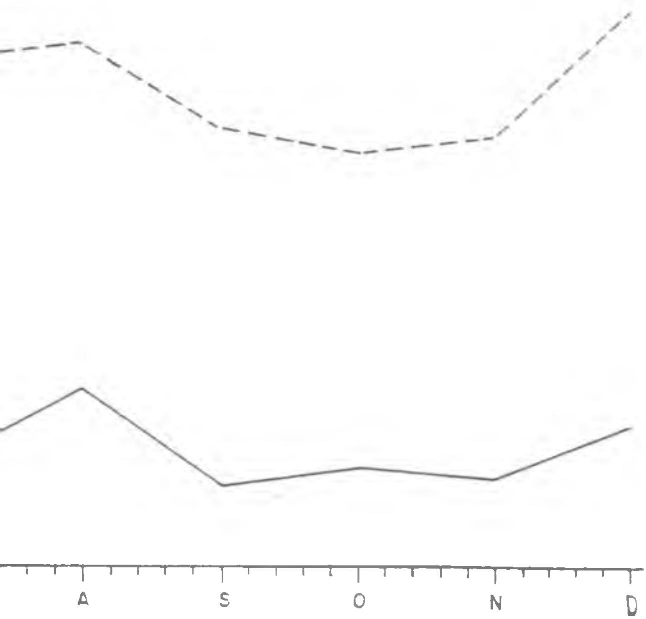
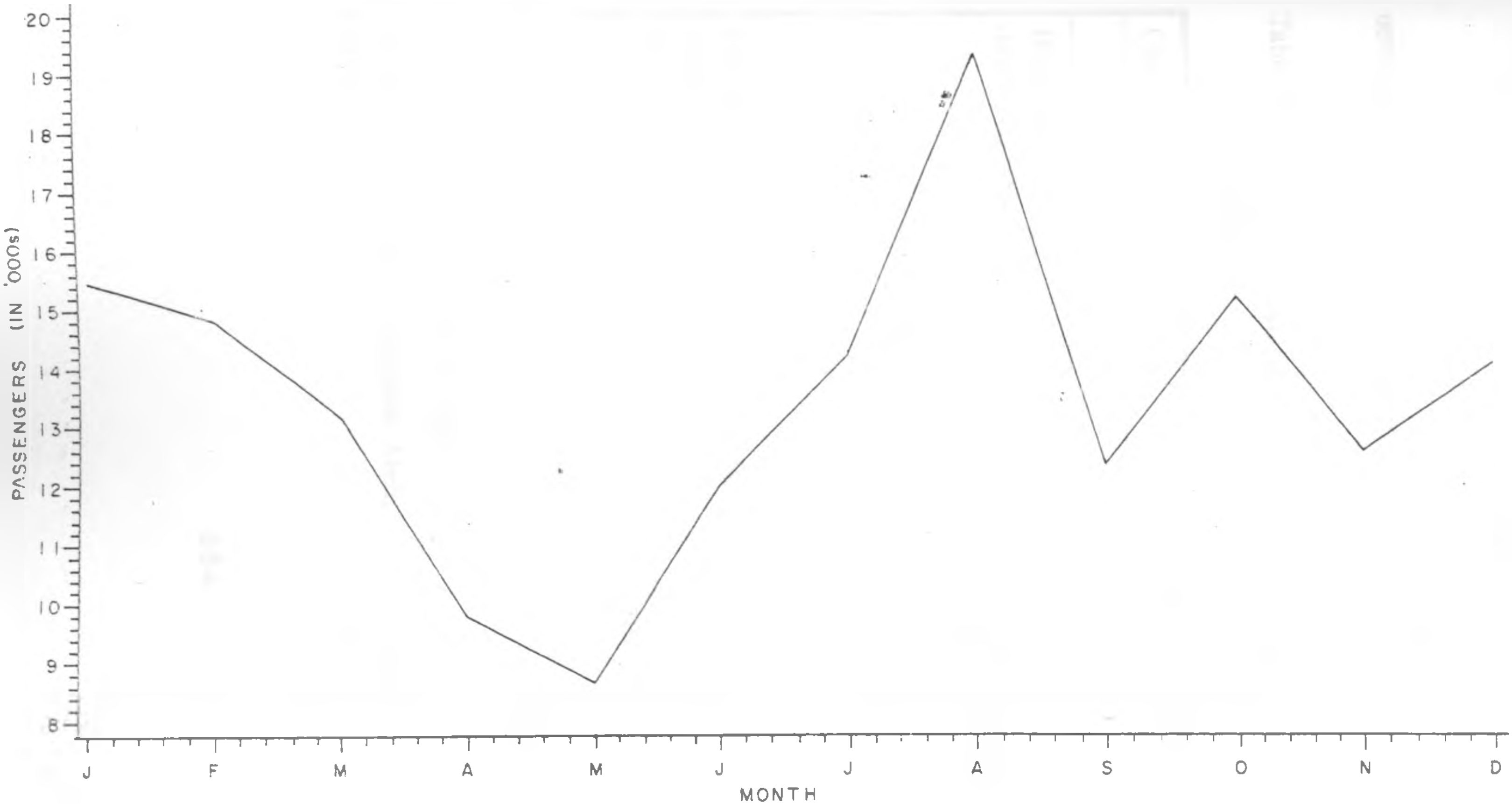


FIG 4. 9 (a) SEASONAL PASSENGER — TRAFFIC VARIATIONS IN



Source : ICAO (1989)
Airport Traffic, Series A T — No 30, pp 102 –103

ENYA, 1989



SOURCE · CIVIL AVIATION BOARD (CAB) 1990

FIG. 4.9 (b) SEASONAL VARIATION OF DOMESTIC AIR CHARTER TRAFFIC, 1990.

The main tourist regions in Kenya are shown in fig 4.10. Table 4.8 shows the main tourist regions and the type of air service(s) available in 1973 and 1990. Domestic air charter services are used to serve temporal and spatial fluctuations in demand for commercial air transport services (Appendix xii).

Thus the pattern of domestic air transport services produces a complex nationwide network of flights because of the dominance of air charter services (Ongaro, 1989).

Table 4.8: Suggested Potential of Kenya's Tourist Regions and Type of Air Services Available

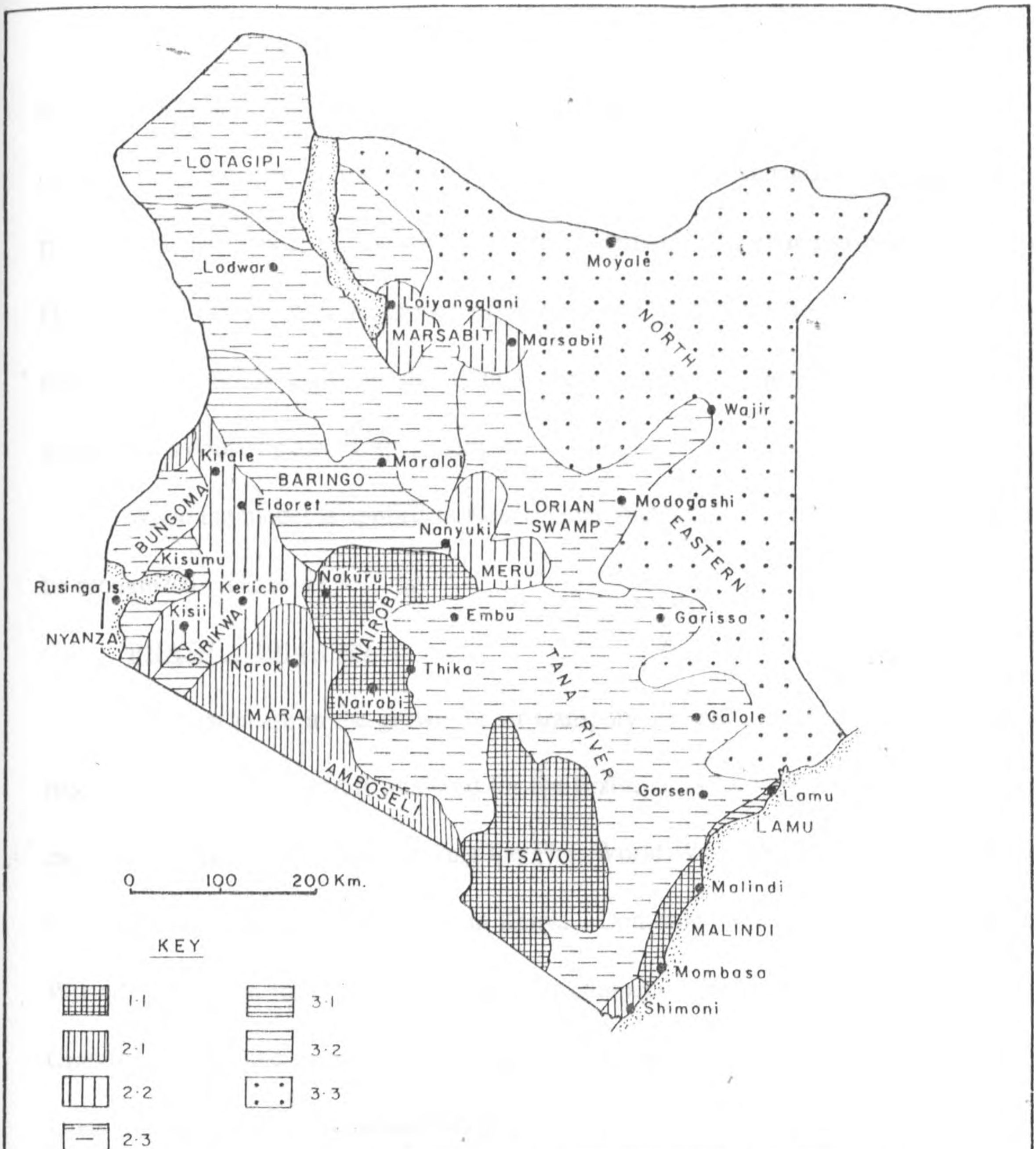
Category	Area	Air Service	Air Service
		1973	1990
High Potential well developed (1b)	Nairobi, Tsavo Mombasa/Malindi	EAA, Nairobi; Charter, Kilaguni, Cottair's Camp EAA, Mombasa/Malindi	Kenya Airways (KA), Nairobi; Charter, Kilaguni, Cottair's Camp Kenya Airways (KA), Mombasa/Malindi
High Potential Moderately developed (1c)	Amboseli-Maasai Mara Mombasa South Coast, Kitale West	Charter, Amboseli, Charter, Keekorok, EAA, Mombasa Charter, Kitale	Charter, Amboseli, Charter, Keekorok, Kenya Airways, Mombasa Charter
Moderate Potential, Moderately	Marsabit, Meru	Charter, Marsabit Charter, Samburu,	Charter, Marsabit, Charter, Meru

Category	Area	Air Service	Air Service
developed (IIc)	Eldoret/Kericho	Charter, Eldoret	Mulika, Charter, Eldoret
High Potential Underdeveloped (1d)	Lamu	Charter, Lamu	Charter, Lamu
Moderate Potential, Underdeveloped (IId)	Baringo Kisumu	Charter, Baringo EAA, Kisumu	Charter, Baringo Kenya Airways, Kisumu
Low Potential, Moderately Developed (IIIc)	Lake Turkana	Charter, Ferguson's Gulf	Charter, Lodwar, Kalokol
	Lorian Swamp	Charter, Wajir	Charter, Wajir
	Tana River	Charter, Garissa, Hola	Charter, Garissa
	Bungoma	None	None

Source: After Ouma, J.P.B.M (1970)

4.6 A COMPARISON BETWEEN THE GROWTH OF AIR TRANSPORT IN KENYA AND THE "IDEAL-TYPICAL SEQUENCE" MODEL OF HOLSMAN AND CRAWFORD

Holsman and Crawford (1975) developed an integrated model of air transport growth. This model was applied to North Western Australia, an underdeveloped region. It is a four-phase model and these phases can be seen as ideal-sequence types each being considered similar to a wave emanating from peripheral foci. This study applies the model in the Kenyan situation in order to test its validity. The growth of air transport



High Potential	Moderate Pote.	Low Potential	Negligible Pote.	Stage of Development
1·1				Well developed
2·1	2·2	2·3		Moderately developed
3·1	3·2		3·3	Underdeveloped

Figure 4.10 Tourist regions of Kenya, modified, though essentially after J.P.B M. Ouma (1970)

system in Kenya is compared with the phases identified in Holsman-Crawford model in order to show whether the transport system conforms to the postulates of the model. typical sequence model of transport growth" is tested. The four-phases identified by Holsman and Crawford in the growth of air transport are summarised in Chapter 1. The main concern here is to present the result of the comparison of Holsman-Crawford model and Kenya's domestic air transport network.

When the model is applied in Kenya, three distinct phases of network growth can be recognized. These are:-

PHASE 1: 1914-1929

The first phase in the growth of air transport network in Kenya covers the period from 1914 to 1929. Aircraft was used for the first time in East Africa during the British campaigns against the Germans during the First World War. During this pioneer phase, there were no scheduled air services in Kenya. Domestic air services were provided by Wilson Airways, a local private air transport company. As postulated in the Holsman-Crawford model, the main functions of air services during this phase were surveys of all kinds (reconnaissance, geological survey etc).

PHASE 2: 1930-1945

During this phase, regular scheduled air services were introduced by Wilson Airways linking Nairobi with other important urban centres in East Africa. As demand for travel increased, the frequencies of services along various routes had to be increased. This period saw the development of the first domestic air routes in Kenya. With the outbreak of the Second World War, civil aviation was interrupted as aircrafts were taken over by the colonial government and used for military purposes.

PHASE 3: 1946-1993

This phase covers the period from 1946 to the present time. Intermediate nodes became firmly established. Some of the important intermediate nodes included Nakuru, Nyeri, Nanyuki and Eldoret. Their appearance could possibly be as a result of greater regional significance through the establishment of surface links to them (Ogonda, 1986). Both scheduled and chartered services became well developed. Scheduled services were being provided by East African Airways (EAA), an East African regional airline. Chartered air services were centre on the intermediate nodes to service their hinterlands.

Newer and better equipped aircrafts were also introduced during this period. The Lodestars were used in Kenya for the first time in 1948. In the early 1950's, the Dakotas (DC3) were introduced. The DC3's were larger than the Lodestars. DC3's are still in use today at Wilson Airport for domestic air services. In the 1950's, air services were improved in the country and this led to an increase in air traffic. This trend continued up to independence.

In the post-independence period, domestic air transport made great strides. The third level aviation sector (general aviation) became very important with the government using light aircrafts to better administer and bring rapid development to the outlying and remote areas of the country. In the mid-sixties, Kenya saw the beginning of its recognition as a tourist destination. This led to the development of Flying Safaris and in a few years time, domestic air transport's biggest market was tourist traffic, followed by business sector and government charters. There was a dramatic growth in domestic airline operations associated with the new tourist centres.

The fourth phase of the model stipulates that if conditions are suitable for settlement, full integration of the network will occur. However, given the physical factors of much of the country (more than 80% of the country is arid or semi-arid), it is doubtful if dense settlements will ever occur even with reasonable developments of technology. Without dense settlements, it is unlikely that sufficient air traffic will be generated. Most of the airstrips in the Game Parks and Reserves and some of the remote parts of the country such as Turkana, Wajir and Mandera are suitable for light aircraft.

In the 1989/93 Development Plan, emphasis was put on Core industries: industries considered essential for the formation of a strong and sustainable industrial base. They are also vital in forging the necessary linkages between manufacturing industry and the agricultural, and transport and communication sectors. Some of these industries are: metallurgical, centring on iron and steel production; capital goods industry for making machine tools and hand tools; chemical and bio-technological industries (to provide fertilizers and pesticides) and local resource based industries such as agro-industries for processing oil seeds, coffee, tea, pyrethrum, hides and skins etc. So far, no such core industries have been established in the Arid and Semi-Arid areas of Kenya. It is unlikely that industrialization will become an important economic activity in this region in the foreseeable future.

4.6.1 HOW THE MODEL FITS KENYA

This model provides a very useful summary of certain regularities in the growth of air transportation. The general trends of air transport growth in the study areas correspond to those proposed in the Holsman-Crawford model. However, there are certain trends observed in the development of the Kenyan domestic air transport network that are not considered in the Holsman-Crawford model. As already indicated in chapter 2, military factor has been very crucial in the development of domestic air transport in

Kenya. Air transport was introduced in the country by the British colonialists during the First World War. During this time, the Royal Airforce sent an aircraft to help the British soldiers in their war campaigns against the Germans. After the war, air surveys of all kinds were carried out throughout the country, mainly for military purposes. The military factor has not been given much emphasis in the Holsman-Crawford model.

The growth of the Kenyan domestic air transportation network has been characterised by shifting arcs. For example, it has been observed that during the early days of aviation, Kisumu was the focal point of air transport, both as a water and later as a land aerodrome. Gold prospectors travelling to Kakamega started their journeys from Kisumu. However, as the country continued to experience rapid economic development, airline passenger traffic grew very fast. The introduction of larger aircraft requiring better developed airport facilities, led the initial arc to change and shift from Lake Victoria to Nairobi.

In this chapter, extensive use has been made of graph theoretic techniques to test the null hypothesis. The matrix powering technique and graph theoretic indices have been used to discern the main trends in the evolution of the domestic air transport network. This study has established that the development of air transport in the country accords with the postulates of the Holsman-Crawford model. Therefore, the null hypothesis that: "there is no significant difference between the stages of growth of the

Kenya air transport network and the one predicted by the Holsman-Crawford ideal-typical sequence model of air transport growth" is accepted.

NOTES

1. Air traffic load factor refer to the proportion of seats or freight capacity actually sold to the maximum capacity offered by aircraft. The calculation of the load factor represent one way of measuring availability of market for air services and the revenue earning capacities of aircraft. There is a minimum average load factor that an aircraft must carry to break-even in terms of costs and revenue.

REFERENCES

1. Burton, R (1991): Travel Geography. Pitman Publishers, London.
2. Central Bureau of Statistics (CBS), Statistical Abstracts. 1970-1990.
3. Civil Aviation Board of Kenya: Air Transport Statistics, (1983-1989, Ministry of Transport and Communications (unpublished).
4. De Souza, A.R. (1990): A Geography of World Economy. Merrill Publishing Company, U.S.A.
5. Holsman, K.J. and Crawford, S.A. (1975): "Air Transport growth in underdeveloped regions," Australian Geographer. Vol. 13, No. 2, pp 79-90.

6. Hoyle, B. (1988): Transport and Development in Tropical Africa. Case Studies in the Developing World. John Murray, London.

7. ICAO (1989): Airport Traffic. Series A.T-No.30, pp.102-103.

8. ICAO Journal : The official magazine of International Civil Aviation. July 1991, pp 43.

9. IATA (1983): Nairobi Airport Traffic Forecast. 1981-1996.

10. Kansky, K.J. (1963): The Structure of Transportation Networks. Chicago, department of Geography, Research paper No. 84.

11. Lachene, R. (1965): "Network and the location of Economic Activities", Papers of the Regional Science Association. Vol. 14, pp 183-196.

12. McCormack, R.L. (1976): "Airlines and Empires: Great Britain and the Scramble for Africa, 1910-1932", Canadian Journal of African Studies. Vol. 10, 87-105.

13. Mowforth, M. (1979): Statistics for Geographers. Harrap Publishers, London.

14. Nystuen, J.D. and Dacey, M.F. (1962): "A Graph Theory interpretation of nodal regions", in papers of Regional Science Association, Vol. 7, 29-42.

15. Ogonda, R.T. (1986): The development of Road Transport system, Ph.D Thesis (unpublished), University of Nairobi.

16. Ongaro, S.L. (1989): Commercial Air Transportation in Kenya: A geographical study of some Aspects of Domestic Flights, B.A. Dissertation, (unpublished), Department of Geography, University of Nairobi.

17. Ouma, J.P.B.M. (1970): Evolution of Tourism in East Africa. East African Literature Bureau, Nairobi.

18. Taaffe, E., Morrill, R., and Gould, P., (1963): Transport Expansion in underdeveloped countries: A Comparative Analysis, in the Geographical Review, Vol. 53, 503-529.

CHAPTER FIVE

THE ANALYSIS OF AIR PASSENGER FLOWS

5.0 INTRODUCTION

This chapter describes, analyses and explains the spatial patterns of domestic and international air passenger flows. Cartographic analysis is employed to illustrate the spatial patterns of the inter-district air passenger flow matrix. Simple Linkage Analysis, a variant of the Dominant Flow Analysis is used to identify dominant cluster nodes in the domestic air passenger system. Multiple linear regression model is applied to the international air passenger flows for prediction purposes. In this chapter, the hypothesis that: "the volume of air passenger traffic does not vary with sizes of the central places and the distances between them" is tested.

Very little recent information exists on the spatial structure of Kenya's domestic and international air passenger system. The purpose of this chapter is to further understanding of that system by discussing the geographical conditions under which it operates. Air passenger transportation reflects the physical, political and economic conditions under which it operates (Sagers and Maraffa, 1990).

5.1 DOMESTIC AIR PASSENGER TRANSPORTATION

Air transportation is becoming popular in Kenya, mainly because of the material savings in time, and the size of the territory. Although Kenya is not a big country, poor surface transportation in a large part of the country, especially the Northern and North Eastern regions, has made it imperative to use aircraft as a means of transportation. The development of domestic air transportation has brought these areas (including National Parks and Game Reserves) within a few hours of flight time of the main urban areas such as Nairobi and Mombasa.

5.1.1 INTER-DISTRICT AIR PASSENGER FLOWS

Before analysing in detail the inter-district pattern of air passenger flows, an examination is made of the expected pattern of air passenger movement as it would appear on the basis of the potential model formulation represented by the population potential map of Kenya (Fig 5.1). The idea here is to find out if there is any correspondence between the population potential map constructed and the maps of actual flows (Figs 5.2 and 5.3). The concept of population potential and the mathematical equation for deriving the population potential at a point have been discussed in chapter three. The population potential data used in the construction of the population potential map is given in appendix xiii.

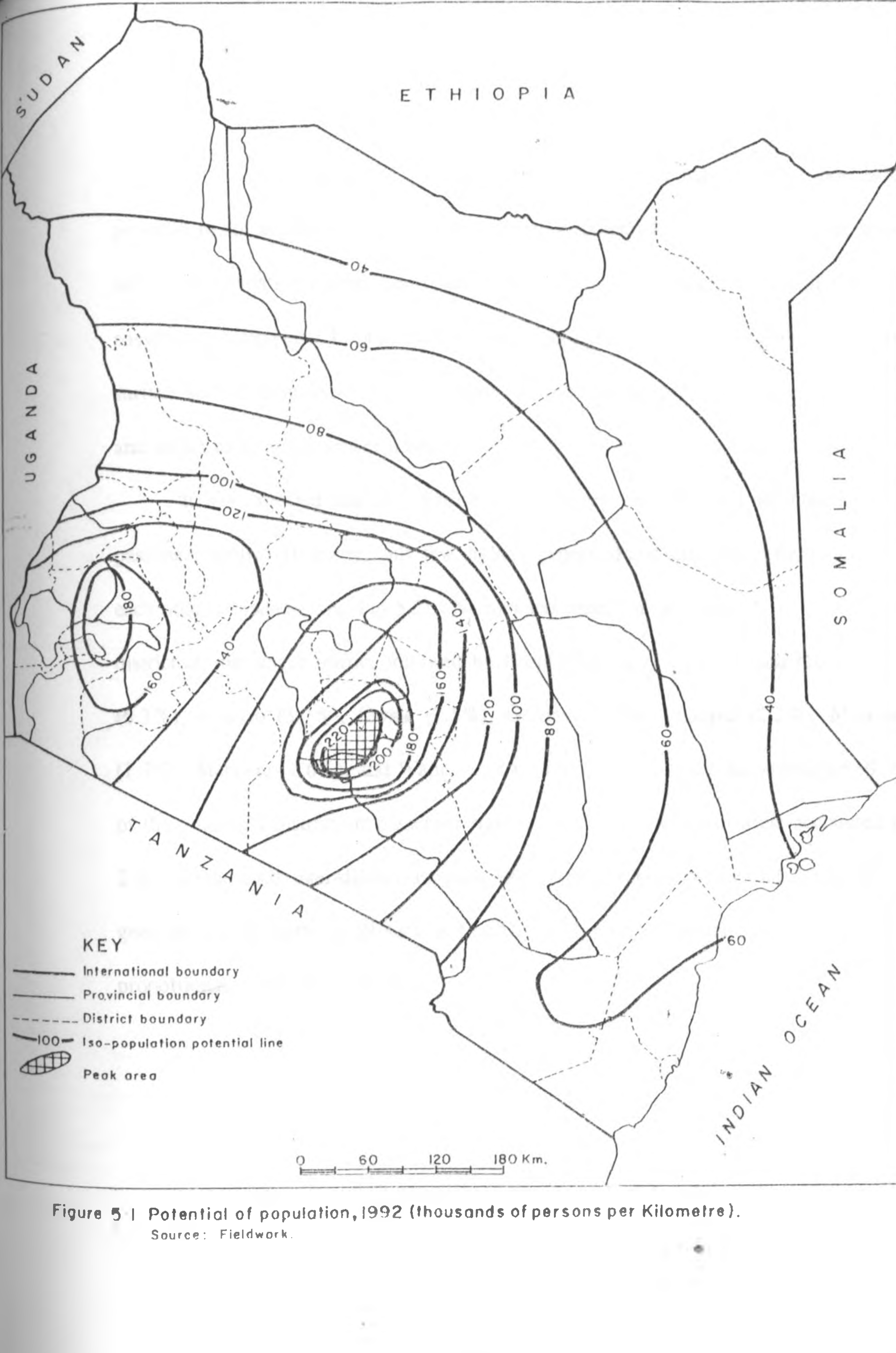


Figure 5.1 Potential of population, 1992 (thousands of persons per Kilometre).
Source: Fieldwork.

An examination of the population potential map reveals areas of population potential peaks as well as areas of low population potential. It is expected that places with high population potential correspond closely with those places with high actual air passenger movements. In other words, areas appearing high on the population potential surface such as Nairobi, Central Province and parts of Western Kenya should generate and attract more air passenger traffic.

It was expected that each district in the country generated and attracted some air passenger traffic. However, only few districts generated and attracted traffic to and from each other (Appendix xiv, Fig 5.2). Nairobi accounted for about 38.8% of all the inter-district air passenger traffic, followed by Narok District (17.3%), Lamu (10%), Kilifi (6.3%), Kajiado (3.7%), Kwale (2.5%), Garissa (2.2%), Laikipia (2.2%), Mombasa (1.7%), Mandera (1.6%), and Wajir (1.4%). The eleven districts accounted for 97.7% of the total inter-district air passenger traffic. The other twelve districts accounted for 2.3% of the total inter-district air passenger traffic. Districts that did not attract or generate any air traffic at all such as Machakos, Murang'a, Kiambu or Kericho have no proportional circles shown in them.

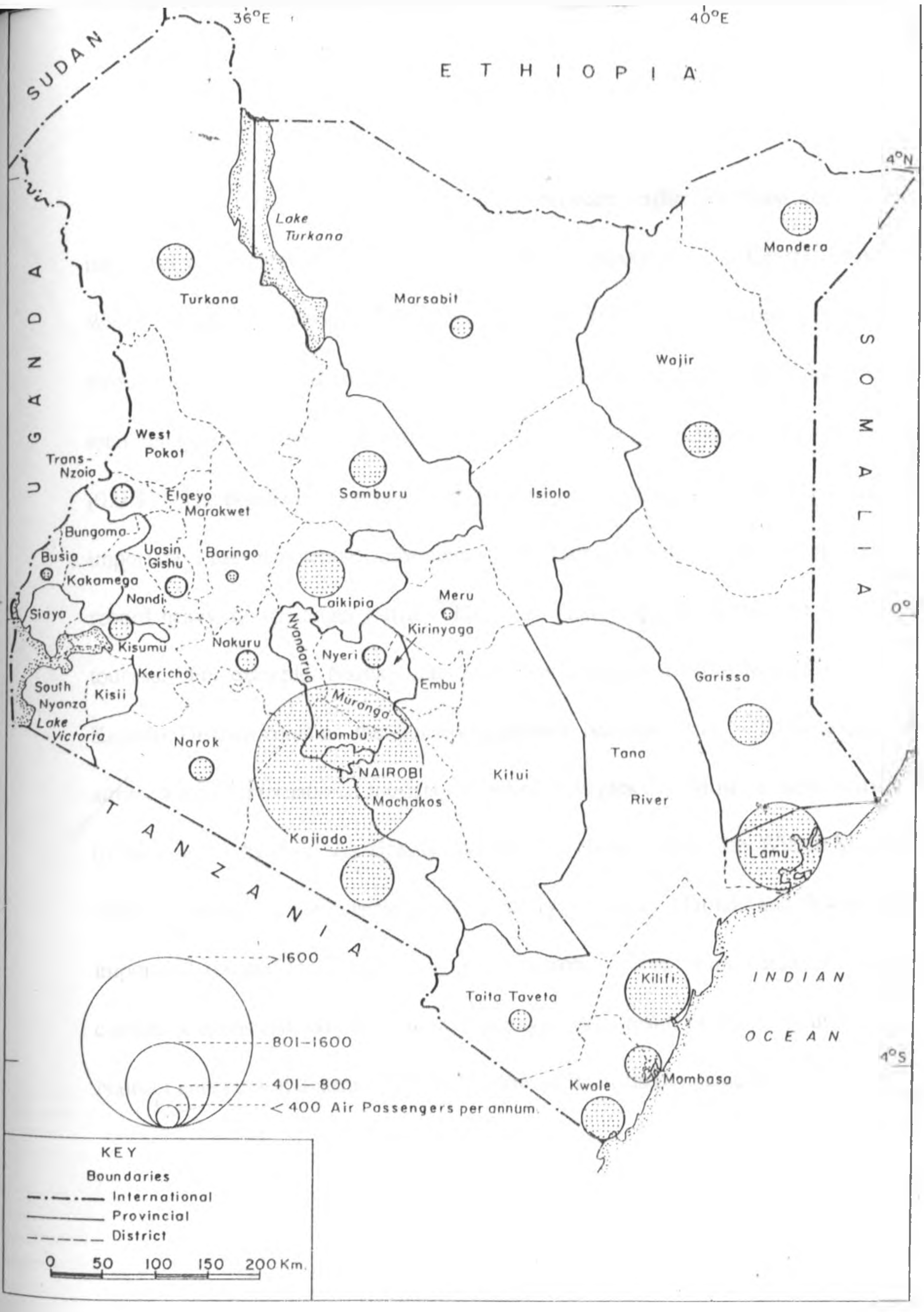


Figure 5.2 Air passeger traffic generated and attracted in various districts of Kenya, 1991.
Source: Fieldwork

No discernible correspondence exists between traffic generated and attracted in inter-district air passenger traffic and population potential map in Central Province and Western Kenya. Although these areas contain points of population potential peaks, passenger generated and attracted are very few. Kisumu accounts for about 0.3% of the total inter-district passenger traffic, Uasin Gishu (0.1%), Kakamega (0.0%) and Kisii (0.0%). The population potential map does not show the coastal zone and Maasailand as important areas of potential movement. Yet, Lamu, Kwale, Kilifi, Narok and Kajiado record heavy air passenger traffic. These are mainly tourist resorts and attract a lot of tourists. For example, Narok contains the world famous Maasai Mara Game Reserve. Kajiado District contains the famous Amboseli National Park. These tourist resorts attract a lot of international tourists every year (chapter 2). Most of these tourists travel to these areas by air. As already indicated in chapter four, the Wilson-Maasai Mara domestic sector is the busiest in the country. Lamu, Malindi and Kwale are very important resorts for beach tourism. Nairobi is the administrative, commercial, communications and industrial centre in Kenya. As a result of the many urban functions, Nairobi generates and attracts a large volume of inter-district passenger traffic.

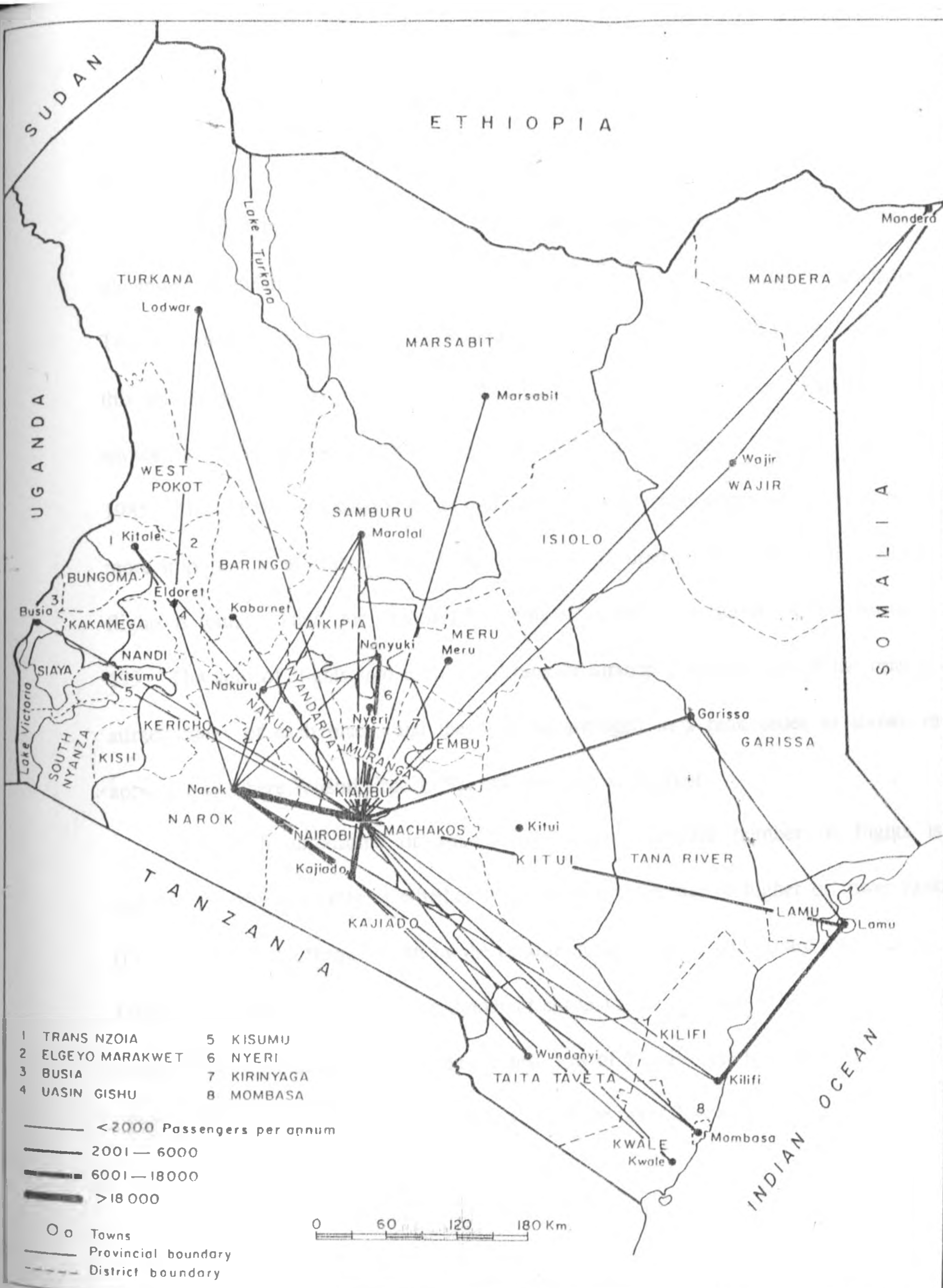


Figure 5.3 Inter-District Air Passenger flow map.
Source: Fieldwork, 1992.

5.1.2 SIMPLE LINKAGE ANALYSIS

The nodal structure of flows in Kenya's domestic air transport network is illustrated by means of a graph theoretical technique called Simple Linkage Analysis. This is a variant of the technique developed by Nystuen and Dacey (1961). According to this technique, the flows to and from various locations form a matrix. Appendix xv shows the origins and destinations of scheduled domestic flights in Kenya for the year 1985. The interaction matrix appears complex but some nodal points stand out as being more important than others. For each aerodrome or airstrip, the sum of all incoming flights is found. Thus, for Amboseli the sum of all incoming flights for this period is 493. The sum of flights into each aerodrome or airstrip gives an idea of the relative attractiveness of each place, and they can be arranged in a rank order as shown in appendix xv where Wilson airport, Nairobi, emerges as the first.

For each aerodrome or airstrip, the largest outward number of flights is represented, independently of whether it is directed to another of higher or lower rank (Fig 5.4a), then the flows set out by the central cluster nodes 5 and 10 are disregarded. Finally the flows issued by 5 (central node of cluster) is represented. The central node of the network is excluded. The second greatest flow of 5 is directed toward 10 (Fig 5.4b). The final cluster (Fig 5.4c) offers a wide view of the main flow within the country.

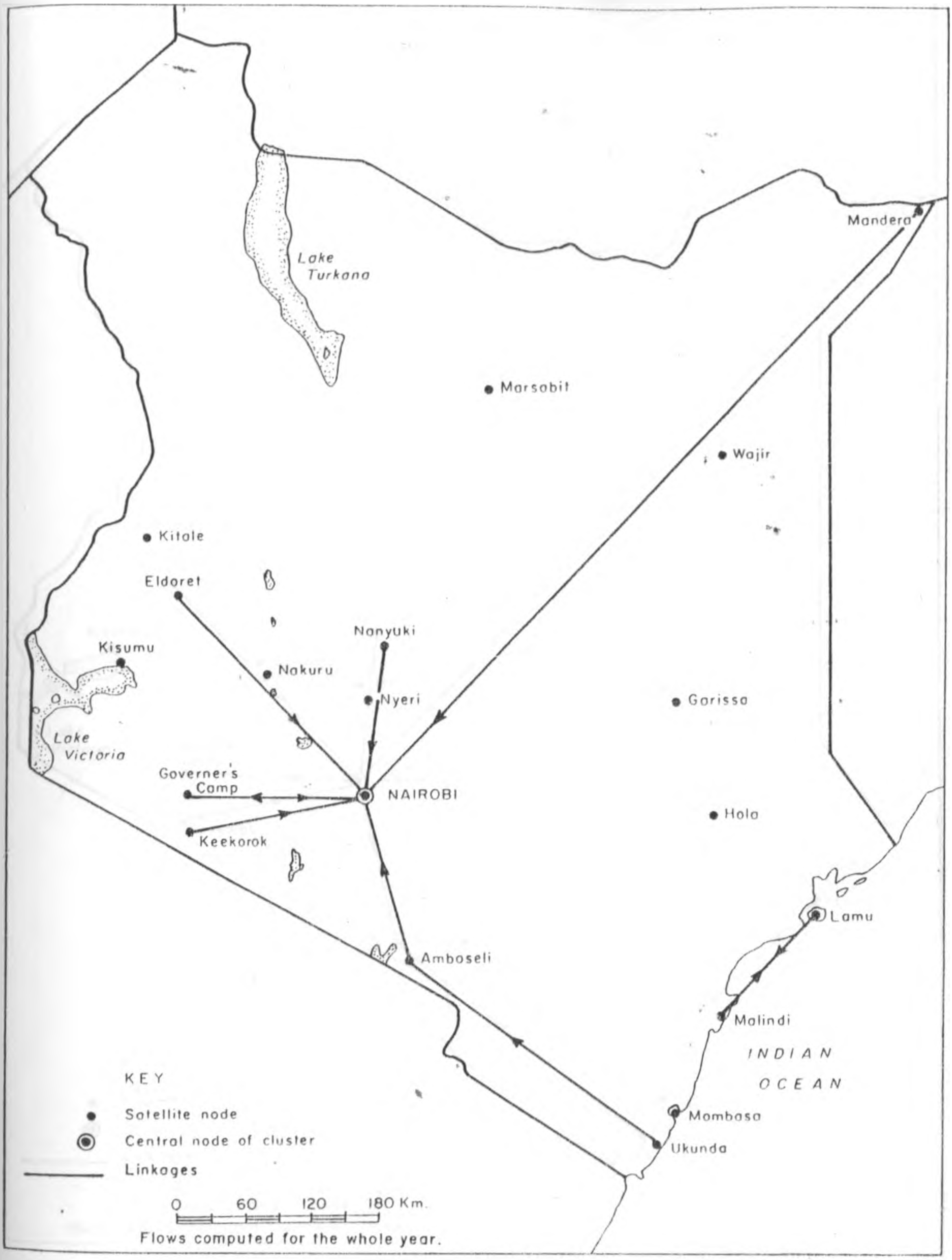


Figure 5·4a Simple linkage Analysis: Largest outward flows.
Source Central Bureau of Statistics, 1985

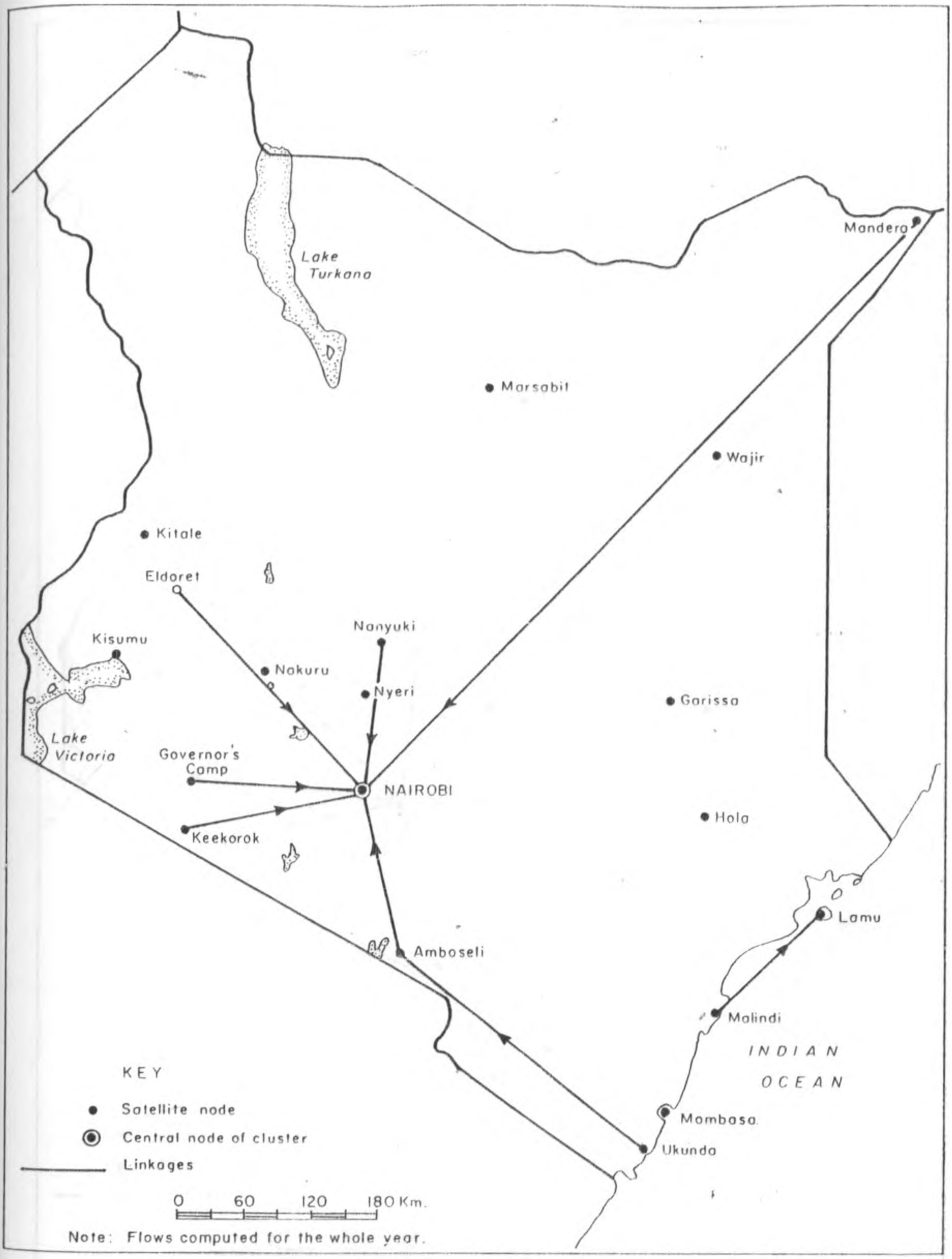


Figure 5·4b Simple linkage Analysis: Flows Issued by Central cluster nodes disregarded.

Source Central Bureau of Statistics, 1985

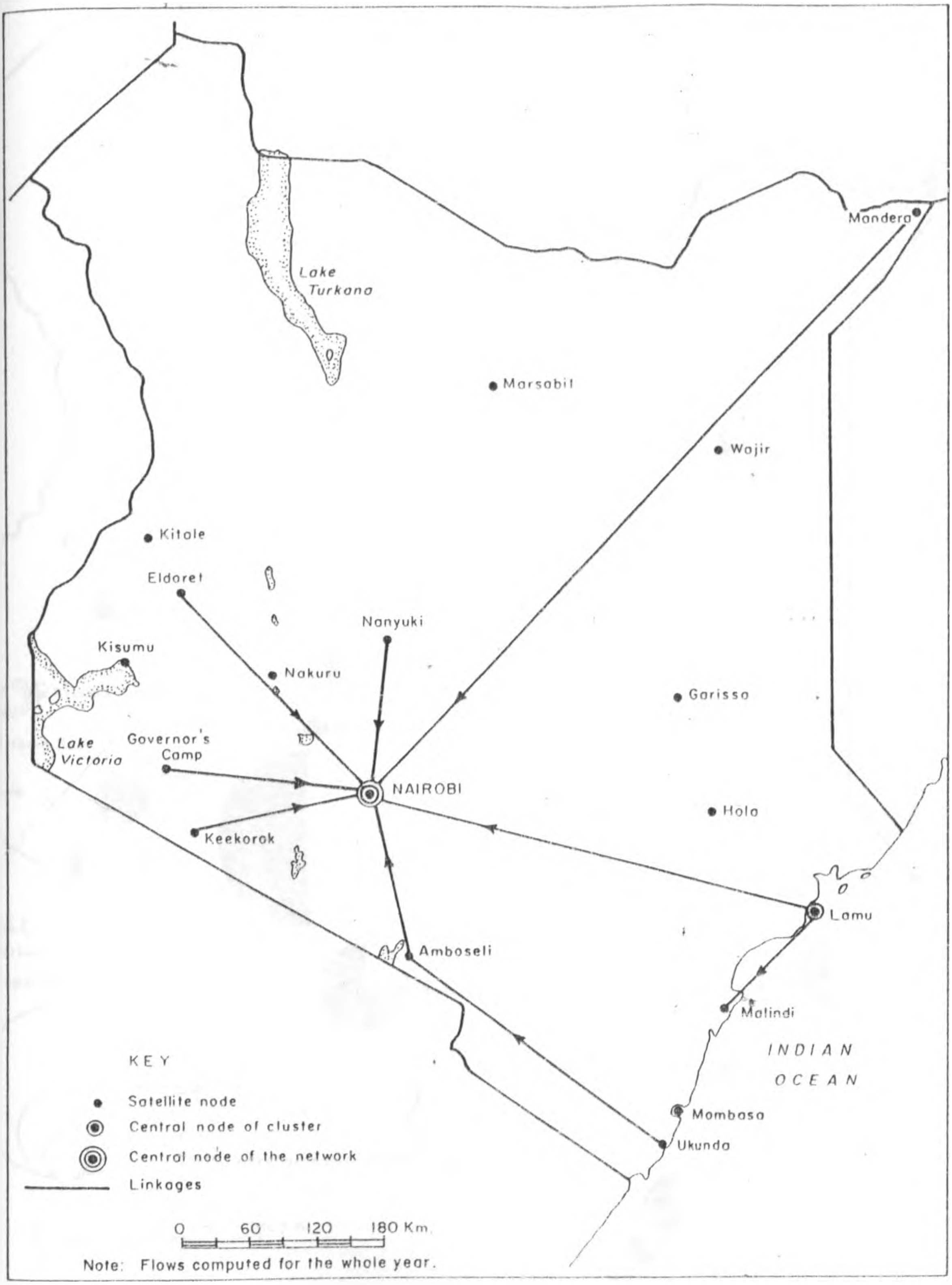


Figure 5·4c Simple linkage Analysis : Final cluster.
Source Central Bureau of Statistics, 1985

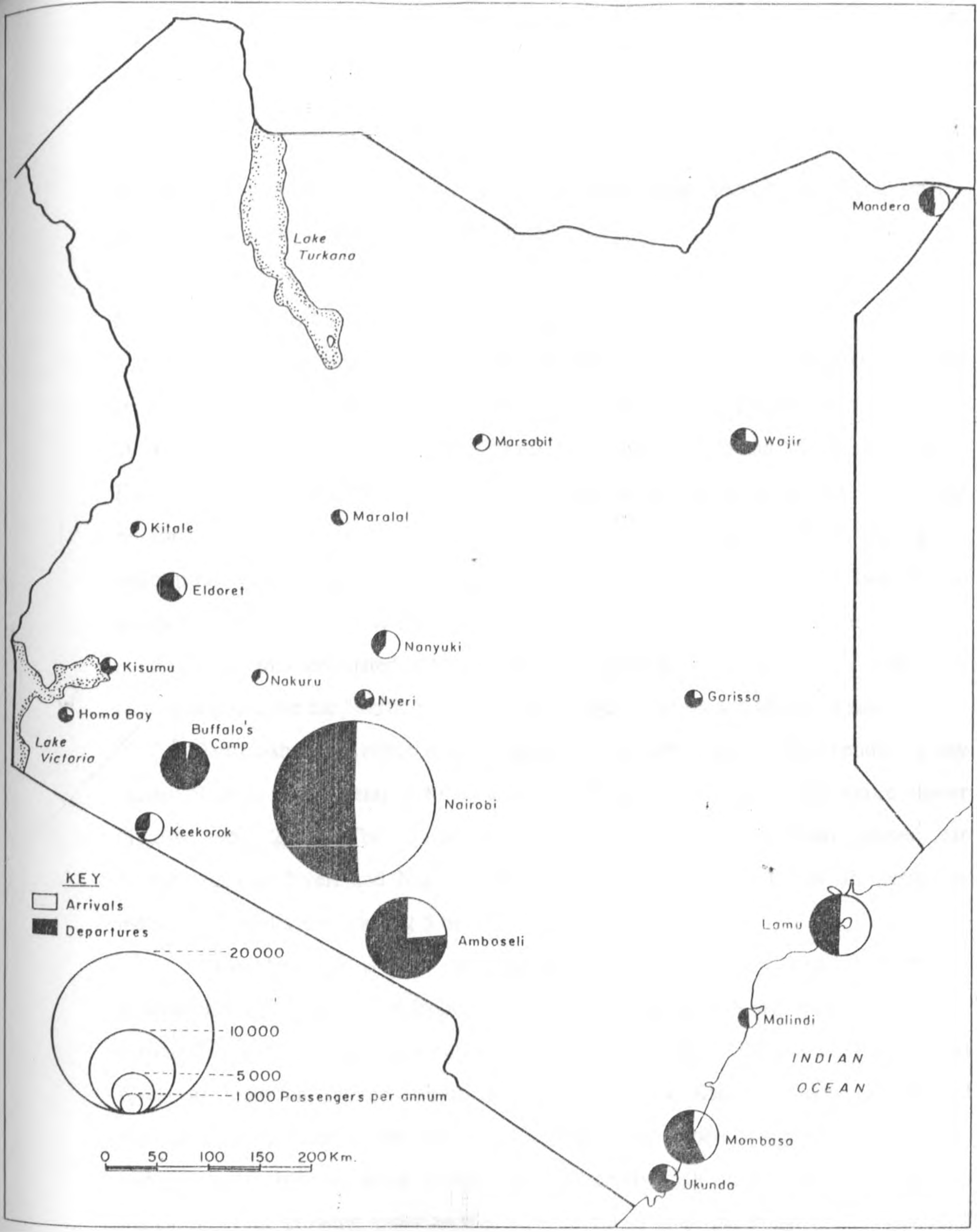


Figure 5·5 Main air traffic generating and attracting centres, 1991.
Source: Fieldwork

Wilson airport, Nairobi, emerges as the central node of the network and Lamu on the Kenyan coast as the central node of the cluster.

5.1.3 PASSENGER TRAFFIC AT MAIN AIRPORTS

Fig. 5.5 and Appendix xvi show the main air traffic generating and attracting centres in Kenya. Nairobi (Wilson Airport) leads with 37,874 total passengers, followed by Amboseli (9,514), Lamu (5,741), Mara Buffalo camp (3,535) and Mombasa (3,247). Fig. 5.6 shows air-passenger indexes for selected urban centres in Kenya. This map reinforces what is revealed in Fig. 5.5. The map of air-passenger indexes depicts the relationship between air-passenger traffic and urban population as expressed in the number of air passengers per 1000 inhabitants in 1991. An analysis of the map reveals a number of factors associated with air passenger generation and attraction. The main factors revealed are the "traffic-shadow" effect, urban function and length of haul.

"Traffic-shadow" effect is the tendency of the largest city (urban centre) in any cluster of cities (urban centres) to act as the traffic-receiving point for the entire cluster (Taaffe, 1956, 223). The "traffic shadow" effect is evident for urban centres near Nairobi such as Nyeri and Nakuru. The two urban centres have low air passenger indexes (Appendix xvii and Fig 5.6).

Urban function is also an important factor associated with air-passenger generation and attraction. Nairobi is the capital city as well as the leading industrial, commercial and communication centre. Urban centres such as Mombasa, Kisumu and Nyeri are important regional service centres. Mombasa, Kisumu, Nakuru, Nyeri and Eldoret are important administrative, industrial and commercial centres too. Resort and/or special function urban centres have extremely high air passenger indexes, an indication of the growing importance of personal travel in air passenger traffic. Lamu, a tourist resort on the Kenyan coast has the highest air passenger index of 478 air passengers per 1000 population. Malindi, another important tourist resort has an air passenger index of 21 which is still above the median value of 12.

It is also apparent from Fig 5.6 that high indexes are found in as far off places as Mandera and Wajir. The high indexes for Mandera and Wajir could be due to the fact that distance from Nairobi is great enough to give air transport a definite advantage over land transportation. Thus Mandera and Wajir tend to be Long-haul urban centres. Most of the air passengers travelling to these towns are civil servants on official duty and therefore require quicker means of transport. The effect of length of haul on surface competition is very important. Overnight rail service from Nairobi to Mombasa or to Kisumu is an important factor in surface competition. Thus if an urban centre is beyond the reach of overnight rail service from Nairobi, it may be considered a long-haul urban centre such as Mandera and Wajir; if it is within reach of overnight service, it may be considered a medium-or short-haul urban centre such as Kisumu and Mombasa. Within the zone of overnight service road and rail passenger transportation are dominant; beyond the zone air transportation holds its strongest competitive position, both in fares and in convenient service (Taaffe, 1956). The margins of the zone of overnight rail service therefore represent a competitive equilibrium between air and rail passenger transportation.

5.2 INTERNATIONAL AIR PASSENGER TRANSPORTATION

International scheduled passenger traffic through Nairobi can be divided into three (3) distinct market areas:

a) Europe

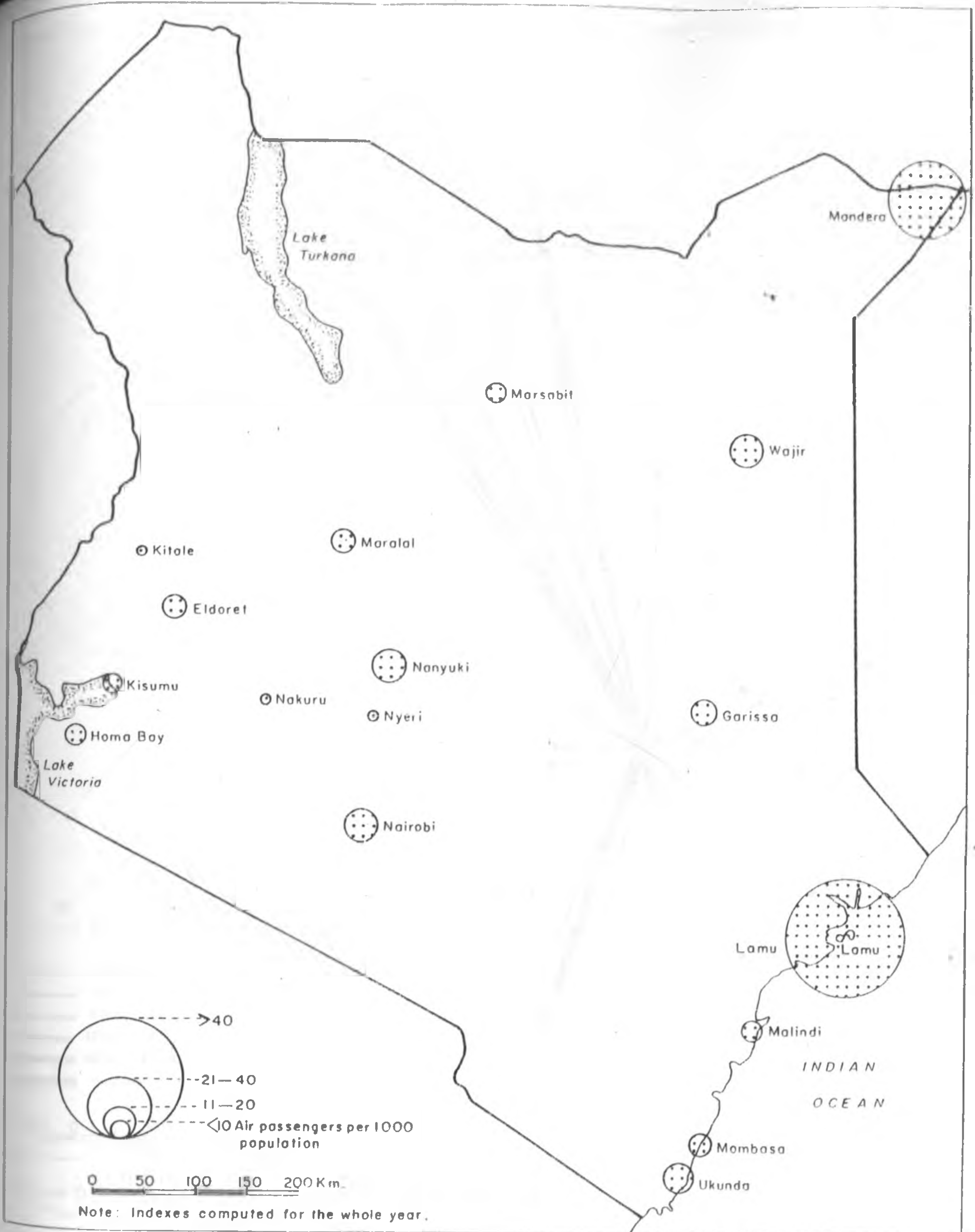


Figure 5·6 Air Passenger Indexes, 1991.
Source: Fieldwork.

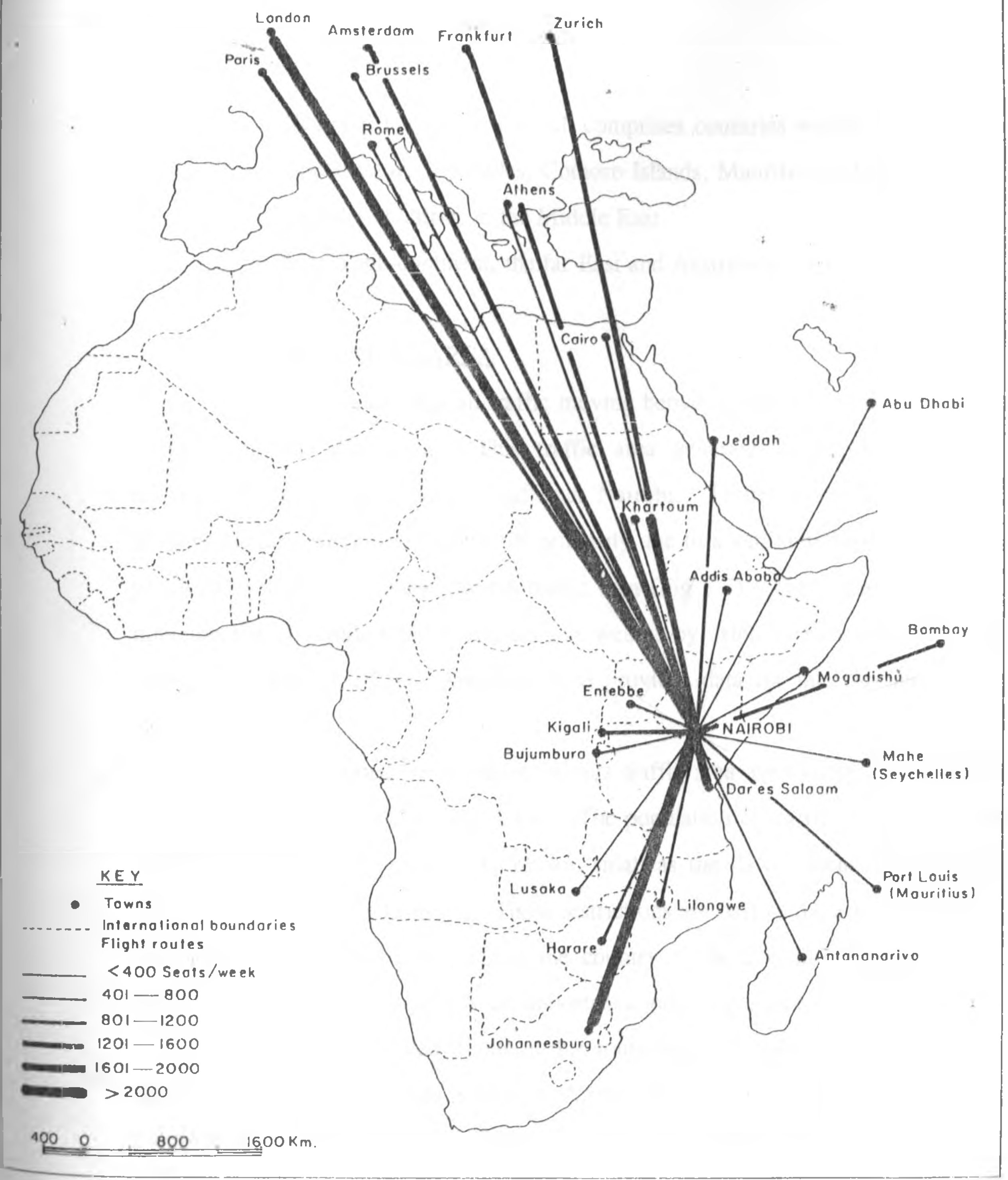


Figure 5·7 International Air Carriers' Route Capacities.
Source: ICAO, 1990.

b) Regional market area which comprises countries within Africa (including Madagascar, Seychelles, Comoro Islands, Mauritius and Reunion). It also includes countries in the Middle East.

c) Indian sub-continent, the far East and Australasia

5.2.1 EUROPE TRAFFIC AREA

This traffic area covers all traffic moving between Nairobi, on the one hand, and Europe, on the other hand. This traffic area generates about 43% of the total international scheduled passenger traffic at Nairobi. Traffic from this area has been growing rapidly every year since 1979 primarily due to a substantial increase in capacity provided by European airlines in this traffic area (Fig 5.7). This capacity increase was implemented by adding more frequencies as well as by using aircraft with bigger seating capacities (Tables 5.2-5.3). Appendix xviii provides data for international air carriers route capacity.

The great majority of travellers in this traffic area are tourists from Europe and from the United State of America (USA). The population of traffic generated in Nairobi is rather limited. It is expected to remain small as the Government of Kenya has put restrictions on travel by Kenyans. These restrictions are part of the actions undertaken to improve the balance of payments of the country. There is also some business and convention travel, since Nairobi is an important connecting centre in Africa.

Most of the scheduled flights in this route area use Nairobi as a transit point for services between Europe and Southern, Africa and Indian Ocean (IATA, 1983, King, 1984). The proportion of these flights was 74% in 1979 and about 80% in 1981. No important changes have taken place in the itinerary pattern of European airlines and therefore this percentage has tended to remain stable. The aircraft mix in this traffic area

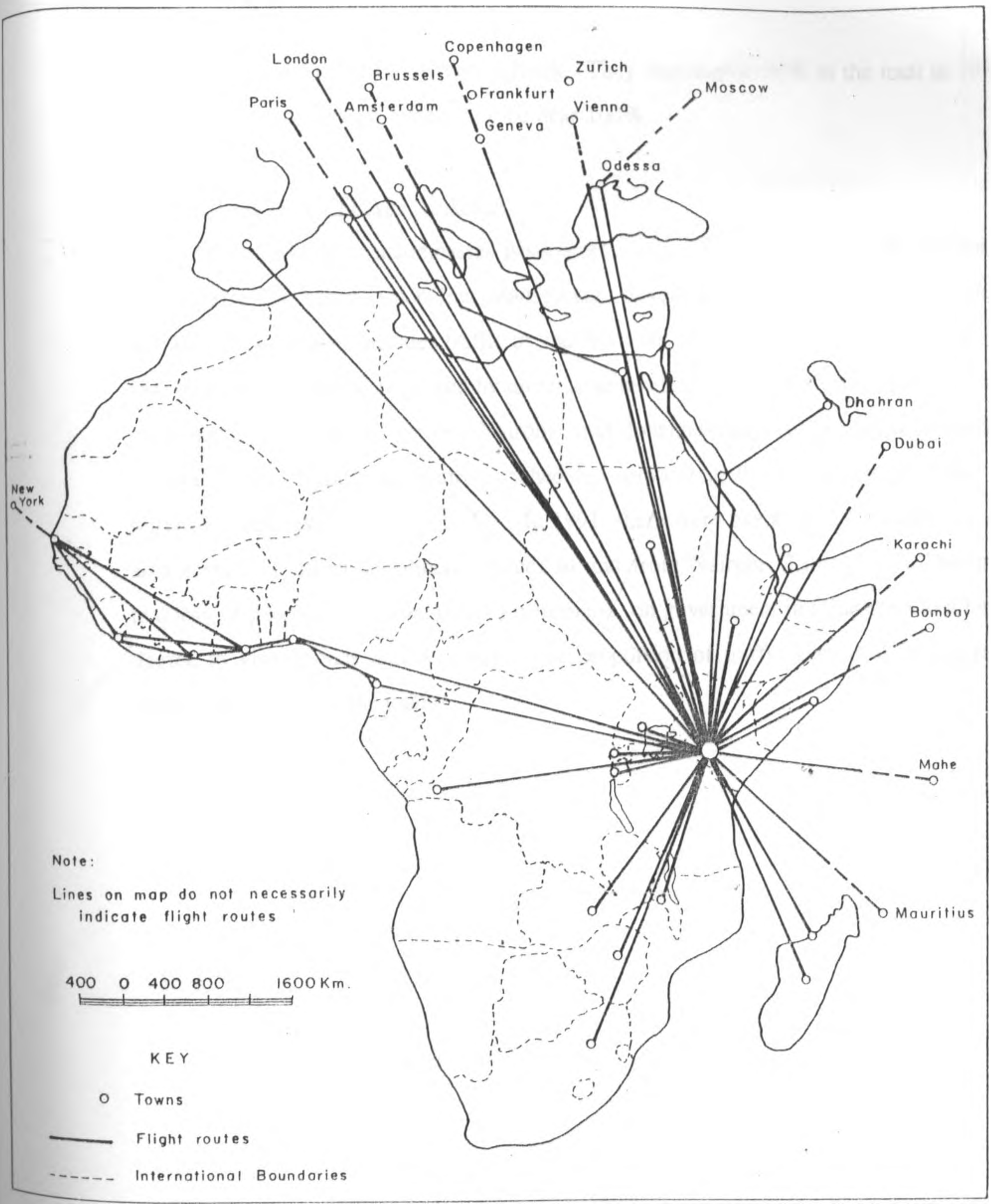


Figure 5·8 DIRECT SCHEDULED COMMERCIAL AIRLINE PASSENGER SERVICES TO NAIROBI

Minimum of one service weekly shown

Source : Fieldwork

shows a predominance of wide-body aircraft. They represented 58% of the total in 1979, 74% in 1981 and are now expected to be near 100%.

5.2.2 REGIONAL TRAFFIC AREA

This traffic area encompasses passengers moving between Nairobi and the rest of the countries in Africa, (including Madagascar, Seychelles, Comoro Islands, Mauritius and Reunion). It also includes traffic to and from the Middle East. In 1981, thirty-four (34) cities in this area were served by direct scheduled services to and from Nairobi. The main traffic flows were between Nairobi and Johannesburg, Addis Ababa, Entebbe, Lusaka, Mahe, Harare and Cairo. Scheduled services in this area were provided by thirty (30) airlines (IATA, 1983, 53). In 1991, there were twenty five (25) cities in this area served by direct scheduled services to and from Nairobi (Table 5.1). The great majority of people in this area travel for business, on government missions and to a lesser degree to visit friends and relatives. The proportion of traffic generated in Kenya is about a third (1/3) of the total.

Table 5.1 : Origin of Service, Weekly Frequencies and Aircraft Utilized, Jomo Kenyatta International Airport, Nairobi, 1991

Origin of Service	Weekly Frequency	Type(s) of Aircraft Utilized
Abu-Dhabi	2	B767
Addis Ababa	7	B727
		B757
		B767
Amsterdam	4	B747
Antananarive	2	B737
		B747
Athens	2	B747
Bombay	2	A-310
Brussels	3	DC-10
Cairo	5	B767
Dar es Salaam	3	F-27
Entebbe	3	F-27
Frankfurt	9	A-300
Harare	3	B737
		B767
Jeddah	2	A-300
Johannesburg	10	B747
		DC-10
Karachi	2	A-310
Khartoum	1	B707
Kinshasa	1	B737
Lagos	1	A-310
Lilongwe	3	B737
London	14	B747
Lusaka	3	B737
Mauritius	1	B767
Mogadishu	1	A-310
Paris	10	B747
Rome	3	A-310
Sofia	2	TU-154
Tel Aviv	3	B747

Vienna	2	A-310
Younde	1	B737
Zurich	6	B747

Type of Aircraft	Approximate Capacity in Seats
Boeing 707 (B707)	200
Boeing 727 (B727)	134-200
Boeing 737 (B737)	100-150
Boeing 747 (B747)	395-500
Boeing 757 (B757)	200
Boeing 767 (B767)	300
Air Bus series 300 (A-300)	300
Air Bus series 310 (A-310)	250
DC-10	275-350
Fokker 27 (F-27)	45
Fokker 50 (F-50)	54

Source: Fieldwork, 1991

Table 5.2 : Aircraft Type Mix

Aircraft Type	1981	1986	1991	1996
0-49 seats	-	-	-	-
50-124 seats	-	-	-	-
125-179 seats	5	2	1	-
180-249 seats	4	8	11	11
250-349 seats	5	6	6	7
350-499 seats	6	7	7	10
500+ seats	-	-	2	2
Total Aircraft Movements	20	23	27	30
Average No. of seats available per aircraft	264	277	287	304
Average No. of Passengers per Aircraft	92	98	105	114

Source: IATA, 1983, pp 47

5.2.3 INDIAN SUB-CONTINENT, FAR EAST AND AUSTRALASIA TRAFFIC AREA

This area groups traffic moving between Nairobi and the Indian sub-continent (including Sri Lanka and the Maldives), the Far East and Australasia. This are contributes the least volume of traffic (7%). The main traffic flows are to and from Bombay and Karachi. In 1981, four (4) airlines provided direct air services in this region. The proportion of Kenyan residents travelling in this area is fairly high compared to other traffic areas (about 40% of total passengers). The main market generating this

Kenyan resident traffic is Asians living in Kenya. They travel mostly to visit friends and relatives and for business. Part of the remaining 60% of the passengers is made up of those travelling between the far East and Australasia region and Nairobi via the Indian sub-continent (IATA, 1983). The direct scheduled commercial airline passenger services to Nairobi from the cities in all the traffic areas in 1991 is shown in Fig 5.8. The leading sources of international origin/destination traffic on scheduled airlines operating in Nairobi in 1990 are shown in Fig 5.9. London, with 192,413 passengers, was substantially ahead of Bombay with 80,910, Frankfurt was third with 56,018, and Entebbe, fourth, with 53,969. Other points in Europe were prominently evident (e.g. Amsterdam, Paris and Rome) as well as such closer points to Nairobi as Addis Ababa, Dar es Salaam and Cairo.

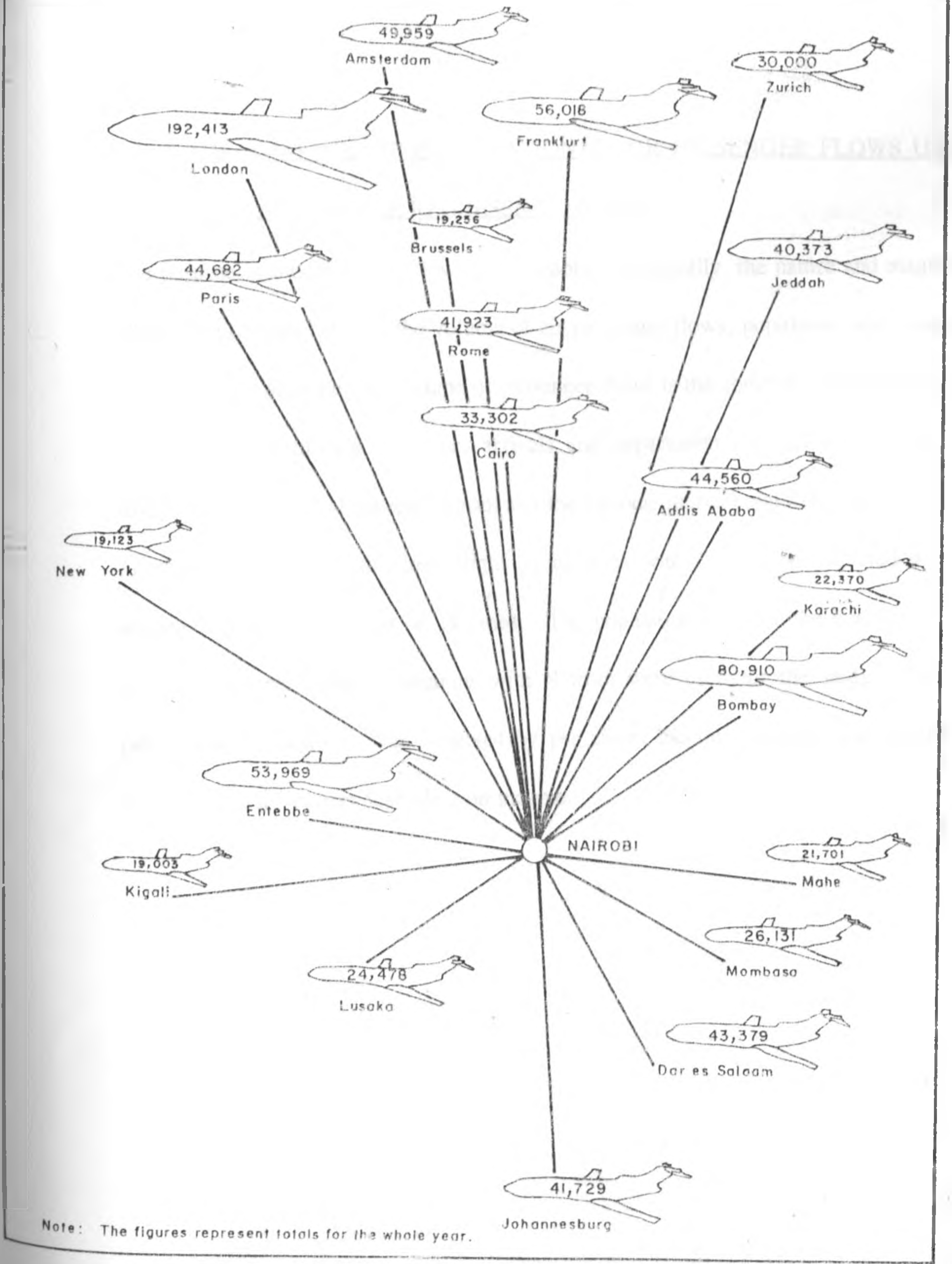


Figure 5·9 Twenty largest air passenger origin/destination points, 1990, Nairobi. Scheduled International Airlines.

Source: Central Bureau of Statistics, 1990, Nairobi

5.2.4 THE ANALYSIS OF INTERNATIONAL AIR PASSENGER FLOWS USING MULTIPLE LINEAR REGRESSION MODEL

The purpose of modelling the flows is to establish statistically, the nature and magnitude of the relationships between the volume of air passenger flows, population and distance. The dependent variable, the volume of passenger flows is the combined data representing movements in both directions (i.e. arrivals and departures). Distance was measured using airline distances between Nairobi and the various international airports. Only those international airports with direct flight connections with Nairobi were included in the analysis. This gave a total of 29 cities. The population data for the countries whose cities have direct flight connections with Nairobi were used for the study. The total population for each city was weighted by per capita income. It was assumed that the propensity to travel was dependent on income.

The volume of passenger flows is the measure of interaction or demand for air service for a specific origin. The multiple linear regression equation used in this chapter is of the form:

$$Y = a \pm b_1X_1 \pm b_2X_2 \pm \ldots b_nX_n + \epsilon \ldots\ldots\ldots\ldots\ldots\ldots (5.1).$$

Where: Y is dependent variable, X_1, X_2, X_3 ... X_n are independent variables,

a, b_1, b_2, ... b_n are partial regression constants

ϵ - error (disturbance) term which explains the effects of unspecified variables.

The logarithmic transformation of equation (5.1) gives:

$$\text{Log } Y = a \pm b_1 \log X_1 \pm b_2 \log X_2 \pm \epsilon \ldots\ldots\ldots\ldots\ldots\ldots (5.2)$$

Where Log Y = Volume of interaction between cities i and j

Log X_1 = Population of origin weighted by per capita income

Log X_2 = Distance between cities i and j

a, b_1, and b_2 are parameters to be estimated

As indicated in chapter three, the relationships in passenger flows may not be linear. To approximate linearity, data had to be transformed using common logarithms.

Table 5.3 : THE RELATIONSHIPS BETWEEN VOLUME OF PASSENGERS, POPULATION AND DISTANCE[a]

Country	Log Passenger Volume (Log Y)	Log Population (Log X_1)	Log Distance (Log X_2)
Ghana	3.69	9.75	3.63
Ethiopia	4.65	9.77	3.07
Netherlands	4.70	11.37	3.82
Greece	4.02	10.73	3.66
India	4.91	11.45	3.66
Belgium	4.28	11.21	3.82
Burundi	4.07	9.10	2.94
Egypt	4.52	10.51	3.55
Tanzania	4.64	9.49	2.82
Cameroon	3.69	10.06	3.49
Uganda	4.73	9.62	2.72
Germany	4.75	12.10	3.80
Saudi Arabia	4.61	10.94	3.41
Côte d'Ivoire	2.15	9.97	3.68
Malawi	4.19	9.17	3.15
Mauritius	3.91	9.34	3.49
Nigeria	3.85	10.45	3.58
Rwanda	4.28	9.34	2.88
Somalia	4.28	9.02	3.00
South Africa	4.62	10.94	3.46
Sudan	3.93	10.53	3.29
Zambia	4.39	9.48	3.26
Pakistan	4.35	10.57	3.64
United Kingdom	5.28	11.92	3.83
USA	4.28	12.72	4.07
Italy	4.62	11.94	3.73
Israel	4.13	11.56	3.57
Switzerland	4.48	11.29	3.78
France	4.65	12.00	3.81

[a] Appendix xix provides raw data for this table.

Source : Central Bureau of Statistics, 1990

STATISTICAL ANALYSIS AND INTERPRETATION

To establish the functional form of Y, X_1, X_2 and value of a, b_1 and b_2, multiple regression and correlation analysis was used after the data had been normalized using common logarithms (Table 5.3). In order to examine the relative contribution of each of the two independent variables on the level of variations in the volume of passenger movements, the variables were subjected to step-wise multiple regression analysis. The application of the multiple linear regression model resulted in a low level of explanation of 43% (Table 5.4). Distance explained about 30% of the total variance. The addition of population weighted with per capita income, increased level of explanation to 43%. This means that population accounted for only 13% of the total variance.

Table 5.4 MULTIPLE COEFFICIENTS OF CORRELATION[2]

Variable	R	R^2	R^2 change	b	SE	F ratio*
Population	.361	.130	.130	.59	.134	9.79
Distance	.655	.430	.299	-1.47	.399	9.79

* Statistical significance level is 0.01

The resulting finding, though less satisfactory in view of the substantial proportion of the unexplained variance, indicates that distance and population weighted with income per capita are two important factors of spatial interaction. Unveiling the determinants of international air passenger flows is essential to the understanding of the tourism phenomenon in Kenya. When discussing Ullman's (1956) spatial interaction model, Murphy (1985), first made an analogy to the complementarity principle. He argued that this principle referred to a situation in which there is a demand in place A for a tourist attribute and place B, which possesses the attribute, can supply it. In such an event, the pattern of tourist movement created is unilateral, that is, from the demand area to the supply area. In other words, place B complements the demand occurring at place A. The second pre-condition for determining the possibility of any tourist interaction is the transferability of tourists from their place of residence to the tourist destination. Thus, a destination has to be accessible. Hudman (1980) has observed two key elements of accessibility: travel time and travel cost. He has demonstrated that although travel time between USA and South America and Western Europe is the same (because of economies of scale and cheaper air fares to Europe), it is South America that attracts far more tourists per annum from the USA. One wonders whether the approach that supports the view that air fares are the dominant factor shaping people's destination choice is still relevant. Do air passengers really choose a destination merely by comparing air fares to alternative destinations? It is likely that the cost assessment is only part of a comprehensive evaluation in which travel motivation, destination attributes, people's family situations and time-budget constraints and other inputs are all taken into account.

Murphy's third pre-condition for creating tourist spatial interaction is that there be a minimum number of intervening destinations between two potentially interactable areas. The intervening destinations work as intervening opportunities by offering the same sort of destination attributes, on the one hand, but are closer to one's place of residence and thus offer a better deal in terms of travel time and travel cost, on the other hand. Usually, the more intervening destinations there are between the generating area and attracting area, the less will be the probability that the latter area will attract a large number of tourists from that particular generating area. However, unlike other types of travel (e.g. shopping trips, journey to work), tourist travel itself is sometimes perceived as part of the tourist adventure (Hudman, 1980). Hence, the rationale of looking for a destination corresponding to one's expectations, but which is more distant than any other similar destination, is perfectly understandable (Matthieson and Wall, 1982). Moreover, even if cost considerations are the potential tourist's prime concern, it (cost consideration) does not necessarily lead to shorter trips (Table 5.5).

Table 5.5: Relating Volume of Air Passengers to Distance (km).

Distance (km)	No. of Air Passengers (N = 200)	Percentage (%)
< 750	29	14.5
750-1500	3	1.5
> 1500	168	84.0
Total	200	100.0

Source: Fieldwork, 1992

The table reveals that majority of air passengers (84%) travelling to and from Kenya come from a distance greater than 1500 kilometres. The pattern showed in table 5.5 can be explained by the fact that distance has become gradually less related to cost in travel business today. A two-week package holiday in Kenya might cost the European traveller less than an equivalent package in the Mediterranean on his doorstep (Sampson, 1984). Majority of the international air passengers (55%) come from Europe and North America (Table 5.6). United Kingdom, North America (USA and Canada), France and India tend to generate more air passenger traffic to Kenya than other countries. UK still maintains close links with her former colony. As a result, many Britons visit Kenya for holiday as well as for business.

Several socio-economic and demographic characteristics (variables) have been identified that play a key role in explaining air passenger travel behaviour. The variables of age, income, level of education and social group are amongst the most frequently used in examining the influence of personal background characteristics on the propensity to travel (Robinson, 1979, Pearce, 1987a). Hudman (1980) posited that the propensity to travel abroad varies with age, occupation and income. As people grow older, their propensity to travel decreases. In terms of occupation, professionals comprise 60% of the total trips abroad from USA. However, although in general tourist behaviour is said to be differentiated along socio-economic axis, some empirical studies have indicated that this conclusion does not consistently hold true. Inconsistencies have been found

Table 5.6: Nationality of International Air Passengers

Nationality	Number (N = 200)	Percentage (%)
Kenyan	20	10
British	30	15
French	18	9
German	10	5
American*	32	16
Belgian	8	4
Swiss	4	2
Dutch	4	2
Italy	4	2
Indian	18	9
Rest of Africa	30	15
Rest of the World	22	11
Total	200	100

* Residents of USA and Canada.

Source: Fieldwork, 1992

especially when personal characteristic variables have been used to explore "situation-specific" consumer behaviour. This implies that tourists of different income levels, would not necessarily assess differently the relative importance of scenic qualities when considering alternative tourist destinations. Thus, relationships between socio-economic variables and travel behaviour do not really explain recreational behaviour. The present study has also confirmed the existence of the inconsistencies alluded to above. About 62% of the total international air passengers interviewed were aged 40 years and above (Table 5.7). This tends to disapprove the proposition that as people grow older their propensity travel decreases. In terms of occupation, professionals comprise 11% of the total air passengers interviewed. It would appear that businessmen account for about 64% of the total trips to Kenya (Table 5.8).

Table 5.7: Age-structure of Air Passengers

Age (years)	Number (N=200)	percentage (%)
< 19	0	0
20-24	6	3
25-29	14	7
30-34	26	13
35-39	30	15
40-44	34	17
45-49	24	12
50-54	32	16
> 55	34	17
Total	200	100

Source: Fieldwork, 1992

Table 5.8: Occupational Status of Air Passengers

Occupational Status	Number (N=200)	percentage (%)
Business	128	64
Civil service	26	13
Professionals	22	11
Others*	24	12
Total	200	100

* Students and Missionaries.

Source: Fieldwork, 1992.

In analysing air passenger travel behaviour, it is also important to consider certain intrinsic and extrinsic travel motivations. In this case, the socio-demographic background of the traveller is not perceived as the direct travel determinant, but as a personal situation that might result in or impinge upon certain subjective travel motivations. In other words, it is suggested that people do not travel because they are old, are married, or belong to a particular social class. As a result, variables referring to life-styles, value systems, travel preferences, travel needs and travel motivations are used as proxies and explanatory factors for travellers' destination choice behaviour. In Kenya, international air passengers for leisure account for 67% of the total air passengers and those for business about 27.5% (Table 5.9).

Table 5.9: Trip Purposes

Purpose	Number (N=200)	percentage (%)
Leisure	134	67.0
Business	55	27.5
Others*	11	5.5

* Administrative, or relief work trips etc.

Source: Fieldwork, 1992.

This finding is consistent with the present situation in Kenya where about 88% of the visitor departures consist of holiday tourists (Table 2.9, which see). From the above findings, the null hypothesis that "the volume of air passenger traffic does not vary with the sizes of places and distances between them" is rejected.

NOTES

1. The "busy" day is defined as the second busiest day in the average week during peak month. That is to say, the average traffic level for all the days of the peak month is defined in order to obtain an average weekly pattern during that month. The weekly pattern excludes peaks associated with special events such as religious festivals, and conferences etc.
2. It is important to test for multi-collinearity in multiple regression and correlation analysis. The independent variables should be uncorrelated with each other. Multi-collinearity can be discovered by examining the matrix of intercorrelations

between independent variables. If correlation coefficients between X_1 (independent variable 1) and X_2 (independent variable 2) is about ± 0.7 or even higher, then multi-collinearity may be present and one variable can be left out. However, multi-collinearity may be due to complex relationships between more than two independent variables which do not show as simple correlation coefficients. A reliable test of multi-collinearity would be to examine the stability of regression coefficients and their standard errors. Neither should change much in the presence or absence of any other independent variables. If the independent variables are perfectly correlated the regression coefficients cannot be determined. The standard errors of the correlation coefficients get larger and larger as the correlation increases. In this chapter, the regression coefficients have been found to be quite stable indicating that multi-collinearity is absent.

REFERENCES

1. Central Bureau of Statistics : Statistical Abstracts (various years), Ministry of Planning and National Development, Government Printer, Nairobi.
2. Hudman, L.E. (1980) : Tourism: A Shrinking World, Columbus, OH, Grid Inc.
3. IATA (1983) : Nairobi Airport Traffic Forecast. 1981-1996, Nairobi.
4. ICAO (1989) : Airport Traffic. Series A.T-No.30, pp.102-103
5. Lowe, J.C. and Moryadas, S. (1975) : The Geography of Movement. Houghton Mifflin Co, Boston, USA.
6. Matthieson, A. and Wall, G. (1982) : Tourism - Economic, Physical and Social Impacts, London.
7. Murphy, P.E. (1985) : Tourism: A Community Approach, Methuen, London.

8. Nystuen, J.D. and Dacey, M.F. (1961) : "A Graph Theory interpretation of Nodal Regions" in Papers of the Regional Science Association. Vol. 7, 29-42.

9. Robinson, H. (1979) : A Geography of Tourism, MacDonald and Evans.

10. Sagers, M. and Maraffa, T. (1990): "Soviet Air-passenger Transportation Network", in the Geographical Review, Vol.80, No.3, pp 266-278.

11. Sampson, A.L. (1984) : Empires of the Sky: The Politics, Contests, and Cartels of the World Airlines, London.

12. Taaffe, E.J. (1956) : "Air Transportation and United States, Urban Distribution", in the Geographical Review. Vol 56, No. 2 pp 219-238.

13. Ullman, E.L. (1956) : "The Role of Transportation and the Bases for Interaction", in Thomas, W.L. (Ed), Man's Role in Changing the Face of the Earth, Chicago.

CHAPTER SIX

THE ANALYSIS OF COMMODITY FLOWS

6.0 INTRODUCTION

So far, little geographical work has been done and published in Kenya dealing with commodity flows by air at the national and/or international scale of analysis. Therefore, there is need for such a study, particularly one dealing with the modelling of international air freight flows using multiple linear regression model. The use of the multiple linear regression model may shed some light on the factors that influence the spatial distribution of commodity flows. This Chapter describes, analyses and explains the spatial patterns of international air freight flows. Some of the problems that have arisen in the use of air freighting in Kenya are discussed. Unlike domestic air passenger transportation, there is very little domestic air cargo. Therefore, it was not possible to carry out any meaningful commodity flow analysis at the national level. In this Chapter, the hypothesis that: "the volume of air freight does not vary with sizes of places and distances between them" is tested.

6.1 THE GROWTH AND IMPORTANCE OF AIR FREIGHT

It is generally agreed that airfreight has the advantages of speed and suitability for fragile goods. Thus, products of high perishability are often carried by air. In addition, the speed of transit means that goods and capital are not locked up as is the case with sea freight (Funnell, 1970).

Air freight can be used as a development tool. Air freight is being used to satisfy demand otherwise unattainable such as sending of exotic tropical produce from Kenya to the Western fruit and vegetable market. Availability of air freight can be used to exploit differences in climatic and labour conditions. Kenya enjoys the reverse or complementary growing seasons to those in Europe. As a result, horticultural growers are able to grow fruits, vegetables and flowers for sale in the Western European market.

Adequate and timely provision of all kinds of equipment and supply is a fundamental necessity for the economic development process in all developing countries. In-bound freight includes a wide range of manufactured goods for which shippers are prepared to pay comparatively higher general cargo rates while much of the outbound freight is accounted for by fewer export products which are shipped at lower specific commodity rates. Increasingly, air transport is being recognized as a means of developing new export trade for Kenya and other African countries by increasing the

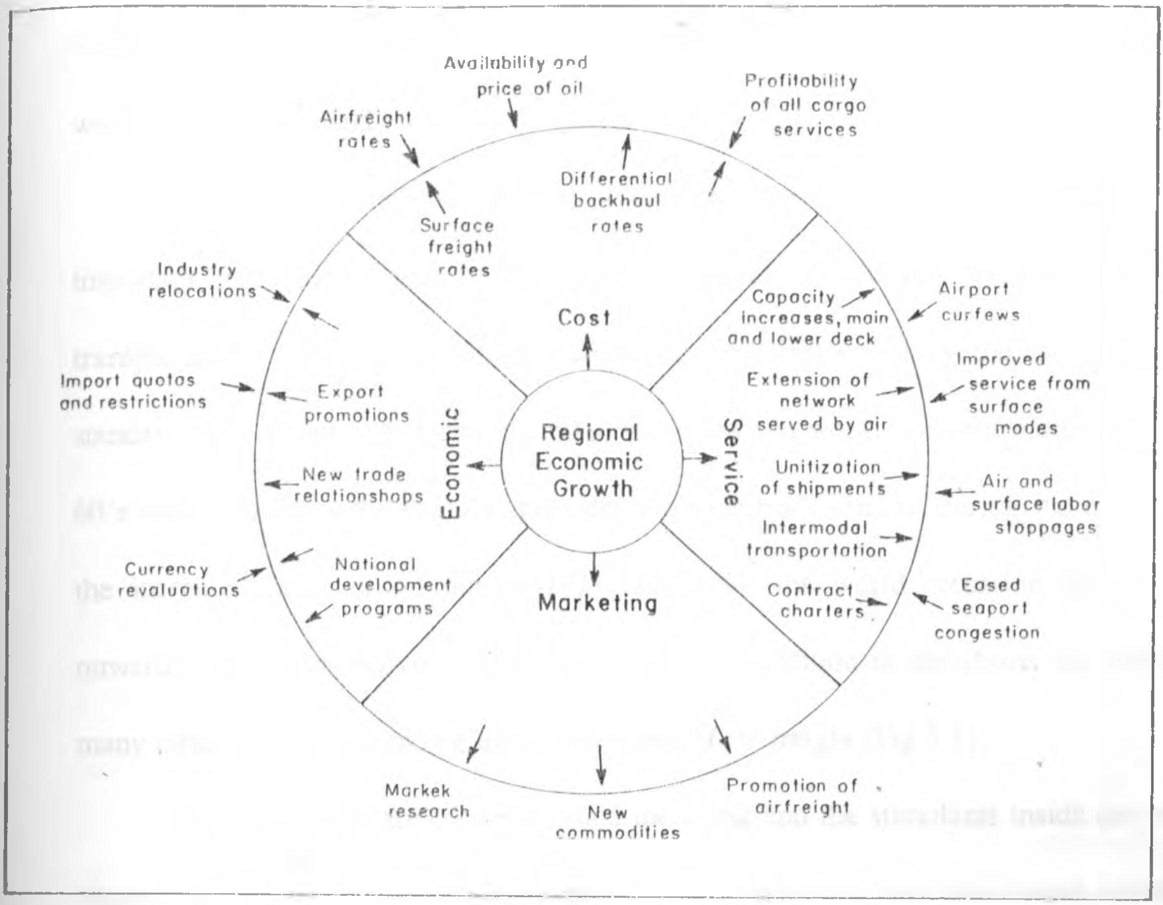


Figure 6·1 Forces and constraints on airfreight growth. After: Boeing Commercial Airplane Company, 1980.
Source: Eriksson, G. A. (1986), pp 308

number of markets to which goods can be exported, especially perishables and products with a seasonal demand.

Before discussing the patterns of domestic and international air freight, it is important to outline some of the general aspects of causality behind air freight transportation. The growth of air freight has been influenced by the introduction of standard-body jet aircraft during the 60's, slow down in world economies during the late 60's and early 70's, the stimulus provided by wide-body aircraft during the early 70's, the increased price of oil during 1973 and 1974, the world recession during 1974 onwards and world recovery (Eriksson, 1986). In addition to the above list, there are many other factors influencing the development of air freight (Fig 6.1).

The constraints are located outside the circle and the stimulants inside the circle. More important for economic geographers are the sectors of cost and service which are both very closely connected to each other. Service is positively correlated to cost. In recent years, inflation rates all over the world have had a serious impact on airline operating costs. These high inflation rates, coupled with the increase in oil prices, have increased airline operating costs at unforeseen rates (ibid, 1986, 307). The user of air freight is concerned with improvements not only in the air but in total transit performance. The air service and, hence, an upswing in air freighting, is also due largely to containerisation. This is illustrated in Fig 6.1 by "unitization of shipments. The introduction of handling goods in specially constructed containers has contributed to the ease of handling goods, to make it faster and better utilizing of aircraft. It has also simplified the documentation process.

6.2 PATTERNS OF AIR FREIGHT

6.2.1 DOMESTIC AIR FREIGHT

Domestic air freight forms a negligible proportion of the total market, accounting for about 2.6% of the total air freight handled at Jomo Kenyatta International Airport (Table 6.1). Domestic air freight accounts for about 22% of the total air freight at Moi International Airport (MIA). Most of the domestic cargo is carried by road or rail.

One point that is clear from table 6.1 is that domestic air traffic varies from one period to another. The lowest volume of domestic air traffic is handled between the month of April to September. This is mainly because most of the cargo carried by air on the domestic network is connecting to and from an international flight. It should be realized that much of the cargo movement may still be on a consignment basis to meet special demands rather than a regular flow. The little freight moved within the country consists mainly of miraa (*catha edulis*) and relief supplies. Miraa is the main commodity transported by air regularly from Wilson airport to North Eastern Kenya by light aircraft. Kenya Airways (KA) carries freight and mail on few major domestic routes (Table 6.2).

Table 6.1: Monthly Variation in Domestic Freight and Mail handled at Jomo Kenyatta International Airport (metric tonnes), 1989

Month	Freight			Mail		
	Loaded	Unloaded	Total	Loaded	Unloaded	Total
January	49.6	75.3	124.9	7.3	3.0	10.3
February	34.0	103.2	137.2	6.0	3.1	9.1
March	37.6	88.6	126.2	6.6	3.7	10.3
April	30.3	43.9	74.2	2.4	2.0	4.4
May	33.8	40.8	74.6	2.4	2.0	4.4
June	30.9	33.5	64.4	4.2	3.2	7.4
July	37.8	34.6	72.4	5.1	2.6	7.7
August	34.9	17.1	52.0	3.0	2.9	5.9
September	30.1	14.3	44.4	4.0	2.3	6.3
October	29.4	77.2	106.6	3.2	2.8	6.0
November	43.5	70.6	114.1	3.6	3.1	6.7
December	46.4	91.8	138.2	2.9	3.1	5.0

Source: ICAO, 1989, Airport Traffic, Series AT-NO 30, PP 103

The most important domestic route for both freight and mail is the Nairobi-Mombasa route. Nairobi-Malindi route is also important for domestic freight and mail.

6.2.2 INTERNATIONAL AIRFREIGHT

Kenya's rapid economic development has led to the rapid growth of a successful air freight business especially the export of high quality horticultural produce. Besides, Nairobi has the advantage of considerable nodality in the international air transport network (Chapter 5). Table 6.3 indicates the recorded total international air cargo at Jomo Kenyatta International Airport, Nairobi.

Table 6.2: <u>Freight and Mail Handled along Major Routes by Kenya Airways, 1979/80 to 1986/87*</u>

	1979/80	1980/81	1981/82	1982/83	1983/84	1984/85	1985-86	1986-87
FREIGHT (TONNES)								
Nairobi-Mombasa	205.0	212.0	220.0	308.0	737.0	598.0	1,114.0	338.0
Nairobi-Malindi	2.5	2.6	2.2	1.4	2.1	5.0	13.4	9.1
Malindi-Mombasa	0.04	0.04	0.03	0.4	0.2	0.1	0.5	0.5
Nairobi-Kisumu	-	-	-	0.5	2.6	14.0	41.0	35.5
MAIL (TONNES)								
Nairobi-Mombasa	119.0	132.0	97.0	120.0	176.0	184.0	128.0	166.0
Nairobi-Malindi	4.0	6.0	5.0	5.0	7.0	6.0	5.5	4.6
Malindi-Mombasa	-	-	-	2.0	2.0	1.6	0.8	0.08
Nairobi-Kisumu	-	-	-	2.0	4.0	5.0	3.0	2.0

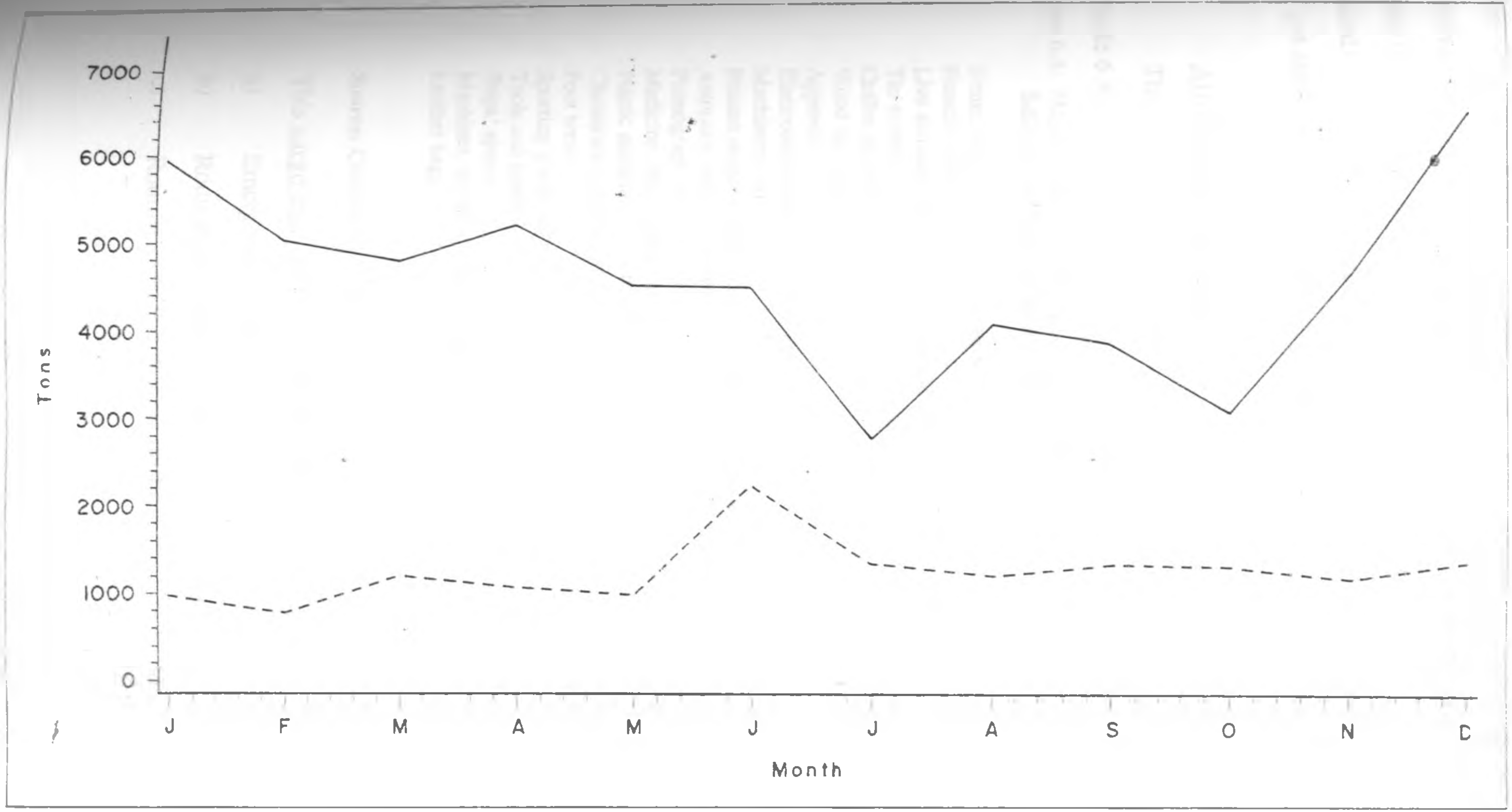
*Data not available for the period 1987/88 to 1991/92

Source: Kenya Airways, Statistics Section

Table 6.3: Monthly Variation in International Freight and Mail Handled at Jomo Kenyatta International Airport (metric tonnes), 1989

Month	Freight			Mail		
	Loaded	Unloaded	Total	Loaded	Unloaded	Total
January	2980.1	828.9	3809.0	70.8	105.9	176.7
February	2583.2	653.9	3237.1	65.4	121.5	186.9
March	2647.9	703.2	3351.1	56.7	108.7	165.4
April	2964.6	747.9	3712.5	66.0	103.3	169.3
May	2467.7	857.9	3325.6	74.1	82.8	156.9
June	2385.1	656.0	3041.1	68.3	96.1	164.4
July	2080.9	719.6	2800.5	61.7	81.9	143.6
August	2383.3	736.3	3119.6	74.2	94.3	168.5
September	2543.7	817.2	3360.9	76.8	86.7	163.5
October	3567.4	944.6	4512.0	64.4	101.2	165.6
November	3745.5	975.3	4720.8	65.3	90.5	155.8
December	3429.7	799.1	4228.8	66.8	95.7	162.5

Source: ICAO, 1989, Airport Traffic, Series AT-NO 30, pp 103



North-bound Cargo

South-bound Cargo

Figure 6·2 Volume of North-bound and South-bound Cargo.
Source Kenya Airfreight Handling Limited (KAHL)

According to ICAO (1971), there is an important directional imbalance in the movement of air freight between Africa and Europe, with south bound cargo being more than north bound (Appendix xx and Fig. 6.2). However, according to Rie (1974), the current situation of cargo traffic in Kenya is contrary to the prevailing situations in other parts of Africa. In terms of tonnage, there is an imbalance in favour of out bound (north bound) cargo traffic. Some times, the outbound cargo traffic could be three times as high as the south bound (in bound) cargo traffic (Table 6.3).

AIRFREIGHT GOODS

The various commodities carried by aircraft constitute what is called cargo mix (Table 6.4).

Table 6.4: Major commodities moving in Air Freight at Jomo Kenyatta International Airport (JKIA), Nairobi

Fruits, vegetables and cut flowers
French beans
Live animals (fish, monkeys, day old chicks)
Tea samples
Coffee samples
Wood carvings
Apparels
Electronic/electric equipment and parts
Machinery and parts
Printed matter (magazines, newspapers, periodicals)
Autoparts and accessories
Phonograph records, tapes, TV, radios, recorders
Medicine, pharmaceuticals, drugs
Plastic materials and articles
Chemicals, elements and compounds
Foot wear
Sporting goods, toys, games
Tools and hardware
Ships' spares
Machines, electronic data storage/processing
Leather bags

Source: Compiled by Author

This cargo mix can be divided into three groups:

a) Emergency traffic

b) Routine perishable traffic

c) Routine surface-divertible traffic

With emergency traffic is meant traffic that is not planned in advance and where time is of utmost importance. This includes drugs for medical emergency or heart transplant, or spare parts. The routine perishable traffic, includes cut flowers going to florists, fresh fruits and vegetables (tomatoes, avocados, mangoes). To this group belongs printed matter (newspapers and magazine) whose value perishes quickly with time. In both cases, speed is the primary consideration and the cost factor is of secondary importance (Eriksson, 1986). In third category, the cost factor is primary, while the speed factor (time) becomes only incidental to cost considerations. The routine surface-divertible traffic, is traffic that an airline has won from the surface modes of transportation, and must work to keep them from returning back to surface modes (e.g. cameras, toys, tools). The top ten imports by air in Kenya are shown in Appendix xxi and table 6.5.

Table 6.5: Top ten imports by air into Kenya (Percentage Value), 1991 * *

Import Item	Value (%)
Medicaments (retail)	23.0
Medical dressing (not cotton and non-adhesive)	17.5
Non-penicillin antibiotics (retail)	15.4
Motor vehicle parts	7.9
Antibiotics (penicillin)	7.5
Iron/steel springs (not-leaf type)	7.0
Literature*	6.7
Medicaments (other, not for retail)	6.2
Medicaments containing alkaloids (not for retail)	4.4
Automatic Data processing equipment	4.4
Total	100.0

*Not single Sheet or Dictionaries and Encyclopedia

* * Actual figures are shown in appendix xx1

Source: Department of Customs and Excise, 1991

Table 6.6: The Top Ten Exports by Air from Kenya, 1991 (Percentage value) * *

Export Item	Value (%)
Beans (vigna spp, phaseolus spp)	51.9
Fresh or chilled vegetables (excluding mushrooms, spinach, asparagus and celery)	30.7
Avocadoes	5.8
Guavas, mangoes and mangosteens	4.5
Fresh fruit (other)	1.8
Strawberries	1.7
Leeks and others alliaceous vegetables	1.4
Prepared and preserved vegetables (other)	0.8
Pineapples	0.8
Vegetables (cooked in boiling water or steam)*	0.6
Total	100.0

* could be uncooked and exclude spinach, legumes and potatoes
* * Actual figures are shown in appendix xx11

Source: Department of Customs and Exercise, 1991

Most imports passing through Jomo Kenyatta International Airport (JKIA) consist of medicines, pharmaceuticals and drugs, that is, emergency traffic (Table 6.5). Air freight exports from Kenya are dominated by horticultural products (Appendix xxii and Table 6.6). Kenya is in a favourable position for export of fresh fruits and vegetables including spices, as well as cut-flowers to Europe and Western Asia, not only in the Northern-hemisphere winter, but by careful planning of exotic types during the rest of the year at a reduced level. Market reports suggest that there is room for considerable expansion over and above current levels to Europe. The Western Asian market is small but has yet to be tapped.

The main direction of air-cargo exports is mainly to UK and continental Europe (Table 6.7). Movement to the Middle-East and within Africa is on a smaller scale. The cargoes to Europe are those falling into the high value/perishable category requiring careful handling and rapid delivery. The main destinations are London, Frankfurt, Amsterdam, Paris, Zurich and Rome. The bulk of the movements consist of fresh vegetables, cut flowers and spices (Table 6.8). A wide range of carvings is exported along with other tourist goods. Kenya has an elaborate organization for exploiting the air freight potential with special packing and forwarding plants in the main areas of production along with a network of sales representatives operating in Europe (Funnell, 1970).

Table 6.7 Direction of Air freight from Jomo Kenyatta International Airport (tonnes), 1990

Country	Tonnes	Percentage (%)
United Kingdom	17,325	35.0
Holland	9,557	19.0
France	9,292	18.6
Germany*	5,894	12.0
Belgium	2,671	6.8
United Arab Emirate (UAE)	1,004	2.0
Switzerland	931	1.9
Saudi Arabia	805	1.6
Seychelles	266	0.5
Djibouti	256	0.5

* Former Federal Republic of Germany

Source: Horticultural Crop Development Authority (HCDA), Ministry of Agriculture, Republic of Kenya, 1990 (tonnes)

Table 6.8: Export statistics for the leading Horticultural Products from Kenya to all countries, 1990

Commodity	Amount (tonnes)
French beans	16,330
Cut flowers	14,423
Avocadoes	3,311
Mangoes	2,613
Okra	2.548
Chillies	2,120
Aubergines	1,592
Karella	1,462
Pineapples	767
Strawberries	639

Source: H.C.D.A., 1990

PROBLEMS HINDERING DEVELOPMENT OF AIR-CARGO EXPORTS

There are a number of problems hindering the development of an export business utilising air cargo. These are:

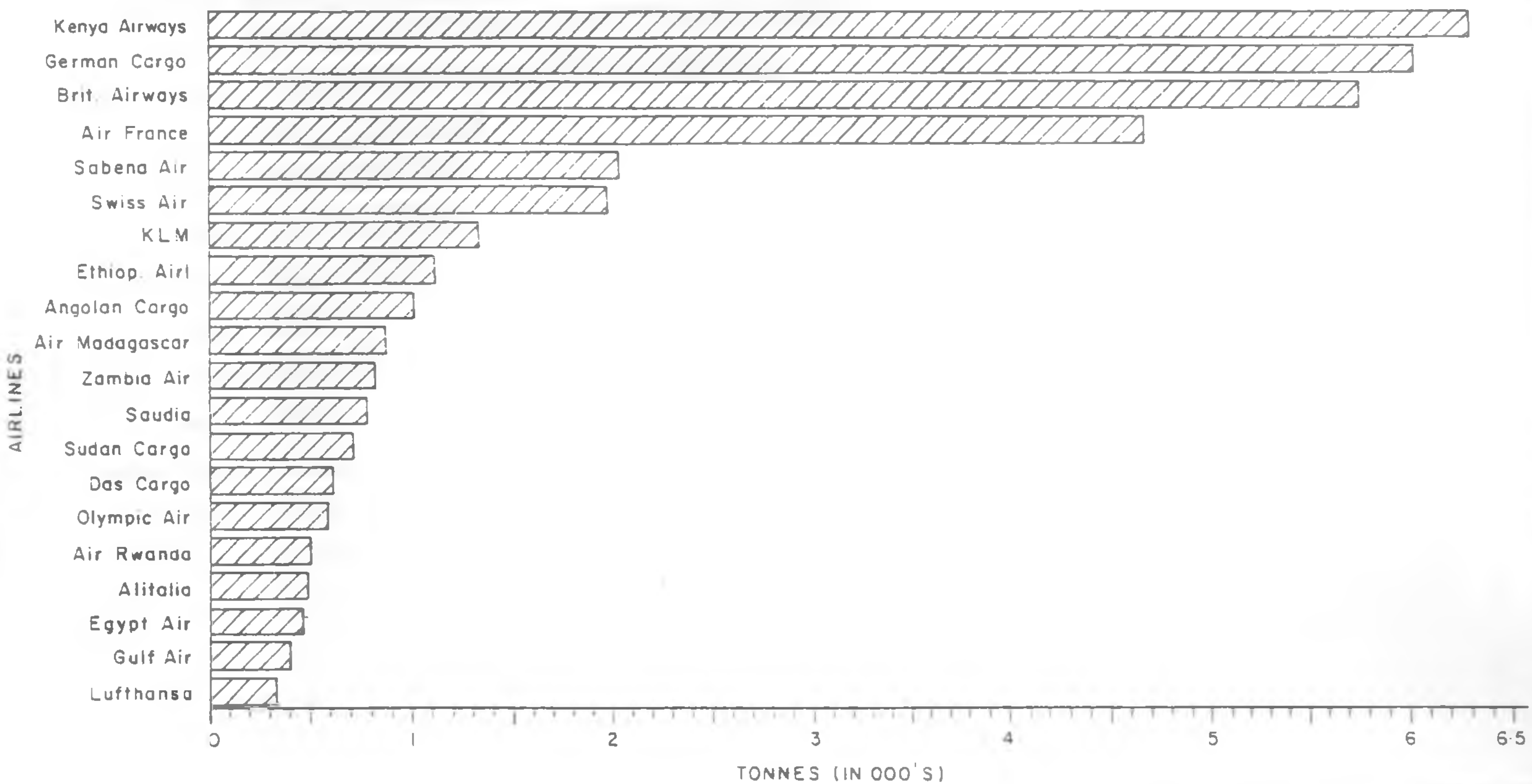
a) The need to select and develop products that can benefit from air freight possibilities.

b) Difficulties which are directly the concern of air carriers.

c) Lack of adequate common-user cold storage facilities at Jomo Kenyatta International Airport (JKIA).

Increasing competition is being faced by Kenya horticultural exports in European markets from those of the Mediterranean countries especially Israel. The Mediterranean countries have the great advantage of proximity to the main market, and the opportunity to utilise cheaper forms of transport. Although Kenya has developed trade in exotic fruits, competition is very strong. Kenya faces stiff competition in the export of pineapples from Côte d'Ivore (Ivory Coast). The European market is open for some fresh vegetables during the winter months. At all times of the year it is possible that tropical produce could sell in this market. However, as Funnell (1970) observes, many of the products which could find a market in Europe do not specifically require an "equatorial" as against a "tropical" environment. For some of the products, notably citrus fruits, the tropical conditions are more ideal. Thus the Mediterranean countries can produce many of the horticultural products just as Kenya. This means that Kenya does not only lack any environmental comparative advantage over the other countries, but is some 3,000 Km further away from the market. Apart from the growing competition from other horticultural producers, there is the question of quality. The European market is very discriminative and it is not possible to sell just any kind of produce. The European Economic Community (EEC) has established special quality controls in order to standardise its tariff arrangements.

Another problem faced in Kenya is limited capacity for air cargo. Since most of Kenya's products are destined for the European market to meet off-season demand, there is a peak demand for outbound capacity during this period. It has already been observed that in addition to speed, the precision of delivery is facilitated by air transport. For horticultural produce, it is of particular significance as any variation from the planned marketing time could affect the price considerably. The amount of freight that any given airline can carry is dependent upon the passenger load and the necessary fuel requirements. Figures 6.3 and 6.4 show the top twenty airlines handling exports and imports at Jomo Kenyatta International Airport, respectively (Appendix xxiii and xxiv). The national flag carrier, the Kenya Airways (KA), is the main carrier for both exports and imports passing through Jomo Kenyatta International Airport (JKIA). Other important scheduled air carriers are the British Airways, Air France, Sabena and Swiss Air. The volume of air cargo handled in both directions (North bound and South bound) is now sufficient to justify the generation of a service which is dominantly utilising specialised freighters (Figs 6.3 and 6.4). Specialized freighters operating into and out of JKIA are German cargo, Das cargo and AF freighter.



SOURCE KENYA AIRFREIGHT HANDLING LTD 1991

FIG 6.3 TOP 20 AIRLINES HANDLING EXPORTS AT JOMO KENYATTA INTERNATIONAL AIRPORT, 1991

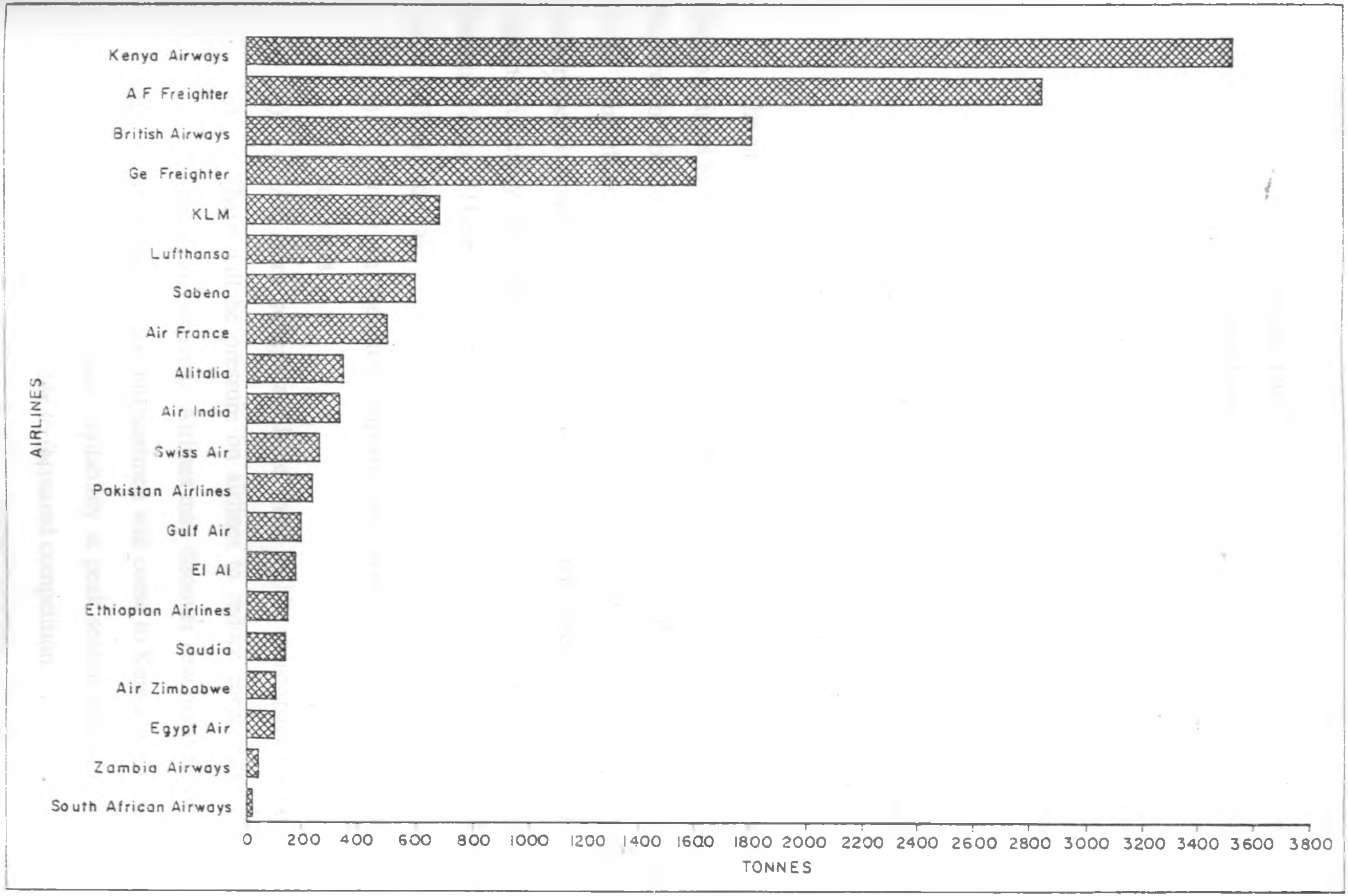


Figure 6·4 Top 20 Airlines handling Imports at Jomo Kenyatta International Airport, Nairobi, 1991.
Source: Kenya Airfreight Handling Ltd, 1991.

It is difficult to estimate fairly accurately the available freight capacity at JKIA (Diamond *et al.* 1969). The problems of measuring capacity for freight is complicated by many factors:

a) There are many different models of each type of aircraft each with a different capacity.

b) Total space on a plane varies with time depending on factors such as weather conditions at points of departure and destination, altitude and distance between landing points.

c) Space available for freight depends on the number of passengers being carried and amount of baggage with them.

The problem of lack of adequate capacity for air cargo can be solved by granting landing rights to more airlines. If more airlines wish to run services out of JKIA, Nairobi, but are not able to secure landing rights to do so, the simplest means of increasing capacity is to issue those rights. Bilateral Air Service(s) Agreements are negotiated between Governments which, subject to the conditions of the agreements, nominate the carriers which will enjoy the landing rights negotiated. Airlines can also be given temporary landing rights. There are several gains to be realised from granting of landing rights to more airlines, such as:

a) Some air freighted imports may arrive a little sooner saving costs to importers.

b) With more capacity available, there will be more space for exporters.

c) There will be pressure on airlines to reduce cargo rates to induce more imports and exports. Airlines may discover new markets for Kenya.

d) More tourists and businessmen will come to Kenya due to more connecting flights, greater space availability at peak season and increased promotional efforts by airlines due to increased competition.

e) Revenue from landing fees, ground handling fees, parking fees and night take-off fees would earn considerable revenue to the government.

In addition to air space, another constraining factor is the absence of adequate common-user cold storage facilities at JKIA. Some of the large producing and exporting companies have their own cold storage facilities, but the facilities available to small exporters are inadequate. This has two adverse effects:

a) It limits the possibility of "pre-cooling" produce, a process that is favoured by importers in European Community.

b) It makes the small exporters vulnerable if cargo space is not available as planned. If for any reason, cargo space fails to be made available after the produce has reached the airport, the exporter either faces the complete loss of his consignment or must sell at knock down price to an exporter with surplus space.

MOVEMENT OF MAIL

Direction is a geographical primitive. Together with distance it is implicit in all spatial relationships (Gaile, 1980). In this study, direction has been incorporated in the analysis of international mail traffic into and out of Kenya. In directional statistics, observations are angles measured with respect to a reference direction or axis. Data are grouped according to the direction of destination with 0° as North. The directional data are graphically represented by means of a linear histogram (Fig. 6.5). Most of the incoming mail originates from the North, with a significant amount also from the South. The outbound mail is destined mainly for the North and the West (Appendix xxv).

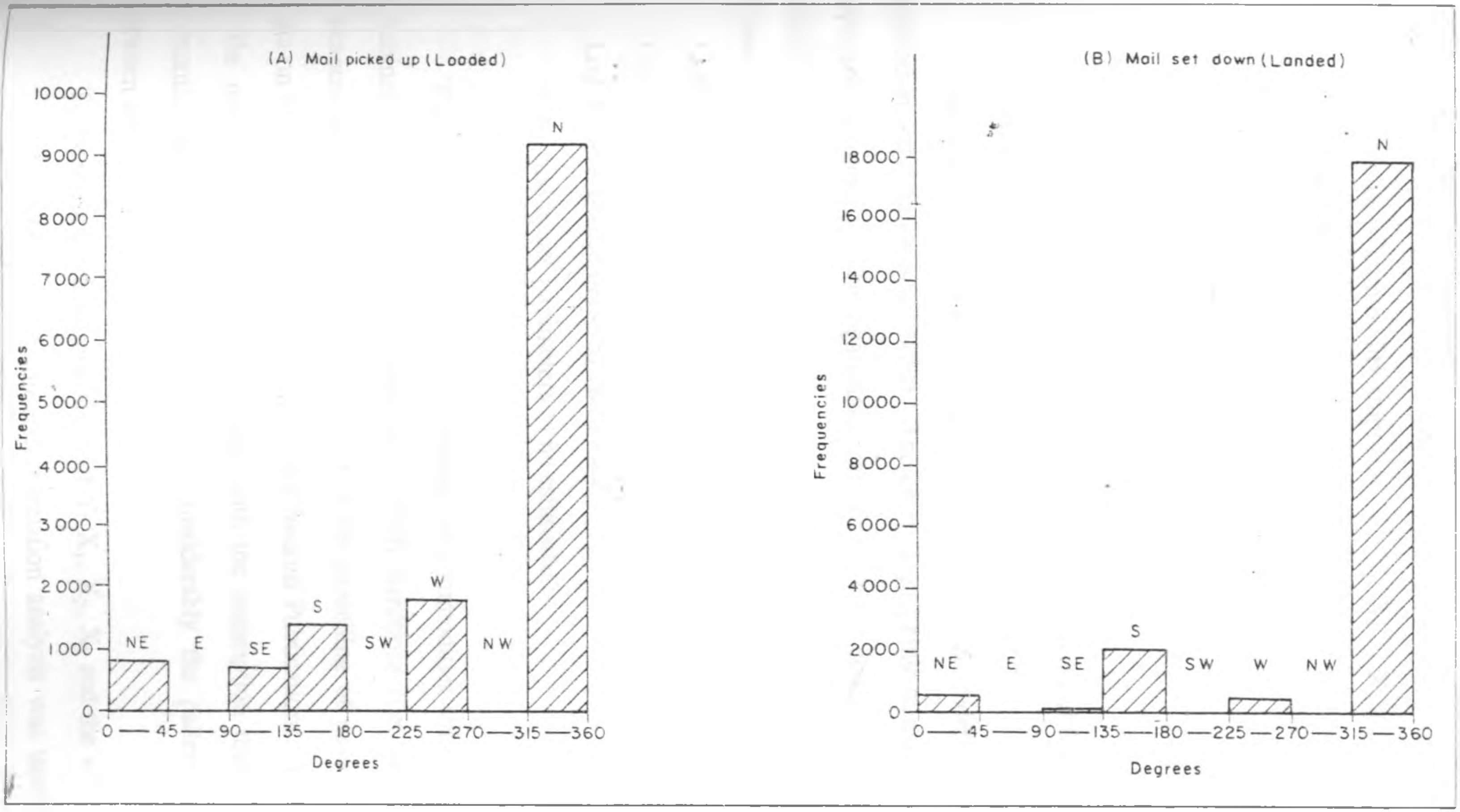


Figure 6·5 a&b Linear Histogram of Mail Loaded / Landed at Jomo Kenyatta International Airport 1990 (Kgms per week)

Source: Fieldwork.

6.3 ANALYSIS OF COMMODITY FLOWS USING MULTIPLE LINEAR REGRESSION MODEL

In this study, multiple linear regression model is applied. The regression equation utilised is of the form:

$$Y = a \pm b_1X_1 \pm b_2X_2 \pm \dots b_nX_n + \epsilon \dots\dots\dots\dots\dots\dots (6.1).$$

Where: Y is volume of commodity shipment, X_1, X_2, X_3 ... X_n are independent variables,

X_1 = Population

X_2 = GDP

X_3 = Distance between i and j

a, b_1, b_2, ... b_n are partial regression constants

ϵ - error (disturbance) term which explains the effects of unspecified variables.

The relationship between volume of interaction and independent variables such as population and distance is not linear. Therefore, logarithmic transformation is necessary to approximate linearity. The logarithmic transformation of equation (5.1) gives:

$$\text{Log } Y = a \pm b_1 \log X_1 \pm b_2 \log X_2 \pm b_3 \log X_3 \pm \epsilon \dots\dots\dots\dots\dots\dots (6.2)$$

Where Log Y = Volume of interaction between cities i and j

Log X_1 = Population of origin weighted by per capita income

Log X_2'= GDP of j

Log X_3 = Distance between cities i and j

a, b_1, and b_2 are parameters to be estimated

The dependent variable, the tonnage of commodities shipped and received, is the combined data representing movements in both directions (i.e. arrivals and departures). Distances are the same as the ones used in the modelling of passenger flows (Chap. 5). Data on GDP was obtained from the United Nations Publications. The variables were used in the multiple linear regression model with the assumption that distance, cultural and economic influences can and do affect considerably the pattern of trade transactions between areas.

To establish the functional form of Y, X_1, X_2, X_3 and the value of a, b_1, b_2 and b_3, multiple regression and correlation analysis was used after data had been normalized using common logarithms (Table 6.9). In order to examine the relative contribution of each of the three independent variables to the level of variations in the tonnage of shipments, these variables were subjected to stepwise multiple regression analysis. The results of stepwise multiple Regression analysis are shown in Table 6.10

Table 6.9 : The Relationship Between Volume of Commodity Flow, Population, Gross Domestic Product (GDP) and Distance*

Country	Log Cargo Volume (Log Y)	Log Population (Log X_1)	Log GDP (Log X_2)	Log Distance (Log X_3)
Ghana	1.77	7.16	9.73	3.63
Ethiopia	2.96	7.69	9.77	3.07
Netherlands	3.51	7.17	11.37	3.82
Greece	2.60	7.00	10.73	3.66
India	2.84	8.92	11.45	3.66
Belgium	3.55	7.00	11.21	3.82
Burundi	2.35	6.72	9.07	2.94
Egypt	2.98	7.71	10.51	3.55
Tanzania	2.62	7.38	9.49	2.82
Cameroon	1.74	7.06	10.06	3.49
Uganda	2.77	7.23	9.62	2.72
Germany	3.91	7.80	12.10	3.80
Saudi Arabia	3.39	7.16	10.94	3.41
Côte d'Ivoire	-0.70	7.07	9.97	3.68
Malawi	2.45	6.91	9.17	3.15
Mauritius	2.26	6.04	9.34	3.49
Nigeria	2.83	8.06	10.45	3.58
Rwanda	2.29	6.84	9.34	2.88
Somalia	2.71	6.79	9.02	3.00
South Africa	2.25	7.54	10.94	3.46
Sudan	2.20	7.39	9.53	3.29
Zambia	2.57	6.89	9.48	3.26
Pakistan	2.25	8.03	10.57	3.64
United Kingdom	3.97	7.76	11.92	3.83
USA	1.59	8.40	12.71	4.07
Italy	3.01	7.76	11.94	3.73
Israel	2.16	7.59	11.56	3.57
Switzerland	3.31	6.82	11.29	3.78
France	3.93	7.75	12.00	3.81

* Untransformed data for this table is provided in appendix xxvi.

Source: Central Bureau of Statistics, 1990

The use of the multiple linear regression model resulted in a low level of explanation, accounting for only 23% of the total variance distance explained about 7% of the total variance while GDP performed much better than distance by accounting for 14% of the total variance.

Table 6.10 : Multiple Coefficients of Correlation[1]

Variable	R	R^2	R^2 Change	b	SE	F Ratio*
GDP	.376	.141	.141	.68	.856	4.434
Distance	.458	.210	.069	-1.14	.836	3.455
Population	.479	.230	.020	-0.28	.842	2.490

* Significant level = 0.01

The major European destinations of Kenya's horticultural exports are UK, the Netherlands, France, Germany and Belgium (Table 6.7). In Africa, the major destinations for Kenya's horticultural exports include Ethiopia, Malawi, Zambia and South Africa. The West African countries of Côte d'Ivoire and Cameroon import significantly fewer commodities. A possible explanation for this pattern is the lack of adequate direct flight connections between Nairobi and the West African States. Following the above findings, the Null hypothesis (H_0) that: "the volume of air freight does not vary with sizes of places and distances between them" is rejected and the alternative hypothesis (H_1) is accepted.

6.4 FREIGHT TRAFFIC FORECAST

As already indicated, lack of adequate air cargo space at Jomo Kenyatta International Airport (JKIA) is a serious constraint. Therefore, it is important that a study such as this one should give an indication of the future trend in the growth of horticultural exports by air. Such information would be very useful to policy makers and transport planners in order to take appropriate measures to cope with any increase(s) in the volume of air freight traffic in the future.

In this Chapter, an attempt is made to analyse the trends in the growth of horticultural exports by air through Jomo Kenyatta International Airport (JKIA) using time-series analysis model. A time-series model always assumes that some combination of pattern is recurring over time. The basic data are from official statistics of Horticultural Crops Development Authority (HCDA) for the period 1978-1990. In the time series analysis, use is made of index numbers and the "least squares method".

6.4.1 : INDEX NUMBERS

In the use of index numbers, a base year, is chosen and all the figures for other years are expressed as percentage of the figure for the base year (Table 6.11). The figure for the base year is 21,007 metric tonnes. The advantage of using index numbers is that they are independent of the initial magnitude of the data, such as the unity in which they are measured. Index numbers express each figure as a percentage of the base year, so that analysis of growth and decline can be made easily. However, index numbers have their own serious limitations. One of the major limitations of the index

Table 6.11 : Volume of Horticultural Exports by Air to all Destinations (metric tonnes), through Jomo Kenyatta International Airport (JKIA), Nairobi, 1978-1990

Volume (metric tonnes)	Year	Index Number
21,007	1978	100.0
21,376	1979	101.8
22,266	1980	105.5
23,352	1981	111.2
24,596	1982	117.1
28,850	1983	137.3
31,298	1984	149.0
30,001	1985	142.8
36,211	1986	172.4
36,557	1987	174.0
58,119	1988	276.7
49,503	1989	235.7
49,147	1990	234.0

Source : Computed by Author

numbers is that they do not show proportional change between any two years in a time-series, but only between one year and the base year. To overcome this difficulty, a trend line is usually drawn. This is discussed in the next section.

From Table 6.11, it would appear that there has been an upward secular trend in the volume of horticultural exports passing through Jomo Kenyatta International Airport (JKIA). Significant increases in the volume of exports occurred in the period 1988-90. The volume of exports during this period more than doubled.

6.4.2 : TREND CURVE BY LEAST SQUARES

The trend curve enables deviations of individual values to be minimized. The trend curve or "least squares" method is tedious but more rigorous because it minimizes the sum of squares of the differences between the observed values and corresponding trend line values.

All straight line graphs have equations of the form:

$$Y = MX + C \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(6.3)$$

Where, Y and X are variables

M = Constant that determines gradient of trend curve

C = Constant to determine Y intercept.

Every line has a unique combination of values of M and C, and when these are known, the line can be drawn by plotting two points and ruling a line through them (Fig 6.7). Table 6.12 shows the calculation of a trend (least squares) line.

Table 6.12 : The Calculation of the trend line for Horticultural Exports by air to all destinations through JKIA, Nairobi, 1978-1990

Years (X)	(Y)	X^2	XY
1	21,007	1	21,007
2	21,376	4	42,752
3	22,266	9	66,798
4	23,352	16	93,408
5	24,596	25	122,980
6	28,850	36	173,100
7	31,298	49	219,086
8	30,001	64	240,008
9	36,211	81	325,899
10	36,557	100	365,570
11	58,119	121	639,309
12	49,503	144	594,036
13	49,147	169	638,911
$\Sigma X = 91$	$\Sigma Y = 432,283$	$\Sigma X^2 = 819$	$\Sigma XY = 3,542,864$

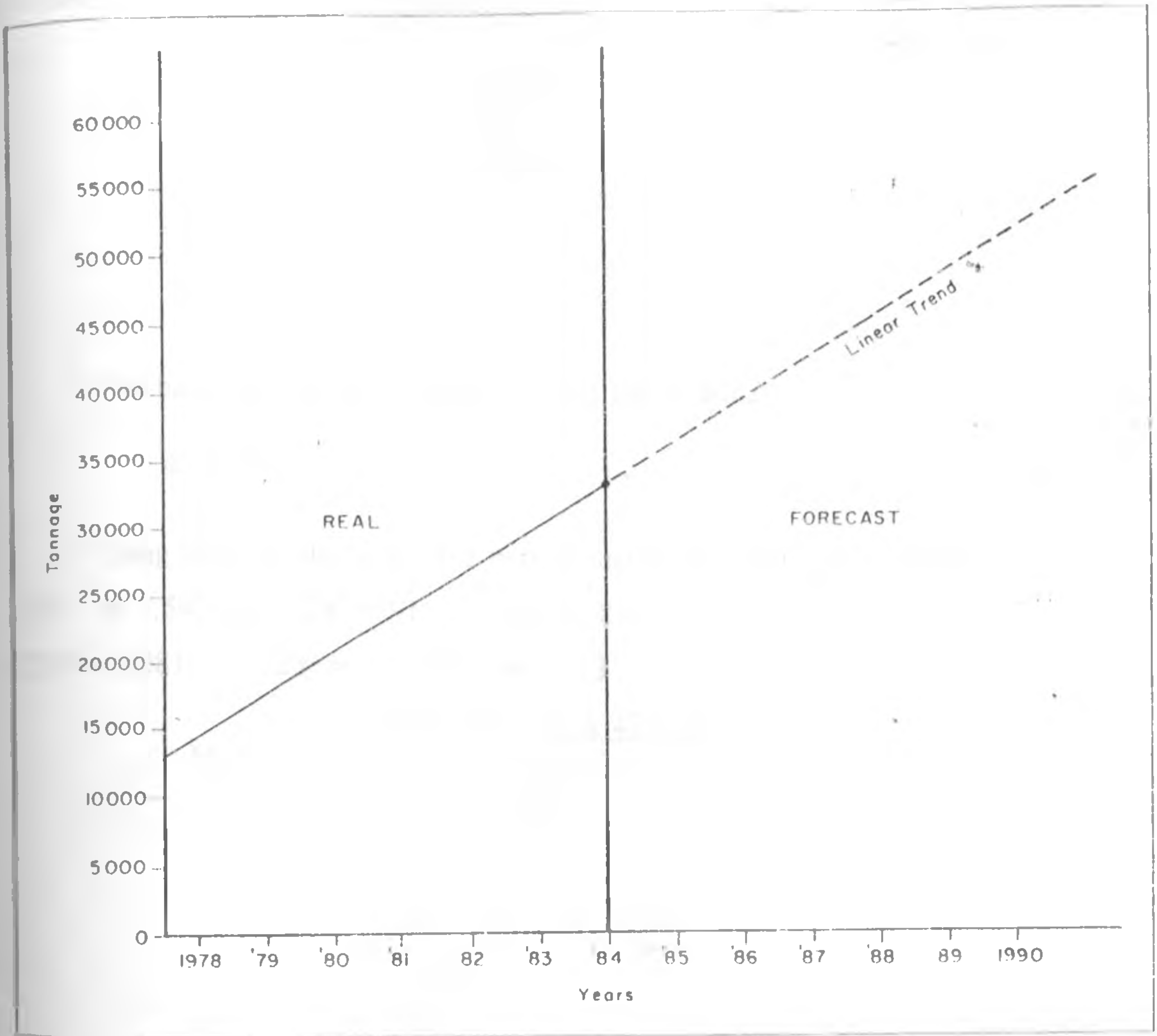


Figure 6 6 Trend curve for Horticultural Exports by Air to all distinations through Jomo Kenyatta International Airport 1978—1990
Source: Fieldwork.

If the years involved are listed under (X) and the appropriate volume of horticultural exports under (Y), then the number of units (m) which Y will increase per unit increase X can be derived by means of the following formula:

$$M=\frac{\Sigma XY-\frac{\Sigma X-\Sigma Y}{n}}{\Sigma X^2-\frac{(\Sigma X)^2}{n}}\ldots\ldots\ldots\ldots(6.4)$$

The base constant (C) is derived using the formula:

$$C=\overline{Y}-M.\overline{X}\ldots\ldots\ldots\ldots\ldots\ldots(6.5)$$

Using data on table 6.12, the two constants M, and C are computed as shown:

$\Sigma XY = 3,542,864$, $\Sigma X = 91$, $\Sigma X^2 = 819$,

$(\Sigma X)^2 = 8281$, $\Sigma Y = 432,283$, $n = 13$

$$M = \frac{3,542,864 - \frac{91 \times 432.283}{13}}{819 - \frac{8281}{13}}$$

$$= \frac{3.542.864 - 3.025.981}{182}$$

$$= \frac{516.883}{182}$$

$$M = 2,840.0$$

$$C = \overline{Y} - M.\overline{X} = 33,253 - (2,840 \times 7)$$

$$= 13.373$$

The equation for the straight line (trend curve) is:

$$Y = MX + C = 2840X + 13,373\ldots\ldots\ldots\ldots(6.6)$$

The trend curve reveals that the trend in the growth of horticultural export is not characterised by wild and apparently random fluctuations from one year to the other.

1. The same test applied in Chapter 5 is applied here to show whether there is any multi-collinearity. The standard errors of the correlation coefficients do not appear to increase significantly as each independent variable is added.

REFERENCES

1. Department of Customs and Excise (1991) : Ministry of Planning and National Development, Republic of Kenya, Government Printer, Nairobi.
2. Diamond, P., Mitchell, F. and Muturi, M. (1969): Report of the air freight study Group, IDS, Discussion Paper No. 79, pp 1-49, University of Nairobi.
3. Eriksson, G.A. (1986) : Air freight : Geographical Patterns and Economics : Forecasting models with an example from Finland, in Geojournal. Vol. 12, No. 3, pp 305-316.
4. Funnell, D.C. (1970) : Comments on the Role of air freight and exports in East Africa with special Reference to Uganda; East African Geographical Review. No. 8, pp 61-69.
5. Gaile, G. L. and Burt. J. E. (1980): "Directional statistics" in Concepts and Techniques in Modern Geography. No. 25.
6. Horticultural Crops Development Authority (1990), Ministry of Agriculture, Republic of Kenya, Government Printer, Nairobi.
7. ICAO (1971) : Air freight and air mail (Africa). Circular 104-AT/25.
8. ICAO (1989) : Airport Traffic. Series AT-No. 30, pp 103.
9. Kenya Airways (various years), Statistics Division, Nairobi.
10. Rie, J.J. (1974) : International Civil Aviation Organization, Inter-Country Project, RAF/73/005, UNDP/Republic of Kenya, Report on Air Transport Economic. Nairobi.

CHAPTER SEVEN

THE ANALYSIS OF THE RELATIONSHIP BETWEEN AIR TRANSPORT AND THE SPATIAL PATTERN OF DEVELOPMENT

7.0 INTRODUCTION

Throughout the inhabited world, transport in one form or another is a basic and essential part of daily rhythm of life. In developing countries such as Kenya, transport is generally regarded as one of the most important factors involved in the process of development. But, the relationships between transport and development are complex and vary spatially and over time (Hoyle, 1988). The definition of the concept of development is as given in Chapter 1 of this study.

The measurement of development efforts in developing countries has generally focused on the growth of GNP per capita and other aggregative indices. But, GNP per capita is now regarded as a poor spatial index (Kituuka, 1988). It is now widely accepted that development must be conceived in broad terms of social well-being. Narrow economic definitions although precise, provide only part of the picture. Development should be thought of not only in terms of income and consumption but also in terms of people's health, education, housing conditions, security, civil rights and so on. In other words, the notion of development extends beyond fundamental economic dimensions to encompass variations in social well-being (Drewnowski, 1974, McGranaham *et al.* 1970, Morris, 1980).

In this chapter, an attempt is made to construct a new measure of the variation in human welfare and to relate air transport growth to the spatial pattern of development in Kenya. The new composite index is used as a basis for ranking, classifying and comparing all the districts in Kenya according to their levels of development. The null hypothesis (H_0) tested in this chapter is: "There is no significant relationship between the development of air transport and the spatial patterns of development."

7.1 PREVIOUS MEASURES OF DEVELOPMENT

Berry (1961) produced one of the earliest multi-dimensional measures of economic development. He factor-analysed forty three(43) economic, social and political variables which he weighted using factor weights and applied the factor scores for creating composite indices (Table 7.1). This study revealed four development dimensions, namely: technological, demographic, income and external relations and large and small nations. Nations were ranked on these two scales and mapped. However, many of the variables used by Berry (1961) are redundant and there is little theoretical discussion underlying their selection. The resulting indices are highly generalized and difficult to interpret.

In subsequent years scholars from several disciplines have proposed various development indices in an attempt to create a more meaningful measure (UN Research Institute, 1972, Cole, 1981, Ram, 1982). All the scholars agree that a single indicator such as the GNP per capita is convenient to use, but it neglects too many important aspects of human welfare. Each author sought to produce a new index that reveals broader or deeper views of the development problem, but, unfortunately, while each measure has some unique perspective, none is comprehensive (Tata and Schultz, 1988).

Table 7.1 Comparison of selected Development Indices

Author(Date)	Variables (number)	Weighting	Basis of composite Index	Utility of Index
Berry (1961)	Economic, social, political inputs and outputs (43); redundant; minimal theoretical base	Factor weights	Factor scores	Ranks countries; regionalises world on four generalised dimensions
UN Research Institute (1972)	Economic, social, structural inputs and outputs (18)	Correspondence curve fitting	Adds results	Ranks countries; decides GNP per capita is better measure; unidimensional
Morris (1979)	Social outputs (3); redundant; minimum theory	Equal	Scales variables, adds results	Ranks countries, unidimensional
Cole (1981)	Physical, economic, social inputs (18); redundant, minimum theory	Factor weights	Factor scores of generalised component	Ranks 60 countries, tri-dimensional
Ram (1982)	Social, economic inputs and outputs (6); redundant, minimum theory	Scales data (0-100)	Principal Component Scores	Ranks countries on income and basic needs fulfilment, unidimensional
Population crisis committee (1987)	Social, economic, political inputs and outputs (10)	Equal	Scales variables, adds results	Ranks countries on human suffering; maps index, unidimensional
Tata /Schultz (1988)	Physical, social, economic, political outputs (10); on theory of human welfare	Factor weights	Factor scores; quintiles; any statistical categorisation	Ranks and maps 160 countries in overall welfare, individual systems or combinations; multi-dimensional; robust measure

Source: Tata, R.J. and Schultz, R.R.(1988), pp 582

7.2 EVALUATION OF DEVELOPMENT AT THE SUB NATIONAL LEVEL

Most scholars have endeavoured to measure variation in human welfare at the national level (table 7.1). However, little effort has been made to compile development indicators to measure the spatial variation of human welfare at the subnational level. One of the gaps this study hopes to bridge is the need to construct a composite development index to measure development at the district level. Some attempts have been made to measure development at the district level in Kenya (Ogonda, 1986, Rok, 1986a, Kituuka, 1988).

Ogonda (1986) used a group of 18 high -correlate core indicators to compute sectoral indices and the overall composite index of development for 39 largely rural districts in Kenya (Table 7.2). The study excluded the two predominantly urban districts of Nairobi and Mombasa. But, it is necessary to include Nairobi and Mombasa districts in the analysis in order to compare their levels of development with those of other districts, and to obtain a complete picture of the emerging spatial patterns of development in the country. It is also doubtful whether some of the component indicators selected were not highly inter-correlated. A composite index is unnecessary if components are highly correlated with one another because then any one of the component indicators itself will serve as an adequate index (Hicks and Streeten 1979, 577).

The ministry of Planning and National Development and Messrs Mwaniki Associates together with the assistance of UNDP and the backing from other U.S. based universities recently attempted to compile district development indicators mainly of Socio-economic variables considered to be simple measures that could eventually be used to form basic data files for calculating Gross District Product. Data were computed on all Kenya's 41 Districts. The indicators were those for which district data could be obtained in Nairobi (Kituuka, 1988). In all, 25 indicators were selected (Table 7.3).

Table 7.2: 18 Core Indicators used to compute Composite Development Index for 39 Districts of Kenya, 1986

	Indicator
1.	Road Density, km/km^2, (classified roads)
2.	Connectivity index (Beta index)
3.	Number of Passengers generated
4.	Total population (000s)
5.	Population density (persons/km^2)
6.	Potential agricultural production
7.	Percentage wage employment in agriculture
8.	Percentage wage employment earnings in agriculture
9.	Percentage wage employment in industry
10.	Wholesale and retail trade licences issued
11.	Percentage wage employment earnings in wholesale and retail trade
12.	Post office facilities
13.	Telecommunications line capacity
14.	Number of primary schools
15.	Primary school enrolment ratio
16.	Number of secondary schools
17.	Health facilities
18.	Health personnel per 1000 population

Source: Ogonda, R.T. (1986), pp 121.

The attempt by the Government (Rok, 1986a) to compile development indicators for the country's districts is commendable but, there are some shortcomings. The main ones are:

a) What is readily available in Nairobi as published data may not necessarily be the most significant attribute of spatial development of most rural districts.

b) All too often massive statistical data is collected that has little or no relevance to development. The relevance of indicators such as beans production and milk deliveries is doubtful.

Table 7.3: Key Economic and Social Indices of District Development in Kenya

Indicators

1. Total population
2. Wage employment
3. Wage earnings
4. Beans production
5. Coffee production
6. Overall Tea production
7. Smallholder Tea production
8. National Cereals and produce Board (NCPB) maize purchases
9. Milk deliveries to KCC
10. Livestock numbers
11. Livestock deliveries to KMC for slaughter
12. Sugar production
13. Cotton production
14. Wheat purchases by NCPB
15. Tobacco production
16. Millet purchases
17. Combined agricultural and livestock sales
18. Banking Institutions
19. Bank deposits
20. Credit (combined loans)
21. New vehicles registered
22. Traffic flows per district
23. Rail cargo consignment
24. Primary school enrolment
25. Health facilities per head of population

Source: Republic of Kenya, 1986a

Kituuka (1988) developed physical, structural, social, economic and demographic variables for evaluating the phenomenon of development in one district in Kenya - Murang'a District. His overall objective was to derive a description of the spatial relationships through a number of development variables using the explanatory strength of Common Factor Analysis (CFA). The development variables used in Kituuka's study are shown in Appendix xxvii. The study deliberately omits to dwell on the distributional aspect of development but seeks to examine the existing structure for a district in Kenya. It is doubtful whether such a composite development index developed for one district only has any universal application. Moreover, some of the indicators selected such as number of locations, number of plantations, percentage average number of locations producing 6 major horticultural crops, percentage of villages with telephones and number of postal facilities are not very relevant in measuring development. The fact that one village has more telephones or postal services than another does not necessarily mean that it is more developed than the other. The strongest of the four principal factors extracted using Common Factor Analysis (CFA) accounts for about 53.3% of all the variance in the data matrix. This suggests that the original variables were highly intercorrelated. As already pointed out, a composite index is unnecessary if components are highly correlated with one another.

The UNDP's first Human Development Report (1990) introducing the concept of Human Development, argued that the real purpose of development should be to widen the range of people's choices. To quantify and clarify the process of human development, the report also introduced a new yardstick of human progress, called the Human Development Index (HDI). By combining indicators of GNP per capita, education and health, the HDI offers a measure of development much more comprehensive than GNP alone. HDI includes three key components: Longevity, knowledge and income which are combined to arrive at an average deprivation index. Longevity is measured by life expectancy at birth. Knowledge is measured by two education stock variables: adult literacy and mean years of schooling. The measure of educational achievement is obtained by assigning a weight of two-thirds to literacy and one-third to mean years of schooling. The full technical description of HDI is provided in the Human Development Report, 1991, Technical Note 1, pages 88-89.

While HDI is an important measure of human welfare, it has a number of shortcomings. The HDI is a national average just like GNP per capita. Therefore, the index masks a lot of regional disparities. The index also ignores human freedom as well as political volatility. In other words, it assumes that political stability prevails in a given country all the time. It is felt that the index constructed in the present study, is a much better index for measuring not only human development but development as a whole.

The selection of the development indicators used in the present study was based on a number of criteria:

a) The relevance of the indicators in measuring development.

The concept of development adopted in this study conforms with the basic needs criteria supported by many scholars (Lewis, 1963, Seers, 1972, Todaro, 1977). Indicators such as the number of radios per 1000 population, newspaper circulation, postal services, number of television sets per capita were thought to be irrelevant and unrealistic in measuring development in a Developing country.

b) Conceptual Linkages

The selection was also guided by the conceptual linkages with existing studies using similar techniques of analysis (Berry, 1961, Soja, 1968, Ram, 1982, Tata and Schultz, 1988). Some of the indicators which have been used in the studies cited above were selected because of their general acceptability as measures of development.

c) Availability of data

Development indicators were compiled for all the 41 districts of Kenya. Indicators for district data that could be obtained easily for comparison purposes were selected.

The variables (indicators) used in the present study are shown in chapter three (Table 3.4) and the raw data is provided in Appendix xxviii. It is possible to assess the level of development of each district in a country by evaluating the operations of its physical, social, economic and political systems. Within the context of its contribution to development, the goal of the physical system is to provide society with natural resources and living space to satisfy their needs (Tata and Schultz, 1988). The productivity of primary (extractive) economic activities such as agriculture, mining, fishing and forestry depends largely on nature. Size, shape, terrain, climate, environmental hazards and absolute and relative location are factors that can enhance or diminish natural productivity. It is assumed that regions (districts) with superior endowments in the physical system have great potential for development. Nature provides physical resources which man must organize and manage if they are to be used to satisfy human needs. In order to measure the potential impact of the physical system on human welfare, two variables were selected: population per square kilometre of arable land and total value of primary industry output per capita. Population per square kilometre of arable land is a measure that has some connotation about potential productivity of the physical environment. Food and many other plant and animal resources come from the land, and the carrying capacity of the land is an important concept for evaluating human welfare. The total value of primary industry output per capita encompasses the concepts of both natural productivity and people's development of natural resources.

The economic system converts physical and human resources into useful goods and services to satisfy human demands. GNP per capita and manufactured goods value added are the two common and useful measures of output in economic systems. GNP per capita is the most used index of development status. Data on GNP per capita was not available at the district level. Manufacturing goods value added (MVA) is strongly correlated to GNP per capita. Manufacturing goods value added (MVA) is a rough measure of modernity of economic structures. Manufacturing requires entrepreneurship, capitalization and high technological inputs. The health of the manufacturing sector is a good measure of the general prosperity of the entire economy.

Social indicators such as primary school enrolment and infant mortality rates imply many aspects that indicate human welfare. Prenatal and post natal care, education levels of parents, medical services, nutrition, access to safe drinking water, environmental sanitation, and related social characteristics are factors that have an impact on infant mortality rates (Hicks and streeten, 1979, Tata and Schultz, 1988).

The role of the political system is to establish order and justice in society and to manage human and physical resources efficiently. Two variables were chosen to measure types of political system: Government expenditure per capita and voter participation rate. Government expenditure per capita is a direct measure of the effectiveness in raising revenue and consequent spending to satisfy citizen demands.

The significance of technology in economic development is widely recognized, and the improvement of productive efficiency and service infrastructure is a basic element in development planning (Smith, 1977, 210). The variables included here are energy consumption per capita, road density, length of railway/1000 population, number of air transport nodes and number of air passengers generated. These variables were expected to correlate strongly with MVA.

7.3 DATA ANALYSIS

In this section data that could be disaggregated in accordance with the 41 administrative districts of Kenya were utilized for multivariate analysis. 20 variables that were considered relevant in measuring the pattern of development at the district level in Kenya were selected for factor analysis. 41 x 20 data matrix for the whole country was assembled comprising 20 variables spread out in 41 districts (Appendix xxviii). The entire data observation matrix was transformed in order to overcome the limitations of comparing the data when expressed not only in different units but also in different scales. By means of Common Factor Analysis (CFA) it was possible to examine the internal relationships between the selected variables isolating the most important variables in a matrix of correlation coefficients (Kituuka and King'oriah, 1991).

In this study, the factor matrix was based on the R-type option extracted by principal component solution and rotated to orthogonal varimax rotation method. Data was analysed using a computer statistical package available in the "sub-program factor of the statistical package for social sciences (SPSS).

Table 7.4: Correlation matrix

Var.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1.000																			
2	-.084	1.000																		
3	-.122	.004	1.000																	
4	-.042	-.004	.160	1.000																
5	.032	-.090	-.120	.155	1.000															
6	-.028	-.058	-.106	.601	.168	1.000														
7	-.031	-.048	-.156	.127	.349	.245	1.000													
8	-.025	-.107	-.163	.191	.449	.310	.900	1.000												
9	-.109	-.247	.172	.066	.214	.108	.432	.230	1.000											
10	-.027	-.155	-.112	.162	.399	.305	.815	.885	416	1.000										
11	.113	-.068	-.272	.099	.493	.279	730	.909	061	.813	1.000									
12	-.041	.149	-.402	-.178	-.164	.007	-.031	-.038	-.276	-.118	.093	1.000								
13	-.354	-.062	.434	.204	.075	.072	-.049	.082	.433	.027	-.284	-.365	1.000							
14	.160	.062	.366	-.194	-.121	-.179	-.081	.130	-.610	-.066	.315	.434	-.551	1.000						
15	.131	.111	.249	.058	-.229	-.167	-.228	-.271	.032	-.218	-.326	-.221	.419	-.310	1.000					
16	-.330	.082	.106	.235	.416	.179	.040	.157	.096	.068	.083	-.122	.452	.167	.127	1.000				
17	-.140	-.159	.323	.030	.275	.026	.033	.037	.444	.326	-.006	-.384	.516	-.500	.226	.440	1.000			
18	.122	.105	.039	.533	-.071	.001	-.185	-.146	-.240	-.273	-.120	-.086	-.027	.133	-.075	-.104	-.354	1.000		
19	-.213	-.155	-.110	-.026	.037	-.109	.160	-.069	.270	-.036	-.197	-.226	.272	-.324	.228	.055	-.034	-.160	1.000	
20	-.014	-.015	-.101	.125	.051	.309	.710	.600	.262	.485	.386	-.007	-.063	-.084	-.249	-.030	-.165	-.159	.052	1.000

7.4 INTERPRETATION OF FACTOR ANALYSIS RESULTS

7.4.1 THE CORRELATION MATRIX

The basic requirement for common factor analysis (CFA) is the correlation matrix. The transformed data was used for computing a correlation matrix (Table 7.4). The individual variables in the correlation matrix reveal certain aspects of development pattern in the area of study. The values of bivariate correlation coefficients for 20 variables show how these aspects are associated. Some variables exhibit high positive associations while others are highly negatively correlated. Some variables exhibit very low associations. Correlation coefficients of $\pm$ 0.300 are considered significant at 0.05 confidence level. Correlation coefficients of $\pm$ 0.500 and above significant at 0.001 confidence level are regarded as "high" and are underlined.

Generally, variables associated with relatively "high" correlation coefficients have greater diagnostic power in the pattern of development at the district level in Kenya. In other words such variables tend to account for a greater variation in the spatial pattern of development than others. Some of the variables used in the present study such as Manufactured Goods Value Added (MVA), infant mortality rate, percentage of the people employed in agriculture, energy consumption per head, length of railway per 1000 of population and road density have received a lot of attention in similar studies (Berry, 1961, Ogonda, 1986, Tata and Schultz, 1988). The main task here is to establish whether their empirical associations in Kenya replicate their known patterns in previous studies.

Transportation is part of the "development infrastructure" and is closely linked to the general economic development of a country. (Haggett, 1969). Transportation is a critical factor in the promotion of, not only the general development, but also the development of other sectors of a country's economy. An area can have a high potential for development, but its natural resources can only be fully exploited if there is an efficient means of transporting the essential inputs and for marketing products
(Ogonda, 1986). Transportation permits regional specialization in economic activities such as agricultural and industrial production. Strong positive correlations between the number of air passengers generated and manufactured goods value added as well as percentage share of Gross Domestic Product (GDP) lend support to these arguments (Table 7.4).

Population is also closely related to development. The higher the population of a given area, the greater the demand for the new components of development. Ceteris Paribus, it can be argued that the higher the level of development in a given unit area, the more concentrated the population. The bivariate correlation coefficient for population density (variable 10) and percentage share of GDP (variable 7) is .815. The correlation coefficient between population density (variable 10) and manufactured goods value added (variable 8) is .885.

High negative correlation coefficient exists between total population (variable 9) and Government expenditure per capita (variable 14). The correlation coefficient for the two variables is of the order of -0.610. As already indicated elsewhere, government expenditure per capita is an indirect measure of effectiveness in raising revenue and consequent spending to satisfy citizen demands. The Kenya Government allocates more development funds per capita to the arid and semi-arid lands (ASAL) in order to promote human welfare in the region. The arid and semi-arid lands are sparsely populated. Measures such as primary school enrolment ratios can be used to indicate the percentage of the population having basic needs deficiency (Hicks and streeten, 1979). Enrolment ratios and Government expenditure per capita are negatively correlated. The correlation coefficient between the two variables (variable 13 and 14) is -.551 (Table 7.4). This indicates that the districts receiving more development funds per capita are those experiencing basic needs deficiency. It is interesting to find low correlation coefficients between percentage wage employment in tourism and number of air passengers generated. The correlation coefficient between the two variables (variable 4 and 20) is .125. This is partly due to the fact that majority of the people employed in the tourist industry in any given district are migrants from other districts. This is particularly true of the coastal region of Kenya. It is also relatively cheaper to travel by other transport modes such as road or railway. The correlation coefficient between the length of railway /1000 population and percentage wage employment in tourism is .533 which is highly significant (Table 7.4). The visual representation of correlation coefficients for selected variables is shown in Fig 7.1.

7.4.2 FACTOR PATTERNS

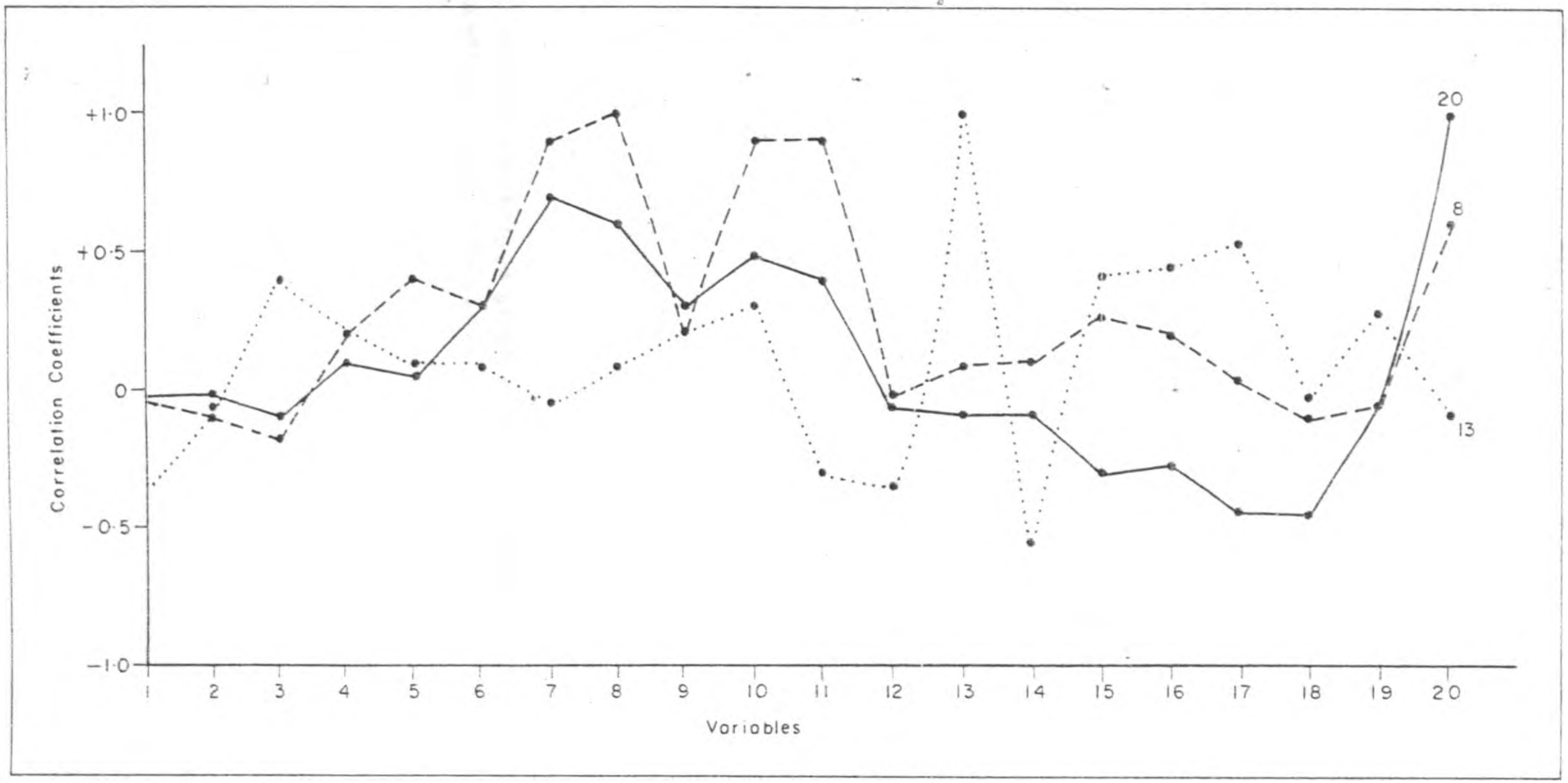
Factor analysis with varimax rotation was used to construct the composite Index for Development Status (CIDS). The results of the factor analysis are summarized in the rotated factor matrix of common factor coefficients (table 7.5). Five factors (dimensions) were extracted, which taken together accounted for and explained 66.5% of the variance in the 20 variable by 41 district data matrix.

The five factors (dimensions) extracted were considered significant in the sense that they were of practicable and interpretable importance (Ngau, 1979, 115). The five factors satisfy all the criteria:

a) Each factor has an eigenvalue greater than 1.0

b) Each factor accounts for at least 5% of the total variance

c) When a cumulative percentage graph is used, the curve rises steeply for the first five factors and then rises less steeply thereafter (Fig 7.2).



KEY

- – – – – 8 Manufactured value added
- ....13 Enrolment ratio in primary schools
- ________ 20 Number of air passengers generated

Figure 7·1 Visual representation of Correlation Coefficients for selected Variables.
Source: Fieldwork.

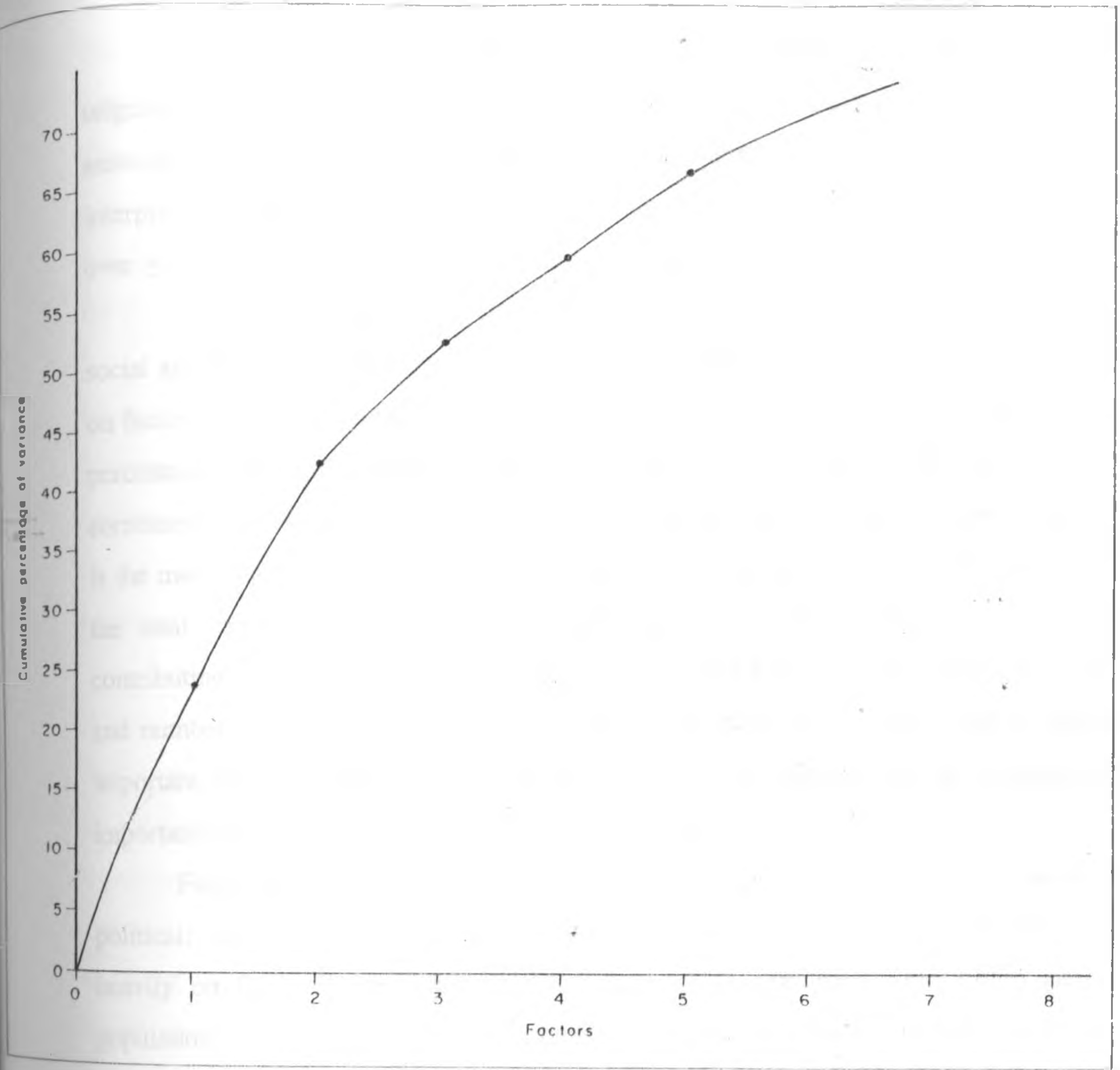


Figure 7·2 Cumulative percentage graph to show significant factors in factor Analysis. Source: Fieldwork.

The factor loadings can be interpreted as "correlation coefficients" between the original variables and the new factors (dimensions). Factor loadings indicate the relative association of the variable to the factor and therefore, form the basis of factor interpretation. In order to simplify interpretation of the factor patterns, factor loadings of over ± 0.300 are considered "high"and are underlined.

Factor I is complex with six variables loading heavily on it, three economic, two social and one technological (infrastructural). The three economic variables loading heavily on factor I are manufactured goods value added (.948), percentage share of GDP (.910) and percentage wage employment in manufacturing (.535). The list of the variables most highly correlated with Factor I undoubtedly identifies it as the economic factor (dimension). This is the most important factor (dimension) of development in Kenya, accounting for 23.7% of the total variance and 35.6% of the total common variation (table 7.5) The other contributing variables are population density (.922), percentage of urban population (.879) and number of air passengers generated (.623). Air transport variable is one of the most important variables loading heavily on this factor. This indicates that air transport is an important factor in economic development.

Factor II is also complex with seven variables loading heavily on it, three social, two political, one economic and one technological (infrastructure). The social variables loading heavily on factor II are infant mortality rate (.724), enrolment ratio (.658) and total population (.562). These three variables make factor II a strong measure of the social system. Other contributing variables include road density (.724), Government expenditure per capita (-.709), percentage wage employment in agriculture (.600), and voter participation rate (.482). Higher numbers in infant deaths reflect lower human welfare while higher enrolment ratios in primary schools indicate higher human welfare (Tata and Schultz, 1988). This factor accounts for about 18.9% of the total variance and 28.4% of the total common variance.

Two technological (infrastructural) and two economic variables load heavily on factor III. The length of railway loads heavily on the factor (.725). Road density has a fairly significant negative factor loading (-.300) on factor III. Factor III can be regarded as the technological (infrastructural) factor. Other variables loading heavily on this factor are percentage wage employment in tourism (.896) and percentage wage employment in wholesale and retail trade (.608). Transportation is very important in promoting tourism as well as marketing of manufactured goods and of other products. Hence, high loadings on this factor by tourism and commercial sector variables. The technological factor accounts for 9.5% of the total variance and 14.3% of the total common variance.

In factor IV, two physical factors load heavily on it. These are persons per square kilometre of arable land (-.686) and total value of primary production per capita (-.300). This can be identified as a physical factor. It is interesting to note that variable 16 (energy consumption per capita) loads very heavily on the physical factor. This is because woodfuel is the major source of energy in most rural districts of Kenya. Therefore, energy consumption per capita can also be a good indicator of the physical system.

Government expenditure per capita, a political indicator, loads heavily on the fifth factor. The factor loading for government expenditure per capita is .452. Therefore, this factor can be considered as a political factor. Every government is interested in satisfying its citizens and enjoying mass support for its policies and programmes. At present, more development funds per capita are allocated to less developed districts in Kenya in order to improve the welfare of the people living there. Two indicators of development of air transport load heavily on this factor too. These are the number of nodes on domestic air transport network and the number of air passengers generated. Their factor loadings are .656 and .464 respectively, (Table 7.5). This underlines the importance of air transport in promoting not only economic development but also political development in the country. In Kenya, air transport is crucial for administrative purposes especially in the more remote districts of the country. Senior government officers usually form a high proportion of domestic air passengers.

Table 7.5 : Factor structure of spatial pattern of Development in Kenya (Varimax/orthogonal rotated factor matrix)

Variable No.	Variable Name	Factors I	II	III	IV	V	h^2
1	Persons per square kilometre of arable land	.0522	.0838	.0109	-.6860	-.4290	.6640
2	Total value of primary industry output per capita	-.1898.	-.2896	.0307	.3000	-.0493	.1403
3	Percentage wage employment in agriculture	-.2137	.6000	.0991	.0442	-.0471	.4482
4	Percentage wage employment in tourism	.1464	.2172	.8957	.1136	-.0269	.8845
5	Percentage wage employment in manufacturing	.5354	.1889	-.0089	.3308	-.3280	.5394
6	Percentage wage employment in wholesale and retail trade	.3680	-.0213	.6077	.2024	.1004	.5561
7	Percentage share of Gross Domestic Product (GDP)	.9009	-.0249	.0430	-.0578	.2228	.8671
8	Manufactured goods value added per capita (MVA)	.9484	-.0701	.0951	.0148	-.0438	.9155
9	Total population	.3911	.5623	-.1229	.0092	.4486	.6855
10	Population density	.9216	.1343	-.0350	.0151	.0085	.8688
11	Percentage urban population	.8785	.2080	.0217	-.0041	-.2864	.8975
12	Infant mortality rate	.0535	.7244	-.1083	.1237	-.0034	.5546
13	Enrolment ratios in primary schools	-.1036	.6580	.0945	.4556	.2774	.7371
14	Government expenditure per capita	.0057	-.7090	-.0690	-.1346	-.4518	.7296
15	Voter participation rate	-.3667	.4820	.0223	-.0257	.0524	.3706
16	Energy consumption per capita	.1204	.2373	.0870	.8118	-.1507	.7601
17	Road density (km/km²)	.1662	.7241	.3000	.3809	-.1607	.8128
18	Length of railway/1000 population	-.2793	-.0444	.7250	-.1941	-.2264	.6945
19	Number of nodes in domestic air	-.0648	.1751	-.1155	.0431	.6556	.4799

Variable No.	Variable Name	Factors					
		I	II	III	IV	V	h^2
	transport network						
20	Number of air passengers generated	.6245	-.1518	.1753	-.1397	.4639	.6784
Percentage of total variance		23.7	18.9	9.5	7.6	6.8	66.5
Percentage of common variance		35.6	28.4	14.3	11.4	10.2	
Eigenvalue		4.7	3.8	1.9	1.5	1.4	

7.5: SPATIAL PATTERNS OF DEVELOPMENT

Factor scores were used to calculate the composite Index of Development Status (CIDS) for each district (Table 7.6). A factor score for each district is the value that describes its position on a particular factor or dimension. The factor scores were standardized to make them comparable. The factor scores have been mapped in order to illustrate the general pattern of the distribution of each factor (Figs 7.3- 7.7). Scores were divided into quintiles in the following ways: more than 1.5 standard deviations above the mean (1), 1.5 to .5 (2), .5 to -.5 (3), -.5 to -.1.5 (4) and less than -1.5 standard deviations below the mean (5). Category 1 always means highest development status and category 5 always means lowest development status. Each district was categorized by quintile for each of the five factors (dimensions).

The summation of quintile rankings places districts on an overall District Welfare or Development Status Scale (Table 7.7)

The range of the overall rankings is 12 to 21. These rankings can be used to divide the districts into developed and less developed categories. Any number of categorization schemes can be applied. In this study, the districts whose average quintile score for the five factors is 3 or less (overall sum 15) are defined as developed and those districts with average quintile score greater than 3 (overall sum 15) are classified as less developed. Using this scheme 27 districts are developed and 14 are less developed

(Table 7.7). The districts are arranged alphabetically within the same overall category. The three most developed districts are Kiambu, Machakos and Nairobi. The least developed districts are Marsabit, Turkana and Garissa, which form part of the Arid and semi-arid lands (ASAL) of Kenya.

A critical examination of table 7.7 reveals some interesting patterns. Whereas Kisii district scores highly in the social and economic factors, it performs poorly in the physical factor. This is a densely populated district (chapter 2) and the amount of arable land per capita is limited. As a result, its overall quintile ranking places it much lower than some of the arid and semi-arid districts of Kenya such as Kajiado. Kajiado district has a fairly well developed tourist infrastructure focusing on the world famous Amboseli National Park. From the foregoing observations, it would appear that the CIDS constructed confirms the order of development among the districts of Kenya. This fact can be easily verified by inspection of the ground truth as one travels through all the districts.

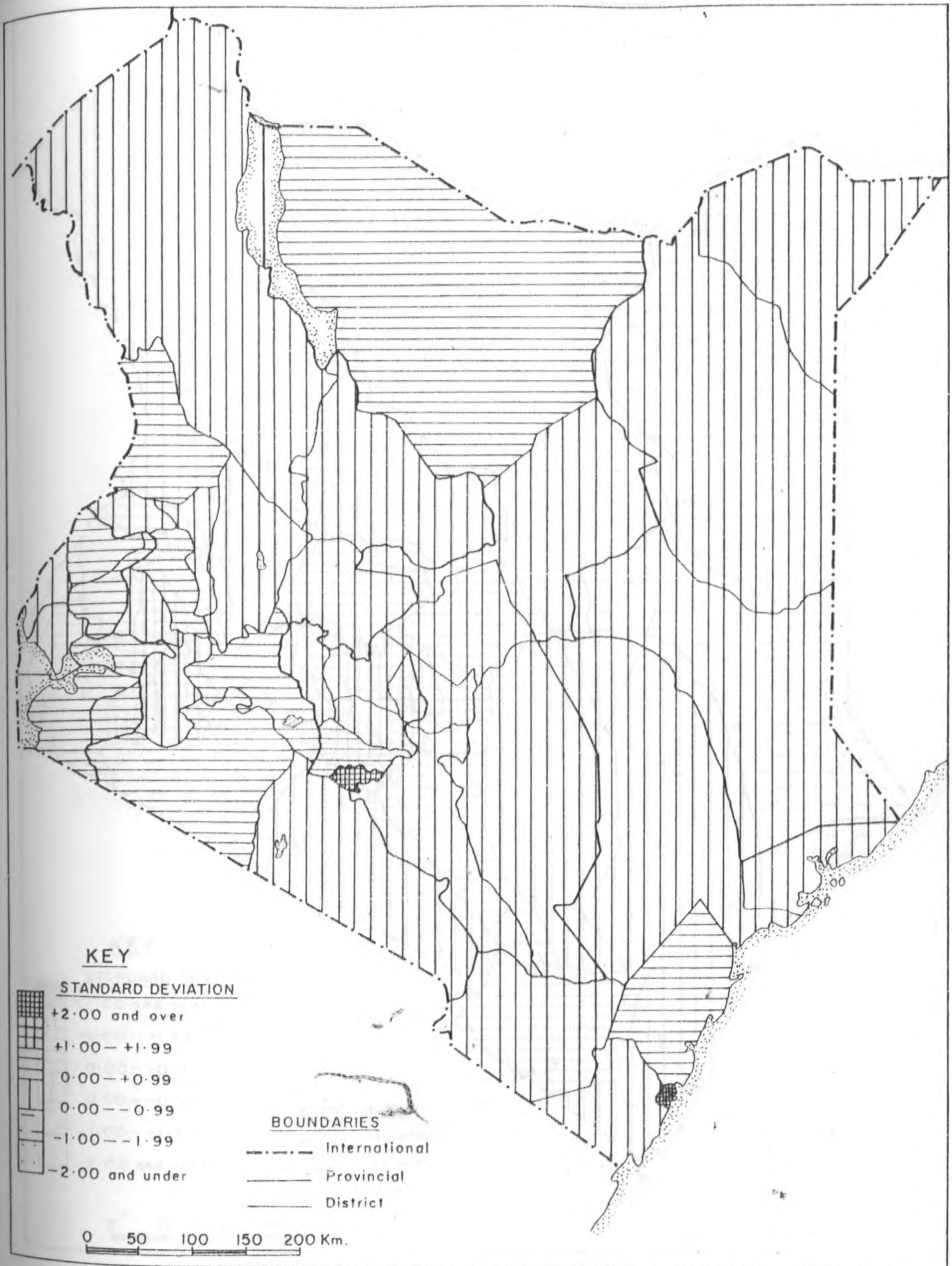


Figure 7·3 Spatial distribution pattern of factor One.
Source: Fieldwork.

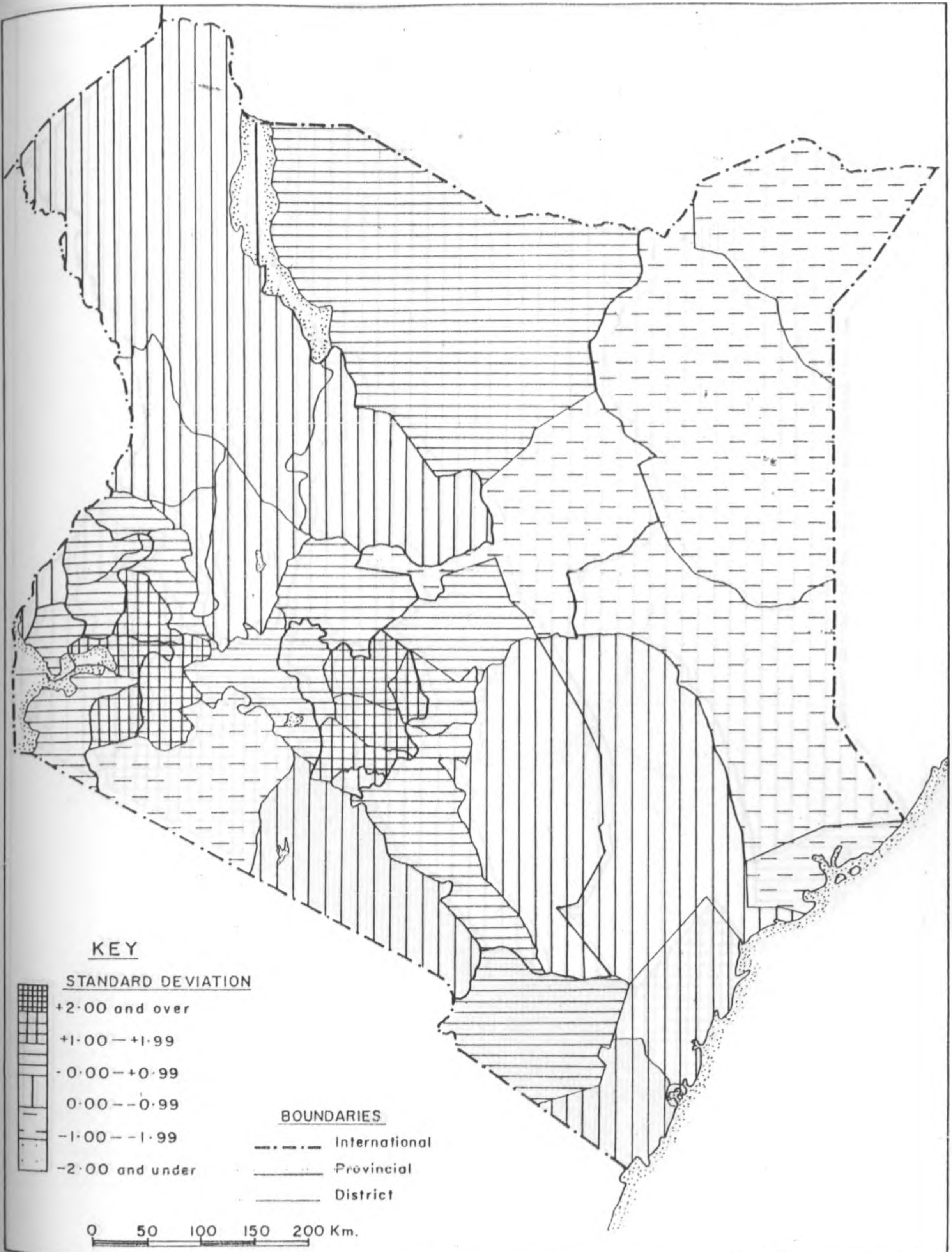


Figure 7·4 Spatial distribution pattern of factor Two.
Source: Fieldwork.

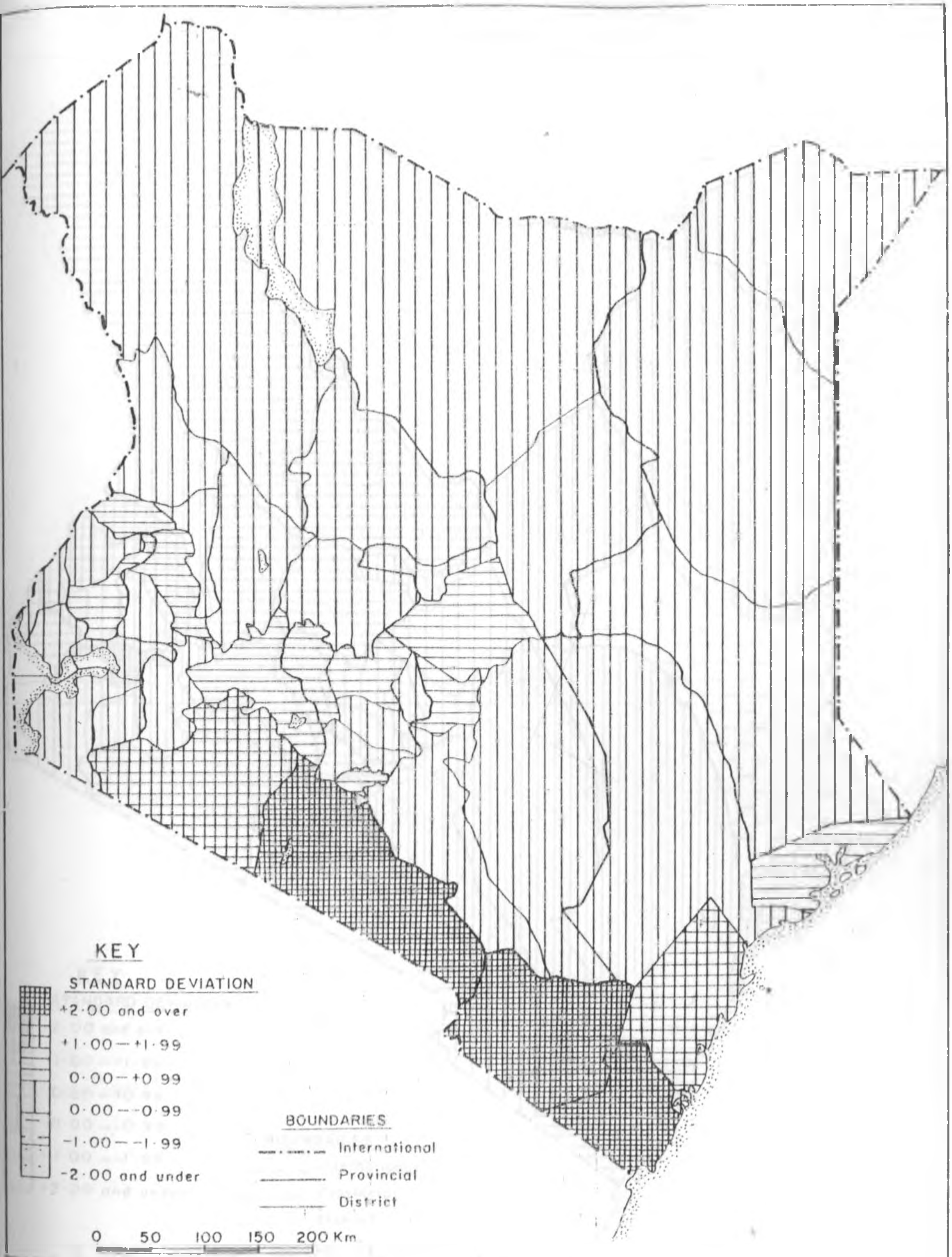


Figure 7·5 Spatial distribution pattern of factor Three.

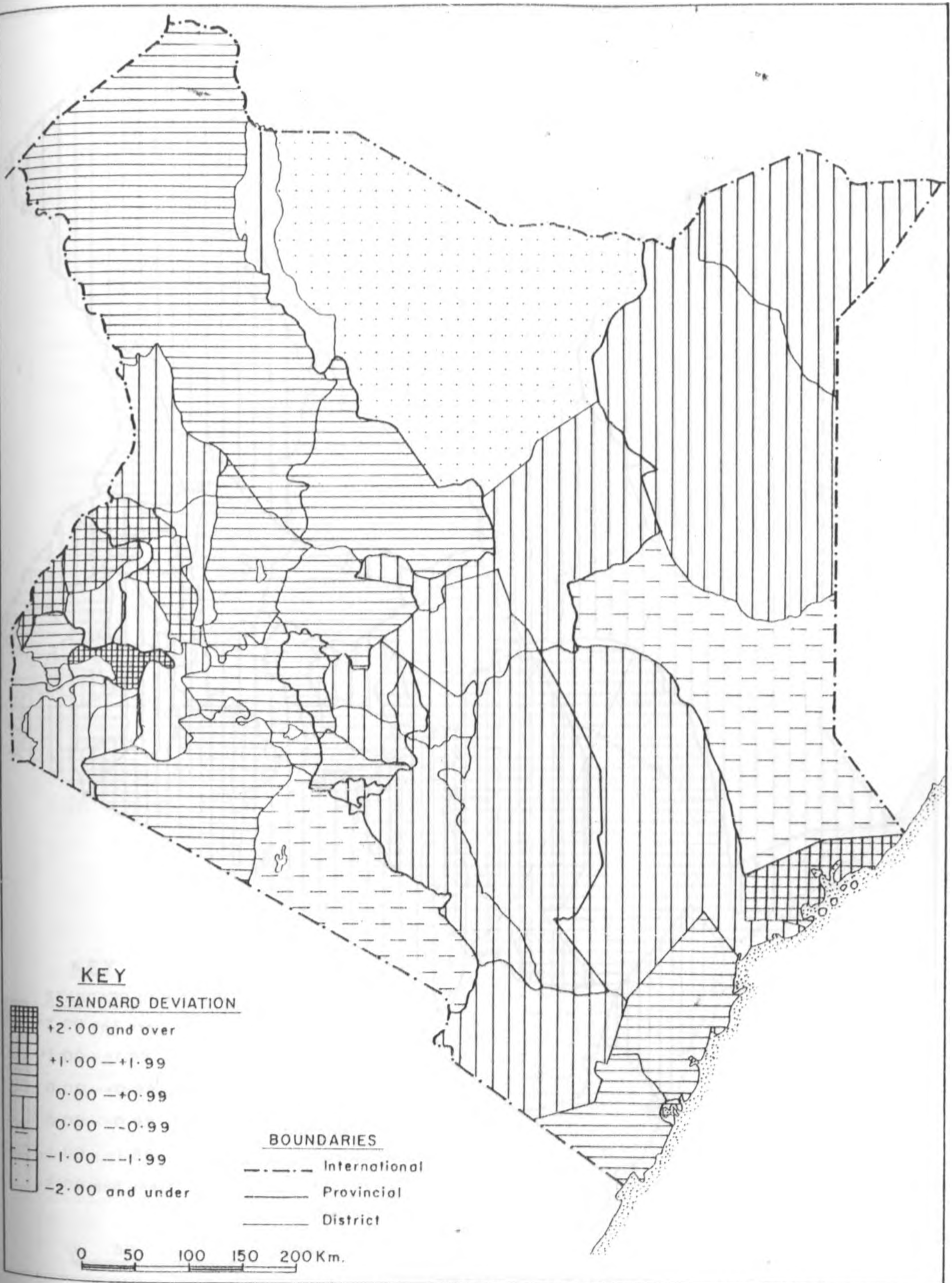


Figure 7·6 Spatial distribution pattern of factor Four.
Source Fieldwork.

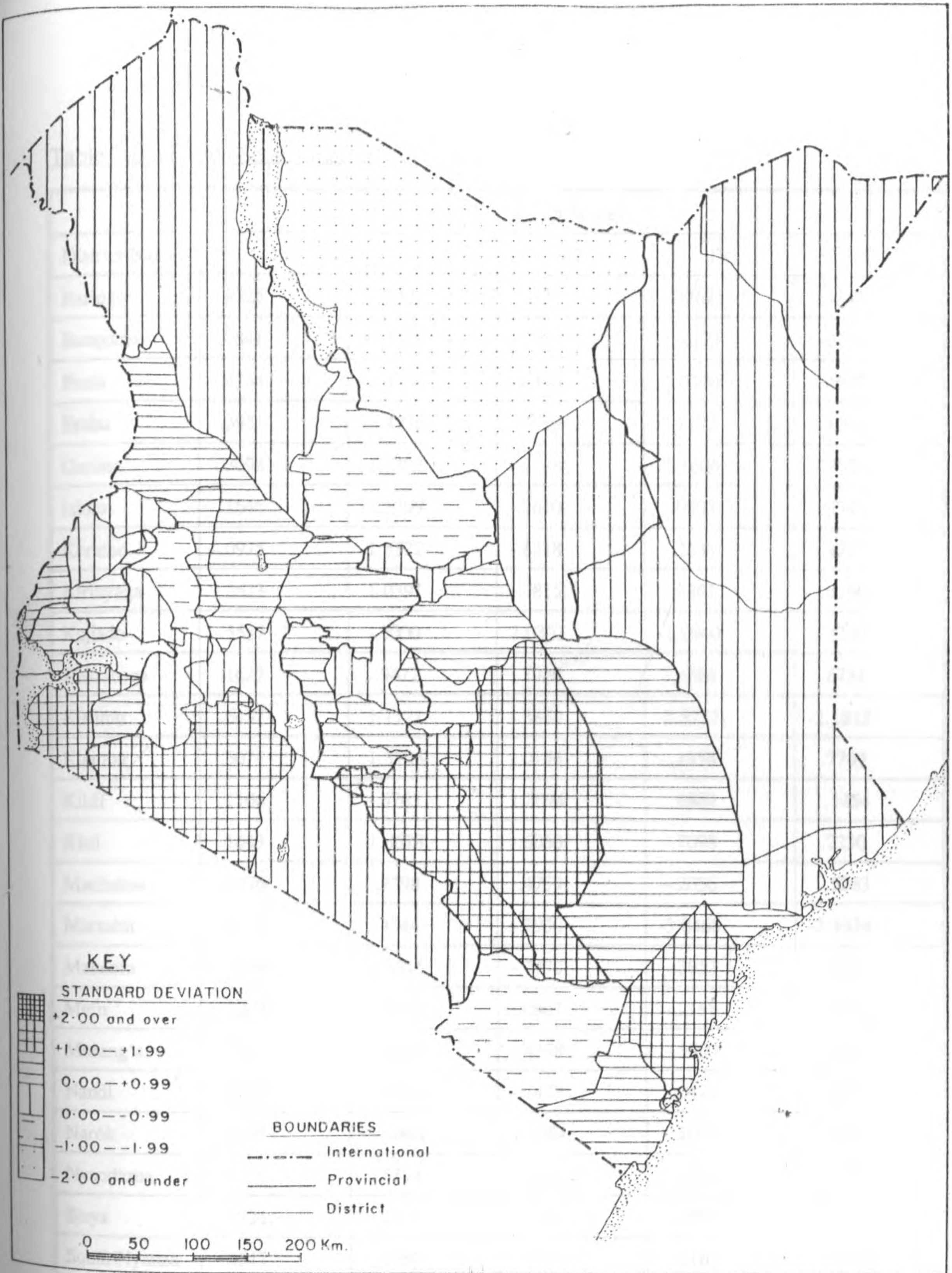


Figure 7·7 Spatial distribution pattern of factor Five.
Source: Fieldwork

Table 7.6: Factor Scores matrix

	Factor Scores				
District Name	I	II	III	IV	V
Baringo	-.8225	-.7423	-.2331	.7262	.4343
Bungoma	.0841	.3989	-.3930	1.2270	-.0795
Busia	-.4744	-.4103	-.4496	1.0770	.4627
Embu	-.3951	.4726	.3568	-.7197	.4092
Garissa	-.3098	-1.7302	-.7768	-1.1606	-.7659
Isiolo	.1646	-1.3299	-.3610	-.0802	-.3749
Kericho	-.0975	1.6522	-.6318	-.2630	-.4207
Kirinyaga	-.2623	1.0391	-.7815	-.3861	.0396
Kajiado	-.5517	-.3000	2.0302	-1.0940	-.1290
Kakamega	.1622	.9477	.7918	-.4686	.6734
Kisumu	.6437	1.1121	-.8839	2.8727	-2.1812
Kiambu	.5074	1.3706	-.0156	.4958	.7709
Kilifi	.2106	-.5765	1.3074	.6889	1.1454
Kisii	.1643	1.3678	-.6060	-.7098	.2230
Machakos	-.0476	.7398	-.4759	-.2030	1.5263
Marsabit	.1069	.4344	-.3930	-3.8468	-2.4634
Mandera	-.3048	-1.4815	-.7770	-.3953	-.7155
Meru	-.2087	.4685	.1807	-.2188	.8260
Murang'a	-.1412	1.9253	-.4358	-.5800	.0860
Nandi	-.5359	1.0051	-.1428	-.0422	-.0456
Narok	.0175	-1.0944	1.1064	.1039	.4244
Nyandarua	-.4356	.5793	.1045	.4512	.3136
Siaya	-.1721	.1830	-.1448	.2591	.7726
South Nyanza	.0347	.0287	-.3459	-.3167	1.3554
Nairobi	4.9582	-.8321	.6049	-.7687	1.6379
Tana River	-.5599	-.7150	-.5552	.5386	.5397
Trans-Nzoia	.4798	.3242	.0031	1.0500	-.1324
Wajir	.1897	-1.7352	-.9220	-.4529	-.5583

	Factor Scores				
District Name	I	II	III	IV	V
Uasin Gishu	.3183	.5028	.3878	1.5367	-1.5595
West Pokot	-.5276	-.9929	-.6761	-.3850	.2907
Taita-Taveta	-.8361	.5083	4.3386	-.4125	-1.3565
Kwale	-.2068	-.3372	2.1360	.4398	.4013
Mombasa	3.0076	-.2068	-.1951	.4897	-2.0397
Lamu	-.4545	-1.7440	.2832	1.5087	-.0751
Nyeri	-.0007	.0686	.2674	-.1561	-.4667
Laikipia	-.2000	.5749	-.3887	.2407	.4974
Elgeyo-Marakwet	-.5944	-.1324	-.7277	-.3202	.1955
Nakuru	.3182	.4671	.4328	.0215	-.3700
Kitui	-.7536	-.0842	-.6383	-.2953	1.6252
Turkana	.2653	-1.6262	-.7214	.2273	-.7722
Samburu	.4421	-.1100	-.0773	.3874	-1.1415

Table 7.7: Human Welfare (Development Status) Rankings by District Factor Quintiles

District Name	Economic Factor	Social Factor	Technological Factor	Physical Factor	Political Factor	Overall Sum of Quintiles
Developed						
1.Kiambu	2	2	3	3	2	12
2.Machakos	3	2	3	3	1	12
3.Nairobi	1	4	2	4	1	12
4.Kilifi	3	4	2	2	2	13
5.Kwale	3	3	1	3	3	13
6.Busia	3	3	3	2	3	14
7.Kakamega	3	2	4	3	2	14
8.Kericho	3	1	4	3	3	14
9.Kisumu	2	2	4	1	5	14
10.Laikipia	3	2	3	3	3	14
11.Meru	3	3	3	3	2	14
12.Murang'a	3	1	3	4	3	14
13.Narok	3	4	2	3	2	14
14.Nyandarua	3	2	3	3	3	14
15.Siaya	3	3	3	3	2	14
16.South-Nyanza	3	3	3	3	2	14
17.Taita-Taveta	4	2	1	3	4	14
18.Trans-Nzoia	3	3	3	2	3	14
19.Uasin Gishu	3	2	3	1	5	14
20.Bungoma	3	3	4	2	3	15
21.Kajiado	4	3	1	4	3	15
22.Kirinyaga	3	2	4	3	3	15
23.Kitui	4	3	4	3	1	15
24.Mombasa	1	3	3	3	5	15
25.Nakuru	3	3	3	3	3	15
26.Nandi	4	2	3	3	3	15
27.Nyeri	3	3	3	3	3	15

District Name	Economic Factor	Social Factor	Technological Factor	Physical Factor	Political Factor	Overall Sum of Quintiles
Developed						
Less Developed						
28.Baringo	3	4	3	3	3	16
29.Embu	3	3	3	4	3	16
30.Isiolo	3	4	3	3	3	16
31.Kisii	3	2	4	4	3	16
32.Lamu	4	5	3	1	3	16
33.Elgeyo-Marakwet	4	3	4	3	3	17
34.Samburu	4	3	4	3	3	17
35.Mandera	3	4	4	3	4	18
36.Tana River	4	4	4	4	2	18
37.Wajir	3	4	4	3	4	18
38.West Pokot	4	4	4	3	3	18
39.Marsabit	3	3	3	5	5	19
40.Turkana	3	5	4	3	4	19
41.Garissa	4	5	4	4	4	21

7.6 THE RELATIONSHIP BETWEEN AIR TRANSPORT AND DEVELOPMENT

In the previous sections, it has been established that air transport is one of the most important factors influencing the spatial pattern of development (Table 7.5). In order to determine the strength of the relationship between the pattern of development with air transport, both bivariate and multiple correlation and regression analyses were performed. A few other important variables such as manufactured goods value added (MVA), enrolment ratios in primary schools, road density and length of railway/1000 population were included in the multiple regression equation for comparison purposes.

Road density and length of railway/1000 population were used as indicators of road and railway transportation systems, respectively. The task here was to find out which of the three transport modes accounted for a greater variation of the spatial pattern of development in the country. The first step involved the examination of the strength of the bivariate correlation between the dependent variable (composite index of development status) and the five independent variables namely: Number of air passengers generated, manufactured value added, Enrolment ratios in primary schools, Road density and the length of railway/1000 population, Table 7.8 presents the bivariate correlation coefficients between the dependent and independent variables.

Any bivariate correlation coefficient of ± .300 is regarded as significant. From the table, it is apparent that air transport has a significant relationship with the Composite Index of Development Status (CIDS). The correlation coefficient between air transport indicator and the composite Index is -.324. The sign is negative because as already indicated, the lower the composite Index of Development Status (CIDS), the higher the level of Development and vice-versa.

Table 7.8: Matrix of Correlation Coefficients between the six variables

Variable	1	2	3	4	5	6
1. Composite Index	1.000					
2. No. of Air Passengers Generated	-.324	1.000				
3. Manufactured Value Added (MVA)	-.253	.600**	1.000			
4. Enrolment Ratios	-.605**	-.063	-.082	1.000		
5. Road Density	-.433*	-.165	.037	.516**	1.000	
6. Railway Length	.097	-.159	-.146	-.027	-.354	1.000

* Significant at .01 (1% percent) level.
** Significant at .001 (0.1 percent) level
The other correlation coefficients are all significant at 0.05(5%) level.

This can be interpreted to mean that the more developed districts tend to generate more air traffic than the less developed districts. The strongest simple correlation is with enrolment ratio (-.605), followed by road density (-.433). The lowest correlation is with railway length (.097). This finding confirms what previous studies have established - that transportation is an important factor in the development process of a country (Sorguc *et al.* 1976, Ogonda, 1986). According to the bivariate correlation analysis, it would appear that road transportation is a much more important factor in Kenya than either air or rail transportation. There are no significantly high inter-correlations (± 0.7 or above) among the independent variables which are likely to introduce the problem of multi-collinearity in the multiple regression analysis. In any case stepwise multiple regression analysis would take care of that.

The next step was the application of stepwise multiple regression analysis. Multiple regression is used here as a descriptive tool to control for other confounding factors in order to evaluate the contribution of a specific independent variable or a set of independent variables to the variation in the dependent variable (Ogonda, 1986). The author is aware that the technique of multiple regression can also be used as an inferential tool to evaluate the relationships between dependent and independent variables from the examination of sample data (Nie *et al.* 1972). The results of the stepwise multiple regression and correlation analysis are presented in Table 7.9. The five independent variables explain 54%

of the variation in the general level of development. This shows that the five selected independent variables are important indicators of development. Whereas the bivariate correlation analysis showed that road transport is more important than air transport, the stepwise multiple correlation and regression analysis revealed that air transportation is more important (Table 7.9).

Table 7.9: Summary Table for the Step-wise Multiple Regression Model

Step	Variable added	R	R^2	R^2change	b	SE_b	F Ratio*
1.	Enrolment ratio	.605	.366	.366	-1.270	.230	18.8
2.	Number of air passengers	.705	.497	.131	-.740	.230	18.8
3.	Road density	.726	.526	.029	-.400	.260	13.0
4.	Manufactured value added (MVA)	.733	.537	.011	-.270	.310	10.4
5.	Rail length	.733	.537	No change	-.002	.020	8.1

* Statistical significance level is 0.01

Air transportation indicator or variable accounted for 13.1% of the total variation in the composite index of Development Status (CIDS) while road transport variable accounted for only 2.9% of the total variation. It can be concluded from the foregoing statistical analysis that air transportation is undoubtedly an important factor in the development process of a region or country. Therefore, the Null (Ho) hypothesis that there is no significant relationship between the development of air transport and the spatial patterns of development is rejected and the alternative (H_1) hypothesis is accepted.

REFERENCES

1. Berry, B. J. L. (1961): "Basic Patterns of Economic Development", in N. Ginsburg (cd): Atlas of Economic Development. University of Chicago Press, Chicago.
2. Cole, J.P. (1981): The Development Gap: A Spatial Analysis of World Poverty and Inequality. John Wiley and Sons, New York.
3. Drewnowski, J. (1974): On Measuring and Planning the quality of life. Mouton, The Hague.
4. Haggett, P. (1969): Locational Analysis in Human Geography. Edward Arnold.
5. Hicks, N. and Streeten, P. (1979): "Indicators of Development: The Search for a Basic Needs Yardstick" in World Development. Vol.7, No. 6, pp567-580.
6. Hoyle, B.S. (1988): Transport and Development in Tropical Africa: Case Studies in the Developing World. John Murray, London, U.K.
7. Kituuka, S.E. (1988): Measuring Development in the "District Focus for Rural Development" in Kenya: The Case of Murang'a District, Ph.D Thesis (unpubl.), Department of Land Economics (Land Development), University of Nairobi.
8. Kituuka, S.E. and King'oriah, G.K. (1991) "Evaluating Development in Small Subnational areas of Developing Countries" in Review of Urban and Regional Development Studies. Vol 3, pp194-205.
9. Lewis, W.A. (1963): Theory of Economic Growth. Allen and Unwin, London.
10. McGranaham, D.V, *et al.* (1970): Content and Measurement of Socio-economic Development: An Empirical Engineering, Geneva, UNRISD.
11. Morris, M.D. (1980): Measuring the Condition of the World's Poor. Pergamon Press, New York.
12. Ngau, P.M. (1974): The Internal Structure of Residential Areas in Nairobi, M.A. Thesis (unpubl), University of Nairobi.
13. Nie, N.H. *et al.* (1975): Statistical Package for the social Sciences (SPSS) McGraw - Hill Book Co., New York.
14. Ogonda, R. T. (1986): The Development of Road Transport System in Kenya, Ph.D Thesis (Unpubl.), University of Nairobi.

15. Ram, R. (1982): "Composite Indices of Physical Quality of Life, basic needs fulfilment, and income: A Principal Component representation", Journal of Development Economics. Vol II, pp227-248.

16. Republic of Kenya (1986a): Resource Management for Rural Development Prospects. Vol. I and II, Ministry of Planning and National Development, Nairobi.

17. Smith, D.M. (1977): Human Geography : A welfare Approach. Edward Arnold.

18. Seers, D. (1972): "What are We Trying to Measure?" The Journal of Development Studies. Vol.8, pp21-36.

19. Soja, E.W. (1969a): The Geography of Modernization in Kenya. Syracuse University Press, Syracuse New York.

20. Sorguc, V.D. *et al.* (1976): "The Relation between Socio-economic Development and Transportation in Turkey," in stringer, P and Wenzel, H. (Eds), Transport Planning for a Better Environment. Press in Press, New York.

21. Tata, R.J. and Schultz, R.R. (1988): "World Variation in Human Welfare: A new Index of Development Status", in Annals of the Association of American Geographers, Vol.78, No.4, 580-93.

22. Todaro M. P(1977): Economic Development in the Third World. Longman.

23. United Nations Research Institute for Social Development (1972): Contents and Measurement of Socio-economic Development. Praeger, New York.

CHAPTER EIGHT

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

8.0 INTRODUCTION

The main objective of this study was to describe, analyse and explain the networks of both domestic and international airlines and to examine their impact on national development. More specifically, the study investigated:

a) The spatial structure of air transport networks in Kenya.
   This involved a detailed historical survey of the evolution of domestic and international air transportation networks from as far back in time as possible. The main stages identified in the growth of the domestic air transport network were compared with the "ideal typical sequence model" developed by Holsman and Crawford (1975).

b) The causal factors that have influenced the evolution of air transport network in Kenya.

c) The patterns of air passenger and commodity flows.

d) The relationship between domestic air transportation growth and spatial pattern of development in Kenya.

In order to achieve the objectives stated above, the following four Null (H_0) hypotheses were formulated and tested. The first Null (H_0) hypothesis formulated and tested was that "there is no significant difference between the stages of growth of the Kenyan air transport network and the one predicted by the Holsman-Crawford ideal-typical sequence model of air transport growth". Second, that "the volume of air passenger traffic does not vary with the sizes of places and the distances separating them". Third, that "the volume of cargo freight does not vary with the sizes of places and the distances separating them". Lastly, that "there is no significant relationship between the development of air transport and the spatial pattern of development." All these hypotheses, except the first one, were formulated within the framework of the conceptual model of air transport development examined in chapter 1. A number of statistical tools were employed to test the hypotheses namely, Graph Theory, Common Factor Analysis (CFA) and multiple regression and correlation analysis.

This concluding chapter summarizes the major findings of the study as revealed by the tested hypotheses. Other important findings which were not hypothesized in the study, but were revealed by cartographic and statistical analysis, are also presented. The conclusions and recommendations arising from the study are also examined. The major contributions made by the present study in furthering knowledge especially in Transportation Geography are highlighted. Suggested areas for future research in this important topic are also outlined.

8.1 SUMMARY OF FINDINGS

8.1.1 MAJOR FINDINGS REVEALED BY TESTED HYPOTHESES

When the stages of evolution of air transportation network in Kenya were compared with those hypothesized in Holsman - Crawford model, a lot of similarities were found. It was established that the Kenyan, domestic air transportation network has developed through three main stages comparable to the first, second and third phases of Holsman - Crawford model.

The first (pioneer) phase in the growth of domestic air transportation network in Kenya covers the period from 1914 to 1929. During this phase, there were no scheduled air services in the country. The main functions of air services during this phase were surveys of all kinds. The second phase covered the period between 1930 and 1945. Regular scheduled domestic air services were introduced by Wilson Airways, a private air transport company, linking Nairobi with other important urban centres in Kenya and other parts of East Africa. As demand for air travel increased in the country, the frequencies of services along various routes increased. The third phase covers the period between 1946 to the present time. During this phase, important intermediate nodes developed such as Nakuru, Nyeri, Nanyuki and Eldoret. Both scheduled and chartered services became well established in the country. These services have continued to expand in recent times with the booming tourist industry. According to the observed data, the fourth phase of the model does not yet exist in Kenya.

As far as the author can remember, this is the first time this theoretical model has been tested anywhere in the world outside Australia. As already indicated, the general trends of air transport growth in Kenya correspond to those proposed in the Holsman - Crawford model. This is a very important finding that would seem to confirm that "Holsman-Crawford" model could apply outside Australia.

The application of the multiple linear regression and correlation analysis to the international air passenger traffic data, showed that distance was an important factor accounting for 30% of the total variation in the volume of international passenger movement between Nairobi and other international air hubs. The addition of population weighted with income to the equation increased the level of the explanation by 13%. When multiple linear regression model was applied to the commodity flow data, it was found that distance explained only about 7% of the total variance. The addition of GDP to the equation increased the level of explanation by 14%. This shows that distance and GDP are important determinants of the volume of commodity tonnage shipped.

Bivariate correlation analysis between the dependent variate (composite index of development Status) and each of the five independent variables, (namely, number of air passengers generated, manufactured goods value added, enrolment ratios in primary schools, road density and the length of railway/1000 population) revealed a significant relationship between air transport indicators and the spatial pattern of development in the country. The correlation coefficient between air transport indicator and the composite index of Development status (CIDS) is -.324. As already indicated in chapter 7, the sign of the correlation coefficient is negative because the more developed districts have a lower composite index of Development Status (CIDS). This means that the more developed districts tend to generate more air passenger traffic than the less developed districts. The strongest simple correlation coefficient was between CIDS and enrolment ratios. Enrolment ratio like infant mortality rate is a measure of basic needs deficiency. This seems to suggest that development is predominantly a social phenomenon.

Step-wise multiple regression and correlation analyses results also confirm that air transport is an important factor influencing the spatial pattern of development. Air passenger generation indicator accounted for about 13% of the total variation in CIDS while enrolment ratio accounted for 37% of the total variance. Railway length/1000 population was insignificant. Four independent variables accounted for about 54% of the total variation in CIDS. This shows that air transport, enrolment ratio, road density and manufactured goods value added (MVA) are the major determinants of the spatial pattern of development in Kenya.

8.1.2 OTHER IMPORTANT FINDINGS NOT HYPOTHESIZED IN THE STUDY

The connectivity of Kenya's domestic air transport network has increased since 1938. An examination of each graph theoretical index on table 4.15 shows that the air transport network has been growing. The network's cyclomatic number (μ) increased from 1.0 in 1938 to 8.0 in 1983. During the same period, the beta (β) index increased from, 1.0 to 1.5.

High values of both cyclomatic number and beta index indicate a highly connected network. A beta (β) index of 1.4 or above indicates advanced or complex interconnection.

The accessibility surface created by drawing isolines reveals a trend from moderate peaking in 1938 to a highly peaked and highly polarized surface in 1973. The point of highest accessibility in 1938 was Nakuru, located in the heart of former White

Highlands. The highest peaks of accessibility by 1973 were Nairobi, Kisumu and Lamu. This pattern has remained almost unchanged since 1973.

A comparison of the population potential map and the map of actual inter-district passenger flows showed that most areas appearing high on the population potential surface did not generate much air passenger traffic except Nairobi, Mombasa, Eldoret, Kisumu and Nyeri. Other areas such as Kericho, Nakuru, Kisii, Kakamega, Bungoma, Kiambu and Machakos generated little or no air passenger traffic.

An analysis of the map of air passenger indexes for selected urban centres in Kenya revealed that "traffic shadow" effect, urban function(s) and length of haul are the main factors associated with domestic air passenger generation and attraction. "Traffic-shadow" effect is evident for urban centres near Nairobi such as Nyeri and Nakuru which have low air passenger indexes.

Urban function is also an important factor associated with air passenger generation and attraction. Important urban centres such as Nairobi, Mombasa, Kisumu, Nakuru and Nyeri generated and attracted a significant proportion of domestic air passenger traffic. This is mainly because of their important commercial and industrial functions. Other urban centres such as Lamu and Malindi are important tourist resorts on the Kenyan coast. Lamu has the highest air passenger index of 478 air passengers/1,000 of population (fig 5.6, which see). It was also found out that the "length of haul" is an important factor associated with air passenger generation and attraction. The high indexes for Mandera and Wajir could be due to the fact that distance from Nairobi is great enough to give air transport a definite advantage over land transportation.

The use of a linear histogram in the analysis of international air mail traffic into and out of Kenya showed that most of the in-coming mail originates from the North (mainly from Europe) and a significant proportion also comes from the South (mainly

South Africa and Zambia). The out-bound mail is destined mainly for the North (Europe) and the West (mainly to Ghana and Nigeria).

Freight Traffic forecasting using a Time- series model indicated that there has been an upward secular trend in the volume of horticultural exports passing through Jomo Kenyatta international Airport (JKIA). Significant increases in the volume of exports occurred during the period 1988-1990. This trend is expected to continue for a long time to come.

8.2 CONTRIBUTIONS OF THE STUDY

The findings discussed in the preceding two sections (8.1.1 and 8.1.2) should be considered as some of the major contributions the present study has made to transport geography, in general, and geography of air transportation in Kenya, in particular. The study has used, albeit, in a modified form, some of the conceptual and methodological approaches adopted by a number of distinguished scholars in transport geography, economic geography, as well as, allied disciplines and subdisciplines. Some of these scholars include Berry(1961), Nystuen and Dacey (1961), Kansky (1963), Herbert and Murphy (1970), Filani (1981) and Tata and Schultz (1988).

The application of a variant of Nystuen and Dacey's technique of Dominant Flow Analysis, (called "Simple Linkage Analysis"), to the domestic air passenger flow data in order to identify dominance - dependency nodal regions of air passenger interaction is an important contribution to the methodology in flow analysis. Most of the previous studies have used the original version of Nystuen and Dacey's Dominant Flow Analysis (Puebla, 1987). In this study, an attempt has been made to explore the possibilities of using "Simple Linkage analysis" in Dominant Flow Analysis. The results of the pattern of air passenger flows shows two dominant centres, Wilson airport, Nairobi and Lamu on the north coast. Wilson airport emerges as the central node of the network and Lamu as the central node of the cluster.

The construction of a new composite index for measuring spatial variation in human welfare at the sub-national (district) level is one of the most important contributions made by this study. The new Composite Index of Development Status (CIDS) is a robust and versatile measure that provides multi-dimensional insights about spatial variation of development at the sub-national (district) level. The approach used in this study was adopted from Tata and Schultz (1988). Basing their rankings on factor scores, they arranged 160 countries of the world in a rank order from most developed to the least developed. They used four factors (i.e. economic, physical, political and social) and 10 variables, including such common indices as GNP per capita, manufactured goods value added (MVA) and infant mortality rate. The major contribution made in this study is the application of CIDS at the sub-national level, a thing that has never been attempted before. This study has also introduced some modifications in the construction of the composite index. The procedures for constructing the new composite index of Development Status (CIDS) are discussed in chapters 3 and 7.

Tata and Schultz (1988) used four factors in the construction of their composite index while five factors have been used in this study. The technological (infrastructural) dimension of development was added in the present study. This is mainly because of the important role technology plays in economic development of a country (Smith, 1977, 210). Tata and Schultz (1988) used 10 variables while 20 variables have been used int his study. All these modifications should be considered as additional contributions to the original methodology. There is a great scope for planners and policy makers to use CIDS for planning purposes.

The paucity of scholarly literature on the growth of air transportation in Africa, in general, and in Kenya, in particular, makes the contribution of this study very significant. Whatever work has been done has been useful and interesting but is otherwise unscholarly, uncritical and outdated (McCormack, 1989). In this study, information on air transport growth has been synthesized from diverse sources such as colonial government annual reports and other archival sources. A lot of statistical data have been collected and organised in form of statistical tables, maps and diagrams. These should provide invaluable sources of data for further analysis and/or reference.

8.3 CONCLUSIONS

This study applied the Holsman - Crawford model (1975) to the Kenyan air transportation system in order to test its validity. The hypothesis that: "there is a significant difference between the stages of growth of the Kenyan air transport network and the ones predicted by the Holsman - Crawford - ideal - typical sequence model of transport growth" is tested. The Holsman - Crawford Model denotes a sequence of events: exploration, penetration, expansion and integration. It is a kind of a "colonial model, for exploiting resources of a given region or country. Kenya has experienced a long period of colonial exploitation and this explains why her domestic air transport system conforms to the postulates of the model. The details of the Holsman - Crawford model are given in chapter 4.

The analysis of nodal structure using a variant of Nystuen and Dacey's method - "simple Linkage analysis", revealed that Wilson airport, Nairobi, is the central node of the domestic air transport network and Lamu, an important tourist resort on the Kenyan coast was the central node of the cluster. This is a much better method of portraying the nodal structure of a network than the Nystuen and Dacey's method. "Simple Linkage analysis" gives greater emphasis to those aspects concerning the spatial structure of the flows.

The application of the step-wise multiple linear regression and correlation analysis to the international air passenger traffic data showed that distance and population weighted with income were important factors influencing the volume of air passenger traffic between Nairobi and the other international air hubs. However, the substantial proportion of the unexplained variance indicates that there are other equally important factors not examined in this study. Some of the factors not examined include travel motivations, destination attributes, and people's family situations.

The results of the step-wise multiple linear regression analysis when applied on commodity flow data revealed that GDP and distance are important factors influencing the volume of traffic shipped. The substantial proportion of the unexplained variance indicates that other important explanatory variables such as transborder trade restrictions, international commodity market situations and customers' tastes should be considered.

The new composite index of Development Status (CIDS) is a very useful index for ranking and classifying all the districts in Kenya according to their development status. The index should be a suitable guide to policy-makers and development planners, not only in Kenya but in other developing countries who are charged with the responsibility of designing and implementing development programmes. More data should be collected at the sub-national (district) level in order to improve on the index.

It has been established by the results of the Bivariate and stepwise multiple regression analysis in chapter 7 that one of the most important factors influencing the spatial pattern of development is enrolment ratio, a social indicator. This would seem to suggest that development is predominantly a <u>social phenomenon</u>. Development is a process involving the improvement in human welfare (Smith, 1977, Kituuka, 1988). The Bivariate and Stepwise Multiple regression and correlation analyses also revealed that air transport is an important factor influencing the spatial pattern of development. Therefore, the Null(Ho) hypothesis that "there is no significant relationship between the development of air transport and the spatial patterns of development" is rejected and the alternative one (H_1) is accepted. There appears to be a close relationship between air transport growth and the spatial pattern of development in Kenya. Air transport is an important factor influencing the volumes and pattern of interaction between Nairobi and other important regional service centres in the country. Air transport promotes business contacts and facilitates the distribution of tourist traffic throughout the country.

8.4 CONCEPTUAL/THEORETICAL LIMITATIONS OF THE STUDY

The descriptive and practical limitations of the study have been discussed in chapter three. In this section, only the theoretical (conceptual) and/or statistical limitations are examined.

8.4.1 GRAPH THEORY

While graph theory may be used to discover the basic structure of interaction within a network, it has some serious limitations. These limitations were pointed out by some of the earliest users (Garrison, 1960, Nystuen and Dacey, 1961, Garrison and Marble, 1965). Graph theory is a theoretical system for finite state problems and is not well adapted to dealing with problems in the continuous plane (Tinkler, 1977).

Graph theory is limited to topological distance in which distance between a pair of vertices is measured by connecting the number of intervening edges, regardless of the physical distance of each edge. However, there are many situations where actual distance between nodes is crucial because of its direct bearing on construction costs and travel time required between the nodes. Methods based in graph theory may be used jointly with other more sophisticated methods that also attempt to discover the basic structure of interrelationship within a network, such as Common Factor Analysis (CFA) and Markov

Chain (Puebla, 1987). Despite the stated limitations, the use of simple graph theoretic indices in the present study provided a good deal of structural clarity and the country's domestic air transport network.

MULTIPLE LINEAR REGRESSION ANALYSIS

Although Multiple Linear Regression analysis appears a highly attractive technique for data analysis, its validity is dependent on the premises that the variables used approximate normality and that the independent variable are not strongly correlated (that is no multicollinearity exists). Normality of data has been approximated in this study by applying logarithmic transformation. A major limitation of such a transformation is that equations are calibrated using values different from the ones that actually define the association being tested. This means that their "lines of best-fit" minimise the squares of logarithms of the independent variables rather than the squares of the actual independent variables.

Multiple Linear Regression and Correlation Analysis do not prove causal associations. They merely give credence to explanations based on estimates of the regression parameters and correlation coefficients. In spite of the shortcomings discussed above, multiple linear regression and correlation analysis provided fairly accurate descriptions of international air passenger and commodity flows in Kenya.

8.5 RECOMMENDATIONS

The findings of this study are important to scholars, researchers, planners and policy-makers. In this section, some specific recommendations are made for scholars, researchers, planners and policy-makers both in the public and private sectors.

TO SCHOLARS:

Scholars will find some practical use of the techniques used in this study. For example, the study has applied Common Factor Analysis (CFA) in the construction of the Composite Index of Development Status (CIDS) to classify and rank districts according to their level of development at a given point in time. In order to assess the relative shift in the level of development for any district over time, time series data covering several time periods should be used. The findings of such a study would improve the performance of CIDS tremendously.

TO RESEARCHERS:

This study has examined some of the major aspects of domestic and international air transport networks in Kenya. However, owing to the complexity of the research topic and the limited financial resources at the disposal of the researcher, it was not possible to cover all the aspects of air transport system. Besides, air transport industry is a dynamic sector of an economy. Thus, there is need for continuous and relevant information gathering which will assist researchers to keep abreast with development in this vital sector. This necessitates constant research activities in air transportation.

A number of areas still remain that need to be explored by future researchers with a view to furthering knowledge and understanding of this important topic. Some of the suggested areas for future research are:

(a) A detailed study of the role of domestic air transportation network in promoting tourism especially on the Kenyan coast.

(b) An evaluative study of the impact of the airline deregulation on international air passenger transport in Kenya. The widespread moves in many developed and developing countries since 1970s to deregulate air transportation services have had profound differential and other unexpected effects on route networks, service frequencies and fares.

(c) A detailed comparative study of the role of air transportation and road transportation on the movement of passengers in Kenya.

(d) To undertake a detailed study on how to increase air freight capacity for horticultural exports on a permanent basis. The main aspects to be investigated should include:

  (i) Examination of policies regarding improvement of air freight capacity for horticultural exports.

  (ii) Promoting maximum air cargo capacity for horticultural exports in co-ordination with authorities concerned, from airlines operating regular and non-regular services from Kenya.

  (iii) Air freight rates.

  (iv) Possibilities of transferring some of the surface cargo to air freight.

TO PLANNERS AND POLICY-MAKERS:

From the analysis made in this study, it became apparent that there are some planning and policy issues which need to be addressed to ensure maximum efficiency in the uplift and discharge of both passengers and freight. Some of the recommendations made to deal with planning and policy issues include:

(a) In order to promote a balanced development in the country, it is recommended that an integrated transportation system should be established. This can be achieved through strategic planning of domestic air services, both scheduled and chartered, but with special emphasis on their integration with surface transportation such as roads and railways. This integrated internal transportation network should increase tourist accessibility to outlying areas. In order to do this, some of the air fields in the National Parks and Game Reserves should be upgraded so as to handle larger aircraft.

(b) The shortage of air freight capacity at Jomo Kenyatta International Airport (JKIA) has seriously hampered the development of horticultural exports. Therefore, it is recommended that efforts should be made to secure maximum freight capacity for horticultural exports on a sustainable basis.

(c) It is also recommended that the Kenya government should encourage the use of more international air charters and scheduled services in order to bring more tourists to the country. This can be achieved by liberalising charter landing rights and additional international scheduled services under bilateral agreements.

(d) The government should control the issuance of the licences to domestic air operators in order to increase the load factor (utilisation ratio) on each of the 15 domestic sectors in the country. The analysis of the load factor on each of the 15 domestic sectors shows that there is an over-capacity problem in the Kenya's air charter industry. The average load factor for most air charters has been less than 50% whereas the ideal load factor should be about 65%-75% to ensure profitable operations. The Civil Aviation Board (CAB) should restrict the issuing of licences on the crowded domestic sectors. Domestic air charter operators should be encouraged to open up new sectors with a view to promoting tourism development.

(e) The cost of aviation fuel is an important element in the economic performance of international airlines operating into and out of Kenya and greatly affects the competitiveness of the tourist industry compared to other destinations. In the past, the international airlines have absorbed the sharp increases in fuel costs. However, they may no longer do so and may be forced to take actions which are damaging to development of tourism and trade in Kenya. The high costs of jet fuel in the country, creates inevitable pressures for increases in passenger fares and cargo rates. Such increases would also depress prospects for increased tourists and commodity exports especially horticultural products out of Kenya. It is therefore recommended that the government should review the prices of both jet fuel and aviation fuel with a view to making them more competitive the world market.

(f) The new Composite Index of Development Status (CIDS) shows that about 14 districts in Kenya are less developed (underdeveloped). Most of these districts can be classified as Arid and Semi-arid Lands (ASAL). Some of the districts have a potential for irrigated agriculture, as well as livestock and tourism development. Attempts are being made by the government to integrate these districts into the mainstream of economic development, especially with regard to the District Focus for Rural Development Strategy (DFRD). The new index can be used as a guide in the allocation of resources so as to bring about equitable development.

REFERENCES

1. Berry, B. J. L. (1961): "Basic Patterns of Economic Development", in N. Ginsburg (Ed): Atlas of Economic Development, University of Chicago Press, Chicago.
2. Garrison, W. (196): "Connectivity of the Inter-state Highway System", Papers, Regional Science Association, Vol. 6, pp 121-137.
3. Garrison, W. and Marble, D.F. (1965): A Prolegomenon to the Forecasting of Transportation Development, Technical Report, 65-35, prepared for US Army.
4. Herbert, B. and Murphy, E. (1970): "Evolution of an accessibility Surface: the case of the domestic United States Air Transport network", Proceedings of the Association of American Geographers, Vol.3, pp 75-80.
5. Holsman, A.J. and Crawford, S.A (1975); "Air Transport Growth in Underdeveloped regions", in the Australian Geographer, Vol 13, pp 79-90.

6. Kansky, K.J. (1963): The structure of Transportation Networks. Chicago, Dept of Geography research Paper No. 84.

7. Kituuka, S.E. (1988): Measuring Development in the "District Focus for Rural Development" in Kenya: The case of Murang'a District, Ph.D Thesis (unpublished), Department of Land Development, University of Nairobi.

8. McCormack, R.L. (1989): "Imperialism, Air Transport and Colonial Development: Kenya, 1920-1946", Journal of Imperial and Commonwealth History, Vol.17 pp 374-395.

9. Nystuen, J.D. and Dacey, M.F. (1961): "A Graph Theory interpretation of model regions", in The papers and proceedings, Regional Science Association. Vol.7, pp 25-42.

10. Puebla, J.G. (1987): "Spatial Structures of Network Flows: A Graph Theoretical Approach", in Transportation Research. Vol.21B, No.6 pp 489-502.

11. Smith, D.M (1977): Human Geography: A Welfare Approach, Edward Arnold Publishing, London.

12. Tata, R.J. and Schultz, R. R. (1988): "World Variation in Human Welfare: A New index of Development Status" in Annals of Association of American Geographers. Vol.78, No.4, pp 580-93.

13. Tinkler, K.J. (1977): An Introduction to Graph Theoretical Methods in Geography, Concepts and Techniques in Modern Geography (CATMOG), No. 14.

SELECTED BIBLIOGRAPHY*

1. Abumere, S. I. (1982): "The Nodal structure of Bendel state", in the Nigerian Geographical Journal. Vol.25, Nos 1 and 2, pp 173-187.
2. Adams, J. G. U. (1971): "London's Third Airport", in the Geographical Journal. Vol. 137, pp. 468-93.
3. Alao, N. (1970): "A note on the solution matrix of a network", in the Geographical Analysis". Vol.2, pp 83-8.
4. Alao, N. (1973): "Some Aspects of Network Theory", in the Geographical Polonica, Vol. 25, pp 107-37.
5. Alexander Gibb and Partners, (1971): Nairobi Airport Report. Nairobi.
6. Alexander, J. W. ; Brown, S. E. and Dahlberg, P. E. (1958): "Freight rates: selected aspects of uniform and nodal regions", in Economic Geography. Vol. 34, pp 1-18.
7. Anderson, T.R. (1956): "Potential Models and the Spatial Distribution of Population", Papers and Proceedings, Regional Science Association, Vol. 2, pp 175-182.
8. Bange, D. W. and Hoefer, J. N (1976): "A measure of connectivity for Geographical regions", Professional Geographer. Vol.28, pp 362-70.
9. Baster, N. (1972): "Development Indicators: An Introduction", The Journal of Development Studies. Vol. 8, 1-20.
10. Beckwith, W.B. (1966): "Impacts of weather on the airline Industry: The value of fog dispersal programmes" in Sewell, W. R. (ed): Human Dimensions of weather Modification. University of Chicago, Department of Geography, Research paper No. 105, pp 195-207.
11. Brady, F. B. (1964): "All Weather aircraft landing", Scientific American. Vol. 210, pp.25-35.

* These are reading materials not referred to in any of the preceding chapters, but were very useful in the preparation of the thesis.

12. Brams, S. J. (1966): "Transaction Flows in the International System", The American Political Science Review. Vol. 60, pp 880-898.

13. Brown, L. A. and Holmes, J. (1971): "The delimitation of functional regions, nodal regions and hierarchies by functional distance approaches", in the Journal of Regional Science. Vol.11, pp 57-72.

14. Burchall, H. (1933): "Air services in Africa" in the Journal of the African Society. Vol.32, pp 55-73.

15. Campbell, C. T. (1974): "Transportation in Developing countries: special reference to Kenya", Traffic quarterly, Vol.28, pp 139-152.

16. Caspair Limited (1973): Air Safaris in East Africa. Nairobi.

17. Chisholm, M. (1985): "Accessibility and Regional Development in Britain: Some questions arising from data on freight flows", Environment and Planning. A. Vol 17, pp. 963-980.

18. Chiteji, F. M. (1980): The development and socio-economic impact of Transportation in Tanzania, 1884 to present, University Press of America, Inc.

19. Clark, W. A. V. and Hosking, P. L. (1986): Statistical Methods for Geographers. John Wiley and Sons, New York.

20. Cliff, A. D. and Haggett, P. (1981):"Graph Theory" in N. Wrigley and R. J. Bennett, quantitative Geography. A British view, Routledge and Kegan Paul, London.

21. Cole, J. P. and King, C. A. M. (1968): Quantitative Geography. John Wiley, London.

22. Cole, V. (1989): "General Aviation: The Developing World's indispensable Transport" in Developing World Transport. Grosvenor Press International, pp 325-327.

23. Colony and Protectorate of Kenya: Blue Books. 1926-1946, Government Printer, Nairobi.

24. Costas, P. and Magahiria, G. (1966): "Studies of present Transportation Patterns: Air Transportation", in Ekistics. Vol. 22, pp 32-5.

25. Craig, J. (1972): "Population Potential and Population Density", Area, Vol.4, pp 10-12.

26. Craig, J. (1972): "Population Potential and Population Density", Area, Vol.4, pp 10-12.

27. East African Common Services Organisation: Annual Reports. 1961-1967.

28. East African High Commission (1951): Aerodromes. Kenya. Tanganyika. Uganda and Zanzibar.

29. East African Standard, 1st August 1969: " Wilson Airways: The story of a courageous Woman", pp(i), (iii).

30. Farrington, J. H. (1985): "Transport geography and policy-deregulation and privatisation", Transactions of the Institute of British Geographers. New series (1), pp. 109-119.

31. Flemming, D. K (1991):"Competition in the U.S. Airline Industry", Transport quarterly, Vol. 45 (2), pp 181-210.

32. Garner, B. J. and Street, W. A. (1978): "The solution matrix, alternative interpretations", Geography Analysis. Vol. 10, pp 185-9.

33. Garrison, W. L. and Marble, D. F. (1964): "Factor-analytic study of the connectivity of a Transportation Network", in Regional Science Association Papers. Vol. 12, pp.231-8, Lund Congress.

34. Gauthier, H. L. (1968): "Transportation and the Growth of the Sao Paulo Economy", Journal of Regional Science. Vol 8, pp 77-94.

35. Goddard, J. B. (1970): "Functional Regions within the city centre: A Study in factor analysis of taxi flows in central London", Transactions of the Institute of British Geographers. No. 49, pp 161-180.

36. Goddard, J. B., and Kirby, A. (1976): "An Introduction to factor analysis", Concepts and Techniques in Modern Geography (CATMOG), No. 7, Geo Abstracts, University of East Anglia, Norwich, London.

37. Goetz, A. R. (1992): "Air Passenger transportation and growth in the US urban system, 1950-1987", Growth and Change. vol. 23(2), pp 217-238.

38. Gould P. R. (1967): " On the geographical interpretation of eigenvalues", Transactions of the Institute of the British Geographers. No. 42, pp 53-86.

39. Haggett, P. and Chorley, R. J. (1969): Network Analysis in Geography. Edward Arnold, London.

40. Haggett, P., Cliff, A. D. and Frey, A. (1977): Location Analysis in Human Geography. Vol.2, Edward Arnold, London.

41. Hansen, W.G. (1959): "How Accessibility Shapes Land Use", Journal of American Institute of Planners, Vol.25 pp 73-91.

42. Harman, H. H. (1964): Modern Factor Analysis. Chicago University Press, Chicago.

43. Haworth, J. and Vincent, P. (1974): "Calculations of prediction Limits in Linear regressions", Area. Vol. 6, pp 113-116.

44. Hay, A. (1973): Transport for the space economy. Macmillan, London.

45. Hay, A. (1975): "On the choice of methods in the factor analysis of connectivity matrices, a comment", Transactions of the Institute of the British Geographers. No. 66, pp 163-7.

46. Harrison, C. R. J. (1949): "Geographical factors in the Development of Transport in Africa" Transport and communications Review. Vol. 2, No. 3, pp 3-11.

47. Harvey, M. W. (1972): "The identification of development regions in developing countries", Economic Geography, Vol 48, pp 229-43.

48. Hauser, D. P. (1974) "Some problems in the use of step-wise Regression Techniques in Geographical Research", in the Canadian Geographer, Vol. 18, pp.148-158.

49. Heathcote, M. A. V. (1932): "By airmail to Kenya", Geographical journal, Vol. 79, pp 502-8.

50. Hilling, D. (1975): "Transport Geography", in J. I. Clarke (ed), An Advanced Geography of Africa. Hulton, pp 436 - 481.

51. Hoare, A. G. (1974): "International Airports as Growth Poles: A case study of Heathrow Airport", Transactions of the Institute of British Geographers . Vol. 63, pp. 75-96.

52. Hofmeier, R. (1973): Transport and Economic Development in Tanzania. IFO Africa - Studies No. 78, Munich, Weltforum Verlag, Munchen.

53. Holsman, A. J. (1977): "The structure of Australian air networks", Australian Geographical Studies, Vol. 15, pp 33-65.

54. Holsman, A.J. "Freight flows in the Australian Economy " Australian Geographical Studies". Vol.17, pp 135-154.

55. Howes, A.M.D. (1958): "Some details of the First Twenty Five Years of Flying in Tanganyika, 1914-1939," in Tanganyika Notes and Records, Vol.50, pp 39-47.

56. Hurst, M. E. E. (ed) (1974): Transport Geography, McGraw-Hill.

57. ICAO (1979): International Air passengers and Freight transport-Africa, circular 147-AT/51, 46.

58. ICAO (1989): Civil Aviation Statistics of the World, Doc. 9180/15, pp 30-31.

59. ICAO (1989): Annual Report of the Connal. Doc. 9553.

60. ICAO (1990): Survey of International Air transport fares and rates. Montreal, Canada.

61. Ilett, J. (1965) : The Pattern of East African Internal Air Services, Entebbe.

62. Irandu, E. M. (1992 a): The Growth of Air Transport in Kenya: A Geographical Analysis, a paper presented in the Departmental Seminar, Department of Geography, University of Nairobi, 27th March, 1992.

63. Irwin, T.M.C. (undated) : Light Aircraft and their Role in East Africa, Lindblad Travel and Tony Irwin (EA) Ltd., Nairobi.

64. James, P. E. and Jones, C. F. (eds) (1954): American Geography: Inventory and Prospect. Syracuse University Press, pp. 310-32.

65. Janelle, D. G. (1968): "Central Place Development in a time-space framework", Professional Geographer. Vol. 20, pp 5-10.

66. Jemiolo, J. and Conway, D. (1991): "Tourism, Air service provision and patterns of caribbean Airline offers", Social and Economic Studies, vol. 40, (2), pp1-43.

67. Johnson, E. A. J. (1970): The organisation of space in Developing Countries, Havard University Press, cambridge.

68. Johnston, R. J. (1978): Multivariate Statistical analysis in Geography: A prime on the general linear model. Longman.

69. Jones, C. F. and Dawkenhard, G. G. (1967): Economic Geography, MacMillan, pp 756-763.

70. Killingray, D. (1984): "A swift agent of Government air power in British Colonial Africa, 1916-1939," Journal of African History, vol. 25, pp 429-444.

71. King, J. W. (1981): International Air Traffic in Africa South of the Sahara: An Analysis for April, 1981. A paper presented at the Annual Meeting of African Studies Association, Bloomington, Indiana.

72. Kissling, C. (1989): "International Tourism and Civil Aviation in the South Pacific: Issues and Innovations" in Geojournal. Vol. 19, No.3, pp 309-315.

73. Knox, P. L. (1949): "Levels of living: A conceptual framework for monitoring Regional Variation in wellbeing", Regional Studies. Vol. 8, pp 11-19.

74. Knox, P. L. (1974b): "Spatial variations in the level of living in England and Wales in 1961," Transactions of the Institute of British Geographers. No. 62, pp 1-24.

75. Koelle, H. H. (1974): "An experimental study on the determination of a definition for quality of life", Regional Studies. vol. 8, pp1-10.

76. Lakshmanam, P. P. (1972): "Regional Patterns in commodity Flows in India", Environment and Planning. vol.4, pp 59-72.

77. Langdale, J. V. (1975): "Nodal Regional Structures of New South Wales", Australian Geographical Studies. vol. 13, pp 59-72.

78. Leinbach, T. R. (1975): "Transportation and Development of Malaya", in Annals of the Association of american Geographers. Vol. 65, pp 270-282.

79. Leinbach, T.R. (1979): "Urban Core Regions and Transport Development: The case of peninsular Malaysia", in Journal of Tropical Geography Vol. 49, pp 34-40.

80. Leong, G. C. and Morgan, G.C. (1982): Human and Economic Geography. Oxford University Press, pp 572-612.

81. Long, W. H. (1968): "City characteristics and the Demand for Inter urban Air travel", Land Economics. Vol. 44,. pp 197-204.

82. Long, W. H. (1969): "Airline service and the Demand for Intercity Air Travel", Journal of Transport Economics and Policy. Vol. 3, pp 287-299.

83. Mather, P. M. (1972): "Varimax and Generality", in Area. Vol.4. No. 1, pp 27-30.

84. Maunder, W. J. (1970): The value of the weather. Methuen and Co. Ltd., London.

85. McCormack, R. (1974): "Imperial Missions: The Air route to Cape Town, 1918-32," Journal of Contemporary History. Vol. 9, pp 77097.

86. Mednedkov, Y.V. (1968a): "An Application of topology in central place analysis", papers of the regional Science Association. Vol. 20, pp 77-84.

87. Meyer, D. R. (1971): "Factor Analysis versus correlation analysis: Are substantative interpretations congruent?". in Economic Geography. Vol. 47, pp 336-343.

88. Mwebesa, M. M. N. (1978): Basic Meteorology. East African Literature Bureau, Nairobi.

89. Nabudere, D. W. (1971): The Transportation System in East Africa. University Social Sciences Council Conference, Makerere, December 14th - 17th, Paper No. 56.

90. Ngila, M. (1988): "Transport Bottlenecks in Tanzania: cases, consequences and Future policy options", in Eastern Africa Social Science Research Review. Vol. IV, No. 2, pp 69-86.

91. Obut, J.U. (1986): "Transportation as a limitation to rural development: the case of Abak in Niger", Geojournal. Vol.12, pp 317-321.

92. O'connor, K. and Scott, A. (1992): "Airline Services and Metropolitan Areas in the Asia - Pacific region, 1970-1990s in the Review of Urban and Regional Development Studies. Vol.4, pp 240-53.

93. Oloo, O. (1993): "Expert calls for limited government control on national carriers", in the Kenya Times. Monday, July, 26th, 1993, pp 11.

94. O'Sullivan, P. M. (1968): "Accessibility and the spatial structure of the economy", Regional Studies. Vol.2, pp 195-206.

95. O'Sullivan, P. M. (1978): "Regions of a transport network", Annals of the Association of American Geographers. Vol. 68, pp.196-204.

96. Paterson, D. (1989): "Airfresh to market" in Developing World Transport. Grosvenor Press International, pp 322-24.

97. Pearcy, G. E. and Alexander, M. (1951): "Patterns of Commercial Air Service availability in the Western Hemisphere", Economic Geography. Vol. 27, pp.316-20.

98. Pearcy, G. E. and Alexander, M. (1953): "Pattern of air service availability in Eastern Hemisphere", Economic Geography. Vol. 29, pp 74-8.

99. Pirie, G. H. (1991): "Reorienting and restructuring transportation in Southern Africa", Tijschrift Voor Economische en Sociale Geografie. Vol. 73 (4), pp. 221-228.

100. Poole, M.A. and O'farrel, P. N. (1971): "The assumptions of the Linear Regression Model", Transactions of the Institute of British Geographers. Vol. 52, pp 145-158.

101. Reichman, S. (1965): "Domestic air transport in Sierra Leone", in the Journal of the Sierra Leone Geographical Association. Vol.9, pp 1-15.

102. Rimmer, P. J. (1985): "Transport Geography", in Progress in Human Geography. Vol. 9, pp 271-277.

103. Rimmer, P. J. (1988a): "Transport Geography" A bit of a caveat here and there", Australian Geographical Studies, Vol. 26 (1), pp 172-183.

104. Rimmer, P. J. (1988b): "Transport Geography" in Progress human Geography.

105. Romsa, G. H., Hoffman, W. L, Gladin, S. T. and Brunn, S. D. (1969): " An example of the Factor analytic - regression model in geographical research", Professional Geographer Vol. 21, pp 344-6

106. Rouget, B. (1972): "Graph Theory and hierarchisation models", in Regional and urban Economics. vol.2, pp 263-96.

107. Sadhuklan, S. K. (1976): "Spatial distribution of connectivity and the level of economic development in India", in Geographical Review of India. Vol. 38, pp 368-373.

108. Sagers, M. J. and Maraffa, T. (1991): "The spatial structural of air passenger service for Kiev and Tashkent", in Soviet Geography, vol 34, pp 552-62.

109. Scott, J. T. Jr. (1967): "Factor Analysis and Regression" in Econometrica, vol. 34, pp 552-62.

110. Shaw, S-L and Williams, J. F. (1991): "Role of Transportation in Taiwan's Regional Development" in Transportation Quarterly Vol. 45, (2), pp 271-296.

111. Shaw, S-L. (1993): "Hub structures of major U.S. Passenger Airlines" in Journal of Transport Geography, vol.1, No. 1, pp.47.

112. Smith, C.E. (undated) : Evaluation of the Large Jet Transport Aeroplane for East Africa, Nairobi.

113. Straszheim, M. L. (1970): "Researching the role of transport in Regional Development", Land Economics, vol.48, pp 212-19.

114. Stutz, F. P. (1973): "Accessibility and the effect of scalar variations on the powered transportation connection matrix", Geographical Analysis, Vol.5, pp61-66.

115. Taaffe, R. N. (1962): " Transportation and Regional specialization: The example of Soviet Central Asia", in the Annals of the Association of American Geographers, Vol.52, pp 80-98.

116. Taylor, M. and Kissling, C. (1983): Resource Dependence Power Networks and the Airline System of the South Pacific in Regional Studies, Vol. 17, No.4, pp 237-250.

117. Tinkler, K. J. (1972): "The Physical interpretation of eigenfunctions of dichotomous matrices", Transactions of the Institute of British Geographers, Vol 47, pp 17-46.

118. Thomas, E. N. (1968): "Maps of residuals from regression: their characteristics and uses in geographical research", in B. J. L. Berry and D. F. Marble (eds), Spatial Analysis. A reader in statistical Geography. prentice-Hall Englewood Cliffs, New Jersey.

119. Ullman, E. L. and Mayer, H. (1954): "Transportation Geography" in Preston James and Clarence Jones (eds), American Geography: Inventory and Prospect. Syracuse University Press, pp 310-332.

120. United Nations, Economic Commission for Africa (1975): "Study of air freight potential in Developing Africa. Vol.1 Regional Masterplan, E/CN.14/TRANS/124.

121. Vasilevsky, L.I. (1963): "Basic Research, problems in the Geography of Transportation of capitalist and underdeveloped countries", Soviet Geography: Review and Translation, Vol 4. pp 36-58.

122. Were, P. A. (1983): Contribution of Transport and Communications to Developing Africa's option in the 1980s and beyond. Seminar on Development options for Africa in the 1980s and beyond, 7th -9th March, Society for international Development-Kenyan Chapter.

123. Wheeler, J. O. (1973): "Transportation Geography Societal and policy perspective", Economic Geography, Vol. 49,pp 95-184.

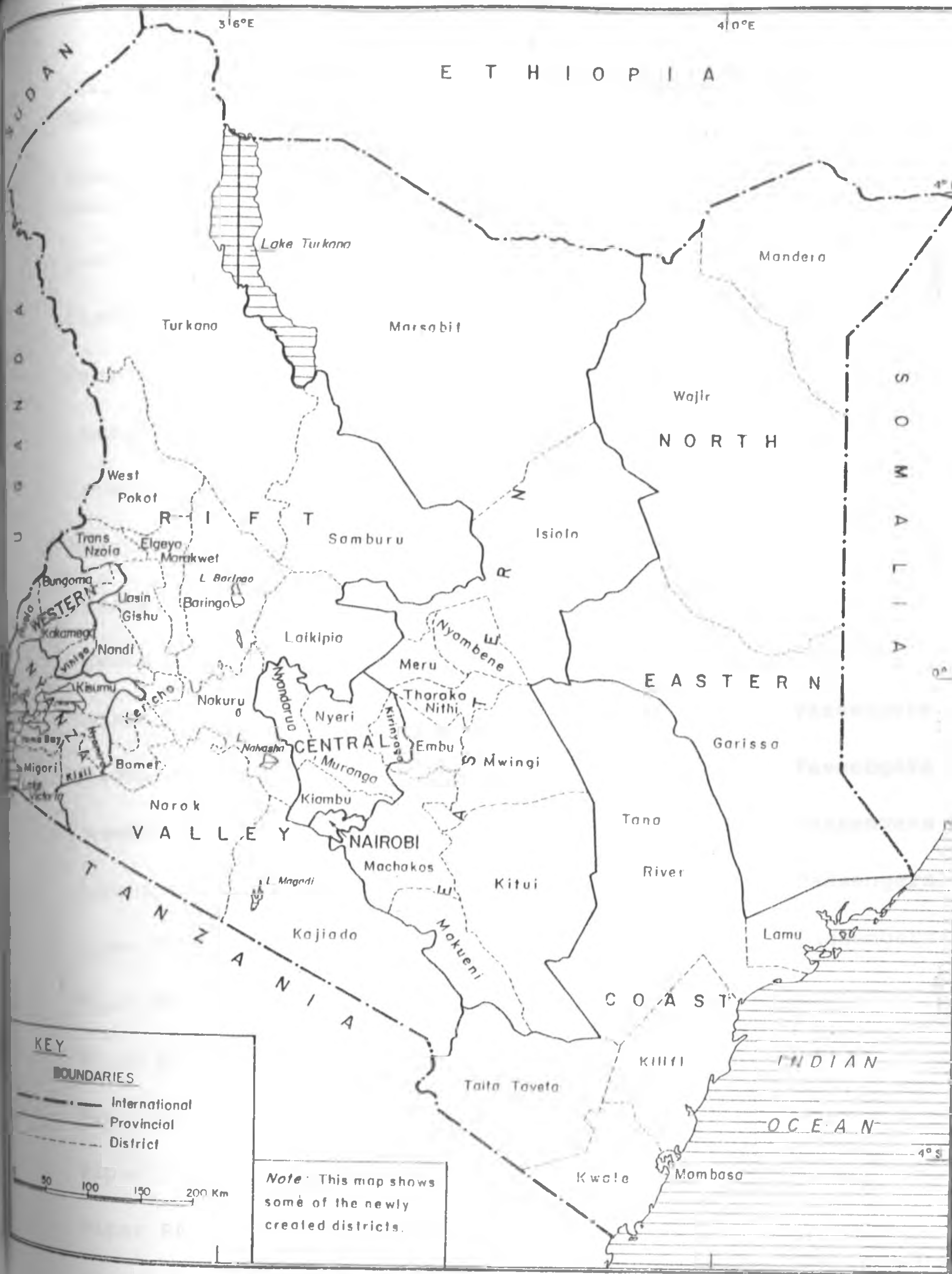
124. White, H. P. (1980): "Transport and development in West Africa", African Research and Documentation, Vol. 24, pp 2-9.

125. White, H. P. and Senior, M. L. (1983): Transport Geography. Longman.

126. Williams, A. V. and Zelinsky, W. (1970): "on some patterns in international tourist flows", Economic Geography. vol 46, pp 549-67.

127. World Bank (1984): Kenya: Transport Sector Memorandum. Washington D.C.

128. Yeates, H. M. (1965): An Introduction to quantitative Analysis in Economic Geography. McGraw-Hill, New York.



APPENDIX I ADMINISTRATIVE BOUNDARIES OF KENYA

APPENDIX II: SOME OF THE AIRCRAFTS USED AT WILSON AIRPORT, NAIROBI

Type of Aircraft	Number of Engines	Number of Passenger Seats	Category
Cessna 150-D	1	2	Private
Cessna 150-G	1	2	Private
Cessna 180	1	2	Private
Cessna 180H	1	2	Private
Cessna 185A	1	4	Private
Cessna 205	1	4	Passengers
Cessna 206	1	4	Passengers
Cessna 210 J	1	6	Private
Cessna 210 L	1	6	Passengers
Cessna 401	2	8	Passengers
Cessna 404	2	10	Passengers
Cessna 414	2	10	Passengers
Piper PA 20	1	2	Passengers
Piper PA 28-235	1	2	Private
Piper PA 23-250	2	2	Passengers
Piper PA 30	2	4	Passengers
Piper PA 31 (Navajo)	2	6	Passengers
Piper PA 32-300(cherokee six)	2	6	Private
Piper PA 34-200	2	6	Passengers
Piper PA 38-112	1	2	Passengers

Beech Baron E-55	2	6	Passengers
Beech Baron E-55,TE-1022	2	6	Passengers
Beech Baron C55	2	6	Passengers
Partenavia P 68B	2	5	Passengers
Partenavia P 68B "victor"149	2	5	Passengers
BN-2A-3 "Islander"	2	8	Passengers
DHC - 2MKI Beaver	1	5	Private[1]
DHC - Twin Otter	2	12	Passengers
DHC 6 - 300 Twin Otter	2	12	Passengers
Douglas DC 3	2	29	Passengers
Fokker 27	2	44	Passengers[2]

[1] Aircraft used for aerial work

[2] Biggest aircraft so far at Wilson Airport. It belongs to Air Kenya.

UNIVERSITY OF NAIROBI
DEPARTMENT OF GEOGRAPHY

CONFIDENTIAL

APPENDIX III: AIR PASSENGER SURVEY FOR DOMESTIC FLIGHTS

PASSENGER'S IDENTIFICATION

1. Passenger's Code Number [| |]

2. Interviewing date [| |]

3. a) Nationality ____________________

   b) If Kenyan state place of residence (Town or District) ________________

4. Occupation (check one)

   a) Business 1 [ ]

   b) Civil Servise 2 [ ]

   c) Others (Specify) 3 [ ] ________________

5. Age (years) [| |]

6. Sex (check one)

   a) male 1 [ ]

   b) female 2 [ ]

7. Marital Status (check one)

a) Single 1 ☐

b) Married 2 ☐

PASSENGER'S TRAVEL PATTERNS

8. What is the origin of the present trip?______________________

9. What is the destination of the present trip? ________________

10. What is the approximate number of trips made per week?______________________

11. Trip Purpose (Check one)

a) single purpose 1 ☐

b) multipurpose 2 ☐

12. Do you use other modes of transport for travelling to your destination?

a) yes 1 ☐

b) No 2 ☐

13. If yes, which ones? (check one)

a) Bus 1 ☐

b) Train 2 ☐

c) Car 3 [ ]

d) Others Specify 4 [ ] ____________

14. Purpose for which mode in number 13 is used (check one)

a) private 1 [ ]

b) leisure 2 [ ]

c) business 3 [ ]

d) official 4 [ ]

e) others (specify) 5 [ ] ____________

15. Which of the following modes would you prefer? (check one)

a) Bus 1 [ ]

b) Train 2 [ ]

c) Car 3 [ ]

d) Aeroplane 4 [ ]

e) Others (specify) 5 [ ] ____________

16. What are the reasons for preference? (check one)

a) quick 1 [ ]

b) cheap 2 [ ]

c) comfortable 3 [ ]

d) others (specify) 4 [ ] ____________

17. Which domestic services would you prefer? (check one)

a) Kenya airways 1 [ ]

b) Privately chartered 2 [ ] ______________

18. State the reason(s) for preference (check one)

a) regular and reliable 1 [ ]

b) comfortable 2 [ ]

c) cheaper 3 [ ]

d) quicker 4 [ ]

e) others (specify) 5 [ ] ______________

19. Which are the major problems if any encountered while using domestic services?

a) ________________________

b) ________________________

c) ________________________

d) ________________________

e) ________________________

20. Suggest how such problems would be solved.

a) ______________________

b) ______________________

c) ______________________

d) ______________________

e) ______________________

UNIVERSITY OF NAIROBI
DEPARTMENT OF GEOGRAPHY

CONFIDENTIAL

APPENDIX IV: AIR PASSENGER SURVEY FOR INTERNATIONAL FLIGHTS

PASSENGER'S IDENTIFICATION

1. Passenger's code number [ ][ ][ ]

2. Interviewing date [ ][ ][ ]

3. a) Nationality ______________________________

   a) Town (city) of Residence ____________________

4. Age (years) [ ][ ][ ]

5. Sex (check one)

   a) male 1 [ ]

   b) female 2 [ ]

6. Marital Status (check one)

   a) single 1 [ ]

   b) married 2 [ ]

7. Occupation (check one)

   a) Business 1 [ ]

   b) Civil service 2 [ ]

   c) Others (specify) 3 [ ] ______________

PASSENGER'S TRAVEL PATTERNS

8. What is the origin of the present trip?____________________

9. Trip purpose (check one)

a) single 1 [ ]

b) multipurpose 2 [ ]

10. Name of the international airline used____________________

11. Reason(s) for choosing this international airline

a) ______________________________

b) ______________________________

c) ______________________________

d) ______________________________

e) ______________________________

12. Did you change airline in flight? (check one)

a) Yes 1 [ ]

b) No 2 [ ] ______________

13. If yes, state the reason(s) for changing airline

a) ____

b) ____

c) ____

d) ____

e) ____

14. Would you like to make more regular trips to Kenya? (check one)

a) Yes	1	☐
b) No	2	☐

15. If yes, at least how many?

a) daily________________________

b) per week________________________

c) per month________________________

d) per year________________________

16. Did you encournter any problems while in flight? (check one)

a) yes	1	☐
b) no	2	☐

17. If yes, which one? (check one)

a) Delays at airport 1 [ ]

b) Delays in landing 2 [ ]

c) Loss of luggage 3 [ ]

d) Cancellation of flights 4 [ ]

e) Others (Specify) 5 [ ] ____________

18. What kind of flights do you prefer? (check one)

a) international scheduled flights 1 [ ]

b) privately chartered flights 2 [ ]

19. Give the reason(s) for your preference

a) ______________________________

b) ______________________________

c) ______________________________

d) ______________________________

e) ______________________________

20. How long did you stay in Kenya? (check one)

a) < 3 hours 1 [ ]

b) 3 ≥ 6 hours 2 [ ]

c) 1 day 3 [ ]

d) < 3 days 4 [ ]

e) 3 ≥ 6 days 5 [ ]

f) 1 week 6 ☐

g) > 1 week 7 ☐

h) others (specify) 8 ☐ ________

21. While in Kenya, did you visit any place? (check one)

a) Yes 1 ☐

b) No 2 ☐

22. If yes, which part of the country did you visit (check one)

a) Game Parks and Game Reserves 1 ☐

b) Coastal beaches 2 ☐

c) Rift Valley 3 ☐

d) Others (specify) 4 ☐ ________

23. State the reasons for visiting such a place (check one)

a) to view wild game 1 ☐

b) to sun bathe 2 ☐

c) to see beautiful scenery 3 ☐

d) others (specify) 4 ☐ ________

UNIVERSITY OF NAIROBI
DEPARTMENT OF GEOGRAPHY

CONFIDENTIAL

APPENDIX V: A SURVEY OF DOMESTIC AIR SERVICES

HISTORICAL BACKGROUND

1. Interviewee's code No. [| |]

2. Interviewing date [| |]

3. Name of domestic airline ________________

4. a) Date when airline began operations in Kenya_____________

   b) The reasons for establishing the airline_______________

5. Number of air craft operating at the beginning______________

6. Which routes did you operate then?

   a) __________________

   b) __________________

   c) __________________

7. Number of flights

a) per week ____________________

b) per month ____________________

c) per year ____________________

8. The number of revenue seats available ____________________

9. The number of passengers actually moved ____________________

10. Amount of cargo (kgm) freighted____________________

11. Amount of mail (kgm) freighted____________________

SERVICES RENDERED AT PRESENT

12. The type of airline service

a) Scheduled	1	☐
b) Chartered	2	☐
c) Others (specify)	3	☐ __________

13. The number of flights

a) per week ____________________

b) per month____________________

c) per year ____________________

14. Routes operated at present

a) ______________________________

b) ______________________________

c) ______________________________

d) ______________________________

e) ______________________________

15. State the length in kilometres of each route mentioned in No.14 above.

a) ______________________________

b) ______________________________

c) ______________________________

d) ______________________________

e) ______________________________

16. State the time taken in minutes or hours along each route.

a) ______________________________

b) ______________________________

c) ______________________________

d) ______________________________

e) ______________________________

17. The airline's total carrying capacity

a) Number of revenue seats ______________________

b) Amount of freight (kg) ______________________

18. Actual number of passengers moves __________________

19. The types of cargo moved

a) ____________________

b) ____________________

c) ____________________

d) ____________________

20. Amount of cargo moved (kg) __________________________

21. Amount of mail moved (kg) ___________________________

PASSENGER RATES

22. a) What is the cost of a single journey in Kshs? ________

b) Is the cost of a single journey the same as that of return journey? (check one)

(i) Yes 1 [ ]

(ii) No 2 [ ]

23. What are the main determinants of air fares? (check one)

a) Supply and demand 1 [ ]

b) Age of passenger 2 [ ]

c) Distance travelled (km) 3 [ ]

d) Others (specify) 4 [ ] ____________

FREIGHT RATES

24. What is the rate of cargo per tonne/km in Ksh?_______________

25. What are the main determinants of rates? (check one)

a) Supply and demand 1 [ ]

b) Type of cargo 2 [ ]

c) Distance covered (kg) 3 [ ]

d) Others (specify) 4 [ ] ____________

26. Which is the service with the greatest demand? (check one)

a) Passenger 1 ☐

b) Cargo 2 ☐

c) Mail 3 ☐

d) Others (specify) 4 ☐ ___________

27. Which is the service with the lowest demand? (check one)

a) Passenger 1 ☐

b) Cargo 2 ☐

c) Others (specify) 3 ☐ ______________

28. Does the demand for services fluctuate during part of the year? (check one)

a) Yes 1 ☐

b) No 2 ☐ ______________

29. If yes, which is the month of

a) Lowest demand? _________________________

b) Peak demand? _________________________

30. What do you do to attract customers? (check one)

a) By offering regular and reliable services 1 ☐

b) By advertising 2 ☐

c) By providing in-flight amenities 3 ☐

d) Others (specify) 4 ☐ ____

31. Does your airline face any problems? (check one)

a) Yes 1 ☐

b) No 2 ☐

32. If yes, which one? (check one)

a) Undercapacity flights 1 ☐

b) Competition from other airlines 2 ☐

c) Competition from surface transport modes 3 ☐

d) Managerial problems 4 ☐

e) Rising cost(s) of aviation fuel 5 ☐

f) Weather conditions 6 ☐

g) Aging aircraft 7 ☐

h) Noise control 8 ☐

i) Others (specify) 9 ☐ ____

33. Suggest how the problems faced by this airline may be solved?

a) ______________________

b) ______________________

c) ______________________

d) ______________________

e) ______________________

UNIVERSITY OF NAIROBI
DEPARTMENT OF GEOGRAPHY

CONFIDENTIAL

APPENDIX VI: A SURVEY OF INTERNATIONAL AIR SERVICES

HISTORICAL BACKGROUND

1. Interviewee's code No. [| |]

2. Interviewing date [| |]

3. Name of International Airline____________________

4. Date when airline beagan operations in Kenya________

5. Number of aircraft operating at the beginning_______

6 Number of flights

   a) per week___________________

   b) per month _________________

   c) per year __________________

7. Number of revenue seats available______________________

8. Number of passengers actually moved ___________________

9. Amount of cargo (kg) freighted_________________________

10. Amount of mail (kg) freighted ______________________

PRESENT SERVICES

11. Type of airline service (check one)

a) Scheduled 1 ☐

b) Chartered 2 ☐

c) Others (specify) 3 ☐ ____________

12. Number of flights

a) per week ____________________

b) per month ____________________

c) per year ____________________

13. Distance covered (km) ________________

14. Time taken (hours) ________________

15. Airline's total carrying capacity

a) Number of revenue seats ____________________

b) Amount of freight (kg) to be carried __________

16. Actual number of passengers carried ________________

17. Type of cargo carried and amounts (kg) ________________

a) ____________________________

b) ____________________________

c) ____________________________

d) ___________________________

e) ___________________________

18. Do you operate in other parts of Africa? (check one)

a) Yes 1 [ ]

b) No 2 [ ] __________

19. If yes, which routes?

a) __________________________

b) __________________________

c) __________________________

d) __________________________

e) __________________________

20. State the distance for each route in (19) above from Nairobi

a) ______________________________

b) ______________________________

c) ______________________________

d) ______________________________

e) ______________________________

21. Amount of cargo (kg)

a) from Nairobi to other parts of Africa

____

____

____

____

b) From other parts of Africa to Nairobi

____

____

____

22. Amount of mail (kg)

a) from Nairobi to other parts of Africa

____

____

____

____

b) From other parts of Africa to Nairobi __________________

____

____

____

PASSENGER RATES

23. a) What is the cost for a single journey is Kenya Shillings?__________________

b) Is the cost of a single journey the same as that of a return journey? (check one)

i) Yes 1 [ ]

ii) No 2 [ ]

c) If no, what is the costs of return journey?__________

24. What are the main determinants of fares?

a) Supply and demand 1 [ ]

b) Age of Passengers 2 [ ]

c) Distance travelled (km) 3 [ ]

d) Others (specify) 4 [ ] __________

25. What is the rate of cargo per tonne/km in

Kshs?______________

26. What are the main determinants of rates? (check one)

a) Supply and demand 1 [ ]

b) Types of cargo 2 [ ]

c) Distance covered (kg) 3 [ ]

d) Others (Specify) 4 [ ]

<u>DEMAND FOR SERVICES</u>

27. Which is the service with the greatest demand? (check one)

a) passenger 1 [ ]

b) cargo 2 [ ]

c) others (specify) 3 [ ] __________

28. Which is the service with the lowest demand? (check one)

a) passenger 1 ☐

b) cargo 2 ☐

c) mail 3 ☐

d) others (specify) 4 ☐

29. Does the demand for your services fluctuate during part of the year? (check one)

a) Yes 1 ☐

b) No 2 ☐

30. If yes, which is the month of (check one)

a) the lowest demand? a ☐

b) the greatest demand? b ☐

31. What do you do to attract clients? (check one)

a) offering regular and reliable service? 1 ☐

b) offering comfortable services? 2 ☐

c) advertising? 3 ☐

d) offering lower rates? 4 ☐

e) others (specify) 5 ☐

32. Does your airline face any problems?

a) Yes 1 [ ]

b) No 2 [ ]

33. If yes, which one? (check one)

a) undercapacity flights 1 [ ]

b) aging aircraft 2 [ ]

c) compettition from other airlines 3 [ ]

d) maintenance problems 4 [ ]

e) managerial problems 5 [ ]

f) financial problems 6 [ ]

g) rising cost(s) of aviation fuel 7 [ ]

h) weather conditions 8 [ ]

i) landing rights 9 [ ]

j) others (specify) 10 [ ] ____

34. Suggest how the problems faced by this airline may be solved.

a) ____________________

b) ____________________

c) ____________________

d) ____________________

e) ____________________

f) ____________________

APPENDIX VII
AERODROMES IN KENYA

CENTRAL PROVINCE

KIAMBU DISTRICT

A) Dyers
B) Kijabe Hospital
C) Kilima Mbogo

MURANGA DISTRICT

A) Cornforth
B) Greystone Farm

KIRINYAGA DISTRICT

A) Kagio
B) Kangaita
C) Njuki-ini

NYANDARUA DISTRICT

A) Njabini
(S. Kinangop)
B) Olkalou
C) Deighton Downs

COAST PROVINCE

KILIFI DISTRICT

A) Baricho
B) Galana Ranch
C) Lali Hills

KWALE DISTRICT

A) Mkomba
B) Ramisi
C) Samburu
D) Shimba Hills
E) Wasini Island
F) Lunga Lunga

LAMU DISTRICT

A) Bodheri
B) Dodori
C) Kiwaihu Mainland
D) Kisingitini
E) Mkunubi
F) Mkowe

TAITA-TAVETA DISTRICT

A) Buchuma Gate
B) Criticos
C) Maungu
D) Hunters Boma
E) Jipe
F) Kasigau Gate
G) Kedai Lodge
H) Mkatau Gate
I) Manyani Prison
J) Manyani Ant-Poaching
K) Mbuyuni Gate
L) Mwatate
M) Mzima Spring
N) Rukinga Ranch
O) Salt Lick Lodge
P) Tsavo Gate
Q) Ngulia Lodge
R) Voi Gate

TANA RIVER DISTRICT

A) Asa
B) Daka Dima
C) Daka Dima West
D) KoraGame Lodge
E) Kora George Adamson
F) Ndiandaza South

G) Sala Gate North
H) Wenje
J) Nyayo
K) Witu

EASTERN PROVINCE

EMBU DISTRICT

A) Kiambere

ISIOLO DISTRICT

A) Archer's Post
B) Malkayaka
C) Ndusi Mine
D) Pernny's Camp
E) Merti
F) Garba Tula

KITUI DISTRICT

A) Enyale
B) Gazi
C) Ithumba
D) Mkomwe Hill
E) Mutomo
F) Kaloboto
G) Kiasa
H) Rhino
I) Comer Roka
J) Tobangunji West
K) Umba Hill

MACHAKOS DISTRICT

A) Athi River
B) Kilima Kiu
C) Konza
D) Masinga
E) Msongaleni
F) Oldonyo Sabuk
G) Kiboko

MARSABIT DISTRICT

A) Kargi
B) Kulal Gotab Lower
C) Logaloga Mission
D) Loiyangalani South
E) Loiyangalani North

MERU DISTRICT

A) Diane
B) Dyers Field
C) Igoji
D) Chogoria
E) Kathangachini
F) Leopards Rock
G) Rojerwero
H) Shaba Camp
I) Ura Gate
J) Mt. Kenya National Park
K) Meru Mulika Lodge
L) Gaitu
M) Mitunguu

NORTH EASTERN PROVINCE

GARISSA DISTRICT

A) Darkan
B) Kurdi
C) Liboi

MANDERA DISTRICT

A) El Roba
B) Malka Mari
C) Rhamu
D) Takabba

WAJIR DISTRICT

A) Khorof Harar

NYANZA PROVINCE

KISII DISTRICT

A) Paroko
B) Kisii

KISUMU DISTRICT

A) Muhoroni
B) Nyabondo

SIAYA DISTRICT

A) Sega
B) Siaya
C) Mageta Island

SOUTH NYANZA DISTRICT

A)Homa-Bay
Hospital
B) Lambwe Valley
C) Migori

RIFT VALLEY PROVINCE

BARINGO DISTRICT

A) Eldama Ravine
B) Kito Pass
C) Tanguebei
D) Kamnarok
E) Kapendo
F) Marigat

ELGEYO MARAKWET DISTRICT

A) Sigor
B) Kimwarer
C) Tot

KAJIADO DISTRICT

A) Elangata Lines
B) Kapiti Isinya
C) Kilimanjaro Safari Lodge
D) Kimana
E) Magadi
F) Nguruman
G) Namanga

NAKURU DISTRICT

A) Naivasha South Lake

NANDI DISTRICT

A) Kapsabet
B) Kapsumbeiwa

NAROK DISTRICT

A) Bakitabu
B) Buffalo Camp
C) Cottars Camp
D) Fig Tree
E) Ilkeri
F) Mara Bridge
G) Governor's Camp(Musiara)
H) Kilgoris

SAMBURU DISTRICT

A) Barsaloi
B) Kombo Sare
C) Kawop
D) Wasini Vermiculite Mine
E) Maralal Kisima
F) Samburu South
G) Samburu North
H) Wamba

TURKANA DISTRICT

A) Kaputir North
B) Katilia
C) Kerio Delta
D) Katilu
E) Kaputir
F) Kangetet
G) Lokori

UASIN GISHU DISTRICT

A) Kaptagat
B) Leseru Station
C) Moiben
D) Ziwa Estate

WEST POKOT DISTRICT

A) Akale Mission
B) Artum
C) Turkwell Gorge
D) Turkwell Gorge(Lower)
E) Kacheliba

F) Sigor

WESTERN PROVINCE

BUNGOMA DISTRICT

A) Bungoma
B) Webuye

BUSIA DISTRICT

A) Busia
B) Nangina

KAKAMEGA DISTRICT

A) Kaimosi
B) Mumias Sugar Company
C) Kakamega

APPENDIX VIII: GROWTH OF AIR TRAFFIC AT JOMO KENYATTA AND MOI INTERNATIONAL AIRPORTS, 1970-1990

YEAR	JOMO KENYATTA INTERNATIONAL AIRPORT		MOI INTERNATIONAL AIRPORT	
	AIR PASSENGERS (000s)	CARGO (TONNES)	AIR PASSENGERS (000s)	CARGO (TONNES)
1970	1,091.0	23,197.4	180.7	1,321.6
1972	1,155.0	30,365.4	202.2	1,301.4
1974	1,605.4	30,942.1	411.3	2,366.9
1976	1,915.0	31,302.8	382.1	1,831.7
1978	1,837.4	30,303.4	236.2	3,725.5
1980	2,117.0	30,894.0	434.5	27,197.8
1982	1,748.0	32,700.0	422.4	17,510.0
1984	1,640.5	41,100.0	417.9	16,230.0
1986	1,789.0	46,400.0	495.2	9,900.0
1988	1,974.0	48,800.0	547.9	9,040.0
1990	2,187.0	55,400.0	614.0	9,310.0

Source: Compiled by Author

APPENDIX IX: DOMESTIC AIR TRAFFIC FOR THE TOP FIVE AIR CHA
OPERATORS, 1990

			PASSENGERS PER MONTH FOR 5 TOP OPERATORS			
MONTH	AIR KENYA	SAFARI AIR	BOSKOVIC	WESTERN	EQUATOR	TOTAL
January	8,461	1,892	2,187	248	348	13,136
February	8,671	2,363	1,917	165	192	13,308
March	8,238	1,596	1,308	224	212	11,578
April	5,388	1,295	876	N/A	293	7,852
May	4,433	1,028	547	8	550	6,566
June	5,983	1,223	870	250	691	9,017
July	7,525	1,616	1,357	415	592	11,505
August	10,795	2,057	1,775	438	834	15,899
September	6,774	1,675	1,039	302	522	10,312
October	9,299	1,914	1,039	348	643	13,243
November	6,717	1,871	1,148	305	766	10,807
December	7,146	2,106	1,365	172	782	11,571
Total	89,430	20,636	15,428	2,872	6,425	134,794
Percentage	66.4	15.3	11.4	2.1	4.8	

Source: CAB, 1991

APPENDIX X: WILSON AIRPORT: LOCAL OPERATORS CAPACITY UTILISATION, 1990.

MONTH	SEATS OFFERED	SEATS UTILISED	LOAD FACTOR a (%)
JANUARY	43480	22,172	51
FEBRUARY	41364	21,800	53
MARCH	38262	20,537	54
APRIL	28170	15,392	55
MAY	17442	13,940	80
JUNE	32409	16,014	49
JULY	38509	19,411	50
AUGUST	47620	26,840	56
SEPTEMBER	35315	18,108	51
OCTOBER	40248	22,212	55
NOVEMBER	42276	20,155	48
DECEMBER	51223	22,506	44
TOTAL	456318	239,087	52

Source: Civil Aviation Board (CAB)
a: computed by author

APPENDIX XI: SEASONAL PASSENGER TRAFFIC VARIATIONS IN KENYA, 1989

MONTH	INTERNATIONAL SERVICES	DOMESTIC SERVICES
January	173,094	56,971
February	138,383	52,048
March	137,817	57,953
April	110,925	54,566
May	90,919	45,962
June	100,067	45,234
July	135,492	57,655
August	138,383	72,004
September	121,966	53,101
October	117,094	56,454
November	120,156	54,174
December	144,012	64,285
Total	1,528,308	670,707

Source: ICAO (1989): Airport traffic, services, at No.30 pg 102-103

APPENDIX XII: SEASONAL VARIATION OF DOMESTIC AIR CHARTER TRAFFIC, 1990

MONTH	PASSENGERS
January	15,464
February	14,822
March	13,173
April	9,779
May	8,641
June	11,977
July	14,214
August	19,346
September	12,327
October	15,197
November	12,554
December	14,072

Source: CAB, 1991.

APPENDIX XIII: POPULATION POTENTIAL IN KENYA (1992)

DISTRICT	POTENTIAL
NAIROBI	365,000
GARISSA	60,000
LAMU	43,000
MERU	161,000
KITUI	122,000
NYERI	162,240
MACHAKOS	182,000
NAROK	135,000
TANA RIVER	56,000
KAKAMEGA	180,000
NANDI	187,000
BUSIA	141,000
BUNGOMA	148,000
S. NYANZA	152,000
KERICHO	161,000
SIAYA	145,000
KILIFI	76,000
MOMBASA	77,000
KWALE	68,000
TAITA TAVETA	62,000
KAJIADO	134,000
KISII	165,000
MANDERA	28,000
WAJIR	44,000
MARSABIT	60,000
SAMBURU	94,000
TRANS-NZOIA	124,000
TURKANA	50,000
ISIOLO	123,000
UASIN GISHU	156,000
ELGEYO	151,000
WEST POKOT	110,000
BARINGO	150,000
NYANDARUA	139,000
LAIKIPIA	150,000
KIAMBU	327,000
KIRINYAGA	166,000
MURANG'A	215,000
EMBU	170,870
KISUMU	185,000
NAKURU	136,000

Computed by Author

APPENDIX XIV: AIR PASSENGER TRAFFIC GENERATED AND ATTRACTED IN VARIOUS DISTRICTS, 1991.

DISTRICT	ARRIVALS	DEPARTURES	TOTAL
NAIROBI	16,403	14,177	30,580
LAMU	3,310	4,603	7,913
MOMBASA	659	712	1,371
NAROK	10,409	11,071	21,480
NYERI	154	55	209
TAITA-TAVETA	119	67	186
KWALE	1,885	98	1,983
NAKURU	81	-	81
SAMBURU	365	-	365
KILIFI	2,453	2,542	4,995
WAJIR	183	943	1,126
KAJIADO	1,480	1,399	2,879
GARISSA	829	890	1,719
KISUMU	133	102	235
LAIKIPIA	904	856	1,760
MANDERA	630	594	1,224
MERU	18	-	18
TRANS-NZOIA	55	63	118
TURKANA	179	185	364
MARSABIT	79	-	79
BUSIA	7	-	7
UASIN GISHU	71	32	103
BARINGO	-	12	12

Source: Fieldwork

APPENDIX XV: SCHEDULED DOMESTIC PASSENGER FLIGHTS IN KENYA, 1985

ORIGIN	DESTINATION										
	1	2	3	4	5	6	7	8	9	10	Nodal?	If yes, to where?
1.AMBOSELI	-	-	156	-	-	-	-	-	-	370	Yes	Wilson
2.ELDORET	-	-	-	-	-	-	-	-	-	292	Yes	Wilson
3.GOVER-NOR'S CAMP	3	-	-	127	-	-	-	-	160	637	Yes	Wilson
4.KEEKOROK	20	2	49	-	-	-	-	-	-	298	Yes	Wilson
5.LAMU	-	-	-	-	-	607	-	-	-	305	No	-
6.MALINDI	-	-	-	-	650	-	-	-	-	72	Yes	Lamu
7.MANDERA	-	-	-	-	-	-	-	-	-	112	Yes	Wilson
8.NANYUKI	-	-	5	3	-	-	-	-	-	192	Yes	Wilson
9.UKUNDA	98	-	52	-	-	-	-	-	-	17	Yes	Amboseli
10.WILSON	372	281	394	379	276	18	332	128	48	-	-	
TOTAL	493	283	656	509	926	625	332	128	208	2295		
RANK	6	8	3	5	2	4	7	10	9	1		

Source: Central Bureau of Statistics, 1985.

APPENDIX XVI: MAIN AIR TRAFFIC GENERATING AND ATTRACTING CENTRES, 1991[a]

AIRPORT OF ORIGIN/ DESTINATION	ARRIVALS	DEPARTURE	TOTAL
NAIROBI	18,495	19,379	37,874
KEEKOROK	578	448	1,026
AMBOSELI	2,253	7,261	9,514
UKUNDA	356	842	1,198
MOMBASA	1,464	1,783	3,247
MALINDI	404	360	764
LAMU	2,856	2,885	5,741
NANYUKI	471	333	804
ELDORET	446	777	1,223
KISUMU	111	239	350
MANDERA	599	516	1,115
GARISSA	69	273	342
MARSABIT	158	86	244
HOMABAY	33	95	
KITALE	83	45	128
NYERI	50	197	247
WAJIR	110	89	446
NAKURU	86	47	133
MARALAL	39	61	100
BUFFALO'S CAMP	87	3,448	3,535

[a]: Airports handling about 100 air passengers per annum

Source: Fieldwork

APPENDIX XVII: AIR PASSENGER INDEXES

URBAN CENTRE	INDEX
Mombasa	7.0
Malindi	21.0
Lamu	478.0
Nanyuki	33.0
Eldoret	12.0
Kisumu	2.0
Mandera	162.0
Garissa	13.0
Kitale	2.0
Nyeri	3.0
Wajir	23.0
Homa Bay	6.0
Nakuru	1.0
Maralal	6.0
Nairobi	28.0

Source: Fieldwork

APPENDIX XVIII: INTERNATIONAL AIR CARRIERS' ROUTE CAPACITY

ROUTE	NO. OF SEATS PER WEEK
NAIROBI-ABU DHABI	239
NAIROBI-CAIRO	750
NAIROBI-ADDIS ABABA	186
NAIROBI-AMSTERDAM	1,264
NAIROBI-ANTANANARIVO	317
NAIROBI-ATHENS	795
NAIROBI-BOMBAY	882
NAIROBI-BRUSSELS	511
NAIROBI-BUNJUMBURA	423
NAIROBI-DAR ES SALAAM	1,856
NAIROBI-ENTEBBE	533
NAIROBI-FRANKFURT	1,434
NAIROBI-HARARE	682
NAIROBI-JEDDAH	566
NAIROBI-JOHANNESBURG	3,835
NAIROBI-KHARTOUM	313
NAIROBI-KIGALI	1,096
NAIROBI-LILONGWE	485
NAIROBI-LONDON	2,738
NAIROBI-LUSAKA	311
NAIROBI-MAHE	333
NAIROBI-PARIS	1,364
NAIROBI-ROME	507
NAIROBI-PORT LOUIS	432
NAIROBI-ZURICH	1,374
NAIROBI-MOGADISHU	328

Source: ICAO, 1990, Fieldwork, 1991/92

... VOLUME OF PASSENGERS, POPULATION AND DISTANCE

COUNTRY	PASSENGERS (No.)	POPULATION (MILLIONS)	GNP PER CAPITA	DISTANCE (
GHANA	4,933	14.4	390	4,270
ETHIOPIA	44,560	49.5	120	1,163
NETHERLANDS	49,741	14.8	15,920	6,672
GREECE	10,355	10.0	5,350	4,564
INDIA	80,906	832.5	340	4,529
BELGIUM	19,256	10.0	16,220	6,555
BURUNDI	11,841	5.3	220	870
EGYPT	33,302	51.0	640	3,544
TANZANIA	43,379	23.8	130	668
CAMEROON	4,848	11.6	1,000	3,078
UGANDA	53,969	16.8	250	520
GERMANY	56,018	62.0	20,440	6,313
SAUDI ARABIA	40,373	14.4	6,020	2,547
COTE D'IVORE	140	11.7	790	4,750
MALAWI	15,629	8.2	180	1,428
MAURITIUS	8,137	1.1	1,990	3,096
NIGERIA	7,090	113.8	250	3,828
RWANDA	19,003	6.9	320	758
SOMALIA	18,848	6.1	170	1,003
SOUTH AFRICA	41,729	35.0	2,470	2,910
SUDAN	8,492	24.5	1,376	1,940
ZAMBIA	24,478	7.8	390	1,814
PAKISTAN	22,370	106.0	350	4,362
UNITED KINGDOM	192,413	57.2	14,610	6,836
USA	19,123	248.8	20,910	11,816
ITALY	41,923	57.5	15,120	5,396
ISRAEL	13,520	38.8	9,330	3,708
SWITZERLAND	30,010	6.6	29,880	6,078
FRANCE	44,682	56.2	17,820	6,492

Source: Central Bureau of Statistics and ICAO, 1990. Computed by Author.

APPENDIX XX: NORTH BOUND AND SOUTH-BOUND CARGO HANDLED AT JOMO KEYATTA INT'L AIRPORT, 1991

MONTH	NORTH-BOUND (TONNES)	SOUTH-BOUND (TONNES)
JANUARY	5,945.0	967.8
FEBRUARY	5,031.4	779.2
MARCH	4,803.9	1,205.8
APRIL	5,233.6	1,068.3
MAY	4,536.5	982.3
JUNE	4,508.2	2,244.8
JULY	2,777.0	1,345.4
AUGUST	4,091.0	1,211.5
SEPTEMBER	3,878.3	1,341.8
OCTOBER	3,086.8	1,320.8
NOVEMBER	4,667.6	1,189.1
DECEMBER	6,548.0	1,373.0
TOTAL	55,107.3	15,029.8

Source: Kenya Airfreight Handling Ltd.

APPENDIX XXI: TOP TEN IMPORTS BY AIR INTO KENYA (KSHS)

IMPORT ITEM	VALUE (KSHS)
MEDICAMENTS (RETAIL)	171,462,263
MEDICAL DRESSING (NOT COTTON AND NON-ADHESIVE)	129,785,273
NON-PENICILLIN ANTIBIOTICS (RETAIL)	114,441,613
MOTOR VEHICLE PARTS	58,655,041
ANTIBIOTICS (PENICILLIN)	55,573,392
IRON/STEEL SPRINGS (NOT LEAF TYPE)	51,992,728
LITERATURE	49,515,748
MEDICAMENTS (OTHER NOT FOR RETAIL)	45,837,625
MEDICAMENTS CONTAINING ALKALOIDS (NOT FOR RETAIL)	32,657,336
AUTOMATIC DATA PROCESSING EQUIPMENT	32,509,995
TOTAL	742,610,974

Source: Department of Customs and Exercise, 1991

APPENDIX XXII: TOP TEN HORTICULTURAL EXPORTS BY AIR FROM KENYA, 1991 (KSHS)

HORTICULTURAL PRODUCT	VALUE (KSHS)
BEANS (VIGNA SPP, PHASEOLUS SPP)	427,468,108
FRESH OR CHILLED VEGETABLES (Excluding mushrooms, spinash, asparagus and celery)	252,756,346
AVOCADOES	47,846,029
GUAVAS, MANGOES AND MANGOSTEENS	37,054,956
FRESH FRUIT (OTHER)	14,470,671
STRAWBERRIES	13,694,016
LEEKS AND OTHER ALLACEOUS VEGETABLES	11,544,729
PREPARED AND PRESERVED VEGETABLES	6,614,821
(OTHER)	6,452,482
VEGETABLES (COOKED IN BOILING WATER AND STEAM)	6,157,816
TOTAL	824,059,974

Source: Department of Customs and Exercise, 1991

APPENDIX XXIII: TOP TWENTY AIRLINES HANDLING EXPORTS AT JOMO KENYATTA INTERNATIONAL AIRPORT, 1991 (TONNES)

AIRLINE	TONNES
KENYA AIRWAYS	6,270.0
GERMAN CARGO	6,006.8
BRITISH AIRWAYS	5,744.6
AIR FRANCE	4,668.2
SABENA AIR	2,035.3
SWISSAIR	1,976.0
DUTCH AIRLINES (KLM)	1,328.4
ETHIOPIAN AIRLINES	1,117.8
ANGOLAN CARGO	1,009.3
AIR MADAGASCAR	874.8
ZAMBIA AIR	818.0
SAUDIA	776.6
SUDAN CARGO	713.2
DAS CARGO	616.6
OLYMPIC AIR	591.5
AIR RWANDA	506.4
ALITALIA	495.1
EGYPT AIR	467.4
GULF AIR	403.3
LUFTHANSA	331.2

Source: Kenya Airfreight Handling Limited (KAHL), 1991

APPENDIX XXIV: TOP TWENTY AIRLINES HANDLING IMPORTS AT JOMO KENYATTA INTERNATIONAL AIRPORT, 1991 (TONNES)

AIRLINE	TONNES
KENYA AIRWAYS	3,528.5
AIR FREIGHTER	2,846.3
BRITISH AIRWAYS	1,812.4
GE FREIGHTER	1,614.8
ROYAL DUTCH (KLM)	691.4
LUFTHANSA	607.3
SABENA	606.4
AIR FRANCE	509.1
ALITALIA	349.3
AIR INDIA	337.3
SWISSAIR	264.1
PAKISTAN AIRLINES	243.8
GULF AIR	197.0
EL AL	181.9
ETHIOPIAN AIRLINES	154.2
SAUDIA	145.4
AIR ZIMBABWE	104.8
EGYPT AIR	101.2
ZAMBIA AIRWAYS	42.7
SOUTH AFRICAN AIRWAYS	17.5

Source: Kenya Airfreight Handling Limited (KAHL), 1991

APPENDIX XXV: FREQUENCIES OF MAIL LANDED AND LOADED (TONNES PER WEEK), 1990

DIRECTION	LANDED	LOADED
North-East East	718	780
South-East	-	-
South	104	670
South-West	2,167	1,473
West	-	-
North-West	367	1,759
North	-	-
	16,831	9,214

Source: Fieldwork

APPENDIX XXVI: VOLUME OF CARGO, POPULATION, GDP AND DISTANCE

COUNTRY	CARGO (TONNES)	POPULATION (MILLIONS)	GDP (MILLIONS US$)	DISTANCE (Km)
GHANA	59.0	14.4	5,400	4,270
ETHIOPIA	915.0	49.5	5,940	1,163
NETHERLANDS	3258.0	14.8	235,616	6,672
GREECE	396.0	10.0	53,500	4,564
INDIA	689.0	832.5	283,050	4,529
BELGIUM	3513.0	10.0	162,200	6,555
BURUNDI	222.0	5.3	1,166	870
EGYPT	951.0	51.0	32,640	3,544
TANZANIA	418.0	23.8	3,094	668
CAMEROON	55.0	11.6	11,600	3,078
UGANDA	587.0	16.8	4,200	520
GERMANY	8046.0	62.0	1,267,280	6,313
SAUDI ARABIA	2147.0	14.4	86,688	2,547
COTE D'IVORE	0.20	11.7	9,243	4,750
MALAWI	281.9	8.2	1,476	1,428
MAURITIUS	180.0	1.1	2,189	3,096
NIGERIA	682.0	113.8	28,450	3,828
RWANDA	193.0	6.9	2,208	758
SOMALIA	514.0	6.1	1,037	1,003
SOUTH AFRICA	179.0	35.0	86,450	2,910
SUDAN	160.0	24.5	33,712	1,940
ZAMBIA	369.0	7.8	3,042	1,814
PAKISTAN	178.0	106.0	37,100	4,362
UNITED KINGDOM	9429.0	57.2	835,692	6,836
USA	39.0	248.8	5,202,408	11,816
ITALY	1024.0	57.5	869,400	5,396
ISRAEL	144.0	38.8	362,004	3,708
SWITZERLAND	2023.0	6.6	197,208	6,078
FRANCE	8477.0	56.2	1,001,484	6,492

Source: Central Bureau of Statistics and ICAO, 1990. Computed by Author.

APPENDIX XXVII: THE 50 VARIABLES USED IN KITUUKA'S STUDY

1.	NOLOCA	Number of locations
2.	NOSLOC	Number of sublocations
2.	NOGIVE	Number of villages
4.	LASQKM	Land area in sq. km
5.	POPULT	Population of the 1979 census
6.	POPDEN	Population Density, 1979
7.	NOHSHD	Number of Households, 1979
8.	NOSMHD	Number of smallholdings[1]
9.	PERPOP	Percentage (1979) population of District total
10.	PERHMP	High/medium potential land as a percentage of total Division Land Area
11.	NOAPI	Number of Agricultural and other Processing Industries
12.	NOPIPP	Number of Processing Industries per 10,000 population
13.	NOPPSF	Population per school facility
14.	NOPRSC	Number of Primary schools
15.	POPPHF	Population per Health Facility
16.	TOHFPL	Total Health facility per 100 sq. km of land
17.	NONPLAN	Number of Agricultural planations
18.	AVLCAG	Average Number of locations where main commercial crops (coffee, tea and horticultural crops) were major sources of income for agricultural households
19.	PERLALC	Percentage of average locations relying on major cash crops, horticultural crops and dairy farming for income.
20.	PERANL	Percentage average number of locations producing 6 major horticultural crops.
21.	PROLAC	Proportionate locations of 10,000 population (1979) producing 4 major subsistence crops.
22.	PROLSC	Proportionate number of locations of 100 sq. km producing 4 major subsistence crops.
23.	LIVPOP	Livestock population distribution, 1985.
24.	PERALL	Percentage number of locations with 5 main types of livestock.
25.	PROPPL	Proportionate number of locations of 10,000 people producing 5 main types of livestock.
26.	PERTTC	Percentage of total district tick control facilities.
27.	POPTCF	Population (1979) per tick control facility.
28.	PROTCL	Proportion of tick control facility per 100 sq. km. of land area.
29.	PERVWE	Percentage of villages with electricity.
30.	PERVWT	Percentage of villages with telephones.
31.	PERVPT	Percentage of villages with public transport.
32.	PERSTR	Percentage of sublocations with at least one tarmac road.
33.	PERSRL	Percentage of sub-locations with a railway line.
34.	NOBRCT	Number of bridges/culverts.
35.	NOPSTF	Number of postal facilities.
36.	NOPWSC	Number of piped water schemes.
37.	NOCLBS	Number of centres with 15 or more of the leading business services.
38.	NOCRAF	Number of centres with 9 or more of the important administrative functions.
39.	PERSCA	Percentage share of major commercial and administrative facilities.

APPENDIX XXVII CONT'D

40.	NOCMOS	Number of centres with more than one street.
41.	NOCOTR	Number of centres with at least one tarmac road.
42.	NOCBLG	Number of centres with over 30 buildings.
43.	NOCMSA	Number of centres with 11 to 40 shops.
44.	NOCOFS	Number of centres with over 50 shops.
45.	NOCSBG	Number of centres with at least not less than 3-storey buildings.
46.	NHPPL	Number of Harambee projects per 100 sq. km. of land.
47.	ANOWGP	Average number of women groups with agricultural staff per 100,000 population.
48.	AMWGPP	Average membership to women groups per 10,000 people.
49.	NOFKCB	Number of 4K clubs in 1985 per 100,000 people.
50.	MFKCPP	Membership to 4K clubs in 1975 per 10,000 people.

Source: Kituuka, S.E. and King'oriah G.K. (1991)

[1] Smallholdings vary in size from 0.5 ha to 20.0 ha.

APPENDIX XXVIII: INDICES FOR COMPUTING COMPOSITE INDEX FOR DEVELOPMENT STATUS (CIDS)

	DISTRICT	1	2	3	4	5	6	7
1.	BARINGO	130	210	9.8	1.3	3.9	3.0	0.4
2.	BUNGOMA	310	80.0	16.3	2.0	22.0	4.6	1.3
3.	BUSIA	248	225	5.8	1.6	2.0	4.1	2.4
4.	EMBU	167	0.9	10.9	2.5	2.9	6.5	0.6
5.	GARISSA	N/A	2.2	7.0	0.7	0.3	1.3	0.3
6.	ISIOLO N/A	39.0	3.2	1.2	N/A	2.9	0.3	
7.	KERICHO	237	13.0	53.5	1.6	10.4	1.1	2.2
8.	KIRINYAGA	152	0.9	20.3	1.3	5.6	2.4	0.7
9.	KAJIADO	1083	167.0	7.0	3.3	9.3	9.4	0.9
10.	KAKAMEGA	440	11.5	23.4	1.7	6.1	3.2	2.7
11.	KISUMU	155	N/A	15.5	1.8	22.5	4.1	2.7
12.	KIAMBU	256	16.6	4.0	4.8	20.7	2.6	5.7
13.	KILIFI	184	1.7	14.8	4.8	15.3	13.1	1.5
14.	KISII	591	40.0	18.0	1.7	5.4	3.5	1.2
15.	MACHAKOS	168	52.7	15.8	1.4	11.3	2.8	2.3
16.	MARSABIT	3895	2.3	6.8	1.2	N/A	2.8	0.3
17.	MANDERA	N/A	125.5	5.7	0.5	N/A	0.90	N/A
18.	MERU	362	50.2	15.2	2.3	3.9	5.6	1.1
19.	MURANGA	242	49	50.7	2.2	3.6	3.2	3.4
20.	NANDI	167	118	61.0	1.8	2.2	1.3	1.0
21.	NAROK	37	108	12.2	3.0	1.0	8.1	0.4
22.	NYANDARUA	123	38.0	16.8	2.0	5.3	4.7	1.8
23.	SIAYA	155	11	0.9	1.9	4.8	5.4	3.0
24.	S. NYANZA	215	39.7	8.0	1.5	2.9	3.7	7.5
25.	NAIROBI	N/A	N/A	3.0	3.2	17.9	9.2	33.2
26.	TANA RIVER	113	33	10.6	1.2	N/A	0.3	0.1
27.	TRANS-NZOIA	214	175	35.9	2.6	2.2	5.9	1.4
28.	WAJIR	N/A	106	4.6	0.4	N/A	0.6	N/A
29.	U. GISHU	142	91	16.0	2.4	28.0	6.0	1.9
30.	W. POKOT	245	112	9.3	0.6	N/A	1.0	0.4
31.	TAITA-TAVETA	379	40.7	31.2	9.5	5.9	4.0	0.6
32.	KWALE	145	2.1	18.0	6.0	2.8	16.9	0.4
33.	MOMBASA	N/A	0.06	1.4	3.4	20.4	10.0	8.9
34.	LAMU	21	91.4	10.3	2.0	0.1	5.4	0.3
35.	NYERI	422	35	15.2	2.9	5.5	7.6	2.0
36.	LAIKIPIA	174	2.6	27.3	1.7	10.1	3.2	0.7
37.	ELGEYO-MARAKWET	160	37.8	10.9	0.5	2.6	0.4	0.5
38.	NAKURU	257	74.0	28.4	1.9	14.5	5.6	4.6
39.	KITUI	57	3.2	5.6	0.6	0.5	1.1	0.4
40.	TURKANA	N/A	8.5	4.3	0.7	N/A	1.5	0.1
41.	SAMBURU	N/A	220.0	9.5	1.3	N/A	4.2	0.5

APPENDIX XXVIII CONT'D.

	DISTRICT	8	9	10	11	12	13	14	15
1.	BARINGO	98.5	325017	30.0	8.5	110	97	0.5	55.0
2.	BUNGOMA	202.3	785535	8.8	140.0	106	106	0.1	50.0
3.	BUSIA	95.8	404049	228.0	3.4	117	95	0.3	54.5
4.	EMBU	180.0	421102	155.0	5.3	55	88	0.4	60.4
5.	GARISSA	80.3	220327	5.0	25.6	150	20	1.0	37.5
6.	ISIOLO	461.1	63931	2.5	37.3	153	77	0.9	50.4
7.	KERICHO	44.8	900679	181.0	5.7	65	100	0.1	50.3
8.	KIRINYAGA	182.4	402892	280.0	4.7	58	89	0.15	56.9
9.	KAJIADO	31.9	238364	11.0	11.9	72	61	0.3	52.3
10.	KAKAMEGA	186.4	1430000	400.0	5.8	100	94	0.2	44.9
11.	KISUMU	906.3	715346	269.0	29.7	83	100	0.3	44.2
12.	KIAMBU	699.4	1000273	408.0	10.9	42	81	0.1	59.6
13.	KILIFI	285.6	647472	52.0	9.5	135	76	0.19	30.7
14.	KISII	179.8	1300000	592.0	5.0	63	81	0.1	49.1
15.	MACHAKOS	260.5	1505539	106.0	11.2	64	93	0.15	50.9
16.	MARSABIT	553.9	155802	2.0	24.5	91	37	0.7	55.6
17.	MANDERA	208.7	136077	5.0	17.0	142	26	0.5	40.0
18.	MERU	208.0	1214950	123.0	7.6	91	83	0.1	52.0
19.	MURANGA	81.3	947625	383.0	7.2	42	93	0.10	60.1
20.	NANDI	366.8	389816	142.0	3.1	67	101	0.27	49.2

APPENDIX XXVIII CONT'D.

	DISTRICT	8	9	10	11	12	13	14	15
21.	NAROK	113.4	332350	18.0	4.1	66.9	64	0.30	25.1
22.	NYANDARUA	213.3	325770	92.0	3.2	49	89	0.23	58.6
23.	SIAYA	259.1	713311	202.0	4.0	134	10	0.12	53.7
24.	S.NYANZA	275.3	1226070	158.0	4.3	133	97	0.10	41.6
25.	NAIROBI	5832.0	1294200	1892.0	100.0	95	63	N/A	36.1
26.	TANA RIVER	91.8	148128	3.8	8.5	106	64	0.60	50.2
27.	TRANS-NZOIA	374.3	445883	181.0	13.3	114	83	0.18	58.2
28.	WAJIR	N/A	220876	3.9	24.0	159	14	0.5	35.1
29.	U. GISHU	740.8	463978	123.0	26.3	60	91	0.21	46.0
30.	W. POKOT	37.6	252615	2.8	5.3	133	61	0.40	41.6
31.	TAITA TAVETA	599.7	196925	12.0	12.5	78	93	0.45	53.1
32.	KWALE	70.8	417983	51.0	3.6	126	72	0.20	45.0
33.	MOMBASA	3482.6	492024	1789.0	100.0	99	64	0.73	30.3
34.	LAMU	826.4	68611	10.0	20.0	200	79	1.03	63.3
35.	NYERI	535.7	674956	206.0	16.6	34	87	0.33	52.6
36.	LAIKIPIA	854.7	226170	23.0	18.3	46	84	0.18	51.4
37.	ELGEYO-MARAKWET	90.4	165965	59.0	2.7	84	84	0.36	48.0
38.	NAKURU	903.9	846810	118.0	27.6	60	90	0.41	42.0
39.	KITUI	39.4	689893	22.0	2.4	91	89	0.17	52.3
40.	TURKANA	386.3	147053	2.1	4.9	103	64	1.22	17.6
41.	SAMBURU	376.4	98291	4.7	20.2	81	54	0.81	49.8

	DISTRICT	16	17	18	19	20
1.	BARINGO	0.63	0.05	0.17	6	12
2.	BUNGOMA	0.68	0.45	0.10	N/A	N/A
3.	BUSIA	0.68	0.45	0.05	N/A	N/A
4.	EMBU	0.96	0.30	N/A	N/A	N/A
5.	GARISSA	1.03	0.01	N/A	2	724
6.	ISIOLO	1.00	0.04	N/A	N/A	N/A
7.	KERICHO	0.65	0.50	0.08	2	N/A
8.	KIRINYAGA	0.80	0.64	0.08	N/A	N/A
9.	KAJIADO	0.84	0.02	0.80	6	1865
10.	KAKAMEGA	1.22	0.50	0.05	N/A	N/A
11.	KISUMU	0.80	1.10	0.10	2	96
12.	KIAMBU	0.68	0.65	0.12	12	N/A
13.	KILIFI	0.68	0.13	0.10	8	3153
14.	KISII	0.56	0.73	N/A	N/A	N/A
15.	MACHAKOS	N/A	0.21	0.20	10	N/A
16.	MARSABIT	0.60	0.05	N/A	2	N/A
17.	MANDERA	1.07	0.05	N/A	2	428
18.	MERU	1.07	0.21	N/A	N/A	N/A
19.	MURANGA	0.46	0.67	0.06	4	N/A
20.	NANDI 0.67	0.43	N/A	N/A	N/A	
21.	NAROK0.16	0.10	N/A	4	10649	
22.	NYANDARUA	0.69	0.30	0.17	6	N/A
23.	SIAYA	1.10	0.50	N/A	N/A	N/A
24.	S. NYANZA	0.90	0.30	N/A	N/A	N/A
25.	NAIROBI	N/A	N/A	0.03	N/A	15792
26.	TANA RIVER	0.98	0.05	N/A	8	N/A
27.	TRANS-NZOIA	0.65	0.50	0.07	N/A	101
28.	WAJIR	1.06	0.04	N/A	3	564
29.	U. GISHU	1.06	0.30	0.30	2	422
30.	W. POKOT	1.11	0.11	N/A	N/A	N/A
31.	TAITA-TAVETA	0.94	0.01	1.30	2	216
32.	KWALEN/A	0.20	0.10	2		N/A
33.	MOMBASA	N/A	0.64	0.04	3	475
34.	LAMU	0.51	0.07	N/A	4	3778
35.	NYERI	0.61	0.60	0.19	4	32
36.	LAIKIPIA	0.98	0.19	0.04	10	1012
37.	E.MARAKWET	1.07	0.3	N/A	N/A	N/A
38.	NAKURU	0.70	0.25	0.4	4	N/A
39.	KITUI	0.61	0.01	N/A	10	17
40.	TURKANA	4.03	0.04	N/A	4	34
41.	SAMBURU	1.29	0.04	N/A	2	285

Source: Fieldwork, 1991/92 and District Development Plan, 1989/93

APPENDIX XXVIII (Key for the Indices)

Index No.	Index Name
1	Persons per square kilometre of arable land.
2	Total value of primary industry output per capita.
3	Percentage wage employment in agriculture.
4	Percentage wage employment in Tourism.
5	Percentage wage employment in manufacturing.
6	Percentage wage employment in wholesale and retail trade.
7	Percentage share of Gross Domestic Product (GDP).
8	Manufactured value added (MVA) per capita.
9	Total population.
10	Population Density.
11	Percentage urban population.
12	Infant mortality rate.
13	Enrolment ratios in primary schools.
14	Government expenditure per capita
15	Voter participation rate.
16	Energy consumption per capita.
17	Road density (Km/Km^2).
18	Length of Railway/1000 population.
19	No. of Nodes in Domestic Air Transport network.
20	Number of Air passengers generated.