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RENEWABLE RESOURCE TRENDS IN EAST AFRICA

Program for International Development
Clark University
Worcester, Massachusetts 01610
1984

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TABLE OF CONTENTS

	Page
Table of Contents	iii
List of Figures	v
List of Tables	vii
Preface	ix
INTRODUCTION	1
Background	1
Audience	2
Principal Findings	2
Data Problems	7
Progress Underway	7
CHAPTER 1 THE EAST AFRICA REGION	9
Regional Definition	9
Ethnic Composition	14
CHAPTER 2 FORCES DRIVING RESOURCE USE	17
Introduction	17
Population History	17
Current Population Distribution	19
Population Dynamics	21
Economic Development and Social Change	28
External Factors in Change	34
CHAPTER 3 THE LAND; ITS CURRENT USE AND DEVELOPMENT POTENTIAL	37
Introduction	37
Soils	42
Vegetation	42
Land Use	46
Protected Areas	51
Forestry	55
Livestock and Pastoralism	56

TABLE OF CONTENTS

	Page
CHAPTER 4 WATER	61
Introduction	61
Rainfall Seasonality	61
Rainfall Intensity	64
Rainfall Reliability and Variability	64
Surface Water: Lakes	66
Surface Water: Drainage Basins	68
Groundwater	69
Water Use	70
Water Use: Irrigation	70
Water Use: Hydroelectricity	73
Water Use: Domestic Water Supplies	76
Urban and Industrial Pressures	79
Marine and Coastal Aspects	80
CHAPTER 5 IMPLICATIONS OF RESOURCE USE TRENDS	85
Summary of Trends	85
Policy Implications	86
REFERENCES	89
SOURCES FOR VISUALS	101

LIST OF FIGURES

FIGURE	TITLE	PAGE
1	Location Map	3
2	Relief and Physiographic Boundaries	11
3	Ethnic Boundaries	15
4	Changes in Consumer Price Indices Since OPEC (1973)	18
5	Population Distribution	20
6	Population Trends: Total Population	23
7	Population Trends: Urban Population	23
8	Population Structure	25
9	Real Per Capita GDP, 1960-1981	29
10	Total Food Production Indices	30
11	Per Capita Food Production Indices	31
12	World Petroleum Price Rises Since OPEC (1973)	33
13	World Coffee Prices	34
14	Ecological Zones	39
15	Soils	41
16	Vegetation	43
17	Change in Forest Cover, Mau Area, Kenya	45
18	Land Use	47
19	Land Use Trends, 1961-1979	49
20	Protected Areas	53
21	Livestock Distribution, 1980	57

FIGURE	TITLE	PAGE

22 Precipitation 62

23 Rainfall Reliability 63

24 Trends of Rainfall Variability: Machakos 65

25 Surface Water 67

26 Kenya: Trends in Water Use 71

27 Irrigated Land 71

28 Electricity: Installed Capacity; Gross Annual Production 75

29 Improved Water Supply 77

30 Per Capita Water Availability 78

31 The East African Coast 81

LIST OF TABLES

TABLE	TITLE	PAGE
1	Physiographic Regions	10
2	Role of Agriculture and Cash Crops in National Economies	12
3	Area and Population	12
4	Selected Social and Economic Statistics	13
5	Population Estimates and Censuses, 1902-1980	19
6	Birth, Death and Fertility Rates in East Africa	22
7	Regional Percentage of Population	24
8	Recent Population Growth Rates of Kenyan and Tanzanian Cities	27
9	Education: Patterns of Change (Percentage of Age Group)	32
10	Debt Burden 1970-1980	35
11	Ecological Zones Map: General Description	38
12	Soil Types and Agricultural Potential in East Africa	40
13	Wildlife Trends in East Africa	54
14	Elephant Count from Tana River to Somalia Border, 1976-1978	55
15	Cattle, Sheep and Goats in East Africa	58
16	Surface Water in Eastern Africa	66
17	Discharge of East African Rivers	69
18	Land Under Irrigation (1980)	72
19	Hydropower Development	74
20	Percentage of Urban Population	79

PREFACE

This study establishes broad benchmarks for past resource trends and future resource use projections in five nations in Eastern Africa. Though many of the region's trends are ominous, especially in deforestation, agricultural yields, soil erosion, population growth, and availability of productive agricultural land, there is also reason for hope. Land users, government officers, and donor agencies have begun to understand the nature of resource pressures, popular mobilization programs have been initiated, procedures for improved resource management are generally being discussed and adopted, local institutions with capability to analyze, monitor, and regulate resource use are slowly expanding. The major unanswered question is whether new policies and practices will evolve quickly enough to arrest current declines and eventually bring about stability in what is now a precarious resource situation. This study concludes that the current position is not without hope. However, major actions and investments will be required on the part of national governments, local land users, and the private sector if future generations of East Africans are to have a future.

This study has evolved from the work of many organizations and individuals too numerous to mention. It has brought together a unique mix of institutions: in the public sector--African governments, the International Affairs Division of the U.S. National Park Service and the Office of Forestry, Environment, and Natural Resources in the U.S. Agency for International Development. In the nongovernmental sector participants have included private voluntary organizations, consulting firms, a private university, and a number of African research groups which work either in academic or parastatal settings. The study's institutional collaboration underlines the important point that no single institution or individual has the necessary skills, information or financial backing to solve East Africa's resource problems. Instead, resolution will emerge only through collective action among varied and diverse instititions.

There are several unique aspects to the study. First, it is based on the premise that only by looking at interactions among sectors will successful and sustainable forms of development begin to occur. We have chosen a five country region, but the same approach can and should be applied at more detailed levels to meet local needs. Second, a conscious attempt has been made to use visual as well as verbal communications. The maps, charts, and graphs are central to the presentation and carry the report's primary message. Third, the maps are a unique compilation of information not previously presented in any similar format. Fourth, the data are packaged in forms which will be meaningful to decision makers and policy makers in the hope of stimulating greater action within both the resource management and development communities of the region.

Several individuals have been instrumental in supporting this publication. Central to its conception have been Jeff Tschirley and Hugh Muller in the National Park Service as well as Molly Kux in USAID. Without their vision and backing, the project would never have been possible. Another crucial ingredient was data collection, sifting, analysis, and presentation in visual form. This major work has been accomplished under the leadership of Ron Eastman, Tim Fast, Lori Sklut, Jeffrey Steinberg and Anne Gibson, all in the Clark University School of Geography Cartography Lab. They have pioneered a distinctive set of visuals which will command considerable attention. Supplementary data for both visuals and text were provided by Random DuBois (University of Chicago) and Bill Weber (University of Wisconsin). Dan Tunstall of the World Resources Institute offered timely and extremely helpful

advice; Norman Myers reviewed the conceptual approach and offered dozens of anecdotes and examples. Finally, a group of dedicated and highly competent research assistants have carried out literature reviews, data analyses and map compilation work. Special thanks go to Elani Thanou, Shajaat Ali, Eliaz Shlomi, Raechael Markell and Tom Dart.

Perhaps most important to acknowledge are the region's residents, the 56,000,000 East Africans who are both the users and protectors of the region's resources. These are the people who will ultimately decide how the region's resources will be used. This report is dedicated to these people in the hope that the presentations will guide policy makers toward a more just and more balanced use of the region's primary resources.

Finally, this report should be viewed only as a first step toward looking at the multitude of factors that affect the development potential of East Africa. Substantial additional work will need to be done in the future, both to refine and expand upon the work done here so that decision makers at all levels will better understand the interactions that are occurring in the region.

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INTRODUCTION

Background

In 1971, Tanzania celebrated its first decade of independence. These were buoyant days in East Africa. Petroleum sold for $2.00 a barrel, the rains in the sixties had been abundant and therefore livestock health and food production had been good, population for the region (1969) stood at a manageable forty million, the East African community was functioning well enough, the governments of the region were generally stable, wildlife had sufficient access to habitat to maintain numbers and lifestyle. For Tanzania, President Nyerere's inspiring Arusha Declaration was but four years old and the bloom had not yet slipped away from his vision of Ujamaa.

To proclaim the accomplishments of Tanzania's first independent decade, Mwalimu* extended invitations to British colonial officials who had previously served Tanganyika -- it has been Tanzania since 1964 -- as district commissioners. D.C.'s are notoriously a rugged, no nonsense lot. Anxious to see how "their" districts were faring after ten years without them, many returned. Almost without exception, the former D.C.'s were impressed with the progress Tanzania had achieved. Most notable was education where school enrollments had soared and literacy rates increased dramatically. Food production was good, rural health and water programs expanding, roads and rails in generally good order, national parks and protected areas expanding, currency stable, and trade within the region as well as export of cash crops increasing. (Personal communications from one of the former D.C.'s, Dr. H.J. Cooke). The buoyance of the sixties was generally felt in other East African countries as well.

Unfortunately for the region, the euphoria was not to last. While the D.C.'s toured their former territories and talked with old friends, seeds of change, though not yet apparent, were sprouting. Some changes came from external sources and were beyond the control of anyone in East Africa. Other forces came from within. A decade later, East Africa would be a very different place.

By the early 1980's, petroleum had risen in price more than 15 fold with devasting impacts on agriculture, transportation, energy, and water supply. A series of droughts in the mid-seventies crippled livestock numbers and cut deeply into food production. A tragic revolution in Uganda and subsequent war destroyed Uganda's previously productive economy and cost Tanzania something like $500 million in foreign exchange to finance the war of liberation. Human population began to reflect improved health practices and growth rates increased sharply -- by 1983 the region's population was 63 million (65 percent rise in 14 years). The East African Community had collapsed with its previously good regional cooperation and trade coming to a standstill. Turmoil in nearby countries (Somalia, Ethiopia, Zimbabwe) disrupted trade and in some cases created a substantial dependent refugee population which placed still additional strains on the region's burdened resources.

In the context of this dramatic shift from an early independence of optimism to a later independence of economic and

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* Mwalimu means "great teacher" in Kiswahili and is the affectionate term by which Tanzanians refer to their President.

political vulnerability, it is important to examine impacts on the region's natural resource base and to determine whether the new conditions of the 1980's may require a rethinking of national resource management practices and policies. To this end, this report reviews resource trends in East Africa over the last few decades and develops a series of possible recommendations.

Many recent publications have surveyed the future prospects of global resources. A few, like Global 2000 (Coun. Env. Quality, 1980) UNEP's state of the environment report (Holdgate, et al. 1982), and Worldwatch Institute's 1984 (Brown, 1984) have attempted a worldwide assessment of major resource use problems. Others focus on particular sectors (food or energy) or one resource (petroleum, water, or forests), and attempt a global analysis of past trends and alternative future projections. Few if any have focused on the interactive pattern of resource use in particular regions of the developing world. This study considers resource pressures in five East African countries, encompassing Kenya, Tanzania, Uganda, Rwanda, and Burundi. It presents a regional picture of resource use and makes judgments about the most important problems arising from current trends. Concern for this relatively small and discrete area will provide a picture more specific than global studies but still broad enough to deal with interactions among different patterns of resource use and their resultant problems.

The goal of the report is three fold:

1. To promote a better understanding of recent trends in the use of East Africa's renewable resources;

2. To indicate where these trends are leading;

3. To alert policy makers to potential conflicts and to prepare host countries and donors alike for the tasks of modifying adverse trends.

Audience

This report is addressed primarily to two important groups of decision makers in and around East Africa. First and most important are middle and upper level professionals and government officials in the countries concerned, together with donor personnel working in these countries. It is intended as a tool for planners, financial analysts, economists, engineers, managers, political leaders, journalists and others whose decisions will affect the well-being of East Africa's resource base. The second group are policy and technical development assistance officers in the United States and Europe who are concerned either with East Africa as a region and view this effort as a microcosmic picture of resource trends in Africa or use it as a prototype for similar efforts in other parts of the world.

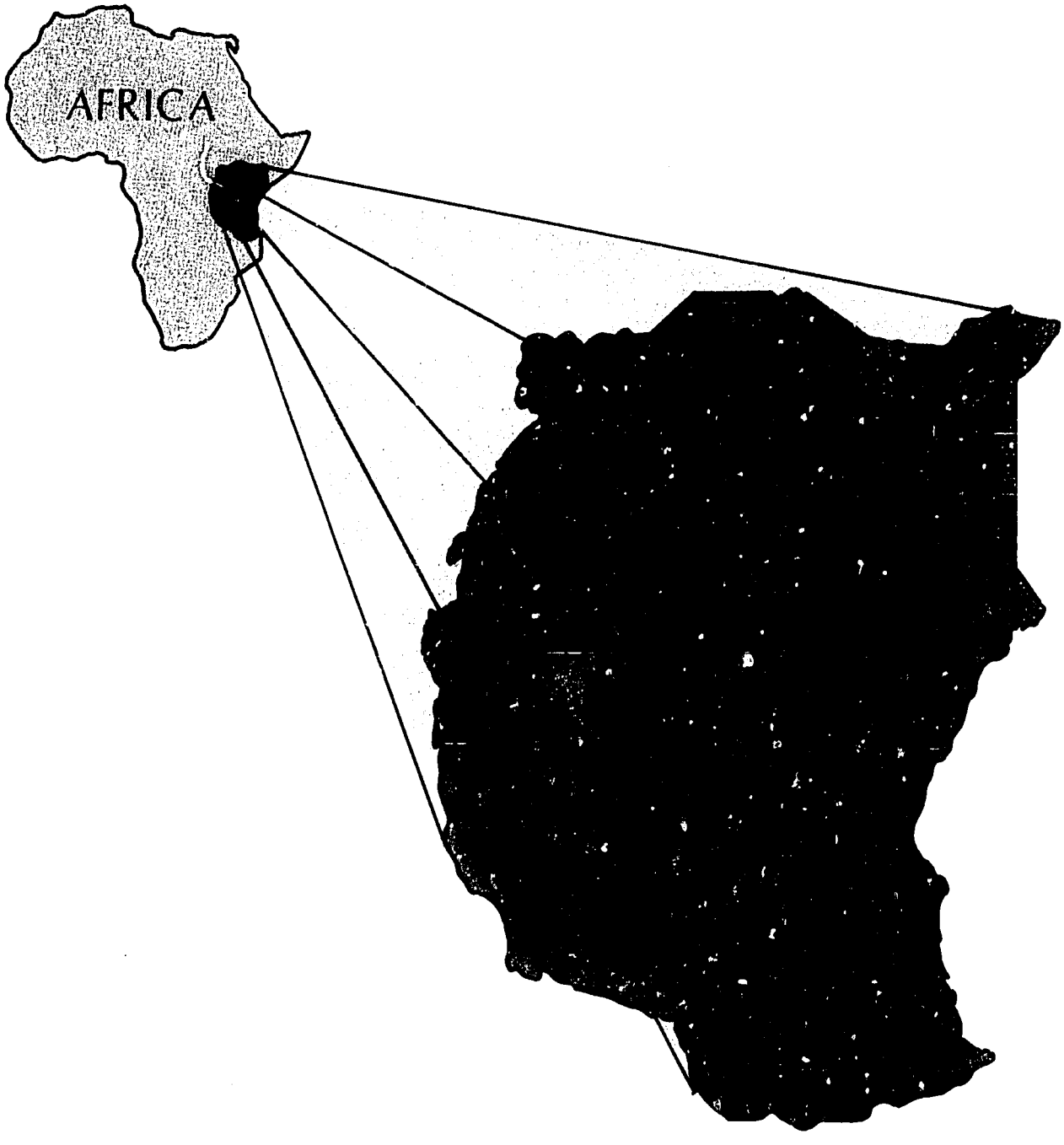
It is clear that most decisions about resource use are taken in the context of more general development planning with strong economic and political factors usually preeminent. This report seeks to provide policy-makers with a contextual framework of resource use and trends for improving development projects, regional planning, and resource use planning and management.

Principal Findings

Three major trends and a dozen or more lesser trends are apparent. All are interconnected as no resource stands in isolation from any other. Yet the three broad trends can be identified as separable from both an analytical as well as a planning/policy perspective. The three are:

FIGURE 1

Location Map



1. Pressure on the Land.

Agricultural land, per capita, is decreasing. Simultaneously, food output, per capita, is declining. The events of the seventies have created a unique situation whereby more people are anticipating a higher standard of living from a constant or even shrinking resource base. Livestock numbers on grazing lands are increasing. These new stock numbers are possibly acceptable when the rains are good. In time of drought, however, the numbers clearly exceed the support capacity of the range. Pressures on marginal (arid and semi-arid lands) are increasing as people move in search of more and better land. Soil loss is increasing, largely because marginal lands are being used for agriculture. Wildlife are losing out to expansion in agricultural and grazing practices. Cash crops and food crops compete for the same land.

2. Pressure on Water Resources.

Parallel to land pressure is concern about the long-run viability of water supplies. Cultivation of marginal land has caused sedimentation to increase in streams and rivers. Dams and reservoirs are filling with silt prematurely; coastal areas adjacent to river mouths are suffering due to beach siltation, depletion of fishing, and destruction of coral and mangrove areas. Urban and industrial waste disposal threatens water quality, especially around the larger cities of Nairobi, Mombasa, and Dar es Salaam but increasingly in smaller cities and towns such as Kisumu, Eldoret, Tanga, Webuye, Kigali, Nakuru, and Thika.

3. Growth in Human Population.

Underlying both water and land pressure are people pressures. Birth rates continue at high levels; mortality rates are dropping. The net effect is rising population growth rates. Kenya, for example, is the fastest growing nation in the world. High population growth rates lead to larger percentages of young people than in other parts of the world who are economically dependent upon others. Rising population rates help to create significantly higher rates of urban expansion. As cities grow, so do urban problems of land pressure in peri-urban areas as well as tensions related to urban unemployment.

Although these three major trends are identified separately, they have meaning only when analyzed together. For example, increased population in Kenya's Central Province is pushing people into neighboring marginal lands and increasing rates of tree removal, both to clear new land as well as to provide woodfuel. Reduced vegetation affects water supply in two ways: increased siltation and decreased absorptive capacity of the soil. The result is higher probability of floods during the rainy season and less water available for human and agricultural use during the dry season. These trends thwart food production; less locally grown food means higher numbers trekking to cities seeking wage employment.

Other examples of linkages among the three major trends could be cited. The point, however, is not to offer a multitude of examples. Rather, it is to suggest that because each problem touches on virtually all aspects of resource issues, so solutions and policies must integrate all technical and socioeconomic political dimensions.

One way to consider increased linkages is to examine some of the subthemes which lie within the three larger trends. They include:

1. Land

(a) Per capita agricultural land is decreasing.

In the last decade, average arable land, per capita in Rwanda has dropped from .6 ha. to .5 ha. In Burundi, average land per capita will reduce by 20 percent in the next 20 years. In Kenya average arable land per capita is now .89 ha.; by 2000 it will have declined to .3 ha.

(b) Food production, per capita, is declining.

Reduction, per capita, of arable land is not automatically a problem. However, there has been no simultaneous increase in technology or other inputs for agriculture. As a result, food production, per capita, is getting smaller for the region. Analysis of this downward trend is complex. For Africa as a whole, population is increasing annually at rates of roughly 3.5 percent; food production is increasing at roughly 2.5 percent. The slower production growth and higher population rate results in decreasing overall per capita food output. Individual statistics for each of the five East African countries are presented in Figures 10 and 11.

(c) More pressure on marginal lands and urban areas.

Population increase is spilling over into less productive or more intensely used areas. Growth rates of seven percent per year are recorded for parts of Kenya's semi-arid land whereas national growth is only four percent per annum; urban growth is expanding much faster than total growth, as noted in Figures 6 and 7. Forests and woodlands are disappearing because of increased land pressure.

(d) Growth of livestock numbers.

Wildlife are generally withdrawing into protected areas because pastoralists and farmers are gradually encroaching on wildlife habitat. Whereas the region in the 1950's could be characterized as a sea of wildlife with intermittent human settlements, much of the region today is a vast ocean of human settlements with occasional stands of wildlife, protected forest, and preserved natural habitat.

(e) Endangered species.

Although most of the larger wildlife species are safe for a decade or more, a few are cause for major concern. Elephants, cheetas, and rhinos seem to be particularly at risk although data are inconclusive for actual numbers. Gorillas in Rwanda are stabilized for the moment though continued protective efforts will be required. The larger problem seems to be that wildlands are not yet integrated into overall land use plans and local livelihood systems. The lack of integration means that habitat encroachment continues and will continue. As habitat disappears, so will its occupants.

2. Water

(a) Deterioration in moist areas.

Soil loss in areas of high agricultural potential is a relatively new trend and seems to be accelerating. Although comprehensive data are not presently available, sedimentation rates are increasing in watersheds of high and medium potential areas. Silt and sedimentation, especially in filling of reservoirs, is becoming severe.

(b) Deterioration in arid and semi-arid lands.

Water supplies are also a growing problem in marginal lands now being developed. In grazing areas, although absolute water scarcity is sometimes a problem, the larger issue is that boreholes attract people and livestock, thereby increasing stress on vegetation. Large numbers increase vulnerability so that in time of ecological stress, livestock, people, and habitat are significantly more at risk than a decade ago. Increased grazing pressures also are adding to soil loss in semi-arid areas which, in turn, increases sedimentation in rivers.

(c) Conflicts and water use.

Urban and industrial water uses are creating problems, especially along the coast, adjacent to perimeters of inland lakes and near rivers and streams. Pollution inventories are episodic but indicative of a growing series of problems. Water supply is also a problem for rapidly growing cities and towns. Finally, water systems are not keeping pace with increases in population and it appears that national goals for water supplies for the end of the century may not be achieved, in part because of financial limitations, partly because of population growth and partly because of resource degradation reducing total supply and/or storage capacity.

3. Population

(a) Population growth.

A high of 4 percent annual growth in Kenya and rates of mostly 3 percent or more (2.5 percent in Burundi is the exception) is of continuing concern. The region's population, now approximately 63 million, will essentially double in the next 20 years for a projected total of 109 million in 2000. Before zero population will be achieved in the 22nd century, the region's population will be over 400 million.

(b) Dependent population.

High growth rates lead to higher percentages of young people in the population pyramid. For most of the region, half of the people in each country will be less than 14 years of age, continuing through 2000. Dependent population of young people alone by 2000 is projected to be approximately 55 million which is about the same as the total population at present. Fifty percent dependents tax the productive ability of the working population.

(c) Growth of urban population.

Urban areas are growing much faster than population as a whole. Urban growth is also extending to some of the smaller regional towns. Two dramatic

examples (Mbeye in Tanzania and Kisumu in Kenya), increased more than 500 percent from 1962 to 1979. Another example of urban growth is in Tanzania where the urban population in 1980 was slightly more than 2 million. By 2000, Tanzania's urban population is projected to be 12 million, whereas total growth rates for the region are 7 to 8 percent.

Data Problems

In the midst of identifying resource trends, it is important to acknowledge a number of uncertainties and inconsistencies in the region's information base. These difficulties include:

1. Data Availability

Any set of trends and projections must necessarily rely on available data. Although East Africa, relative to other developing nations, is moderately rich in data, resource information is still uneven in quality, quantity, and consistency. For example, none of the five countries has basic census data for trends in wildlife or livestock. Longitudinal data for vegetational change since independence in any of the five nations is a matter of inference and calculated estimates. Such data shortcomings must be factored into the weight given to these trend analyses.

2. Regional Comparability.

To develop trends for a region requires comparable data in terms of dates, instruments, and methodologies. Such comparability is simply not available for East Africa. For example, wildlife information exists as a series of individual studies rather than region-wide comparisons. Water data, food production information, forestry loss, and soil erosion are available as bits rather than a full picture. The only possible exception is human population data for which there is reasonably good information throughout the region. As a result, this study may more accurately be termed a series of national reviews linked together rather than a comprehensive regional analysis.

3. Reliability of Projections.

Futurology is an uncertain science. As some present trends may not continue and as many unanticipated events will undoubtedly take place, the projections are inherently tentative. Nonetheless, the trend analyses and projections do show policy and planning officials the direction in which the resource base is moving and what may happen if present policies continue. To this end, the projections provide a valuable planning tool for those working in policy and investment efforts.

Progress Underway

While this report has identified three trends that are approaching crisis proportion and which require urgent action, it must be noted that a number of signs suggest that resource degradation can be controlled. With the exception of Uganda, the region has done relatively well in safeguarding its national parks. In particular, Kenya's ban on hunting has been moderately well enforced and although there is concern for the well-being of a few wildlife species, most large mammals seem to be secure. Awareness of soil loss is now generally realized in the region. Kenya's President, Daniel arap Moi, has led a widely publicized personal campaign to build bench terraces and cut-off drains; Rwanda's President, Major General Juvenal Habyarimana has been vigorous in planting

trees and implementing energy conservation programs; Tanzania's President Julius Nyerere has been a solid and persistent voice safeguarding agriculture and forest resources. Rwanda reports encouraging results in the application of techniques in agro-forestry. Kenya's Integrated Project on Arid Lands (IPAL) has developed several sound land management strategies for increasing production and preserving habitat in the region's dry areas.

Other success stories deal with small farmer activity. Small irrigation in and around Nairobi has proved successful for market garden production and simultaneously at curbing soil loss; sub-catchment planning projects in the Machakos district of Kenya have made a major impact on arresting soil loss. Multiple cropping in Tanzania's Arusha and Kilimanjaro regions has worked well in retaining soil. Yet the region has not yet turned the corner on soil protection or land stabilization. More inputs are required as well as a strengthened infrastructure to monitor, regulate, and enforce resource management policies. Although progress has been made, additional support is still required.

With these trends in mind, then, it becomes clear that resource management assumes a critical role in any plan or assessment for local, national or regional development in East Africa. The events of the seventies have signaled that all is not well for the region's resource base. Several ominous trends suggest that the resource cushion or capital which existed a few decades ago is rapidly disappearing. Although there will probably be no crisis during good or even "normal" years, the trends illuminate a vastly weakened capability to deal with the inevitable "bad" years. Land pressure, population concentrations, fuelwood depletion, food production strains, habitat change, and water shortages are all gradually creeping. They expand in quiet yet persistent ways that may not be apparent to the casual or frequent observer. Yet the creeping continues, illuminated only when drought, war recession or crop failure exposes the vulnerability they have created.

Action is required. It demands the political support of the region's leadership, popular backing from the broadest possible base in both rural and urban areas, a solid institutional infrastructure, financial assistance from the United Nations and the international donor community and a sound technical approach which draws upon mostly local technologies and skills. There are points of encouragement in all of these areas. The next steps require coordination and cooperation on the part of all of the above constituencies.

CHAPTER 1 THE EAST AFRICA REGION

Regional Definition

For this study the region of East Africa includes five nations: Kenya, Tanzania, Uganda, Rwanda, and Burundi (see Figure 1). For veteran Africanists, East Africa is sometimes limited to the three members of the former East African Community (Kenya, Tanzania, and Uganda). However, the growing regional linkages emerging among the old EAC members and Rwanda and Burundi suggest that this study will have more value by including all five nations. There are several bonds of commonality.

All five share a generally similar time span of colonial domination, stretching from the last decades of the nineteenth century to the early years of the 1960's. Each borders Lake Victoria or lies within the watershed of one of Victoria's major tributaries, the Kagera.

Language and culture offer another bond, especially in the developing unity of Kiswahili. Although local languages vary greatly and although two European languages are found, Kiswahili is gradually becoming a lingua franca for the entire region, at least for commercial purposes. At present, Kiswahili is the national language of Tanzania. It is widely used in Kenya, especially in central and coastal areas. Increasing economic contact between the coast and the interior are rapidly expanding both the language and the culture. For example, most small merchants and traders in Kampala, Bujumburu, and Kigali have a rudimentary working knowledge of Kiswahili.

Economic ties and trade strengthen the region's identity. During colonial times, British domination of the East African Community and Belgian control of Rwanda and Burundi kept the two separate. The three EAC members looked to British institutions as a means of identity; Belgian policies pulled Rwanda and Burundi toward Kivu and other parts of the former Belgian Congo. From the 1960s, political independence, combined with economic dependence on the ports of Dar es Salaam and Mombasa, brought the five nations much closer together. Goods carried by road and rail provide lifelines for Uganda. Road transport into Rwanda and Burundi is the only sustained source of imports and exports for the two. Interior portions of Kenya and Tanzania are also heavily dependent upon port access.

A final commonality is rural livelihoods and an economic dependence on agricultural exports, as noted in Table 2. Approximately one half the cash value of goods and services produced in each country comes from agriculture; with the exception of Kenya, at least two-thirds of the foreign exchange for each country is earned through cash crop exports.

Though there are common characteristics and similarities in the region, there are also differences. For example, Rwanda and Burundi are tiny in physical size while Tanzania is quite large (Tanzania has 37 times more land than Rwanda). Population densities are much greater in Rwanda than, for example, in Tanzania. The vegetation is also varied. Although it is dominated by typical plateau savanna and thorn bush complexes, the region as a whole offers a full range of plant life varying from alpine to desert species. Tropical mountain rainforest occurs in mountain areas; desert or semi-desert vegetation is widespread in much of northern and northeast Kenya. Table 1 and Figure 2 highlight more of these physical differences.

TABLE 1 PHYSIOGRAPHIC REGIONS

(1) The Highlands

The mountain areas of East Africa occur mostly around the Rift Valley zones, although old volcanoes such as Kilimanjaro and Meru in Tanzania and Mt. Kenya in Kenya are prominent. The southern highlands of Tanzania also extend well beyond the immediate rift zone. Some soils of the highland areas are derived from volcanic materials and this feature, together with the high rainfall, result in a high level of productivity of the natural environment. Population densities are generally high.

(2) The Rift Valley

The Rift Valley of East Africa is clearly one of the physiographic wonders of the world. It extends through this region in two arcs, each characterized by a lake-filled trough 70 kilometers to 150 kilometers across and sharp valley margins 600 to 700 meters high. The floor of the Rift is an important animal production zone in Kenya but elsewhere its lakes are the most important resource. Rainfall and human population is light. The valley margins are wooded at highest elevations and merge into the highland zone.

(3) The Lake Victoria Basin

Lake Victoria is the second largest fresh water lake in the world (Lake Superior is the largest). Its margins receive good rainfall. The topography in the basin is gently rolling interspersed with low hill ranges and isolated hills. Soils are varied and generally well suited for agriculture.

(4) The Plateaus of East Africa (The Central Plateau, the Eastern Plateau, the Uganda Plateau and the Southeastern Plateau).

By far the largest part of the East Africa region is the gently sloping and rolling plateau surface, varying in altitude from 500 meters to 1000 meters. (Eastern Plateau) to 1000 meters to 1752 meters above sea level (Western Plateaus). Conditions on the plateau are quite varied but soils are of only moderate potential and large areas have only modest annual precipitation. Much of the central plateau in Tanzania is covered by tsetse infested thorn bush and even larger areas of the eastern plateau in Kenya have rainfall totals (250-500 mm.) or a range too small for arable agriculture. The major game preserves of the region are located in this physiographic zone. Human population is generally sparse.

(5) The Coastal Zone

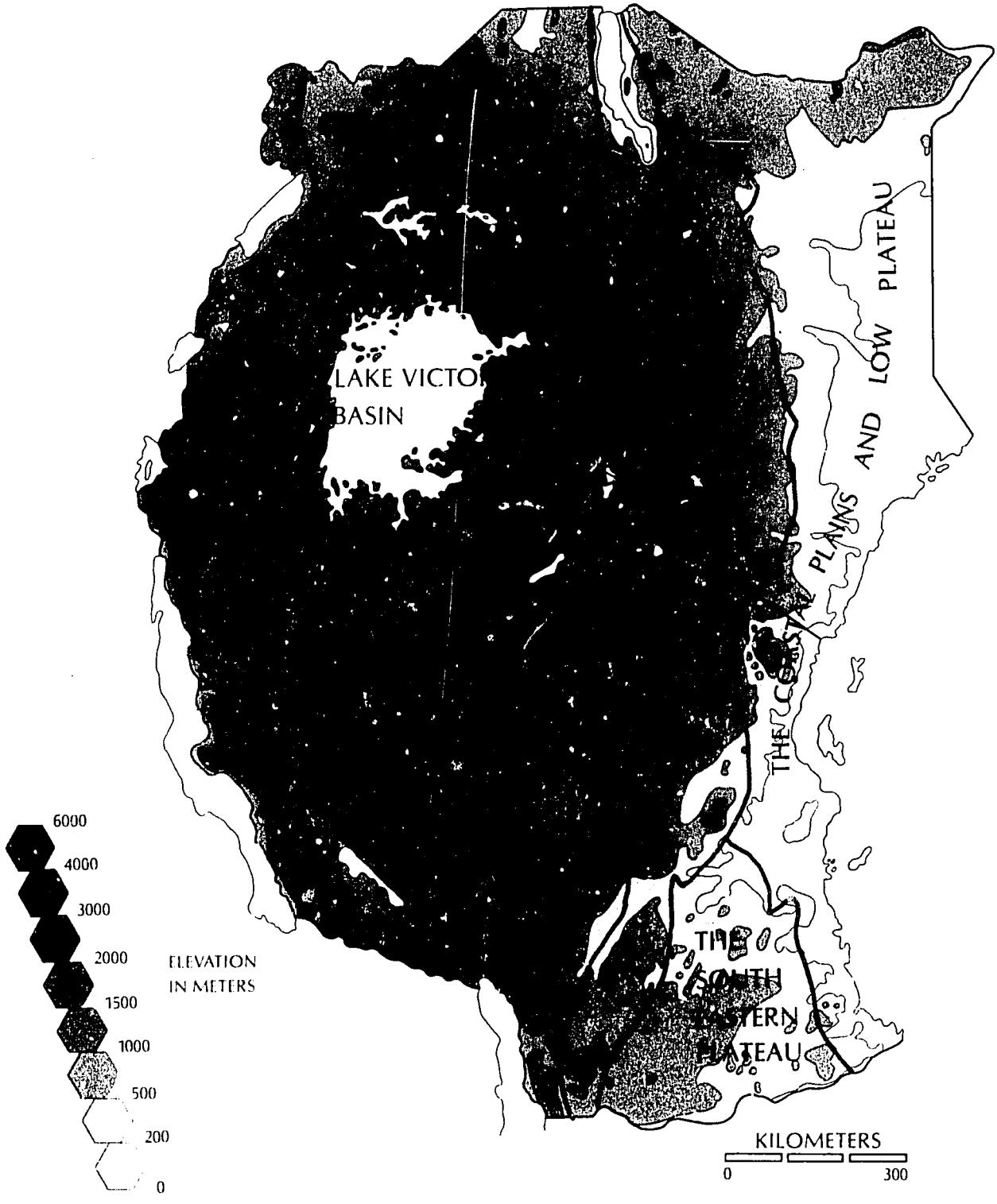
The coastal zone which includes the offshore islands of Zanzibar and Pemba is a distinctive area. Although the limey soils are not very fertile, the higher rainfall allows tropical crop and fruit production. Coral islands and mangrove swamps are each a feature of parts of the coastline. Population densities are moderate to high except along Kenya's northern coast and the flat plains in eastern Kenya.

(6) The River Basins

The East African region is the source of two of the world's great rivers, the Nile and the Zaire (Congo). But the regional rivers including the Tana, Pangani, Wami, Athi, Rufiji, Kagera and Ruwuma are probably more important in terms of local resources. The Nile, discharging northwards through a series of lakes already produces all of Uganda's electricity and has significant future potential for hydropower. The regional rivers originating in the well-watered uplands cross the drier plateau areas where there is irrigation and hydro potential. Three rivers, the Tana, Rufiji and Wami, have significant deltas. Ironically, none of the rivers supports heavy population concentrations though the region of the Rufiji basin in southern Tanzania is generally well populated.

FIGURE 2

Relief and Physiographic Boundaries



Oxford Atlas, 1978; et al.

TABLE 2 ROLE OF AGRICULTURE AND CASH CROPS IN NATIONAL ECONOMIES

	Agriculture as a percentage of GDP	Percentage of total population in rural areas	Percentage of foreign exchange derived from all cash crops
	1977	1977	1975-1977
Kenya	41	87	53.9
Tanzania	44	90	80.4
Uganda	54	89	96.3
Rwanda	46	95	65.3
Burundi	64	98	94.2

Source: U.S. Department of Agriculture, 1983.

TABLE 3 AREA AND POPULATION

	Date of Independence	Total Area (sq. km.)	1983 Estimated Population (thousands)	Pop. Density (People/sq. km.)
Kenya	1963	582,750	18,600	31.9
Tanzania	1961	939,652	20,500	21.8
Uganda	1962	235,690	14,100	59.8
Rwanda	1962	25,900	5,600	216.2
Burundi	1962	28,490	4,500	158.0
		1,812,482	63,300	35 Weighted Average

Source: U.N. Statistical Year Book, 1983.

From an economic and social viewpoint, the nations also vary. Kenya's economy has developed the largest manufacturing capability and is also the most diversified. The other four have much lower per capita gross national products. Rwanda and Burundi have a productive agricultural economy but a low level of GNP per capita, partly because of the low level of activity in other sectors of the economy and partly because much of the agriculture is still at the subsistence level. Given these differences, however, agriculture and pastoralism dominate all five national economies; manufacturing and industrial output are small; exports are mostly agricultural commodities. All five nations face a major struggle to improve the subsistence standards of living of many of their citizens.

TABLE 4 SELECTED SOCIAL AND ECONOMIC STATISTICS

	GNP Million $US 1980	GNP Average Annual Growth Rate 1960-1981 % age	GNP per capita 1981 US $	Development Assistance per capita 1979 US $	Defense Expenditure per capita 1979 US $	Adult Literacy Rate % 1977
Kenya	6769	2.9	420	22.7	13	55
Tanzania	4919	1.9	280	32.2	15	66
Uganda	2778	0.6	220	2.9	NA	52
Rwanda	1156	1.7	250	29.9	2	50
Burundi	881	2.4	230	23.0	NA	25

Sources: World Bank World Development Report. 1982, 1983.
World Bank Accelerated Development in Sub-Saharan Africa. 1981.
Sivard, Ruth. World Monetary and Social Expenditures. 1983.

The population map (Figure 5) indicates that the region is characterized by "islands" of dense population floating in "seas" of less densely peopled areas. The highly populated areas typically have densities of over 150 persons per squ kilometer and the low density areas from 1 to 10 per square kilometer. Tanzania and Uganda generally have larger areas with moderate population densities while Rwanda and Burundi have highly concentrated densities. Kenya has some pockets with great concentrations but also has the most area in the region which is thinly settled.

The islands of dense population are mostly in highland areas with substantial and reliable rainfall. As the region derives its livelihood mostly from agriculture, good rainfall is essential to intensive land use. In addition, the elevation provides warm days and cool nights or an ideal climate to produce export crops such as tea and coffee. These productive zones have attracted many people.

The "seas" of moderate to low population densities are generally drier and plateau areas with less rainfall (250mm to 750mm) and higher temperatures. With hotter climate patterns, evapotranspiration increases and agriculture becomes less productive. Traditionally, these more marginal areas have supported pastoralists and wildlife. In early days, when human population pressures were moderate, these grazing areas provided a good life for nomadic people. More recently, agriculture has begun to spill over into the marginal lands, thereby placing increased pressure on the rangelands and their users.

The diversities of the region are based on the wide differences in the natural features of topography, soils, rainfall and vegetation and even more emphasized by the range of human uses of this varied resource base.

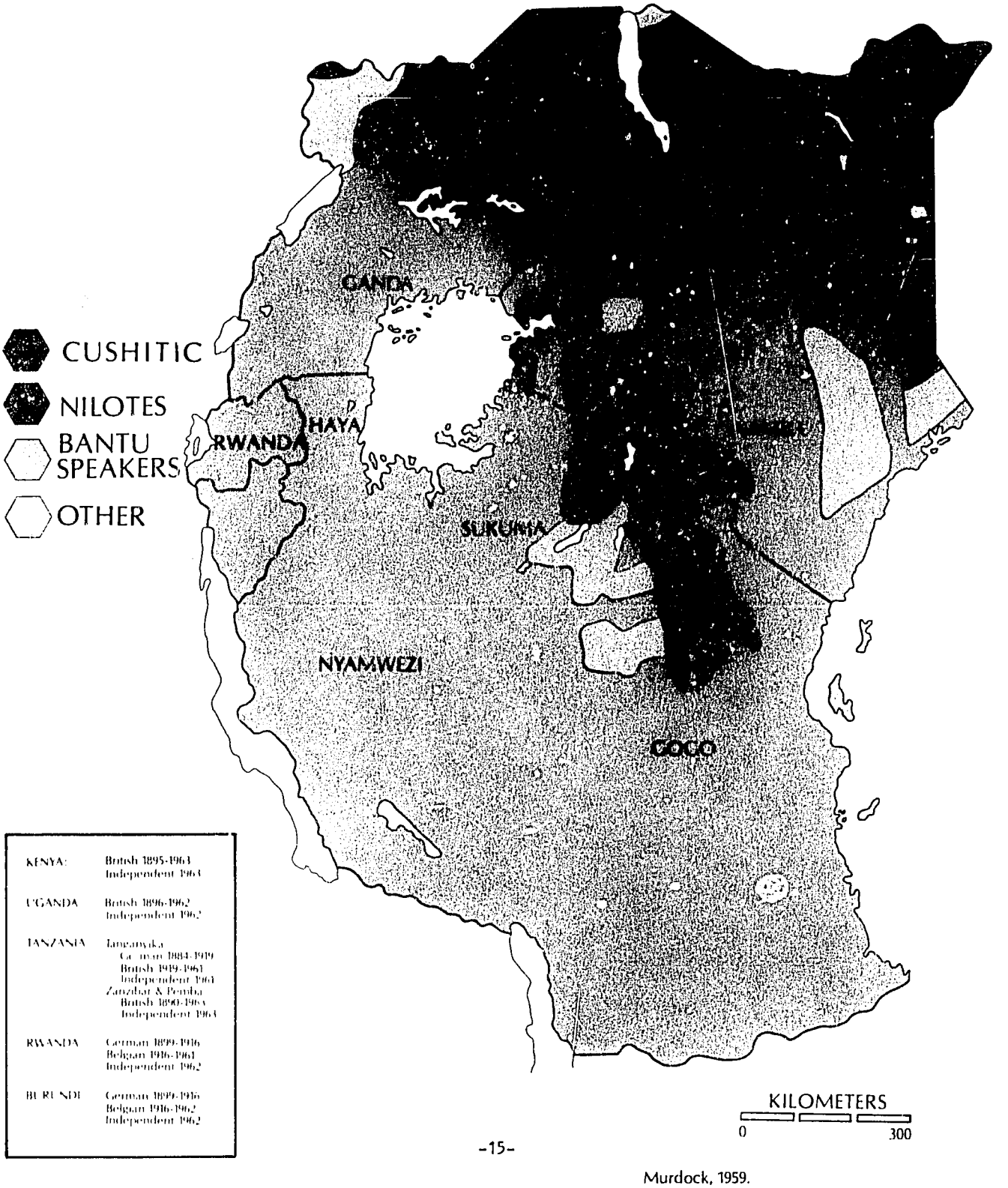
Ethnic Composition

The map of ethnic boundaries (Figure 3) provides an overview of cultural varieties that have become traditional to the area. The map locates the three major culture groups that have made the region an extensive meeting ground and zone of interaction. The largest group, both in terms of physical extent and numbers, are those who speak one of the Bantu family of languages. They are thought to have arrived from central parts of Africa beginning about 1,000 years ago or even earlier. As they populated the region, their skills in iron working and their generally centralized political traditions gave them supremacy over hunters and gatherers who had previously lived there. Bantu speakers are generally agriculturalists though many have learned skills in livestock management from neighbors. Some of the Bantu speaking groups, such as the Buganda, developed great kingdoms and ruled huge populations and large amounts of territory.

The second prominent group are the Nilotes and a related group known as Nilo-Hamites. They trace their origin and take their name from the Nile Valley, to the north. Nilotes tend to be agriculturalists and pastoralists while the Nilo-Hamites are generally tall pastoralists with traditions of migrant livestock management as their basic lifestyle. Nilotic migrations brought them into the region sometime during the sixteenth and seventeenth centuries. Because their livelihood system generally preferred semi-arid ecosystems, there seems not to have been a unified major assault or confrontation with the Bantu speaking agriculturalists. However, even the best of complementary systems have produced extensive competition and local conflicts. Disputes, for example, between the Bantu speaking Hutu and the Nilotic Watutsi in Rwanda and Burundi are well known. Competition among Kenya's Nilotic

FIGURE 3

Ethnic Boundaries



Murdock, 1959.

Luo and Bantu speaking Kikuyu is another example. Land use conflict between the Nilo-Hamitic Masai and the Bantu speaking Kamba is still another instance.

The third group are Cushites, sometimes identified as Galla, Somalis, or Oromo. Though limited mostly to northern parts of Kenya, their presence is extremely important. Their nomadic exploits of courage and daring are well respected among Bantu speakers and Nilotes alike. Their ethnic and linguistic association with the nation of Somalia has sometimes led to political sensitivities. Finally, commercial skills, especially among the Somalis, have led to an East African commercial network of traders which extends into Tanzania and even Rwanda and Burundi. For example, the land-locked status of Rwanda and Burundi makes the two nations almost totally dependent on truck transportation to supply petroleum, manufactured goods, and imported foodstuffs. A significant portion of these trucks are driven and sometimes owned by Somalis.

The colonial territories in East Africa became defined towards the end of the last century. By 1900, boundaries decided among European powers began to be a feature of East Africa. The initial division was between a German dominated southern group of states (Rwanda, Burundi, and Tanganyika) and a British dominated northern group of Kenya and Uganda. The division between the territories cut across many previously established ethnic territories. For example, European colonial boundaries cut through the middle of two different pastoral groups: the Masai and the Karamajong. As these borders subsequently would become national boundaries, their significance is a major influence on the region's history.

The different groups already had differing life styles ranging from the nomadic Boran to the agricultural Ganda. To a considerable extent these differences became wider as a result of colonial rule. Generally, peoples with some agricultural tradition in higher rainfall areas sooner or later entered the cash crop economy while the pastoral peoples in more marginal areas remained essentially isolated from the European economy.

Although the basic pattern of national boundaries was established nearly 100 years ago, the end of World War I brought change. Mainland Tanzania (Tanganyika) became a British mandate for the League of Nations while Belgian colonial authorities assumed mandates over Rwanda and Burundi. These adjustments set the stage for British colonial administrators to sponsor an East African Community among Uganda, Kenya and Tanzania. This community continued to function after independence until the mid-1970s when differing political and economic practices of the countries eventually led to its dissolution.

From a resource management consideration, it is helpful to note that before the 1890s almost all resource decisions were taken by local officials, chiefs, and village leaders. With the advent of colonial rule, national resource management systems replaced some elements of the local systems. Forest reserves were marked out, game preserves were demarcated and land set aside for European farmers, especially in Kenya and northern Tanzania. Since independence, the national governments have retained most of the resource management functions, though each national government has followed a different policy. In Tanzania, major decisions about local agriculture were made by the national government as part of the Ujamaa village program while foreign ownership of natural resources was actively discouraged. In Kenya, large individually owned farms continue to be an important part of the agricultural system, while in Rwanda and Burundi tiny household farms of a traditional nature continue to dominate resource use.

CHAPTER 2 FORCES DRIVING RESOURCE USE

Introduction

Three main forces drive resource use in East Africa:

... growing numbers of people and their distribution;

.. economic development, social change and rising popular expectations;

... international forces which impact national and local economies.

The forces are complex and not easily disaggregated into simple cause and effect relationships. It is clear that a number of trends in the middle part of this century resulted in significantly larger numbers of people. The new population numbers have resulted in a new order of density, mostly in the high potential areas as well as spill-over into towns. A further result was the initially gradual and then later increased movement of people from moist to drier areas. Over the same period, global and national factors have greatly changed the face of East Africa. People everywhere have some benefit from education and health as well as a sense of development that raises expectations for urban and/or wage employment and a more consumer oriented life style.

Figures for the region's population growth dramatically illustrate the first: population almost doubled between 1960 (30.7 million) and 1980 (56.4 million). Adult literacy demonstrates the second: in 1960, the region's average literacy rate was less than 20 percent and roughly one third of the primary age children went to school; by 1980, adult literacy had risen to over 50 percent and as many as 70 percent of the region's primary age children were in school. Petroleum prices illustrate the third force. The international price rose from roughly $2.00 a barrel in pre OPEC 1972 to a high of $34.00 in 1982, thus greatly impacting the cost of many goods in both the commercial and informal sectors (see Figure 12). Consumer prices followed suit. As none of the five East African nations produces oil, the OPEC pricing has had especially heavy impact. Figure 4 indicates some of these price changes, noting, for example, that in less than 10 years prices in Kenya and Rwanda have more than doubled; for Tanzania and Burundi, they have tripled; and for Uganda, the UN has been unable to obtain data since 1977 when there had been a seven fold increase.

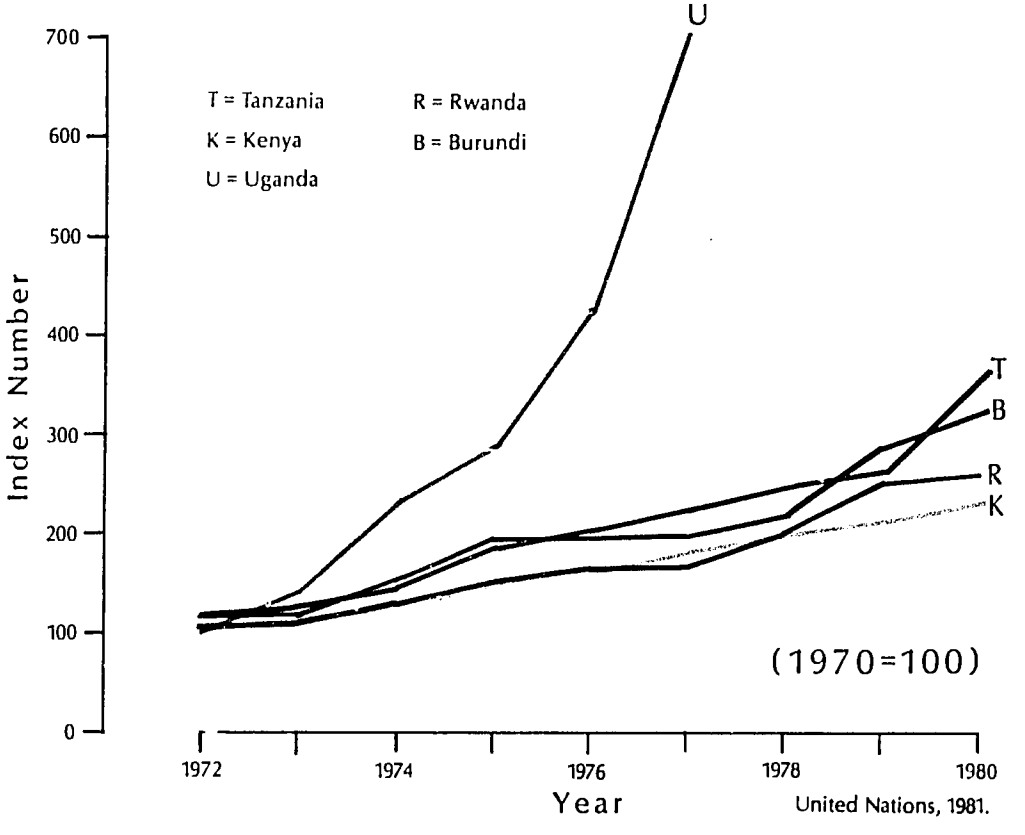
Population History

Early population growth in East Africa is hard to document as formal statistics are unavailable. Demographic history suggests that the population was quite small and scattered in the 17th and 18th centuries, especially compared with West and Central Africa (Zwanbury and King, 1975). While there was steady growth in the 19th century due to gradual agricultural expansion, for example among the Buganda, population numbers tumbled at the end of the century due to the disastrous epidemic of rinderpest and the associated famine which went with it. Colonial wars at the turn of the century and continued disruptions during World War I led to small population growth.

Table 5 illustrates population growth since 1900. Figures for Kenya and Uganda suggest that the increases over the eighty year period approached 400 percent. Even more striking are growth rates of the last 15 years when the overall population increased from 40 million (1967-69) to 62 million (estimate for 1984). This growth

FIGURE 4

Changes in Consumer Price Indices Since OPEC (1973)



United Nations, 1981.

TABLE 5 POPULATION ESTIMATES AND CENSUSES 1902-1980 (in thousands)

	1902	1913	1948	1957-1962	1967-1969	1980	Growth Rates 1980	Estimate 2000
Burundi			2,400		3,500[4]	4,097	2.5%	6,000
Kenya	4,000		5,600	8,636[1]	10,942[4]	15,865	3.9%	34,000
Rwanda			2,300		3,800[4]	5,169	2.9%	9,000
Tanzania		4,100	7,480	8,746[2]	11,604[5]	18,650	3.4%	36,000
Uganda	3,500		4,960	6,538[3]	9,548[4]	12,630	3.0%	23,000
TOTAL			22,740		39,394	56,411		109,000

1 1962 2 1957 3 1959 4 1969 5 1967

Source: Hance, 1970 and UN Statistical Yearbook, 1983.

represents an increase of 55 percent for the 15 year period. Examples for individual countries are even more dramatic. During the colonial years, it took roughly 60 years (1902 to about 1960) for Kenya and Uganda to double their population. From roughly 1960 to 1980, Kenya, Uganda, and Tanzania all doubled again, but this time it took only 20 years. If present trends continue, the region's population will double once again in approximately 22 years or in 2008.

These population figures assume special significance when weighed by the fact that the new citizens are sustained largely by the agricultural output of the natural resource base. The irony is that, for the most part, technologies used now in small agricultural holdings are not very different from the technologies of the 1940's when the population was roughly one third its present number.

Current Population Distribution

Figure 5 shows population distribution for the region. There are four clearly identified zones of dense population separated by areas with many fewer people.

Dense concentrations are found in:

--- the highlands of Rwanda and Burundi;

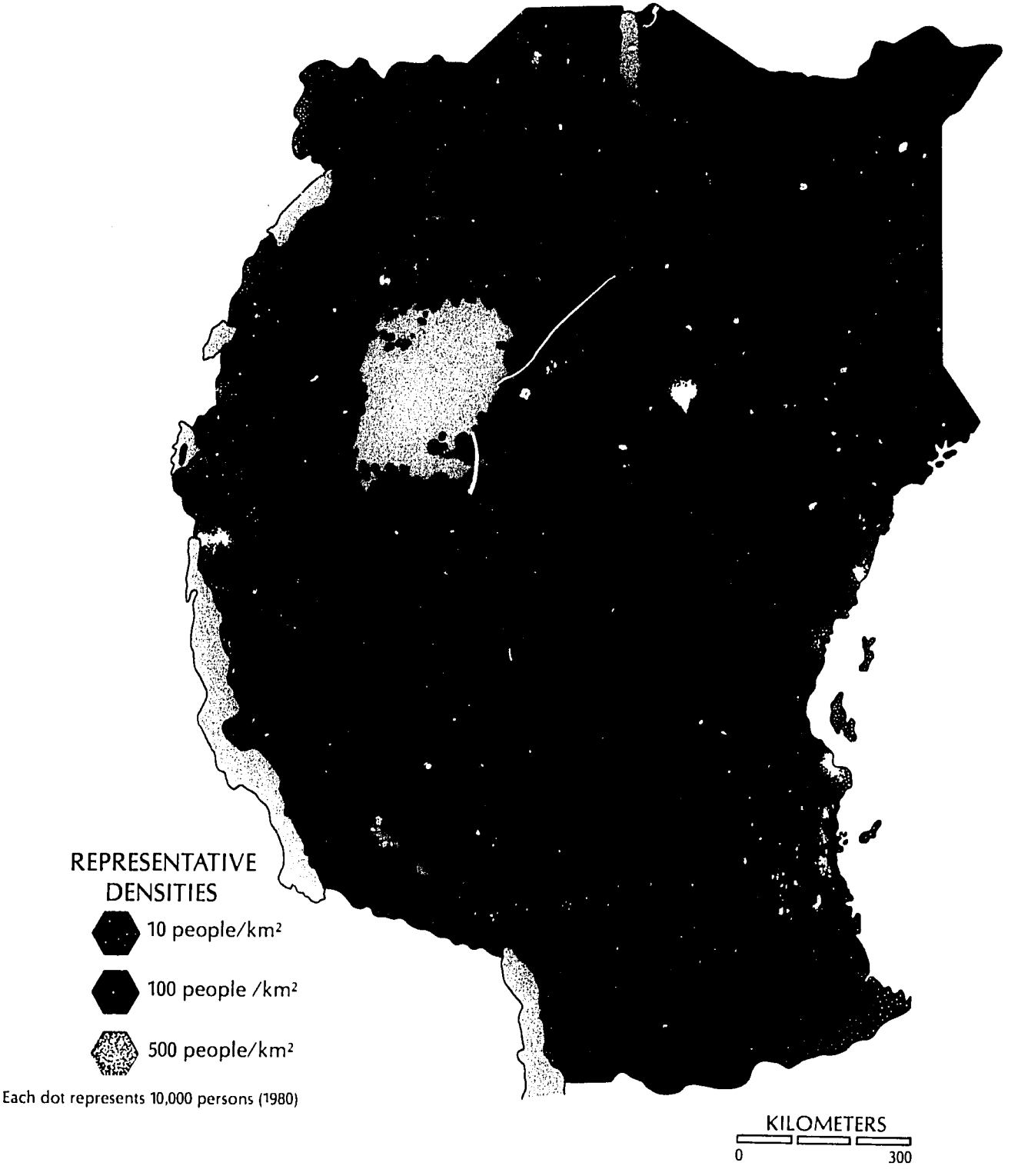
--- the Lake Victoria Basin;

--- the highlands of Central Kenya and Northern Tanzania;

--- and along parts of the coast in southern Kenya, northern Tanzania, around Dar es Salaam and in southern Tanzania.

FIGURE 5

Population Distribution



National Censuses, 1979; et al.

Some two thirds of the region's people now live in these four areas with population densities of over 100 persons per square kilometer. Despite out migration, absolute numbers in these areas continue to increase.

In the Rwanda and Burundi highlands almost the entire population is rural based with densities averaging over 300 people per square kilometer in upland Rwanda. These have been productive areas for many years and today support the densest rural population in all Africa.

The Lake Victoria Basin is the most extensive population concentration. Two or three generations ago the economy was productive in agriculture with bananas, sugar cane, coffee, maize, cotton and vegetables. The lake provided a rich harvest of fish. The region has in recent years attracted small to medium sized industry including coffee and sugar processing, textiles and paper production, thus diversifying the economy. There are a number of rapidly growing urban areas with growth rates noted from the late 1960's to the late 1970's including Kampala, Mwanza (217%), Kisumu (371%), and Bukoba (151%). Note that with the exception of Kampala for which reliable data are not available that growth rates exceed 100 percent for the decade of the 1970's (See Table 8).

The third growth area is in the highlands of Kenya and northern Tanzania where the rich volcanic soils provide the basis for productive agriculture in tea, coffee, maize, vegetables and cattle. The vital agricultural economy has been complemented by the growth of Nairobi just outside the best agricultural land. Founded originally as a supply depot for the extension of the Mombasa to Uganda railway, Nairobi grew rapidly, reaching its present population of well over one million. It now serves as a regional center for all of East Africa. Other important towns include Arushu and Moshi in Tanzania (70% and 94% growth rates in the 1970s) and Thika (125%) in Kenya.

The fourth area of population concentration is along the coast where agriculture provides an economic base and ports developed by the colonial powers provide an additional catalyst for growth. Dar es Salaam and Mombasa are the main urban areas (approximately 1,000,000 and 450,000 respectively), both of which were established as the main colonial entry points to the countries. The growth of Dar es Salaam was accelerated by its role as national capital of Tanzania (earlier as capital of Tanganyika) and as the country's main center of education and light industry. Tanga on Tanzania's north coast and Mtwara to the south are also important centers.

While population is concentrated and growing in these four main areas, the map also indicates a generally dispersed population at moderate densities in the rest of Uganda and in central Tanzania. Northern Kenya and parts of west-central Tanzania are relatively empty areas.

Population Dynamics.

Two major themes dominate population dynamics: (a) changes in growth and fertility and (b) the pattern of population mobility. Each has significant impact on resource use in East Africa.

a) Changes in growth and fertility

Tables 5 and 6 present basic data. The next to last column in Table 5 provides present growth rates. Present trends continued, these figures project 109 million people living in East Africa in 2000. These relatively large increases result from circumstances set out in Table 6. Fertility is high, the birth rate is high and the death rate has been dropping for the last few decades.

Eight births for an adult female (Kenya) is not only high for Africa but is in fact the highest level for any country in the world. In contrast, the average fertility rate, worldwide, is only 3.9

TABLE 6 BIRTH, DEATH AND FERTILITY RATES IN EAST AFRICA

	Crude Birth Rate (Births per thousand in population)	Death Rate (Deaths per thousand	Total Fertility Rate (Average children born to adult female if she were to live all child-bearing years, 15 to 49)
Kenya	54	13	8
Tanzania	46	14	6.5
Uganda	46	15	6.1
Rwanda	49	18	6.9
Burundi	46	22	5.9
All of Africa (average)	46	16	6.5

Source: Population Reference Bureau, 1983.

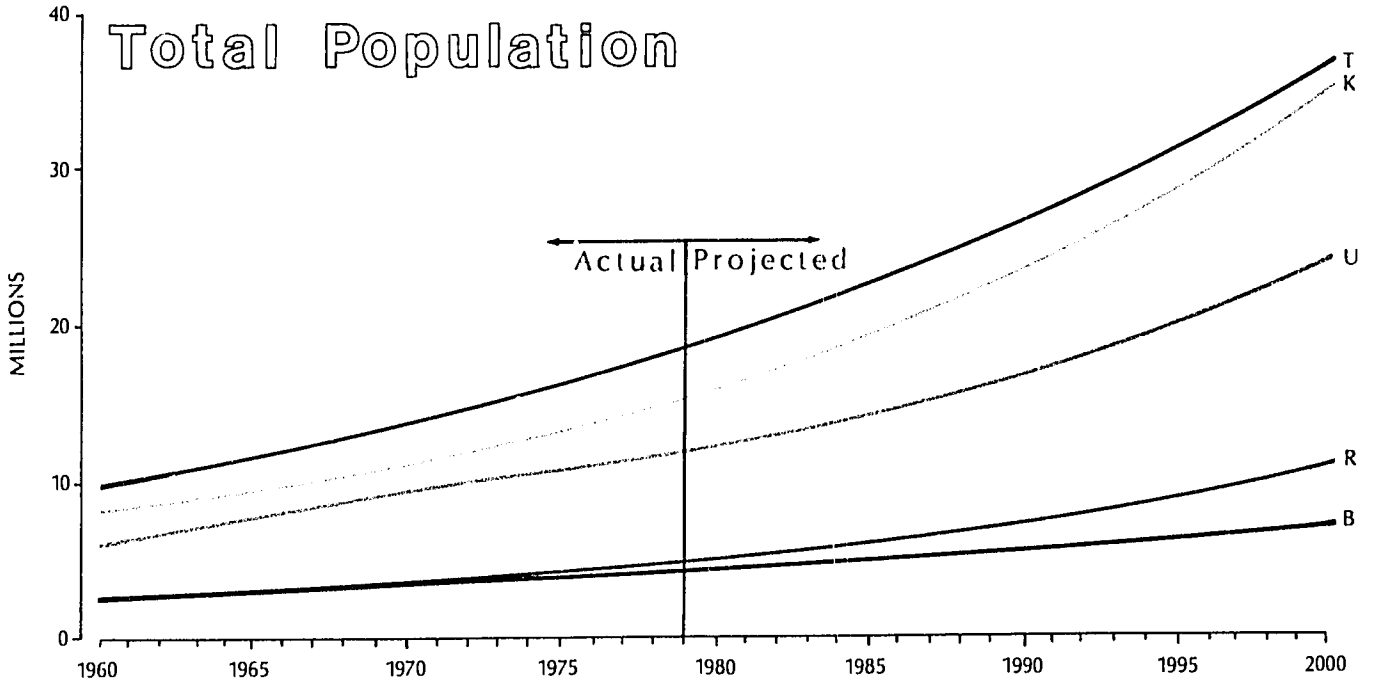
births per adult female. The region's death rate is mostly lower than the average for all of Africa (16) and is not a great deal higher than the average for the world as a whole (11). The combination of high birth rates and a moderately low death rate produces an overall population growth rate of impressive proportions.

Another aspect of population dynamics is age structure. Figure 8 presents age pyramids and projections for each of three key age groups through the year 2000. In a period of rapid population growth, the bulge in numbers is made up largely of young people. The age pyramids show in each country a high proportion of the population (around 50%) to be under fifteen. On one hand this means that, short of some great catastrophe, the continued high growth rates of population through the year 2000 are already assured because this large group of young people will then be entering adulthood. On the other hand, the projected continuing large percentage of young people will mean a substantial increase in their absolute numbers. This situation has important implications for resource management.

For example, in Rwanda and Uganda, the school age population will be rising throughout the 1990s. For Kenya, school age population will rise gradually through about 1995 and then taper off. Viewed from another perspective, Kenya will have a total population of almost 30 million in 1995 (Figure 6). Of these, 20 percent will be less than 5 years, 32 percent will be school age, and another 1 or 2 percent over 65 (Figure 8). These combine to create a dependent population in 1995 of 53 percent or roughly 15 million. Table 5 notes that an already crowded Kenya supported roughly 16 million total population in 1980. In 15 years time, the dependent population alone

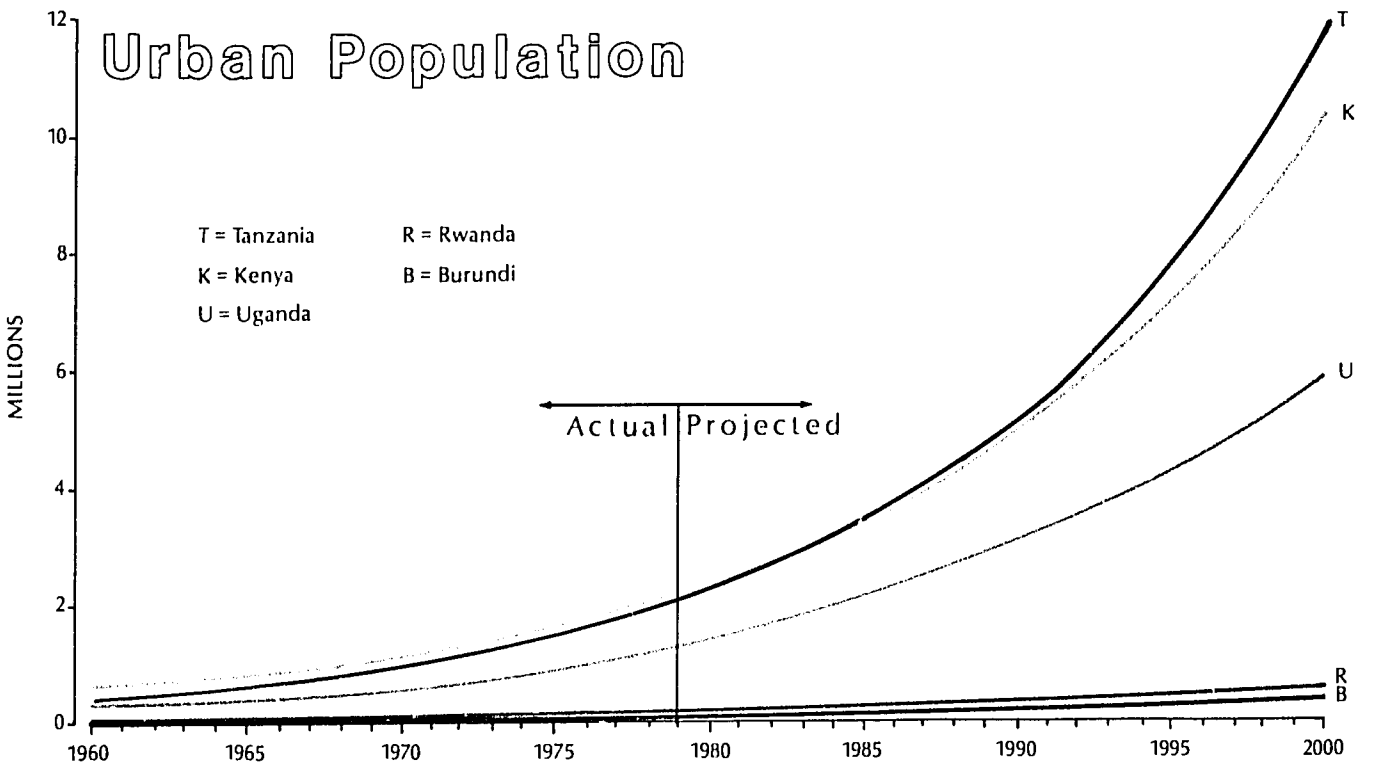
FIGURE 6

Population Trends



National Censuses, 1979; et al.

FIGURE 7



National Censuses, 1979; et al.

will be almost as large as the total 1980 population.

The implications for providing social services for such a large dependent population are staggering. Schools, transportation, health clinics, and water systems are but a few of the facilities that will need major expansion. The problem of feeding the non-producing population is a second concern. Perhaps most troublesome is the task of finding eventual employment for the new citizens when they enter the work force, which by 2000 will be increasingly an urban work force.

b) The pattern of population mobility in East Africa.

East Africa has witnessed significant population mobility in the last two decades and it is almost certain that this mobility will continue. Patterns of movement are complex and may well change over time. A detailed analysis for Tanzania showed movements from one rural area to another; from rural areas to small towns; and from rural areas, small towns and large towns all to the capital city (Claesson & Egeno 1972).

Figure 6 shows differential growth in national totals. Kenya is likely to grow at a faster rate than its neighbors Tanzania and Rwanda. Table 7 illustrates the changing balance among the five countries.

In addition, within countries, population will tend to grow more rapidly in some areas than in others. In each case, uneven growth may create a new potential for migration from areas of high growth to others.

While absolute growth in numbers may be significant, the most important factor may be the changing balance between opportunity for economic production and numbers of people in the different parts of the region. The availability of agricultural land and productive opportunities is a major consideration in migration from one rural area to another.

For example, Tanzania's 1957 census showed significant migration from drier rural areas to more moist rural areas. Approximately 400,000 migrants had voluntarily left western and southern parts of the country for the hope of rural employment in the potentially more productive

TABLE 7 REGIONAL PERCENTAGE OF POPULATION

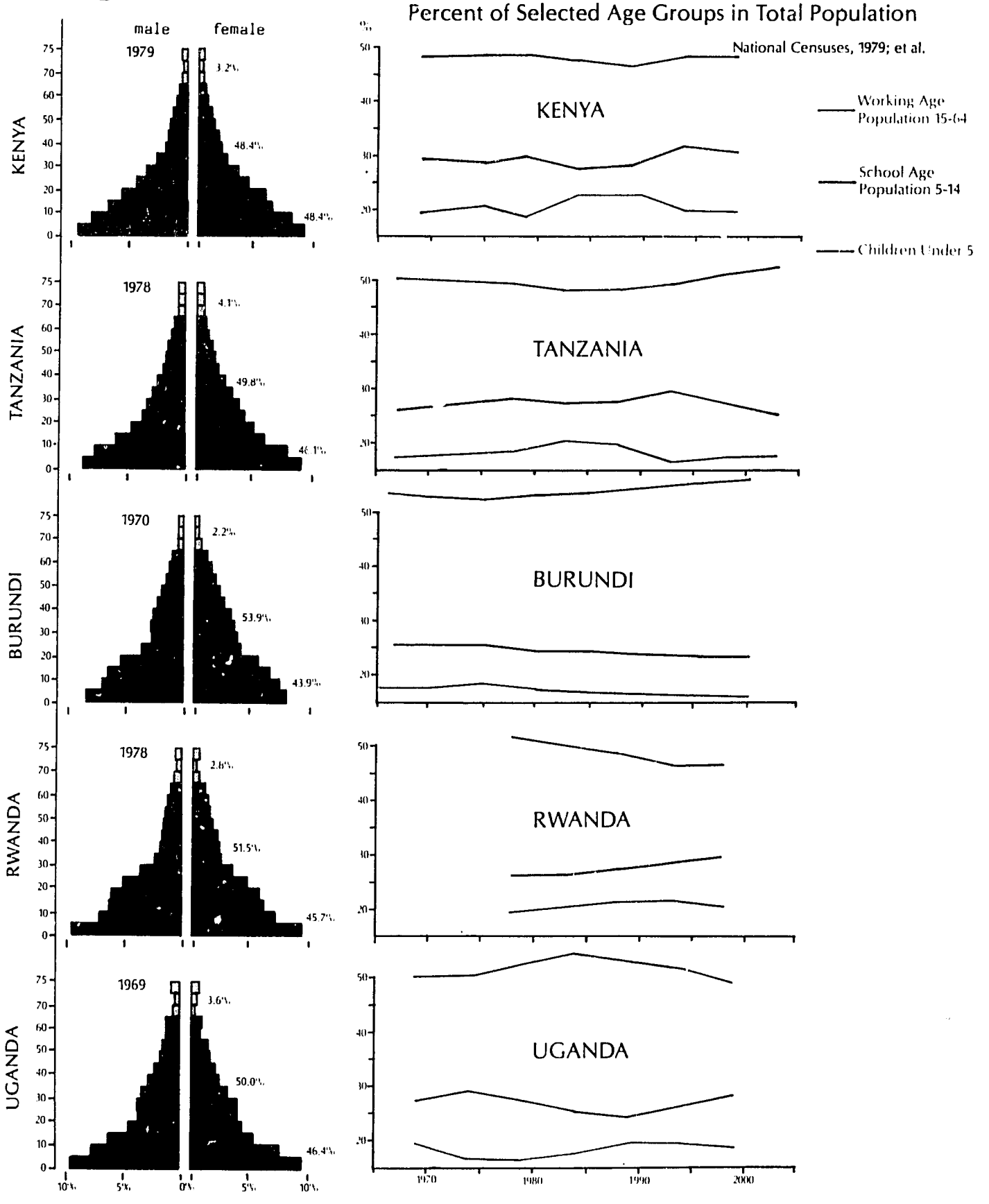
	1960	1980	2000
Kenya	26.15	28.12	31.23
Tanzania	33.28	33.06	33.34
Uganda	22.20	22.39	20.89
Rwanda	9.01	9.16	8.39
Burundi	9.36	7.26	6.15
	100.00	100.00	100.00

Source: UN Statistical Yearbook, 1983.

FIGURE 8

Population Structure

Percent of Selected Age Groups in Total Population



areas in eastern and coastal Tanzania. In 1967, during the next census, the migrations were continuing from drier zones to the higher potential regions of Arusha, Tanga, the coast, and the watershed of Lake Victoria (Maro and Mlay, 1982). At the same time, parts of western Tanzania contain large areas of medium potential land and may already be beginning to be the focus of immigration as the more attractive eastern and coastal areas are taken.

Other important rural to rural movements in the region include large numbers of Rwandans migrating to southern Uganda and movements of Kenyans in a first phase into the high potential areas of the highlands and more recently into the drier margins of these zones, known in Kenya as the arid and semi-arid lands (Bullock, 1971).

Another migration process of the last two decades, universal to all of the region, has been migration to urban areas, especially the primate cities. Figure 7 (Urban Population) identifies the present and projected urban populations. Total urban population for the region (defined as towns greater than 5,000) has grown from about 1.2 million in 1960 to 6.4 million in 1980 and, if current trends continue, may be 25 million in the year 2000. It is of course uncertain whether trends will continue at present rates but under any current projections and estimates, a further large growth in East African urban population is almost certain.

As Table 8 indicates, the greatest growth, especially in the 1960s, was in the major cities. Nairobi and Dar es Salaam each have grown from about one quarter million people in the mid-sixties to nearly one million by 1980 (or higher depending on estimates). However, the table also shows a new trend: rapid growth in middle sized cities. The explosive growth of Kisumu from 32,000 to 152,000 in ten years is matched by Mbeya's six fold increase from 12,000 to 76,000 during a similar period.

At present, the following trends are worthy of special note:

a) population growth will double current population by the first decade of the twenty first century;

b) in the early part of the twentieth century, extensive rural migration took people from lower to higher potential areas;

c) since the 1970's land pressures seem to be increasing to such an extent in high potential areas that rural to rural migrations are beginning to move from high potential to semi-arid and lower potential areas;

d) rural to urban migrations are growing at rapid rates. Urban areas are growing two to three times faster than total populations. Two decades ago the rapid increase was in primate cities. In the 1970's and '80's the rapid increase seems to be moving to secondary cities;

e) growth of secondary cities throughout the region, already rapidly underway, offers an intriguing means to absorb excess rural population through employment generation while avoiding pressures of major urban sprawl associated with both Nairobi and Dar es Salaam;

f) the dependent population (ages 0-14 and over 65) throughout the region is approximately 50 percent of the total population. The large new dependent population will place heavy demands on social services and infrastructure in years to come.

TABLE 8 RECENT GROWTH IN KENYAN AND TANZANIAN CITIES

KENYA

	1962	1969	1979	% Growth Between 1969 and 1979
Kericho	7,692	10,144	29,603	192
Kisumu	23,526	32,431	152,643	371
Kitale	9,342	11,573	28,327	145
Malindi	5,818	10,757	23,275	116
Mombasa	179,575	247,073	341,148	38
Nairobi	266,794	509,286	827,775	63
Nakuru	38,181	47,151	92,851	97
Nanyuki	10,448	11,624	18,986	63
Nyeri	7,857	10,004	35,753	257
Thika	13,952	18,387	41.324	125

TANZANIA

	1967	1978	%Growth
Arusha	32,452	55,281	70
Bukoba	8,141	20,430	151
Dar es Salaam	272,821	757,346	178
Dodoma	23,559	45,703	93
Iringa	21,746	57,182	154
Mbeya	12,479	76,606	514
Morogoro	25,262	61,890	144
Moshi	26,864	52,223	94
Mwanza	34,861	110,611	217
Tabora	21,012	67,392	220
Tanga	61,058	102,409	69

SOURCE: Mascarenhas, 1973; Tanzania Bureau of Statistics, 1978; Kenya, Statistical Abstract, 1979.

Economic Development and Social Change.

Although population change has been a major driving force in the region, it has not acted alone. Parallel to increased numbers of people have come major economic changes, massive expansion in education at all levels, the emergence of independent governments and changes in the people's basic social systems and ways of life.

Economic changes are perhaps the easiest to document. Figure 9 presents growth (or lack of it) in per capita GDP. Kenya has been able to maintain a generally upward climb, moving from an estimated $300 per capita in the early 1960s to well above $400 for the early 1980s. For Kenya, however, these figures must be viewed in the broader context of the nation's social structures. Income differentials have persisted in Kenya from colonial days. To some extent, differentials fall along racial lines with European and Asian Kenyans, though less than 1 percent of population, receiving incomes substantially above the national average. Simultaneously, Kenya has produced an energetic and highly skilled African middle class composed mostly of civil servants, professionals, business people working either for large corporations or as small entrepreneurs, and merchants. This new Kenyan middle class is mostly urban and participates in the economy's formal sector. The middle class has little in common with the majority and rural population (87% in 1977) who continue to derive their livelihoods from Kenya's soil or with the urban poor who eke out a marginal existence as domestics, housequards, casual labor, and seasonally employed.

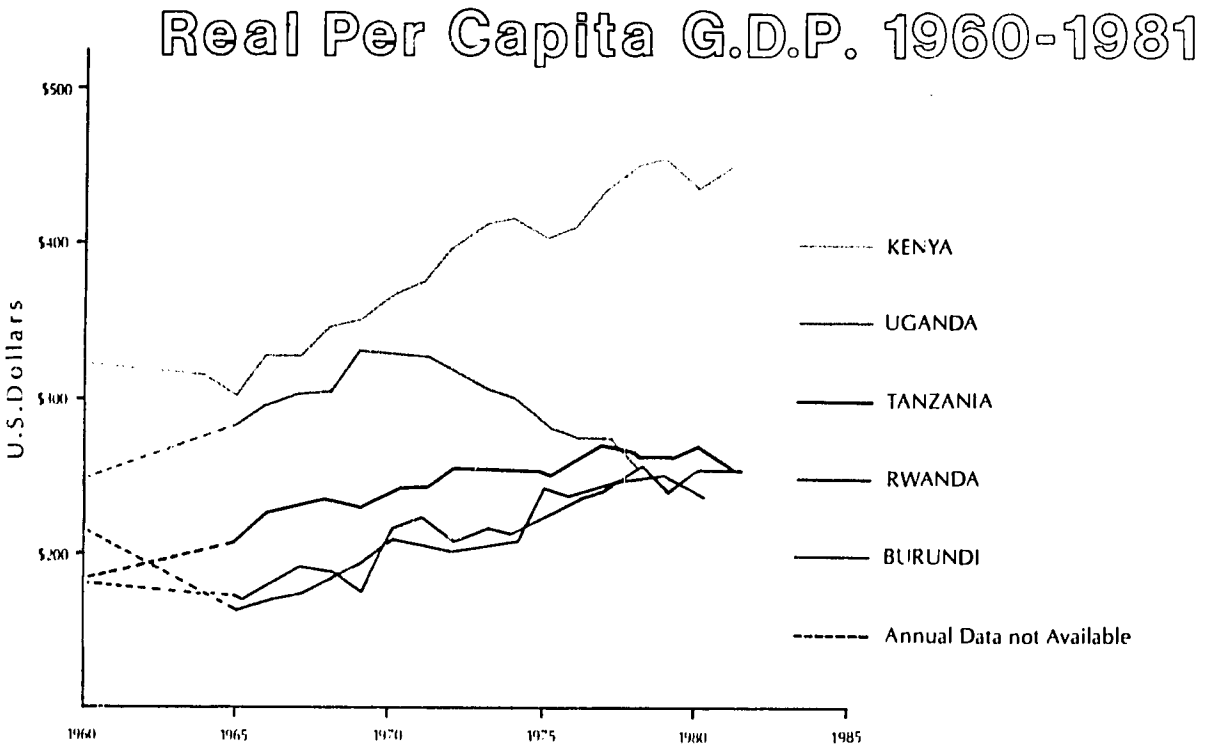
Uganda's national figures are a different story. Per capita GDP rose in the early years and then fell, especially during the latter years of the Amin regime. By 1980, Uganda's figure was essentially the same as it had been in 1960. For the other three nations, any gains in GDP were almost offset by population increase, thereby allowing for only modest per capita progress over the 20 year period.

Food production is another important measure. Figures 10 and 11 show contrasting situations. Figure 10 illustrates the growth in levels of total food production, based on an index of 100 for 1969-71. Production increases are impressive. Rwanda is the most significant, starting from a base slightly below 100 and moving to levels of approximately 150 by the early 1980's. The other four nations have moved in parallel, including perhaps surprisingly, Uganda. In no case is the increase less than 20 percent. More difficult to assess is the explanation for the rise. The two decades have been a time of considerable agricultural investment, mostly by the governments themselves, in part by the donor community, and also by private investors. Simultaneously, the increased population levels have led to more farmers growing food. Finally, the national governments themselves have vigorously encouraged agricultural production as agriculture is generally the largest earner of foreign exchange for all five of the countries.

Figure 11, however, presents a somewhat different picture. Here food production is presented on a per capita basis. Rwanda and Burundi have maintained roughly the same per capita levels. The other three countries now produce significantly less per capita, with approximate averages showing production drops, per capita, from 1969 to 1982 at approximately 10 percent.

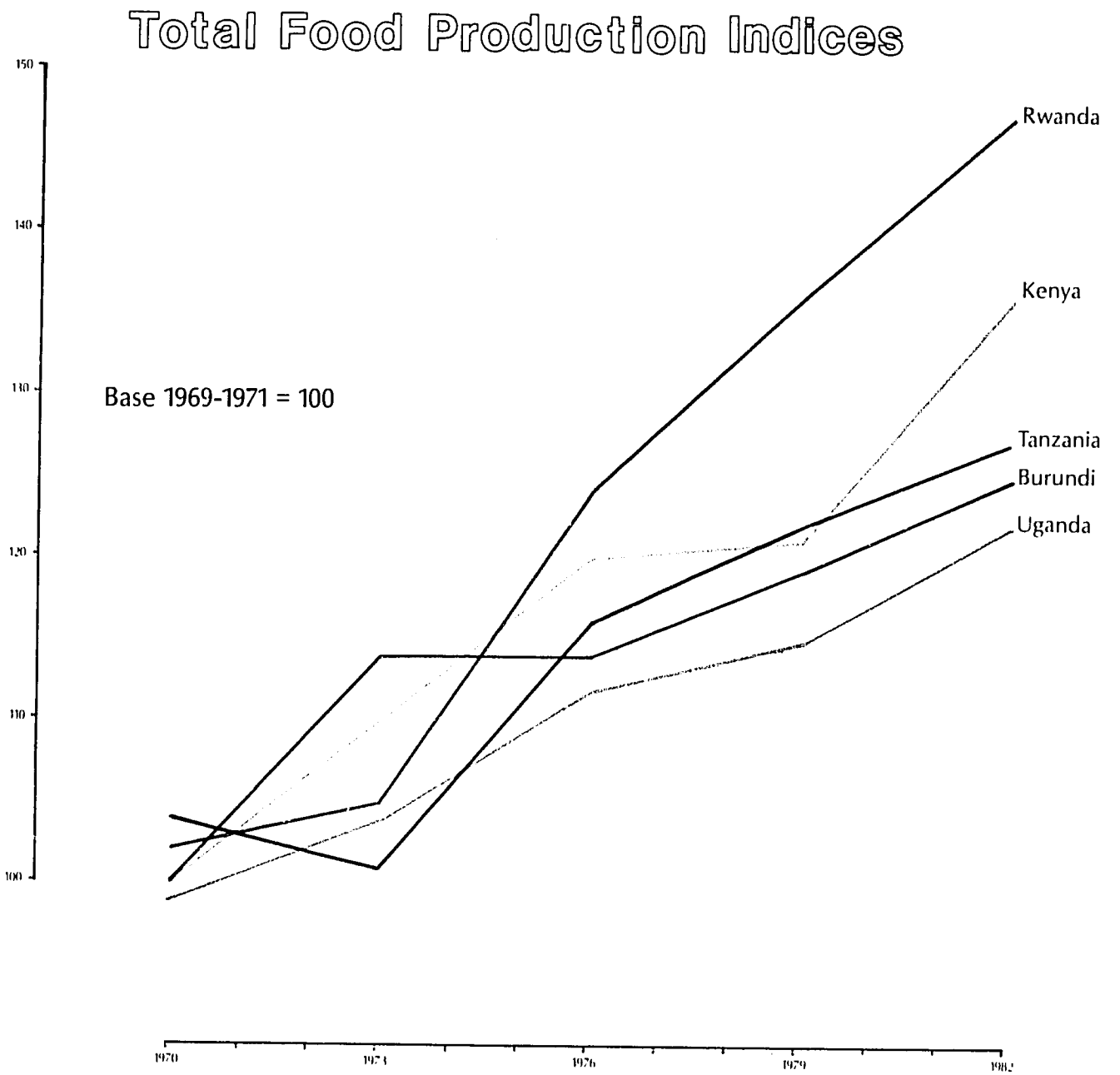
It is not possible to make accurate projections for per capita food production. However, reasoned estimates suggest that there will be no significant change from the current situation for the following reasons. First, the younger populations who need to be fed and who will also be producing more children are already born, as noted in Table 5 and Figure 8. Second, there are not large amounts of arable land

FIGURE 9



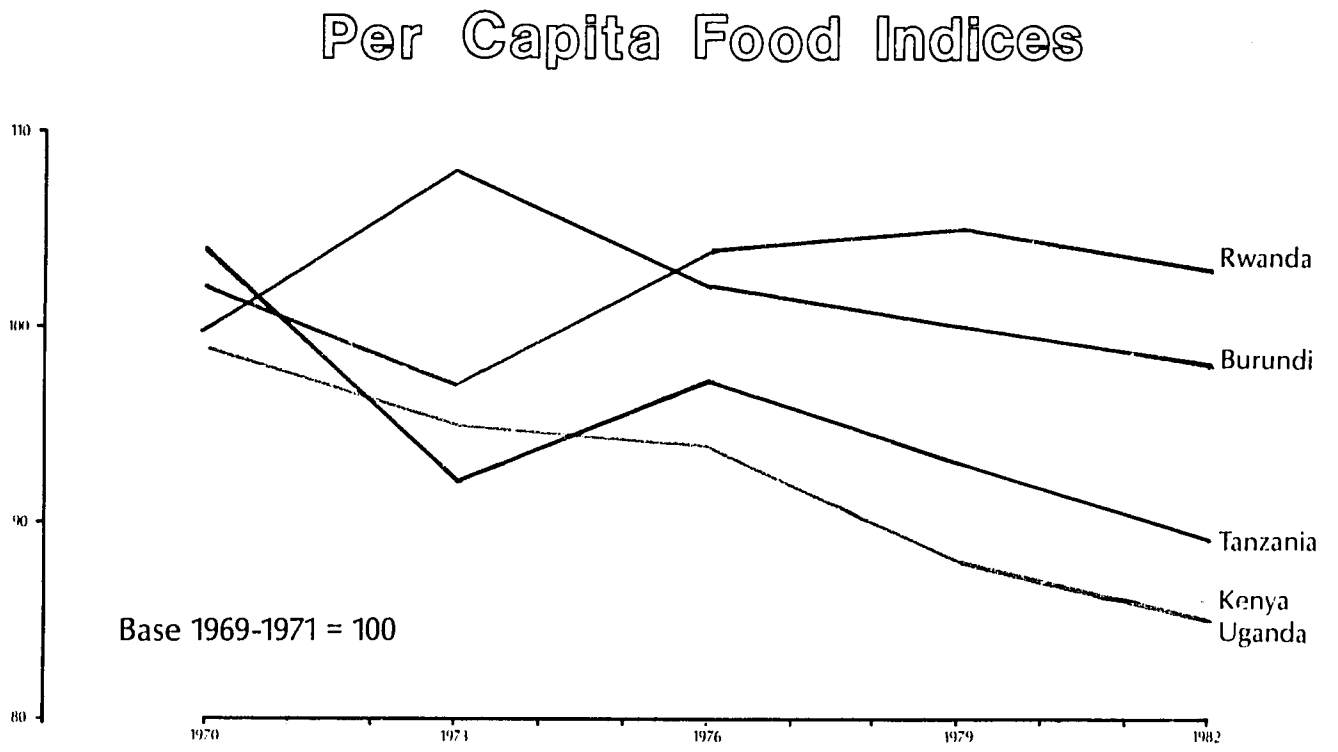
IMF, 1983; et al.

FIGURE 10



FAO, 1975; et al.

FIGURE 11



FAO, 1975; et al.

waiting to be exploited and therefore no significant new agricultural lands are about to come into production. For example, Kenya's Central Province, all but 7 percent of the medium and high potential land not in forests is under cultivation (Western Review, 1 June 84). Third, there are not significant and previously unused major sources of agricultural investment waiting on the horizon to purchase new equipment, fertilizer, or other required inputs. Rather, changes in the region's agricultural development will more than likely progress slowly with modest food increases in output coming largely from increased productivity of present agricultural systems. That several countries in the region are already committed to intensifying agricultural production is encouraging, given the severe crisis that could emerge.

Another important factor in food production is the changing demand for certain products among consumers. Important changes for the region as a whole include:

... preference for maize over sorghum

... preference for wheat over maize

... preference for rice over other grains.

Each of these changes has important implications for resource use. For example, maize is more vulnerable to drought than sorghum. Yet changing food preferences place higher priority on maize. Wheat is more difficult and expensive to grow in East Africa than maize. Finally rice production, at least on a large scale, requires major changes in the pattern of land use and sometimes needs expansive irrigation technologies. All of the changing diet preferences increase cost or, of perhaps greater concern, raise vulnerability in the agricultural sector.

The changes for wheat and rice, especially in the towns, have led to

significant increases in imports of these products, thereby lessening food self-sufficiency and consuming scarce foreign exchange. For example, cereal imports in Kenya cost only $4 million in 1976. They soared to $86 million in 1980 because of a drought and a lean harvest. Since 1980, cereal imports have averaged between $40 and $50 million per year(s). This is a substantial increase over the $4 million level of 1976. For 1984, a failure of the long rains combined with food preference changes again suggest a high food import bill. The story is similar in Tanzania which imported $24 million worth of cereals in 1976. The figure rose to $118 million in 1980 and has settled back to approximately $75 million since 1980.

Were all of the region's countries in healthy economic condition, food imports such as those noted above would be easily managed. However, supply of foreign currency has become a critical factor in the well-being of each nation. Currency devaluations have become commonplace. For example, the Kenyan shilling was worth approximately 7.5 to the U.S. dollar in 1979. In 1984 the exchange rate is approximately 15 to the dollar. Foreign currency itself is in critically short supply.

Another major economic and social change results from education. Table 9 presents changes in numbers of people at various stages in the educational system as well as the percentage of adults who have attained literacy.

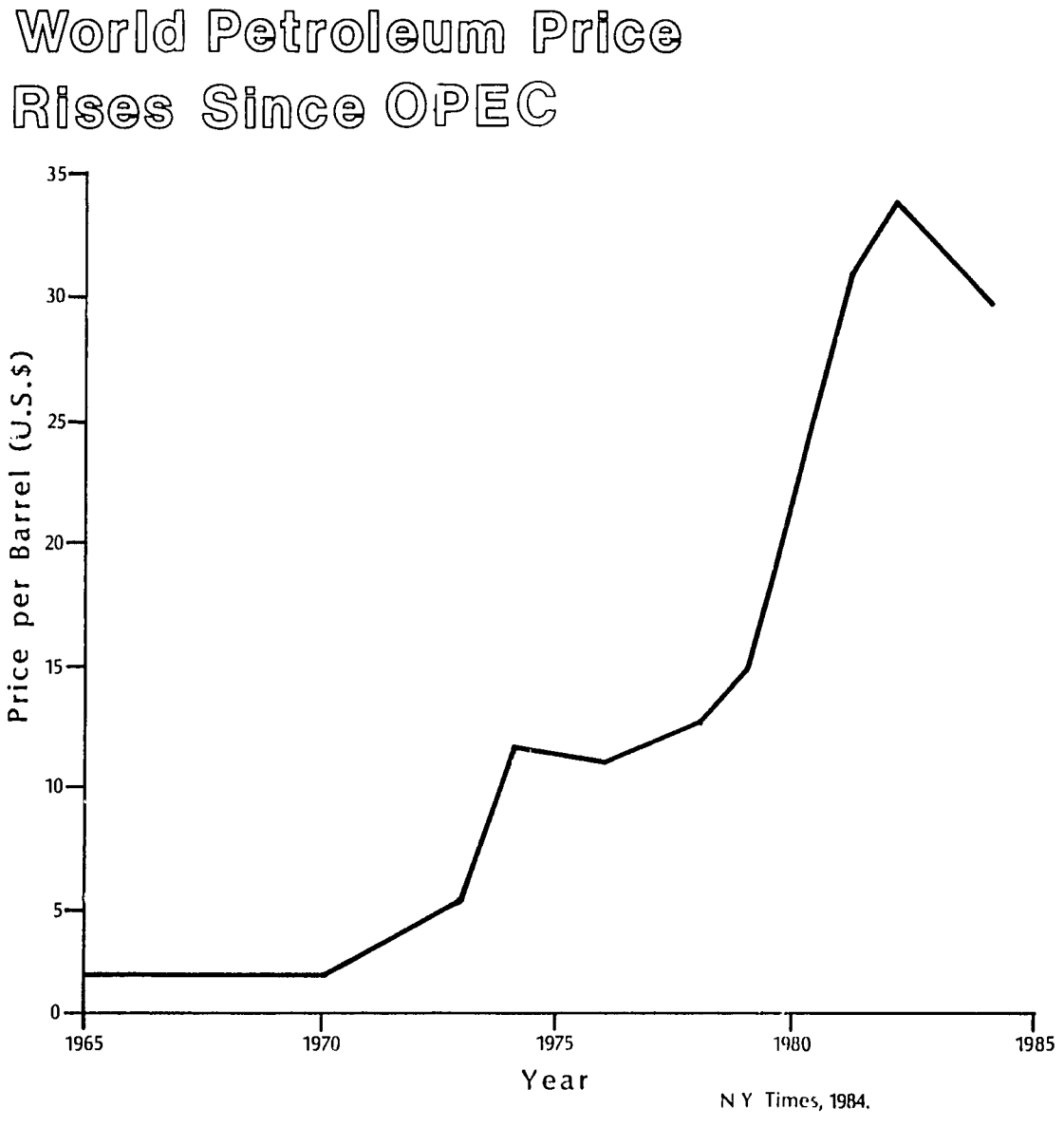
Since independence, the governments as well as individual citizens have placed great emphasis on education at all levels. During the last twenty years the increass in attainment of formal diplomas and degrees has been impressive, both in percentages as well as in absolute numbers. The impact of this change is difficult to assess in quantifiable terms. However, it certainly creates a much greater awareness of national and world conditions as well as increases expectations.

TABLE 9 EDUCATION - PATTERN OF CHANGE (PERCENTAGE OF AGE GROUP)

	PRIMARY SCHOOL		SECONDARY		HIGHER EDUCATION		ADULT LITERACY	
	1960	1978	1960	1978	1960	1978	1960	1978
Burundi	18	21	1	3	0	0	14	25
Kenya	47	99	2	18	0	1	20	55
Rwanda	49	64	2	2	0	0	16	50
Tanzania	25	70	2	4	0	0	10	66
Uganda	49	50	3	5	0	1	35	52

Source: UN Statistical Yearbook, 1983.

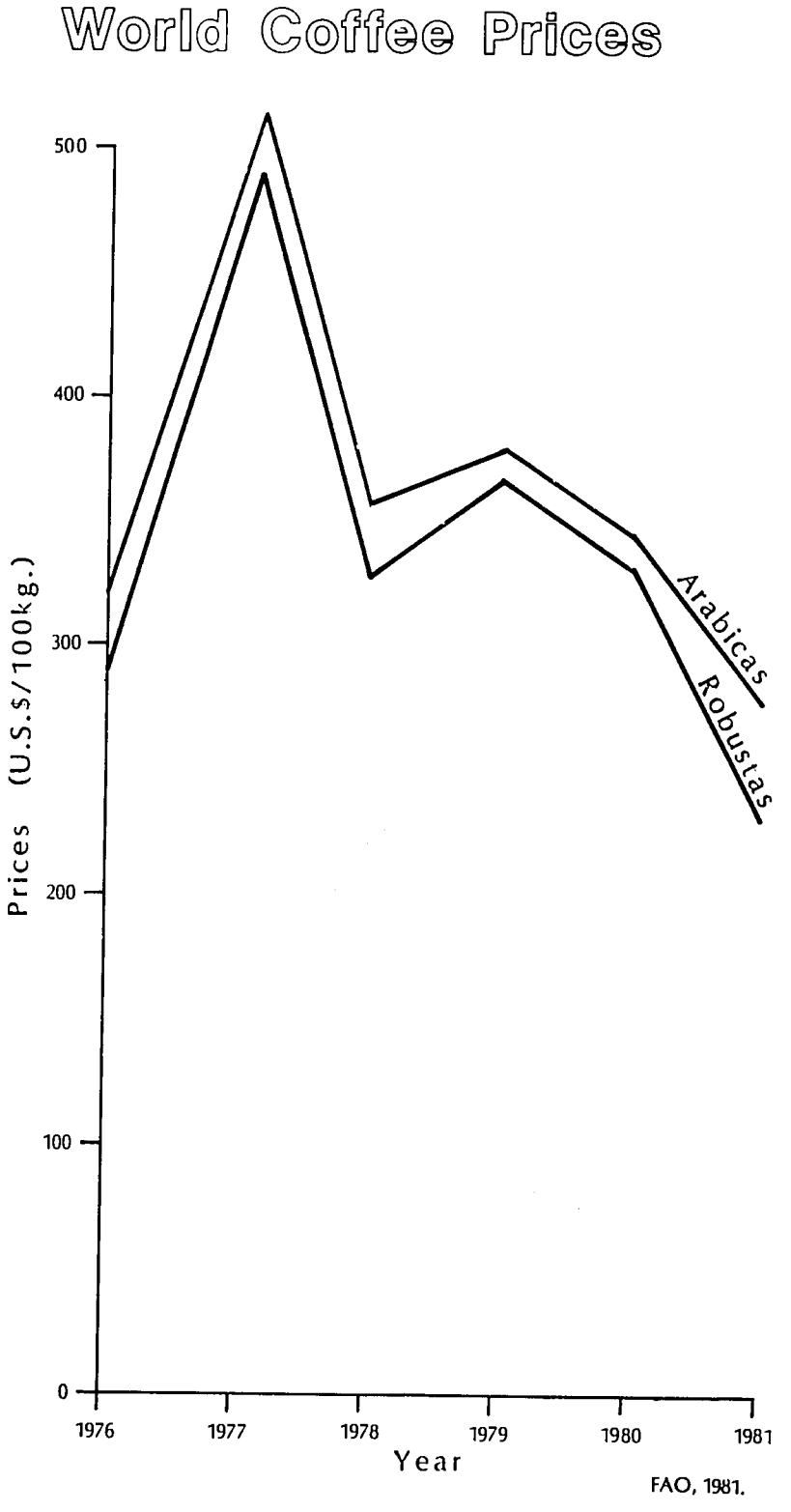
FIGURE 12


World Petroleum Price
Rises Since OPEC
Price per Barrel (U.S.$)
35
30
25
20
15
10
5
0
1965
1970
1975
1980
1985
Year
N Y Times, 1984.

External Factors in Change

Significant external changes have had adverse impacts on East Africa's economic stability. One of the largest factors has been price increases in petroleum, initiated by OPEC in 1973. Figure 12 indicates the change in petroleum prices. If the livelihood systems of East Africa were generating similar increases in revenue, there would be no problem. Unfortunately, major income producers for the region are agricultural commodities such as coffee.

FIGURE 13



With constant coffee production, static commodity prices, and sharp rising import and consumer prices, the region finds itself in a bind. For example, in 1958 a ton of Kenyan coffee paid for 24 tons of imported cement; by 1965 the coffee could purchase only 18 tons of cement; in 1976, a ton of coffee paid for only 11 tons of imported cement (Personal communication from Norman Myers).

Further accentuating the external economic pressures are currency fluctuations. Kenya's shilling has dropped in value by 50 percent since 1970; Tanzania's official rates are more stable but the black market rate (a fairly reliable measure of a currency's true worth) shows a decline comparable with Kenya. Uganda's currency has all but lost value due to the political difficulties of the 1970's and 80's. The currency of Burundi and Rwanda has been much more stble, partly because of lower levels of imports but also because Belgium helps to stabilize its value. If the Kenya shilling buys only half as many dollars as a decade earlier, prices of imported goods have effectively doubled, even if there were no change in dollar amounts.

The net impact of these external factors has been an increase in balance of payment deficits and a concommitant increase in indebtedness of the Third World in general and East Africa in particular. Table 10 notes the rapid increase of debt burden for each of the five countries.

Simultaneously, incomes derived from agricultural exports have not increased significantly over the last 20 years. As the region's foreign currency earnings are almost totally dependent on cash crops (Table 2), East Africans find themselves in a squeeze between rapidly increasing import prices and constant or even declining revenues from exports. A brief Kenyan example for coffee, the region's largest export crop, will illustrate the dilemma.

Over the years, Kenya has derived roughly half of its foreign currency from cash crop exports (54 percent from 1975 - 77). Of this amount, 80 percent comes from

TABLE 10 DEBT BURDEN 1970-1980
EXTERNAL PUBLIC DEBT OUTSTANDING AND DISBURSED (in millions of dollars)

	1970	1980	Percentage Increase
Kenya	$313	1,011	323
Tanzania	248	1,360	548
Uganda	128	669	522
Rwanda	2	158	7,900
Burundi	7	137	1,900

Source: World Bank, 1982.

tea and coffee; 60 percent of the cash crop exports or roughly one third of total foreign currency earnings for Kenya come from coffee (USDA 1983 and Norman Myers' personal communication). Parenthetically one should add that as much as 90 percent of Burundi's and 50 percent of Rwanda's hard currencies come from coffee exports (1975-77).

Coffee is big business for Kenya and developing countries with virtually 100 percent of the world's crop grown in the Third World. Worldwide, the coffee trade amounts to something like $4 billion annually. Since the 1960s, world demand for coffee has been relatively static with world production hovering between four and five million metric tons (it climbed to 5.8 million tons in 1981). (FAO Production Yearbook, 1981, 1982.)

Coffee prices are set on the world market. Although there are occasional surges due to climatic or political problems, the price essentially remains the same. Figure 13 provides details.

Kenya and other national governments have responded to the debt/cash crop dilemma in essentially the only way they can, i.e., by struggling to increase cash crop production. In the case of Kenya, it is for coffee, tea, pyrethrum and sisal. As a result, the economy and resources of the region tend to focus on improved cash crop output, sometimes at the expense of food production. National research institutions, agricultural extension, national marketing, transportation, agricultural credit and price incentives tend to favor, for example, Kenyan coffee farmers over Kenyan maize producers.

The need to increase harvests places even greater pressure on the region's major productive resources of soil, woodlands, water, and rangeland. If the region is to attain significant economic growth, given the present set of available capital, technologies and resources, most of the increased output will have to come from the land. The implications in terms of resource pressures are considerable. Although quantified estimates of land pressures are not possible, it is clear that combinations of population increase, heightened economic and social expectations, declining relative purchasing power of agricultural commodities, growing burdens of overseas debt, adverse balance of payments, and economic dependence on the land place East Africa in a precarious economic as well as natural resource position. Further, there is no reason to believe that significant economic improvement will come in the next decade. If anything, one would project that the adverse economic trends which began in the mid- seventies will intensify in the next ten years.

CHAPTER 3 THE LAND: ITS CURRENT USE AND DEVELOPMENT POTENTIAL

Introduction

Of all resources in East Africa, land is the most vital. Symbolically, it represents livelihood and security. Historically, land lies at the heart of competition between, for example, Hutu and Tutsi in Rwanda and Burundi. Land tenure conflict formed the core of Jomo Kenyatta's classic Facing Mount Kenya; land disputes were the primary cause of the Mau Mau movement in Kenya in the 1950's; land access continues to creates continually increasing pressures as rising aspirations for land holdings overtake availability of productive soil. From an African perspective, land is the mother from which all productivity issues; it is the father to which all "children" shall eventually return. It is significant that relatively few East Africans consider cities their homes, even though they may be third generation urban residents. Rather, home is the ancestoral village where the soil has sustained the family for generations and where the only ultimate security can be found.

Some attachments are economic as the land produces livelihoods for most of the region's people. For pastoralists, land supports cattle; for small farmers, land is food production; commercial farmers equate land with profit; government officials view land as a medium to produce export crops. Perhaps of deeper meaning are the psychological and emotional associations with the land which have been handed down from previous generations.

Five tendencies in land use are suggested:

1. Decreased plot size.

National data indicate that average per capita availability of arable land is shrinking. For example, Rwanda's average farm size in the highlands slipped from .6 ha. in 1960 to .5 ha. in the early 1980's. These average figures mirror the changes at farm level, particularly in the more moist and high potential areas where land is at a premium. Trends in the highlands of Tanzania, Burundi, and Kenya are similar.

2. Food production falling behind population growth.

Nationally, per capita output is falling, as noted in Figure 11. But at the same time, general income levels seem to be rising, as noted in Figure 9. The data suggest that, on average, East Africans are eating somewhat better than in previous years. Combinations of food imports and aid sponsored programs are making food available, in spite of production losses. However, food consumption patterns analyzed by income are not available and one can only guess about actual food consumption by social class or income group. While averages may be increasing, food consumption among the rural and urban poor are surely declining, especially in refugee situations and during all too frequent droughts.

3. Resource deterioration, especially in soil.

Soil erosion is a problem. Studies note that reservoirs in major rivers have accumulated silt at rates far in excess of forecasts. One recent study finds siltation in the Athi River causing problems of coral destruction, fishing declines, beach muck build-up and mangrove loss. (DuBois, 1984). Another study finds high rates of soil loss on high potential lands, especially for maize. (Lewis, 1983). However, no precise data for the region have been accumulated which demonstrate direct linkages between soil loss or other resource degradation and food output.

TABLE 11 ECOLOGICAL ZONES MAP: GENERAL DESCRIPTION

ZONE I: HIGHLAND ZONE (Greater than 3,200 m. altitude)

Climax Community*: Afro-alpine moorland and grassland, or barren land

Potential: Limited, except as a water catchment area and for tourism. Currently used for both of these purposes but at low densities of use.

ZONE II: FOREST ZONE (Humid to dry sub-humid. Moisture index greater than -10.)

Climax Community: Forests, derived grasslands and bushlands, with or without natural glades.

Potential: Forestry or intensive agriculture. This zone currently forest, mostly in the form of protected montane rain forest; and for coffee-banana small farms with some cattle being stall-fed. In many areas farms are getting smaller because of increasing numbers of farmers. Forest reserves are under pressure and in some places are being replaced by farms. In Kenya and Rwanda tea estates and tea growing small-holders are common. Potatoes are an increasingly popular cash crop.

ZONE III: AGRICULTURAL ZONE (Dry sub-humid to semi-arid. Moisture index -10 to -30.)

Climax Community: Moist woodland and savanna.

Potential: Agricultural potential is high, soil and topography permitting. Maize with some bananas and coffee are main crops. Wheat is grown in drier, flatter areas and cotton is important cash crop. Trends are toward smaller farms and increasing number of farmers and some drop-off in soil productivity.

ZONE IV: SEMI-ARID ZONE (Semi-arid. Moisture index -30 to -42.)

Climax Community: Dry woodland and savanna.

Potential: Marginal agricultural potential but a good rangeland area. This area has a wide mix of land-use, including cotton and wheat growing, maize, sorghum and oil seed production, as well as ranching. Large areas in Tanzania and Kenya are game preserves or little used. Prone to drought, land is locally, much eroded and in other areas of low productivity. Trends are toward more crop production and larger amounts of arable land.

ZONE V: ARID ZONE (Arid. Moisture index -42 to -51.)

Climax Community: Tree, shrub and grass steepe.

Potential: Wildlife management. Suitable for rangeland but needs good management. Some parts of this zone in Tanzania are in crops and even here millets are being replaced by sorghum. These dry areas can only support a limited number of animals and the range is clearly over-populated with animals in Kenya, Uganda and Tanzania. Some important game reserves.

ZONE VI: SEMI-DESERT ZONE. (Very Arid. Moisture index -51 to -57.)

Climax Community: Dwarf-Shrub grassland.

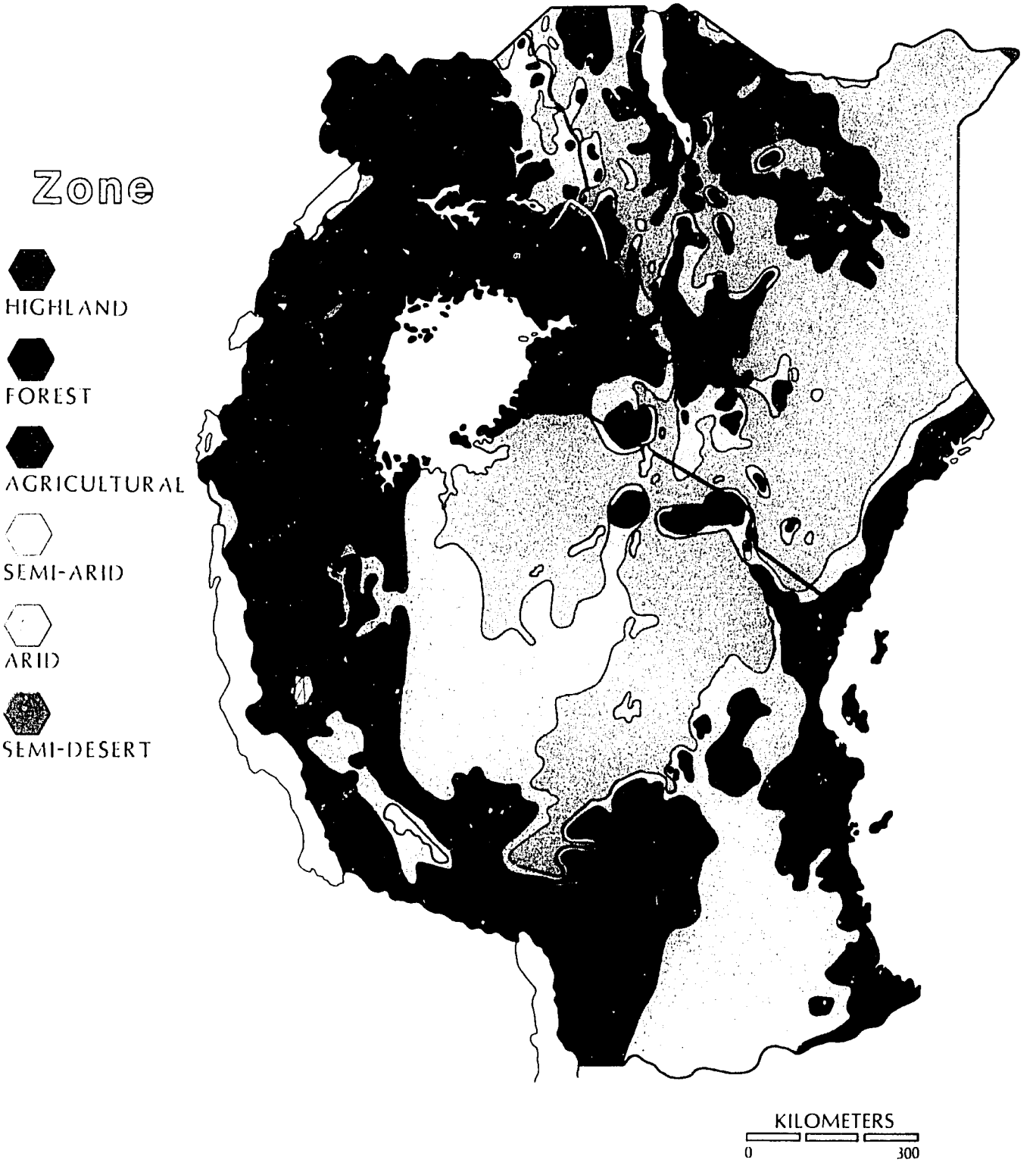
Potential: Limited to nomadic pastoralism that can take advantage of unreliable seasonal flushes. Mostly used at low intensities.

Zones and moisture index calculated from Penman, 1948.

*Defined as vegetation of zone under natural conditions.

FIGURE 14

Ecological Zones



Pratt, 1977; et al.

TABLE 12 SOIL TYPES AND AGRICULTURAL POTENTIAL IN EAST AFRICA

GROUP I: Good Agricultural Potential

Of the Group I soils the Andosols, Cambisols and Nitosols are generally productive and intensely used. On sloping ground there is major loss of soil through erosion and while these soils are quite deep such losses cannot be sustained over long periods. The Nitosols in drier areas are locally degraded to low productivity and generally need good management. The Ferralsols are subject to similar and more intense problems while the Rendzinas traditionally used for grazing are coming into cultivation. Fluvisols are generally not used up to their potential because of the high investment cost of such use.

Andosols: Considerable potential fertility, especially for bananas, beans, vegetables, potatoes, wheat, coffea, pyrethrum, and barley.

Cambisols: Moderately high potential fertility. Suitability varies depending on ecological and topographic conditions. Generally not suited for intensive cropping. Good-to-medium fodder value with limited water availability. The exceptions are humic cambisols in Burundi and Uganda for coffee arabica and food crops, with eucalyptus and cypress plantations being suited to the steeper slopes.

Nitosols: Good agricultural soils suitable for bananas, cassava, beans, maize, tea and coffee. In drier areas, sorghum and millet can be grown. Livestock raising is possible. Steep slopes should be reserved for forest management and erosion control.

Ferralsols: In dry areas, intensive agricultural development not advised; uses limited to extensive ranching. In humid regions, traditional and commercial agriculture are possible. Productivity can generally be enhanced by upgrading natural fallow, use of soil-improving plants, and using mineral fertilizers.

Rendzinas: Rich soils with a high humus content. Intensive irrigated agriculture possible in areas of low relief, but cultivation of chlorosissensitive plants such as citrus not advisable. Moderate slopes are suited to winter cereals and pasturage, while the steeper slopes are only suited to the cultivation of olives, figs, and vines.

Fluvisols: High potential soils. Well suited for intensive agriculture although the capital required for management (e.g., irrigation) may be considerable.

GROUP II: Moderate Agricultural and Good Grazing Potential.

These are a very varied group of soils. The vertisols are relatively stable but hard to work and manage; the Luvisols are often found in an eroded and deteriorated condition and the Acrisols are prone to crusting and surface cementation when cultivated. Some Planosols have been used for rice cultivation but most are grazing areas.

Vertisols: Soils best suited to good pasturage. Cultivation is possible but frequently requires expensive soil management practices: e.g., for cotton.

Luvisols: Soils of lower fertility generally associated with semi-arid conditions. Best suited for extensive livestock raising along with the cultivation of essential food crops.

Acrisols: Generally poor and subject to difficult ecological conditions. Commonly associated with miombo woodlands, and suited primarily to extensive livestock raising in conjunction with a modest food crop program based on cassava, beans, sorghum and eleusine. Large-scale agricultural modernization projects should be avoided.

Planosols: Poorly drained soils suitable for extensive livestock raising in dry periods and rice cultivation during the rainy season.

Solonchaks: Highly saline soils that require intensive management for development.

GROUP III: Low Productivity

By definition these are poor soils with the Regosols and Arenosols severely stressed in some areas. Livestock raising is the optimum use for these soils though crops are grown locally, particularly in the coastal zone where high rainfall totals help to provide a sustainable environment.

Regosols: Sandy soils of extremely limited agricultural potential. Forestry and coconut cultivation possible while fruit trees, groundnuts and tobacco require intensive management practices.

Gleysols: Soils with poor drainage conditions, generally unsuited to agriculture without considerable drainage engineering.

Vermosols: Virtually unused soils almost devoid of plant cover; generally unsuited to agriculture, even with irrigation.

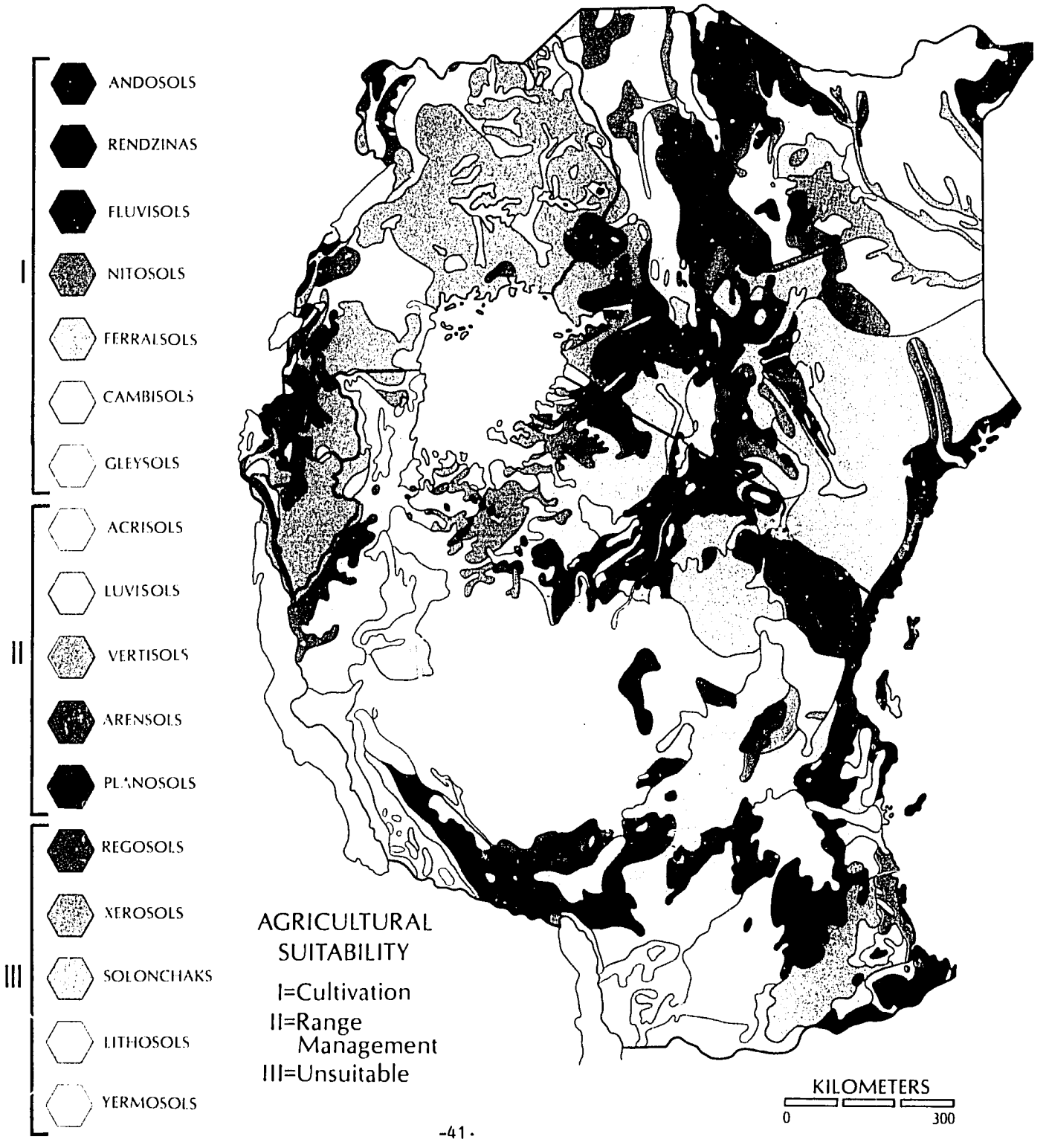
Arenosols: Generally poor soils best suited to extensive livestock raising. Groundnut cultivation is possible where rainfall exceeds 500 mm.

Xerosols: Poor soils associated with arid conditions. Limited extensive livestock raising possible.

Lithosols: Consist primarily of unweathered or partially weathered rock fragments. They are unsuited to agriculture and best left under natural vegetation.

FIGURE 15

Soils



FAO Unesco, 1977.

4. Marketing problems and lack of incentives.

Explanations for slow increases in food production vary. While some argue that soil depletion and population pressure are responsible, others look toward lack of incentives. Politically inspired policies to keep urban food prices low have had a dampening effect on rural production. Further, inefficiencies in marketing and uncertainties in schedules for transportation, processing, and payment have discouraged many farmers. For example, in Tanzania, official prices paid to farmers for citrus fruits are sometimes only 10 percent of those available to farmers on the black market (personal communication).

5. Extension and research services are pointed toward the commercial crop and export sector.

In reviewing literature and in visiting various parts of the region, one senses that major emphasis is still placed on agricultural research relating to coffee, tea, pyrethrum, and other export crops. Extension services also seem skewed in favor of the export sector. However, hard data are not available to verify this trend. What is clear is the fact that colonial governments put disproportionate emphasis on cash crop research and extension services. Independence brought interest in food crop activity but not necessarily action. In recent years, extension officers, especially some of the younger and university trained staff in the region have placed much greater attention to food production.

Soils

While the ecological zones provide the overall bioclimatic setting, the soils of the region provide more detailed information. As fertilizer use is still quite small and localized in most agricultural areas, especially among small farmers, inherent soil fertility is an important determinant of agricultural productivity (Table 12; Figure 15).

Six soil types (Group I) can be classified as good potential for agriculture. Most of these define the high potential zones, with the main exception being the Fluvisols which are found along rivers and in delta areas.

Group II soils have some potential for agriculture or good quality grazing but have some important constraints. Vertisols, for example, can be quite fertile but are very hard to cultivate; Solonchaks are saline and the others are nutrient poor. These soils are often found in ecological Zones IV and V and contribute to the low productivity in those areas.

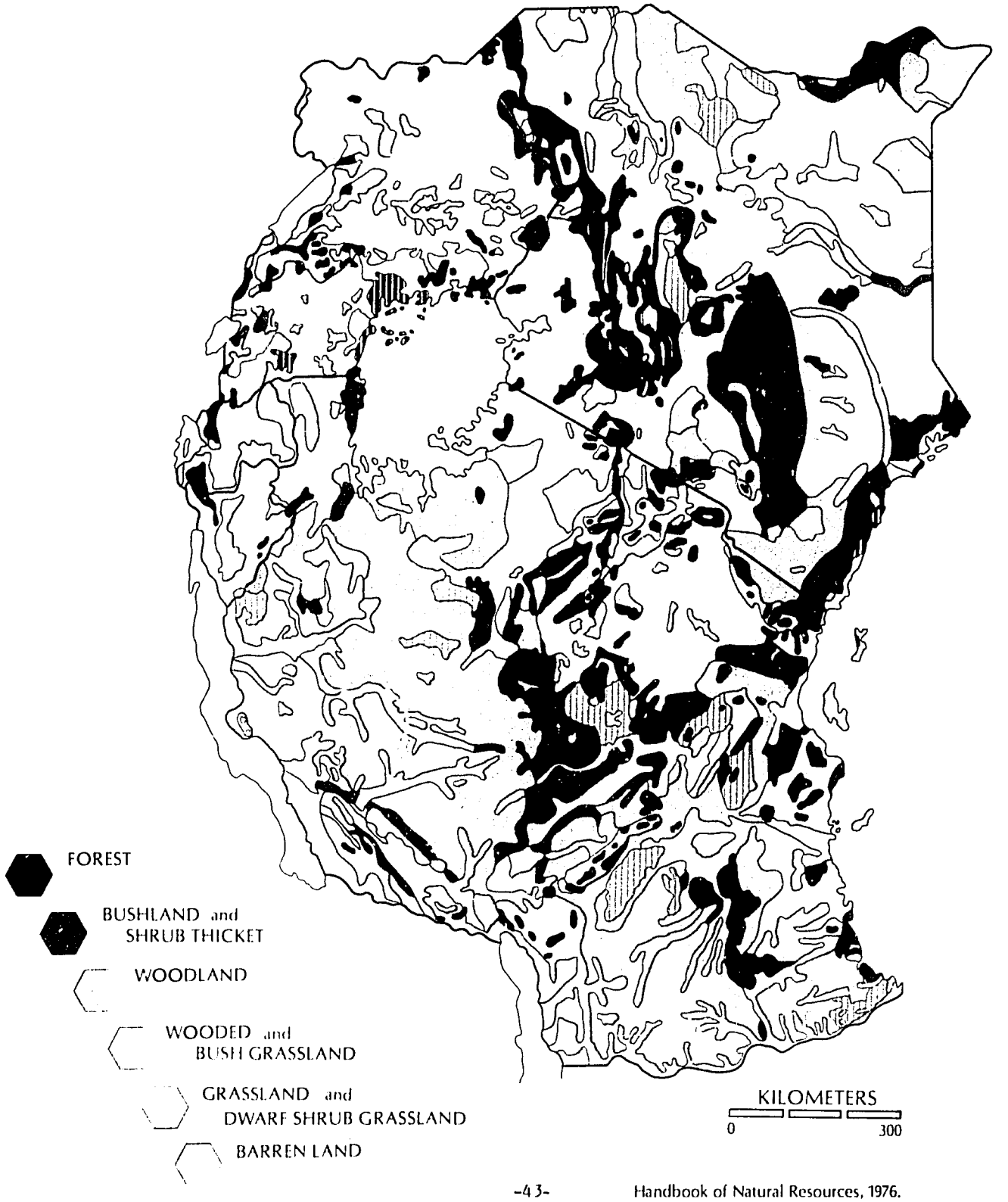
Group III soils are of very low productivity. The Xerosols and Arenosols are associated with the drier areas but some Regosols occur in the higher rainfall zones along the coast, greatly reducing the potential of that area.

Vegetation

The region's "natural vegetation" has correlated closely with the ecological zones, ranging from montane rain forest in Zone I to barren ground and scattered annual grasses and shrubs in Zone VI. However, fire and people have been agents of vegetational change for upwards of a million years and even apparently "natural vegetation" in the drier areas has changed due to these influences. Historical vegetation studies of the region suggest a sharp reduction in tree cover in the Lake Victoria region about 1,000 years ago. Then in the late 19th and early 20th centuries, a rinderpest epidemic reduced cattle numbers by as much as 90 percent and caused a widespread expansion of thornbush, especially in central Tanzania (Kjeckhus, 1977). In the mid and latter part of the 20th century, vegetation trends have taken two forms: range deterioration resulting from overgrazing (see Figure 17 and the accompanying explanation) and reduction of forests and woodlands due mostly to land clearing (Figure 17). In both cases, the precise impact on actual species is not

FIGURE 16

Vegetation



Handbook of Natural Resources, 1976.

known as no comprehensive vegetation survey exists for the region.

Figure 16 shows the distribution of six general categories of vegetation. Heavily wooded and forested areas now generally occur only in protected sites, on upper mountain slopes and in some remote parts of the region. Bushland and shrub thicket occur in a wider range of locations often associated with moist ground and low hill ranges. Woodland is an omnibus category which includes the dense miombo woodland of Tanzania and mixed vegetation of the coastal region. The typical savanna vegetation of wooded grassland is widespread and is the location of many game reserves. The lightly wooded areas thin out to grassland and shrubs as one approaches the drier margins of this area.

Of all the natural features, vegetation is the most dynamic and is steadily being changed through land use. As the region is heavily used, vegetation changes are considerable. For example, it is estimated that over 90 percent of Burundi and 75 percent of Rwanda is utilized by people, either in direct cultivation or through grazing.

A few generalizations are possible about vegetation. Those areas within national parks and nature reserves are generally well protected. Through what one author has described as "an outstanding network of protected areas," the region has done amazingly well to safeguard its natural vegetation within these "safe" areas. This parks network has expanded vegetational reserves in Kenya, worked well at saving forest areas in Rwanda, and been supported by "imagination, flair, political skill and sheer hard work" in Tanzania. (Polhill, n.d.). Even in beleagured Uganda, Polhill finds that the vegetation in protected areas is standing up remarkably with only four sites (Mabira, Ruwenzori, Moroto and Elgon) showing signs of serious encroachment or degradation.

Danger signs are appearing outside of the protected areas. Exploitation of swamps and riverine forests for charcoal and firewood are cause for alarm in Uganda as is conversion of use of swamp grasslands to grow rice. More detailed botanical work has been carried out in Kenya where J.B. Gillett identified 35 varieties of trees, shrubs, and grasses in danger of extinction (Hedberg, 1968). By habitat, the threatened species are distributed as follows: coastal forests (3); coastal rocky limestone forests (4); Taita Hills forests (3); upland forests (3); riverine trees and shrubs (3); upland grasslands (8); arid lowlands (4); plants in agricultural areas (7). Of a list of 700 rare species in Tanzania, only a few are considered to be "endangered." (Ibid.). Even so, that as many as 700 species are rare is cause for concern and calls for continued safeguarding of the region's vegetational resources.

Beyond these broad general trends for the region, more specific trends in vegetation include:

...reduction in forested areas

The Landsat image of Mau (Figure 17) illustrates this for one area. In many areas except perhaps parts of Rwanda a similar process is underway. Perhaps 10 percent of forest in the area has been lost in the last decade;

...reduction in grassland by spread of agriculture

This is most evident in Rwanda where the livestock herd has dropped by about 15 percent in the last decade;

...reduction of woodland because of the need for fuel and for agricultural land

FIGURE 17

Change In Forest Cover
Mau Area, Kenya

Forested in 1973 and 1978

Forested in 1973, unforested in 1978

Unforested in 1973, forested in 1978

Unforested

0 5 Km

Iris International, 1973.

This trend is evident in dry parts of Kenya, Tanzania, and Uganda where woodfuel is hard to find for many and increasingly costly to buy;

...deterioration of grassland into barren land, especially in northern Kenya and central Tanzania and eastern Uganda.

Studies by Rapp (1972) of the Dodoma and Singida areas and reports from other areas show that in Central Tanzania pasture is greatly deteriorated and the range overpopulated by livestock;

...the historical spread of thornbush in Tanzania seems to have been halted.

As Kjeckhus (1977) has carefully documented, the current distribution of thornbush in Central Tanzania is the result of a spread of bush during this century. The bush replaced grassland and brought tsetse to the area. The process appears to have stabilized in the last twenty years.

The vegetation, as a static presentation, must therefore be supplemented with references to the patterns of land use as noted above.

Land Use

Ecological zones, soils and vegetation have meaning only in the context of how they are used and what trends in such uses can be identified. Figure 18 shows current land use for the region. Though a static representation, the map depicts the region's seven major land uses which constitute (with one exception) the livelihood systems of most of the people. The exception is urban and industrial uses which are too small to show on the map though they are extremely important and rapidly expanding uses of the land.

The patterns of resource use have evolved as a result of influences which began many generations ago. The traditional agro-pastoral systems were greatly modified when colonial influences introduced a wage economy and global markets for some products. Commerical cultivation and livestock husbandry created new patterns of resource use, often competing with and conflicting with traditional user patterns, even when the government was the investor. Tourism, preservation of wildlife and forestry were other and later influences which further complicated networks of resource users in East Africa. Most recent is a growing industrial and urban influence which is perhaps the most rapidly expanding force in recent land use trends. Underlying all of these trends is a persistent expansion of agriculture (Figure 19).

The resulting mosaic is therefore a product of history, economics, ecology and global politics though in general the types of resource uses reflect the potential of soil and ecological factors outlined earlier. The pattern of use also reflects:

the conscious protection of some areas for forestry and catchment control;

the protection of some areas for wildlife and tourism;

conflicts between resource users especially between commercial large scale and small scale farm producers (mostly in Kenya and Tanzania);

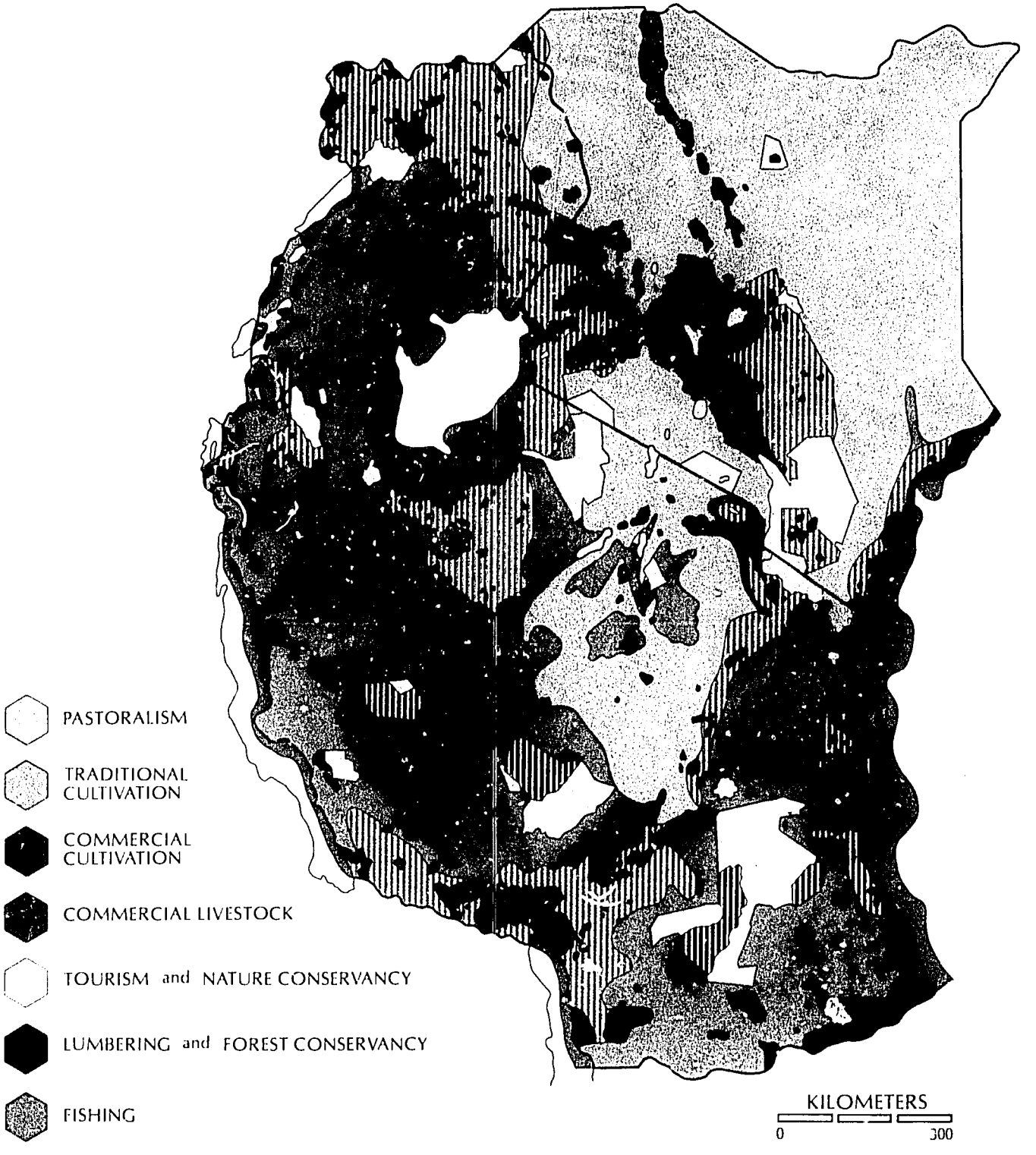
tsetse and other restraints on resource use in large areas of Tanzania and some parts of Uganda.

(a) High Potential Land Use

As outlined earlier, the highest potential for arable cultivation is found in the moist upland regions (Zones II & III). This area has the most intense agricultural uses (intense used here as high

FIGURE 18

Land Use



Oxford Atlas, 1978; et al.

input levels for cash crops, maize, and bananas) and is subject to pressure for even greater intensification. In Kenya, for example, Zones II and III occupy only 19 percent of the land area; yet they sustain 80 to 90 percent of the population. Some estimates suggest that within Kenya's high potential areas only 7 percent of the national land area is good agricultural land. With population growing rapidly each year, the trends in high potential areas include all of the following:

... smaller farm sizes. This is particularly evident in Rwanda and Burundi as well as Kenya. In Rwanda, 743,000 small family farms cultivate a total of 825,000 ha. Average farm size has fallen as much as 30 percent since 1970 and is projected to fall to half current sizes by the year 2000.

... intensification of already intensive agriculture. As farms become smaller with more labor available, some areas show intensification of production with crops planted more closely and with higher inputs. In Kenya and Kilimanjaro in Tanzania, production per ha. has increased but production per person appears to be dropping.

... crop changes to accommodate intensification. Part of the process of change is new crops. In Rwanda and Kenya, potatoes have become an important cash crop in recent years. This crop uses smaller amounts of land for a larger total production. Vegetables and rice production in former grazing areas and a trend to stall fed cattle are also signs of crop/production changes associated with intensification.

... pressure to utilize other land in the areas (i.e., clearing forest land). This trend is best illustrated in Figure 17 which shows the result of five years of forest removal, caused primarily by need to expand intensive agriculture. The pattern also appears in Rwanda, Burundi, and northern Tanzania.

... out migration to towns and lower potential zones. Urban growth including smaller regional and district centers, is documented in Table 8. Population drift from higher to lower potential land is identified in detailed research carried out by Bullock (1971) in central Kenya and Mara (1982) for the Kilimanjaro and Arusha area in Tanzania.

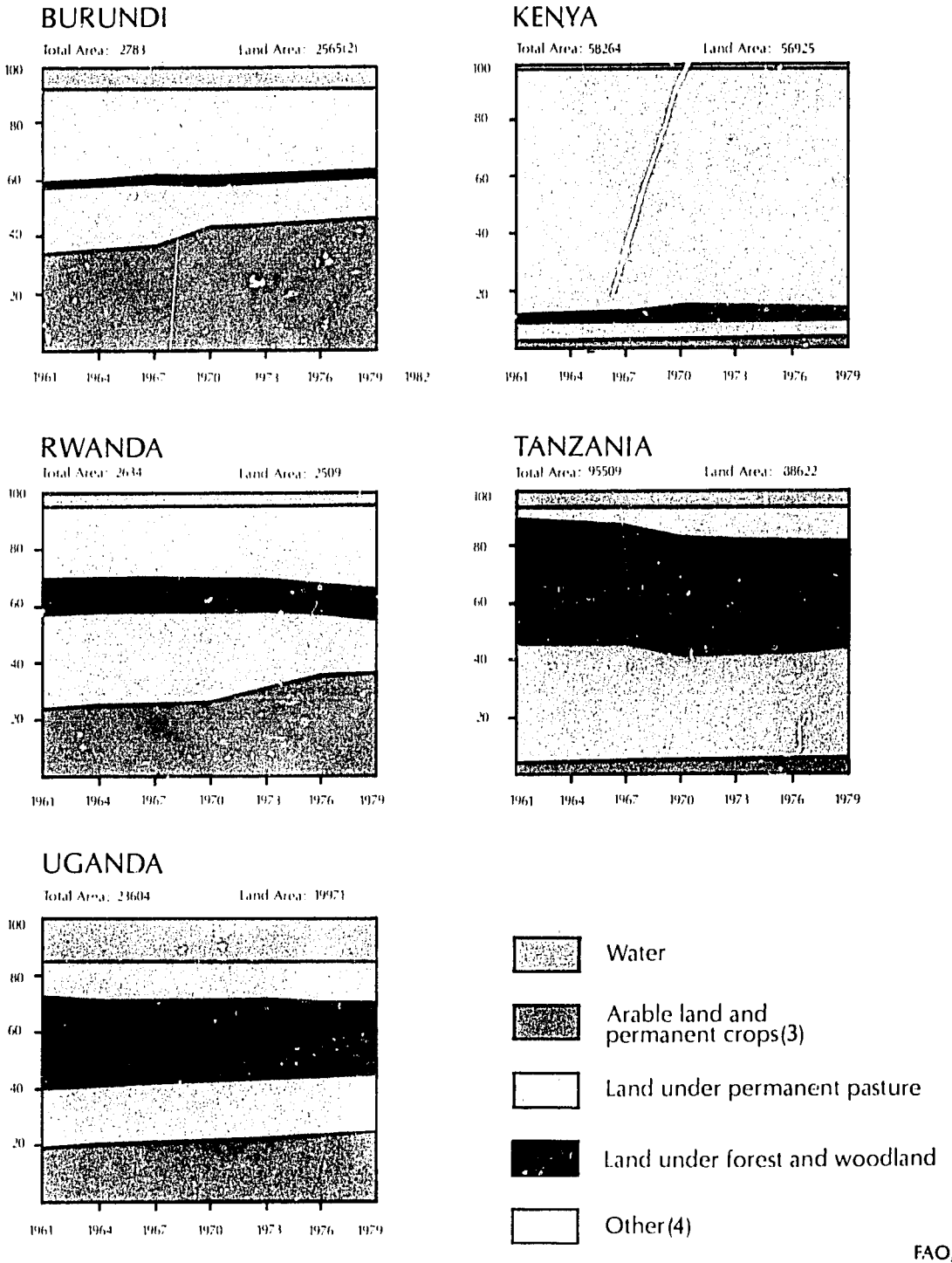
... deterioration in soil quality and soil erosion. No overall data exists for soil productivity changes in the high potential areas. However, site specific studies in Kiambu (Kenya) clearly document a current problem and point to increasingly severe soil loss. For example, some fields planted in maize are losing more than 50 metric tons per hectare per year (Lewis, 1983).

Changes are occurring in Rwanda, Burundi, Kenya, and in the upland areas of Tanzania such as Kilimanjaro. As an example, Figure 17 shows change in forest cover over a five-year period. In this illustration from Kenya, the changes are identified from Landsat imagery and are due to the spread of agriculture. While a few areas show forest regrowth, the dominant trend is of forest removal at a remarkable pace for a five year time span.

Pressures of expanding agriculture on forests are not only intense but are likely

FIGURE 19

Land Use Trends: 1961-1979 (1)



FAO, 1975; et al.

(1) Percentages of total area
(2) 1000 Hectares
(3) Includes land under temporary fallow land and land under permanent crops
(4) Includes unused but potentially productive land built on areas wasteland, parks; roads, barren land etc

to increase. The land tenure system is experiencing, at the same time, both fragmentation and agglomeration. The fragmentation occurs as a result of divisions of property, either through piecemeal sale, subdivision by government and parastatal developers, or through distribution of land to multiple survivors upon the death of a landowner. Agglomeration takes place through large farming efforts, mostly in the commercial sector.

In Kenya, for example, some 31 percent of small scale farmers own land of less than one hectare. In Rwanda and Burundi, many farms are about half a hectare. Such small farms have a higher labor input per hectare than large ones and have a high gross output per hectare. This phenomenon of productivity per hectare reemphasizes the point that population densities, even when considered at very local levels, are not precise measures of economic stress.

For the Kenya case, large farms, with many fewer hectares under crops than small farms, have accounted for over half of the nation's total value of commercial agricultural output in recent years. These production figures assume even greater significance in light of large farms having considerable amounts of land not in production.

It is important to stress that there is no final closure on these trends or on the debate of large farm versus small farm. To imply that large farms will inevitably produce more per hectare is to assume that small farmers will never have access to capital, technology and fertilizer. Small farmers, when inputs are available, behave impressively. Examples of successful coffee production on five to ten hectares in Kiambu (north of Nairobi) are one set of experiences. Another are market gardeners in Ngong near Nairobi, where small diesel irrigation pumps and fertilizers have enabled small holders with two to three hectares each to grow vegetables year round and do quite well. Another example are small farmers in Meru on the slopes of Mount Kenya, who use gravity irrigation, fertilizer and pesticides to produce a crop of 700 bags of potatoes per hectare. Other examples of coffee and bananas on small plots in Kilimanjaro or mixed farming in Rwanda's valley bottoms could be added.

These varieties of land ownership and management are areas which are perhaps overlooked, or at least unintegrated, in the conclusions of many studies of resource management. For example, outputs from the concentration of small holder land ownership in Kenya's high potential zones or on the slopes of Tanzania's Mount Kilimanjaro have not been contrasted with the resettlement schemes of Tanzania's new villages. The legal penalties against land aggrandizement in Rwanda offer additional grounds for comparative land use and resource management analysis. The tentative hypothesis, at least on the basis of present fragmentary information, seems to suggest that the variable for good resource management is not necessarily whether one is dealing with large or small farms. Rather, the difference seems to lie more with the incentive and ability (both financial and technical capacities) of <u>large and small farmers</u> to acquire and use agricultural inputs.

(b) <u>Middle Potential Land Use</u>

In middle potential areas (basically Zone IV) arable agriculture is combined with livestock raising, although large scale agriculture is focused on crops such as pineapple or cotton mostly through irrigation. The middle potential areas are not as intensively farmed as the high potential zones but pressures have increased considerably in recent years. In addition, middle potential areas suffer from drought on the average of one in five years. Areas such as Iringa in Tanzania produce good crops of maize in most years and typify the more productive of middle potential areas. Machakos District in Kenya is a more typical middle potential area where much of the

district experiences problems of sustaining productivity. Some of these areas are receiving an additional influx of population from the high potential areas and thus have growth rates of 5 to 7 percent a year. While the middle potential areas of Kenya are perhaps under the greatest strain, some of the middle potential areas of Tanzania and Uganda have good long-range prospects for increased production once constraints of access and tsetse are removed.

One program, in Tanzania, which sought more productive use of medium potential lands bears special mention. In 1967, Tanzania's Prime Minister, Julius Nyerere, announced his Ujamaa plan which stipulated that rural Tanzanians would be located in village centers. In part, the plan was undertaken to reduce land pressure in high potential areas and utilize less productive areas more effectively. Villagization caught on slowly. By the end of 1968, only 58,500 had been resettled; by 1969, the figure had increased to only 300,000. Planners decided in the early 1970's that the government should take a more active role and by 1973, a new policy required all rural residents to move to nucleated settlements. By 1976, over 13,000,000 Tanzanians had been relocated to live in roughly 7,500 villages. Although some of the newly registered villagers had not moved at all and others moved very short distances, still others moved rather substantial distances in what Ian Thomas has called "one of the largest and most rapid population redistributions in the history of Africa" (Thomas, 1967). The impact of this movement on production is not well documented.

(c) Low Potential Land Use

The marginal lands are more devoted to livestock than agriculture though areas such as Lodoma in Tanzania combine both livelihood systems. Population statistics show that some of these areas have sustained high levels of increase in population in the first independence decade (mid-1960s to mid-1970s) with consequent severe stress on the natural systems. (BRALUP, 1973). In areas like this, livestock numbers are well over the most optimistic stocking capacity and agriculture is losing productivity. These ecosystems have been shown to be under stress by detailed studies of soil erosion and sedimentation. To compound this problem, drought reduces production in two years out of five. The vulnerability of low potential agricultural areas has been increased by the switch of many peasant farmers to maize in preference to the more drought resistant millets.

In summary, agriculture is both intensifying and expanding in East Africa (Figure 19) and while comprehensive data are rare, it is clear to most observers that systems in lands of every potential are under stress. The impact may be greatest in middle and low potential areas in the short run though the concern for the continued high level of productivity of the high potential lands must remain a very high priority for all concerned.

Protected Areas

Parks, game reserves, and protected forests are a significant land use in East Africa. Figure 20 indicates the size of individual parks and the extent of the areas under control. Within these protected zones one finds enormous herds of savanna wildlife, one of the world's last remaining concentrations of mountain gorillas, unparalled landscapes, and a wealth of vegetation types varying from the mountain top glacier and tundra species on Mts. Kenya and Kilimanjaro to the arid and semi-arid grazing lands of northern Uganda and Kenya as well as central Tanzania.

Park preservation dates from colonial times but the present governments have endorsed and greatly expanded both the concept and the territory under control. For example, in Tanzania there was only one national park at independence. During the years since independence, Tanzania has

added 10 new parks as well as confirming 18 games reserves and 49 game controlled areas. These lands constitute 30 percent of Tanzania's total territory. To support these protected areas, Tanzania spends roughly 4 percent of its national budget on conservation activities. On a per capita percentage basis, Tanzanian conservation expenditures are eight times higher than those in the United States (Abrahamson 1983). With some exceptions, the other nations in the region have a comparable record of park protection. Exceptions include Rwanda where portions of park land have lost out to political refugees and a pyrethrum project; Uganda where the recent war has depleted wildlife numbers; and Kenya whose generally superior record is marred by loss of territory in the parks at Amboseli, Masai Mara, and Tsavo.

In spite of these mostly encouraging signs, the region is experiencing a number of severe problems in areas of resource protection. These include:

... increasing difficulties of maintenance of wildlife outside the parks;

... consequent loss of species;

... concern about the ecological viability of some parks as land use is changed around them;

... conflict between uses as a park and the needs of local people;

... many endangered habitats located outside the protected areas;

... loss of control in periods of civil disorder as, for example, during and after the Amin regime in Uganda;

... need for more protected areas.

Wildlife preservation has been and will continue to be difficult. Regionwide statistics are unreliable and inconsistent. Even IUCN's excellent network for monitoring both endangered species and wildlife trade does not have firm data showing trends in wildlife over the last 20 years. However, actual numbers of wildlife are less important than the condition of wildlife habitat. As virtually none of the protected areas in East Africa constitute independent ecosystems, patterns of shared land use among pastoralism, agriculture, and wildlife are the rule. For example, one elephant requires approximately 2.5 square kilometers. As wildlife habitat dwindles, so will the wildlife population.

Given limitations on precise statistics, a few approximations will at least set the context of trends.

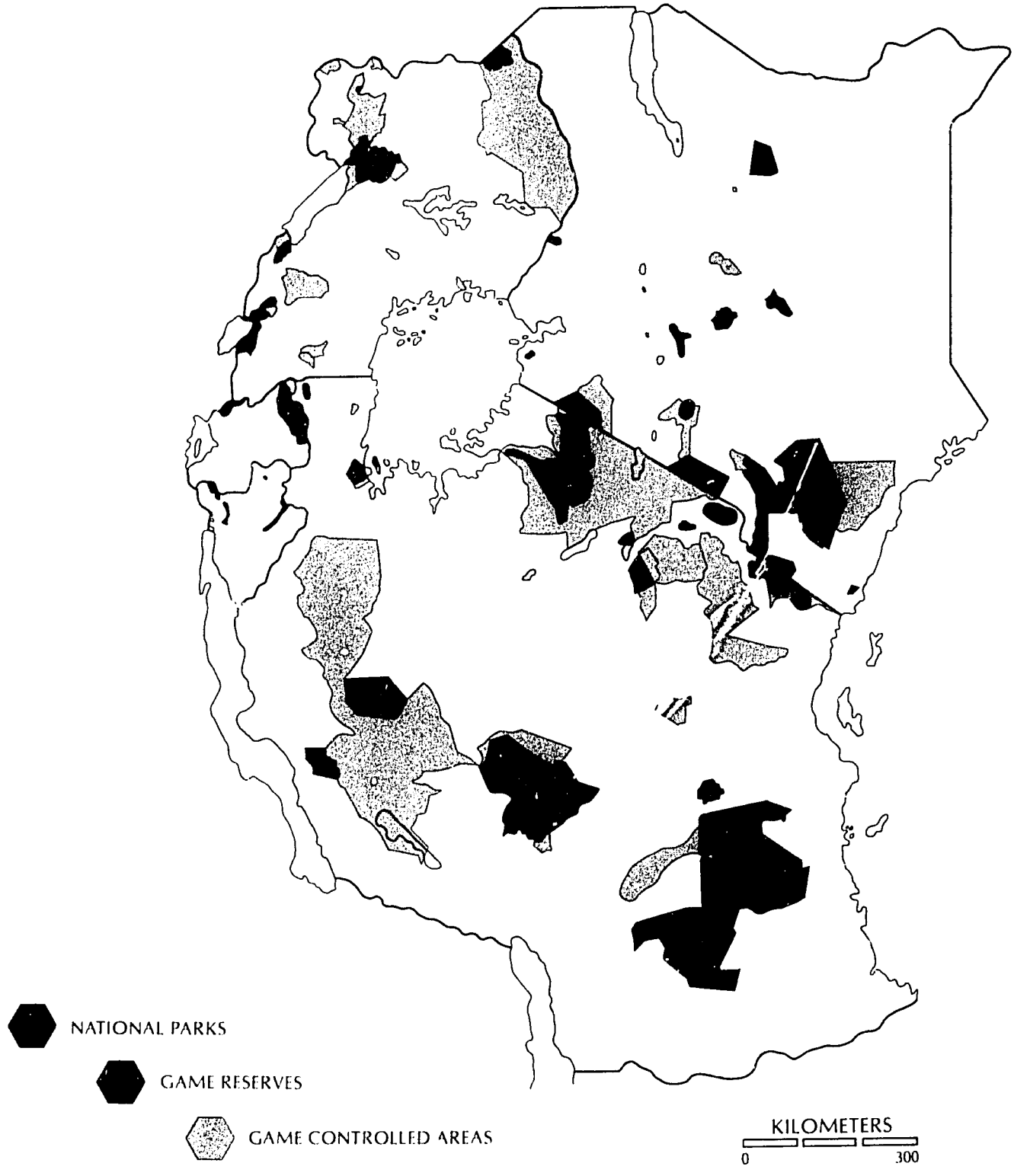
A detailed survey is available (Table 14) for Garissa and Lamu (Kenya) which highlights the peril in which large mammals find themselves. Six aerial elephant censuses for the same area show declining numbers, adjusted for errors of omission and sampling. Note that a significant poaching foray took place sometime between August, 1976 and December, 1977.

While national governments have generally an excellent record for maintaining park areas, problems of defending park boundaries have been recurrent. Most recently the Akagera park in Rwanda was used to resettle refugees from Uganda and the long viability of that area must be in doubt. Park boundaries were ignored in the recent conflicts in Uganda and some species, especially the White Rhino, are greatly at risk. A further park encroachment took place in Rwanda when roughly a third of a protected area was transformed into a large pyrethrum project, financed in part by the World Bank.

To help governments maintain parks and to safeguard habitat, tourism is promoted to earn hard currency as well as general "recreation, refreshment and inspiration" for the increasing numbers of local visitors. Tourist income is the second largest earner of foreign exchange in Kenya (coffee

FIGURE 20

Protected Areas



Department of Overseas Surveys, 1973; et al.

TABLE 13 WILDLIFE TRENDS IN EAST AFRICA (selected examples)

Elephant			
Kenya		1963	1983
		160,000	60,000
Uganda		1970	1980
	Queen Elizabeth Park	2,500-3,500	120
	Murchison Falls	14,000	1,700
Rhino			
Tanzania		1970	1980
	Olduvai	80	0
	Ngorongoro Crater	mid 1970's	1983
		100	20
	Ruaha National Park	1973	1977
		450	30
Kenya			
	Tsavo	1973-74	1979
		5,800	250
	Meru	1976	1979
		130	15
	Amboseli	1969	1979
		70	10

Source: Walker, 1983.

is first); a growing although tightly controlled industry in Tanzania and Rwanda; a nascent one in Burundi; and one that could be revived in Uganda. All indications are that tourism, especially from Western Europe, will increase.

The value of tourism is not enough, however, on social, economic or even ideological grounds, to preserve animal habitats. The general ideas of conservation have to be seen to be obviously beneficial to the local populations. A growing number of both expatriate and local conservationists are coming to believe that the only way to save wildlife and endangered vegetation in Eastern Africa is to make it pay for itself. "Preservation for Profit" and "Multipurpose Parks" are the slogans here. In particular, a leading ecologist, Dr. Norman Myers, has proposed that wildlife be harvested on a commercial basis so that income can go directly to local people. Kenya is now experimenting with plans which will pay a portion of tourism revenue directly to people who live near protected areas.

TABLE 14 ELEPHANT COUNT FROM TANA RIVER TO SOMALIA BORDER 1976-1978

Date	Actual Count	Adjusted Number	Elephant Skeleton Count
March 76	9,955	15,065	
May 76	13,129	15,519	
June 76	11,318	13,764	
Aug. 76	10,420	14,233	1,743
Dec. 77	6,215	12,849	3,408
Jan. 78	6,135	13,087	

Source: Bunderson, 1981.

Forestry

Population growth, rising demand for woodfuel and charcoal, clearing of land for cultivation, and increasing commercial exploitation of forest reserves, and local wildlife practices (e.g., elephants, gorillas) combine to place stress on woodland and forest areas. FAO reviews suggest that forest cover is decreasing, region wide, though the data are extremely general. However, detailed examples in a number of selected sites provide clear indications of the important trends.

In some cases, destruction comes directly to forests as noted in Figure 17. This Landsat image vividly portrays declines at a rate of 5 percent per year. This type of major forest removal seems to come largely from expanding agricultural uses in unprotected areas, though other pressures are also important. Comparable examples of significant tree removal could be cited in the Kakamaga and Nandi forests in Kenya as well as for the other four nations.

In other examples, forest cover removal comes at the hands of expanding urban populations. For example, a recent study for Nairobi shows that firewood and charcoal are by far the cheapest forms of urban energy. Firewood is approximately one-eighth the cost of kerosene and one twentieth the cost of electricity for comparable energy units; charcoal is one-third the cost of kerosene and 13 percent the cost of electricity, also for comparable energy units (O'Keefe, 1984). With such major differentials in pricing, woodfuel products will continue to be the major energy source for urban residents. Given rates of urban expansion (Figure 7), fuelwood pressures generated by need for both charcoal and firewood will certainly grow, at the very least at the same rate as urban expansion, and conceivably even at higher rates.

Another pressure arises from commercial exploitation. For example, major forest cover in northern Rwanda (estimated at removal of 40 square miles) resulted from a project supported by the European Economic Community to increase pyrethrum production (Pyrethrum is used for insecticides). The goal of the project was to increase exports for Rwanda as well as substitute biodegradable pesticides for more toxic substances being used in Europe. Although there were

benefits in terms of Rwandan exports and ecological protection in Europe, the cost to Rwandan forests has been considerable.

Another example emerges as a result of local improvements in health control and social developments. For example, the savanna zones of the Bugesera and Kibunbo regions of Rwanda were relatively unpopulated due to the combined effects of sleeping sickness, low rainfall, and generally poor soils. Tsetse eradication, water improvements, development of the infrastructure, and massive immigration from more populated parts of the country have resulted in the clearing of most of this region over the last ten years. Between 1975 and 1979 alone, over 60 percent (633 square kilometers) of Bugesera's natural tree cover was destroyed, primarily for settlement and charcoal production for Kigali.

At present, woodfuel products continue to be generally available throughout the region and prices continue at relatively low levels compared with kerosene or electricity. However, a number of factors must be considered when projecting into the future. First, prices continue low, relative to petroleum products, partly because of the extreme inflation in petroleum prices (Figure 12). Second, supplies of woodfuel are generally continuous because much land is still being cleared for agriculture. Bugesera, Mau, and Kakamaga are but a few of the examples which could be noted. When trees are cut, they find their way into the market and therefore tend to keep supply up. Third, much of the woodfuel which is gathered comes from non- forest areas. For example, a study in Kenya has determined that 47 percent of Kenya's wood energy demand comes from sources outside of forest areas. Although sustainable production from such suplies is meager, there is considerable "wood capital" now available which is being mined. Thus, as population pressures continue to mount and the capital sources gradually slip away, an inevitable fuelwood crunch will appear. Projections for Kenya suggest that wood demand will rise from 20.4 million tons in 1980 to 49.7 million tons by 2000 with a shortfall (consumption minus production) of 33 million tons in 2000 (O'Keefe, 1984).

While these trends are cause for concern, there has simultaneously developed a strong political awareness of the importance of forest cover, not only as a renewable economic resource in its own right but also as watershed protection, as a preserver of habitat for flora and fauna and as a means to control soil erosion.

A forestry conservation trend exists in the region, linked to an early awareness among colonial authorities. This trend is particularly noticeable in Rwanda and Burundi where, after a post-colonial lapse, both governments have begun a series of aggressive reforestation programs. During the last five years (1978-83), for example, Rwanda's total forest plantation area has increased from roughly 49,500 ha. to an estimated 87,000 ha.

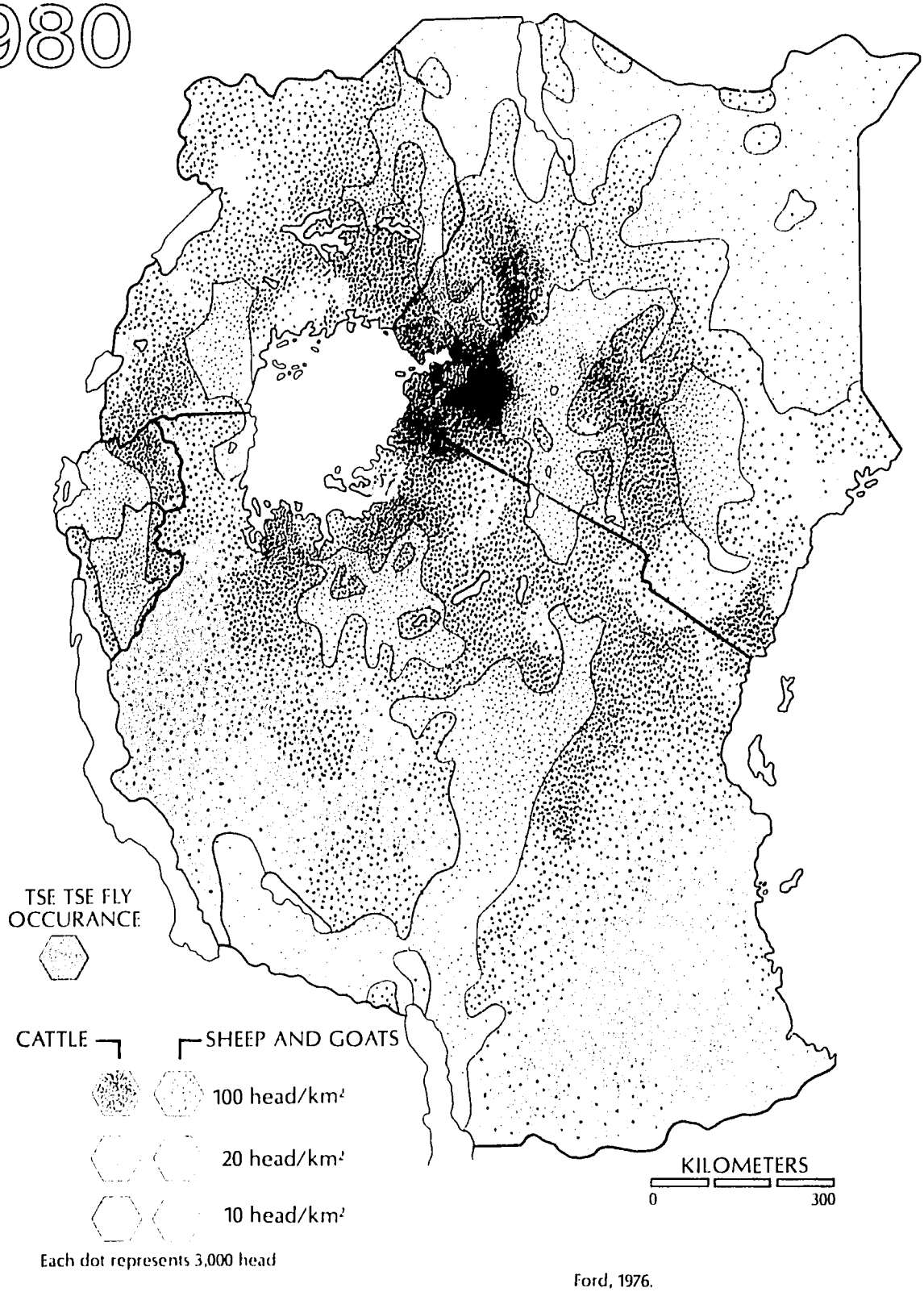
Agro-forestry also offers promise. Experiments in Rwanda suggest that a family of four can meet all of its fuelwood (as well as food needs) through careful management of one to one and one-half hectare plots. Another encouraging development is the accomplishment of a number of private voluntary organizations in the area of forestry. In Kenya, a coordinating council known as KENGO (Kenya Non-Government Organizations) has achieved significant success in disseminating information and planting trees throughout villages in both semi-arid and humid ecosystems. Also worthy of mention are Kenya's National Council of Christian Women (NCCK) groups as well as other women's organizations.

Livestock and Pastoralism

The remaining major category of land use relates to grazing. Between 60 and 70 percent of the entire region is devoted to some kind of livestock raising (Figure 21).

FIGURE 21

Livestock Distribution, 1980



Ford, 1976.

TABLE 15 CA E, SHEEP AND GOATS IN EAST AFRICA (IN THOUSANDS)

CATTLE	1969-71	1979	1980	1981	Percentage change in ten years
Kenya	8,433	9,457	11,000	11,500	+ 36%
Tanzania	10,141	12,388	12,578	12,701	+ 25%
Uganda	3,987	5,000	4,800	5,000	+ 25%
Rwanda	711	631	640*	650*	- 9%
Burundi	676	819	846*	872*	+ 29%
Total	23,948	28,295	29,864	30,723	+ 28%
SHEEP					
Kenya	3,935	4,000*	4,300*	4,700*	+ 19%
Tanzania	2,823	3,716	3,775	3,856	+ 37%
Uganda	799	1,070*	1,072*	1,075*	+ 35%
Rwanda	174	279	290*	300*	+ 72%
Burundi	231	282	316	332*	+ 44%
Total	7,962	9,347	9,753	10,263	+ 29%
GOATS					
Kenya	4,237	4,500*	4,530*	4,580*	+ 8%
Tanzania	4,441	4,574	5,662	5,784	+ 30%
Uganda	1,822	2,150*	2,155*	2,160*	+ 19%
Rwanda	478	824	880*	920*	+ 92%
Burundi	475	608	657	686*	+ 44%
Total	11,453	13,656	13,884	14,130	+ 23%

*FAO estimates

Source: FAO Production Yearbook, 1981.

Table 15 shows that in 1981 over 30 million cattle, 10 million sheep and 14 million goats made up the domestic livestock of East Africa. Further, the FAO data indicate major growth in the last 10 years with sheep and cattle most active (20 and 28 percent) and goats not far behind at 23 percent increase. Only in Rwanda has the national herd begun to shrink, probably due to the reduction in grazing land. This trend may be beginning to take place in Burundi as well although it is too early to confirm it (FAO, 1982).

These declines may be an early sign that livestock pressures will decrease in the face of agricultural expansion. However, there is no indication of abatement in the drier areas where livestock is the primary means of livelihood. For example, in parts of arid and semi-arid Kenya, overstocking is a major problem with degradation of the range, especially soil erosion, a clear consequence. Studies by Dunne (1979) show that severe degradation is localized (for example in Kajiado). Thus, the general state of Kenya's range is one of a series of high pressure points in the midst of a larger sea of modest overstocking. However, "disaster" is relative to rainfall. When rains are good, an overloaded range can provide. In contrast, if one or two rainy seasons are lean, the animals will quickly consume available grasses and both livestock and the range will suffer. For example, Kenya's long rains in 1984 have been a major disappointment with significant livestock deaths already recorded, slaughterhouses running at maximum capacity, and several months to wait before the next "normal" rains. As long run stock trends continue to rise, each shortfall in rain will inflict even greater losses as the cushion of grass is increasingly depleted.

Two additional points are relevant in assessing livestock trends. First, the numbers are among the most unreliable of all resource data. Cattle censuses are fraught with problems. Even air surveys are suspect as cattle increasingly are being kept in penned and covered enclosures, especially in agricultural areas.

The second is disease. Figure 21 illustrates livestock distribution and tsetse location. It notes that the densest concentrations come in several areas that are free of tsetse. However, there are also modestly dense livestock levels in areas where tsetse is present (for example, in Central Province of Kenya, north of Nairobi). Co-existence of tsetse and livestock suggests that cattle owners are prepared to risk loss through disease in exchange for expanded grazing areas. It also indicates that local knowledge has enabled pastoralists to maintain equilibrium between tsetse and cattle with tsetse tending to stay in the more moist regions and cattle preferring the drier parts of an ecological zone.

CHAPTER 4 WATER

Introduction

Water in East Africa is a key resource for agriculture, hydro-power and fisheries as well as for drinking, industry and urban sanitation. Rainfall and surface water are unevenly distributed across East Africa, both over time and space. The pattern of distribution has had much to do with the uneven distribution of people (see Figures 5 and 22). East Africa includes desert and rain-forest and large gradations in between where the arrival of adequate seasonal rains is the prime determinant of a crop's success. With respect to the importance of water resources, the future looks very much like the past, only more so. One knowledgeable observer says:

> I believe that by the end of the century, water supply will be the single greatest constraining factor for expanded food output in several parts of Kenya..."
> (N. Myers, 1984).

Rainfall, along with soil type and slope, determines the pattern of vegetation and land use. Although many aspects of rainfall are important, the mean annual totals (Figure 22) are a helpful first indication. For example the areas receiving 1,500 mm or more annual rainfall serve as important watersheds, since that amount of rainfall exceeds total evapotranspiration allowing excess water to accumulate or run off in streams. These 1,500 mm areas, although comprising only four percent of East Africa, contribute a very large part of the region's stream and river flow. Land which receives between 750 and 1,500 mm per year has good agricultural potential and, depending on the seasonal regime, can often produce two crops per year. Annual rainfall between 500 to 750 mm provides only marginal subsistence agriculture and creates high risk of periodic drought. Areas with 250 to 500 mm are suitable only for pastureland. In the better parts of these zones, ranching is possible. But for the drier areas, only nomadic livestock raising is practical. Areas with less than 250 mm are approaching desert conditions and can support only widely dispersed nomadic peoples and their herds.

The special importance of rainfall in the region's livelihood systems appears in correlations between the pattern of rainfall and land use. Without exception, high rainfall brings high population concentrations (compare Figures 5 and 22). This correlation is not surprising, given that 80 to 90 percent of the region's people still rely on rainfed agriculture and/or grazing for their livelihoods. This rainfall-population correlation is especially graphic in Kenya where 80 percent of the people live on 15 percent of the land in the well watered central highlands, Lake Victoria Basin, and along the coast. The correlations also hold true for the well watered highlands in Rwanda and Burundi, Uganda's and Tanzania's lake region, and Tanzania's southern and eastern belts.

Rainfall Seasonality

Rainfall is not evenly distributed during the year. Seasonality varies widely within the region. In fat, differences in both the seasonal pattern and annual averages can be found within very short distances, depending on topography and local microclimates in the area. Three types of seasonal patterns are especially important and are clearly shown in Figure 23. Within and to the east of the Rift Valley, including the Kenya highlands, a pattern of two distinct rainy seasons prevails. The "long" and "short" rains come in April/May and November/December respectively. In most cases the short rains are unfavorable for agriculture due to their short duration. The second type occurs in southwest and central Tanzania where the two rainy

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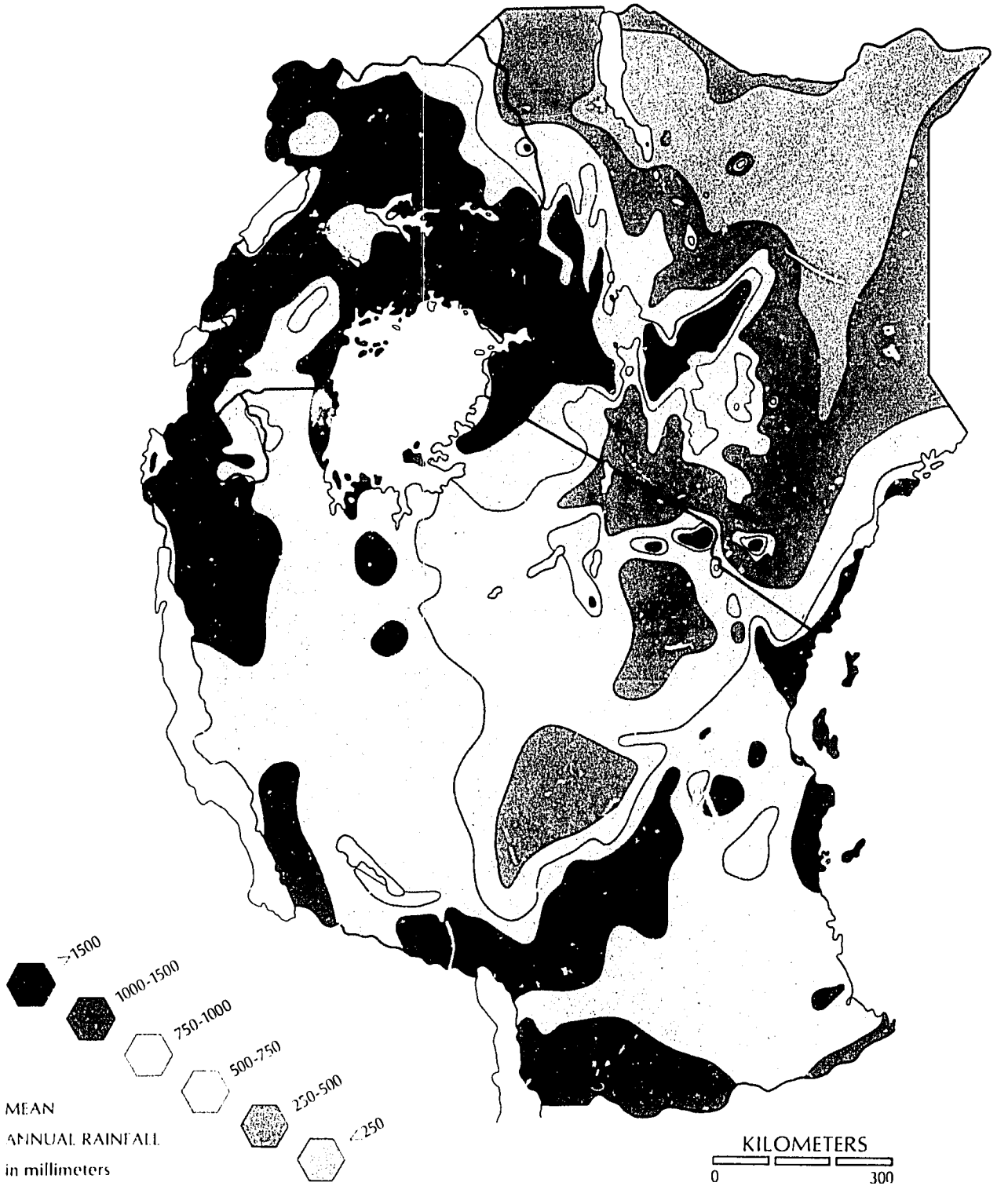
FIGURE 22

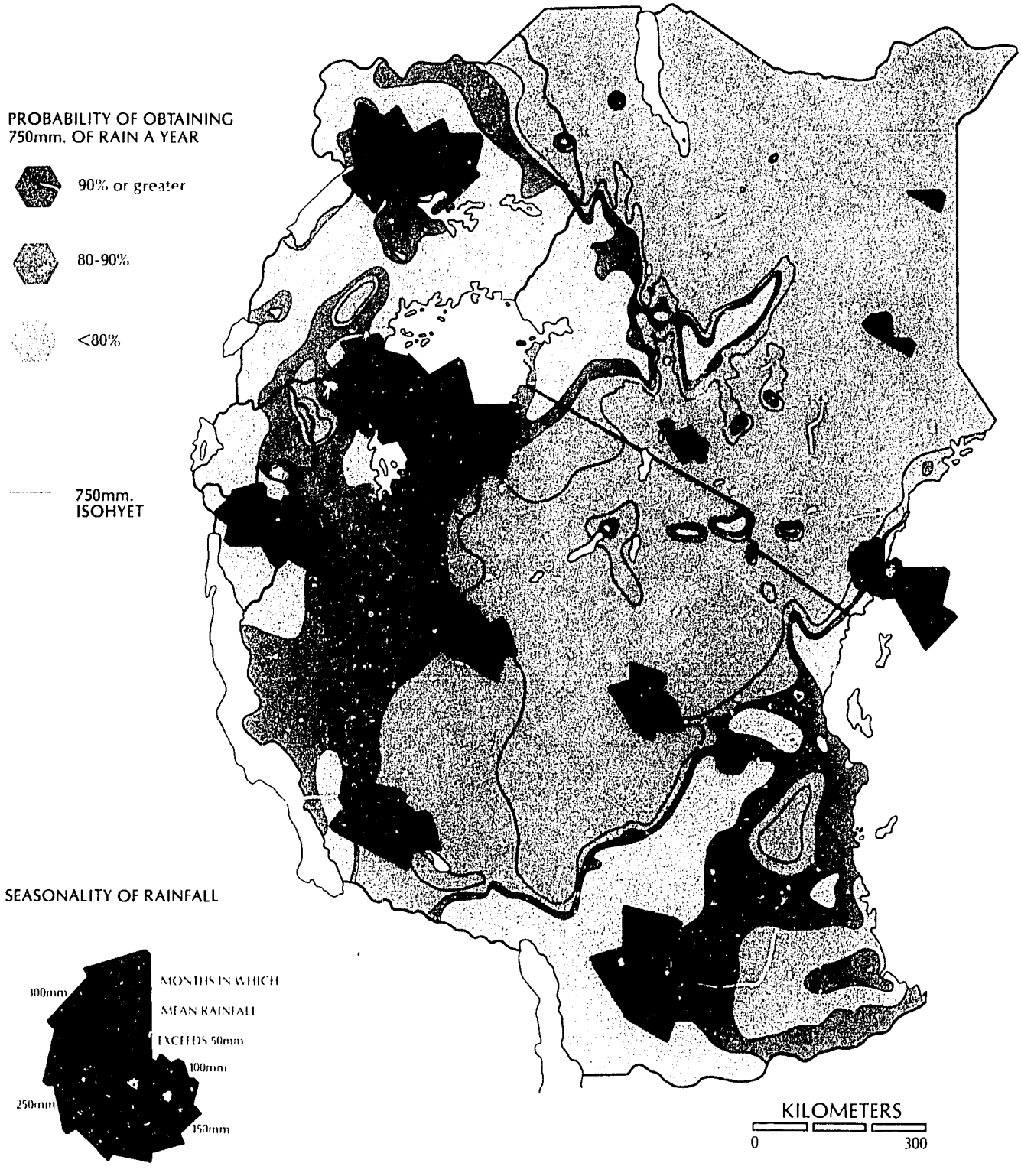
Precipitation



Nieuwolt, 1978; et al.

FIGURE 23

Rainfall Reliability



STATIONS FOR WHICH MEAN MONTHLY RAINFALL NEVER EXCEEDS 50mm

Nieuwolt, 1978; et al.

seasons merge into one, often with two peaks and virtually no rain during the dry period (May to November). The third seasonal pattern is found in Rwanda, Burundi and most of Uganda in the general vicinity of the Lake Victoria Basin. Here, seasonality is less pronounced with one or two rainy seasons but much shorter dry periods and more even annual distribution. The location of the region across the equator and the movements of the Inter-tropical Convergence Zone (ITCZ) result in differing seasonal sequences from north to south. The wet season in northern Uganda (March to November) coincides almost exactly with southern Tanzania's dry season. Other seasonal variations throughout the region are much more complicated than this brief presentation allows. However, these regional climates have an enormous impact on agriculture practices, the types of crops grown, productivity and resource use.

Rainfall Intensity

The region is tropical and its rainfall characteristics conform. Rainfall occurs either associated with frontal systems or from thunderstorms. Both types can and often do yield intense rainfall. Falls of 250 mm an hour are common. Given that the infiltration rate for bare soil is not greater than 188 mm per hour and that a large proportion of the region's rainfall occurs at rates greatly in excess of this absorptive capacity, the dangers for soil erosion become apparent. Protective vegetation in the region therefore assumes much greater importance than in temperate climates. These unique tropical features make soil and water conservation all the more important for all of East Africa but especially those areas with rugged terrain and medium to high rainfall.

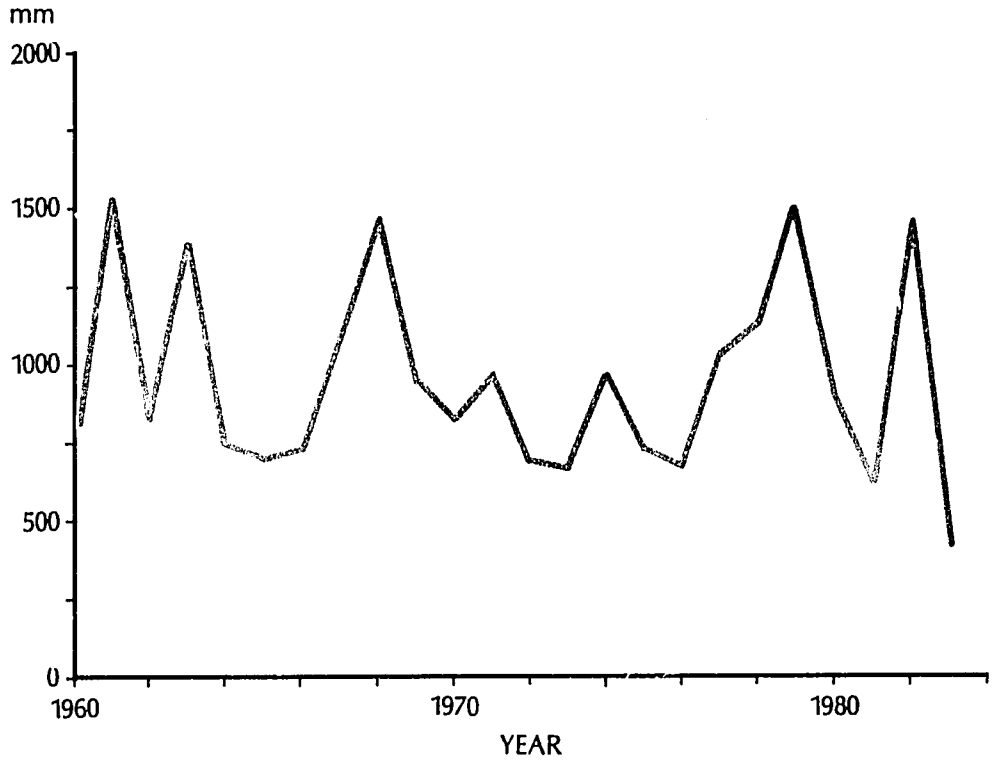
Rainfall Reliability and Variability

Rainfall over much of East Africa also varies significantly from year to year. Figure 23 describes the pattern of reliability. It is not unusual for a rainy season to be delayed or not appear at all. The highest annual total in any single year in the region can be as much as four times the lowest recorded total. A prolonged dry season can have a disastrous effect on crops and livestock. Drought cycles often alternate with heavy, concentrated wet years which bring floods, destroy homes and crops, and expose the population to health hazards. For example, an annual average of 500 mm can conceal a pattern of 1000mm every fifth year and only 375 mm for the intervening four years. A generally accepted standard is that 750 mm is a lower limit for successful commercialized cultivation; only 45 percent of the region receives this with a probability of four years out of five (80 percent reliability). For Kenya, only 15 percent of the land has 750 mm average rainfall with 80 percent reliability. In general, variability is higher and reliability lower in regions which receive lower mean annual rainfall totals.

Another aspect of variability is uncertainty about long term fluctuation. Accurate rainfall data for the region have been kept for only forty to sixty years. For many reporting stations, even shorter time spans are common. These records are not sufficient to plot long term rainfall characteristics. For example, in much of Tanzania and Kenya, rainfall in the 1960s was generally good or even excellent; lake levels were above long term averages during this period. As these were the early years of independence, new development investments, especially in arid and semi-arid areas, were planned and begun. The 1970s, however, have been much drier and the 1980s have begun with some dry years as well (Figure 24). Many of the development projects of the 1960s, especially in ranching and livestock development, have literally dried up. It is not yet clear whether the moist sixties are representative or exceptional and, in like manner, whether perhaps the dry seventies are the more typical rainfall norms. For obvious reasons, planners need to know. In the next twenty years the pattern and amount of rainfall will be an important factor in agricultural

FIGURE 24

TRENDS IN RAINFALL VARIABILITY
MACHAKOS



development. Continued effort in data collection and analysis will be important. It is even more important that these analysis be included in planning for agriculture and irrigation in the region.

Surface Waters: Lakes

Some of the continent's largest (Victoria), deepest (Tanganyika), and most scenic Nakuru) lakes are found in East Africa. These lakes are valuable as sources of water; they modify the climate around their shores; they provide a potential means of transportation, especially for landlocked Uganda, Rwanda and Burundi; they offer good potential for fisheries and tourism; and they serve as potential sources of water supply for both human use and irrigation.

Great Lakes: Tanganyika, Malawi (Nyasa), Victoria, Kivu. The great lakes occupy a total area of 153,000 square kilometers, or about 10 percent of the land area of the region. All except Victoria are long, narrow, deep Rift Valley lakes, Tanganyika being the second deepest lake in the world (after Baikal)in the USSR. Victoria is only 100 m deep being ponded in a shallow down warp of the Earth's crust. However, its extent and location make it the most important of East African lakes. These lakes are all rich in zooplankton and fish stock and have, according to most accounts, considerable potential for yields larger than those presently obtained. In all these lakes fisheries are still underexploited with the exception of Lake Victoria nearshore activity. Increased yields and introduction of modern methods of fishing, however, represent a threat to the equilibrium of the fisheries and require careful management and regulation as well as cooperation among the countries sharing the lakes. For example, the Nile perch in Lake Victoria are presenting a threat to other species, especially the popular and nutritious tilapia. National fish yields have been increasing for Kenya, Uganda, and Tanzania with Tanzania the highest.

The Great Lakes have enormous value as water resources. Although presently used only by lakeshore populations, future agriculture and industry for will doubtless extend the demand for water use. The

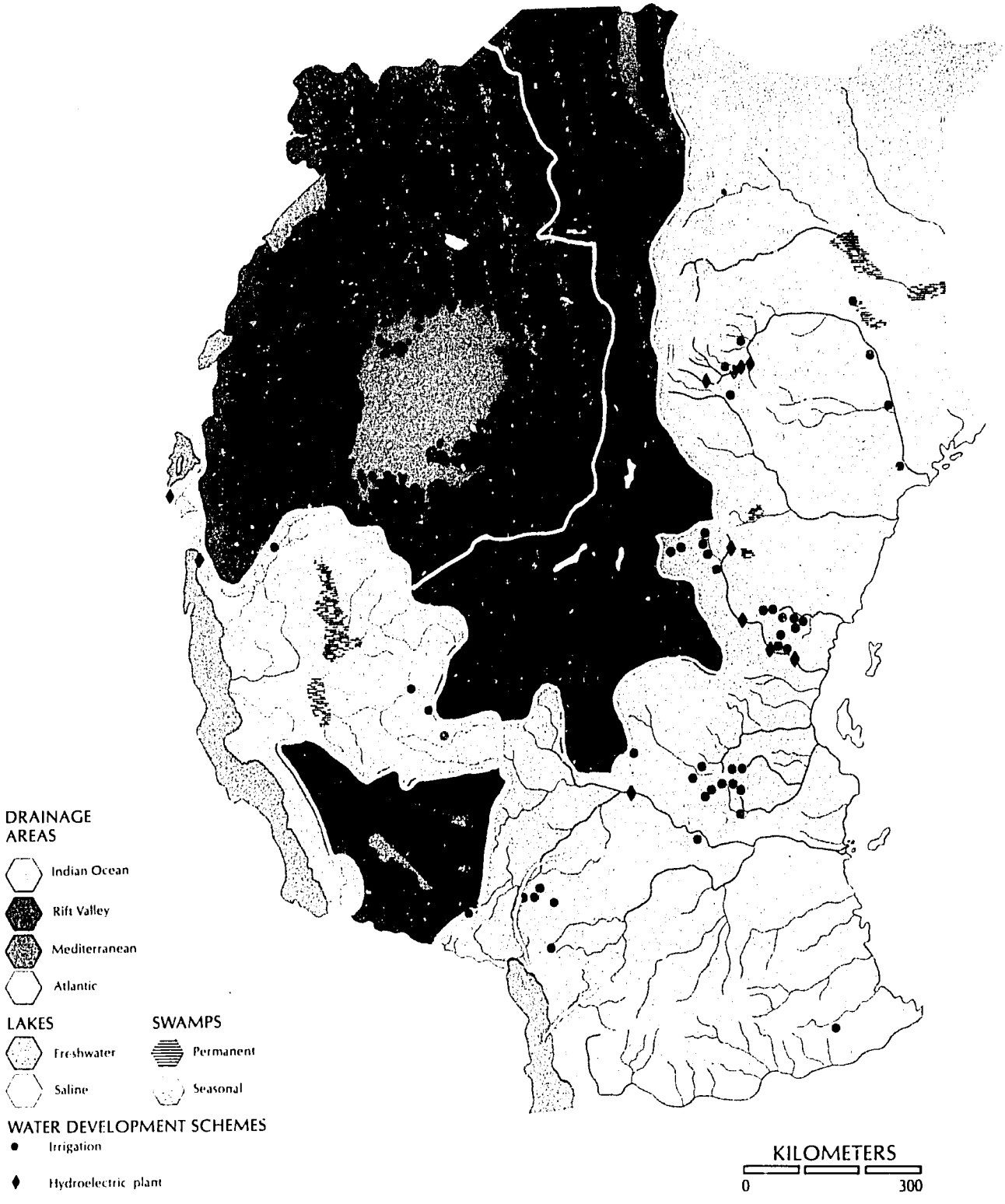
TABLE 16 SURFACE WATER IN EASTERN AFRICA

	Total Area km^2	Water-covered area (lakes/swamps) km^2	Percent of surface covered by water
Kenya	582,650	13,400	2.3%
Tanzania	942,600	54,390	5.8%
Uganda	236,040	36,330	15.4%
Rwanda	25,600	2,048	8.0%
Burundi	27,834	2,180	7.8%
E. Africa	1,814,724	108,348	5.9%

Source: Water Resources of the World, 1975.

FIGURE 25

Surface Water



Ominde, 1971; et al.

exceptional beauty of the lakes and the wealth of the wildlife need to be considered as these new uses are considered. With two exceptions the lakes are not exploited for minerals. The exceptions are Lake Magadi for soda and Lake Natron for salt.

Even though these lakes are generally not exploited, concerns have arisen especially about Lake Nakuru which is well known for its flamingoes. In the late 1970s, the flamingoes left because, some claimed, the disposal of urban and industrial water from Nakuru town was changing the ecology of the lake. However, in 1982, the flamingoes returned even though there had been no major changes in methods of waste disposal. Their temporary out-migration may have been due to other factors. As Nakuru town grows, however, need exists to keep careful control of waste disposal and to safeguard the quality of the landlocked Lake Nakuru Basin.

The current trend is for local planners to consider more actively the lakes as potential sources of water for irrigation, urban water supply and for hydropower. Lake Victoria is the most easily utilized for a number of those purposes and the most vulnerable of the large lakes to ecological change.

Surface Water: Drainage Basins

The map of surface water (Figure 25) identifies four major drainage areas. The first is the eastern third of the region, demarcated by the Rift Valley escarpment. It drains into the Indian Ocean. The second is an internal basin draining into a series of landlocked lakes in the Rift Valley. The Lake Victoria Basin is the third, flowing through the Owen Falls Dam, the Victoria Nile, Lake Kyoga, Lake Albert and eventually into the White Nile. It then joins the Blue Nile at Khartoum and flows north into the Mediterranean through Egypt. The fourth basin drains into Lake Tanzania and ultimately through the Zaire (Congo) River into the Atlantic.

Several river basins lie within these four large drainage systems and represent the appropriate units for water resources management and development. Even though East Africa is the source of two of the world's largest rivers, the Zaire (Congo) and the Nile, the rivers that actually traverse the region are much smaller. They tend to be small to medium size basins with great seasonal variation in flow. Some, especially in the low rainfall zone, even dry up completely during the dry season. Table 17 sets out average discharge figures for the major rivers. The Rufiji is the largest of the regional rivers with good potential for hydropower and irrigation. The Tana, Pangani, Wami and Ruvu are smaller but each is important in that it traverses dry areas and is capable of both irrigation and hydropower. Each has been developed for these purposes but only to a small percent of potential. The Nile in Uganda, the Kagera in west Tanzania and the Malagarasi all have significant potential.

All five nations participate in one organization or another which has specific goals to manage the development of major watersheds. Kenya and Tanzania sponsor national groups. The larger ones include the Tana and Athi River Development Authority (TARDA) in Kenya, the Rufiji River Board in Tanzania and the Lake Basin Development Authority (LBDA) which looks after development within Kenya's share of the Lake Victoria coast. One international authority has made an encouraging beginning. The Kagera River Basin Organization includes Rwanda, Burundi, Uganda, and Tanzania as participating members.

Despite the existence of these large water systems, the region does not contain an abundance of inexpensive or readily available surface water waiting to be exploited. Access to Lake Victoria is controlled through water use agreements with Egypt. In fact, Egypt keeps an officer present at all times at Jinja to monitor the outflow of the lake to assure that these agreements are fulfilled. Streams in the Rift Valley and the lakes themselves do

TABLE 17 DISCHARGE IN EAST AFRICAN RIVERS

River	Station	Catchment Area	Average Discharge
TANA	Garissa	(42,217 km^2)	151 m^3/sec.
VICTORIA NILE	Jinja	(263,000 km^2)	1131 m^3/sec.
RUFIJI	Stieglers Gorge	(158,200 km^2)	740 m^3/sec.
PANGANI	Kerogwe	(25,110 km^2)	30.2 m^3/sec.
RUVU	Morogoro Rd. Bridge	(15,190 km^2)	71.7 m^3/sec.
WAMI	Mandera	(36,450 km^2)	61.8 m^3/sec.
KAGERA	Lake Victoria	NA	255 m^3/sec.

Source: Water Resources of the World, 1975

not have major economic potential for reasons of seasonality as well as water quality, as noted earlier. Major water and hydro plans for Tanzania's Rufiji River have been prepared though only comparatively minor projects have been funded. The Tana and Athi in Kenya have good management through TARDA and development of hydropower and irrigation has occurred. However, major problems in siltation threaten the viability of dams completed and are delaying plans for future investments. In the Kagera Basin, an ambitious plan has been prepared and is now under review. Though total costs exceed a billion dollars, the plan may some day bring new water resources into production for the region. It is clear that surface water development will need to be an important component of development over the next two decades. The management of these resources for effective growth will be a challenge to host countries and donors alike.

Groundwater

The groundwater resources of East Africa are still to a large extent unexplored and underexploited. A reliable regional map cannot be constructed. All five countries have drilled many boreholes in recent years, though they are not yet a large consumer of water in relation to surface water resources. There appears to be considerable potential for subsurface water development in some areas, especially in dry zones. However, only local information is available to assess the impact of these boreholes on water table levels.

Most users are either pastoralists who water their stock or small farmers in dispersed villages. In arid districts where there are few or no perennial streams, such as Dodoma or Singida, only about 40 percent of the total groundwater consumption comes from boreholes. The remainder, especially

numerous water holes and shallow wells dug in stream beds.

In general, groundwater resources are of considerable importance in providing water for increasing human and livestock needs, especially in arid areas, but their importance for irrigation and agriculture is not fully known until better data on availability and rechange is collected.

Water Use

Introduction

Water use in East Africa takes many different forms varying from traditional well supplies to modern irrigation systems and hydroelectric generating stations. The subsections which follow review trends in water use. Although detailed use figures are not available for the region, Figure 26 notes that consumption since 1970 has been rising steadily in Kenya and most likely will continue to increase.

Assumptions Used in the Projections of Water Demand for Kenya

1. Rural Domestic Starting with a per capita daily consumption (p.d.c.) we assume it will grow at 3 percent per annum, reaching in 2000 a value of 481, which coincides with official water consumption targets.

2. Urban Using a similar methodology, we start with a p.d.c. of 100 liters and assume an average annual growth rate of 5 percent which declines after a level of 250 liters is reached in the year 2000. The urban p.d.c. is assumed to include consumption in schools, hospitals and other urban institutions with the exception of industrial demand, which could be high, but for which there is a total lack of data. The projected increase in urban p.d.c. reflects a growth in consumption from the larger share of the population having access to house connections, as well as changing habits resulting from easier access. The actual withdrawals of water for urban centers could be higher due to distribution network defects resulting in leaks and waste.

3. Irrigation The water demand for irrigation was calculated, assuming that the acreage of irrigated land will continue to increase by 8 percent per year, which is the average rate realized in the period 1960-1980. We also assumed the water requirements per hectare to be 11,000 m^3 using an F.A.O. estimate. The alternative projection assumes a higher rate of growth (10 percent) so that all the estimated potential is brought under irrigation by the year 2000.

4. Livestock Water Demand Assuming water consumption to be 23 liters per animal per day for cattle and 5 liters for sheep and goat and animal population growth rates of 3 percent per year, we arrive at the water requirements for total livestock.

Water Use: Irrigation

For most of East Africa, irrigaton is not a traditional practice, even though there is need for controlled water supplies to improve agricultural production in many of the region's drier parts. There is considerable physical potential for increases in irrigated land but it is not clear if and when these will be realized, given the large financial and managerial costs.

Figure 27 illustrates the size and growth of the irrigated area. The more humid countries of Uganda, Burundi and Rwanda have a low and stable area under irrigation. Tanzanian and Kenyan irrigated areas have increased by 100 percent between 1964 and 1976 but still only total 110,000 hectares.

FIGURE 26

Kenya: Trends in Water Use

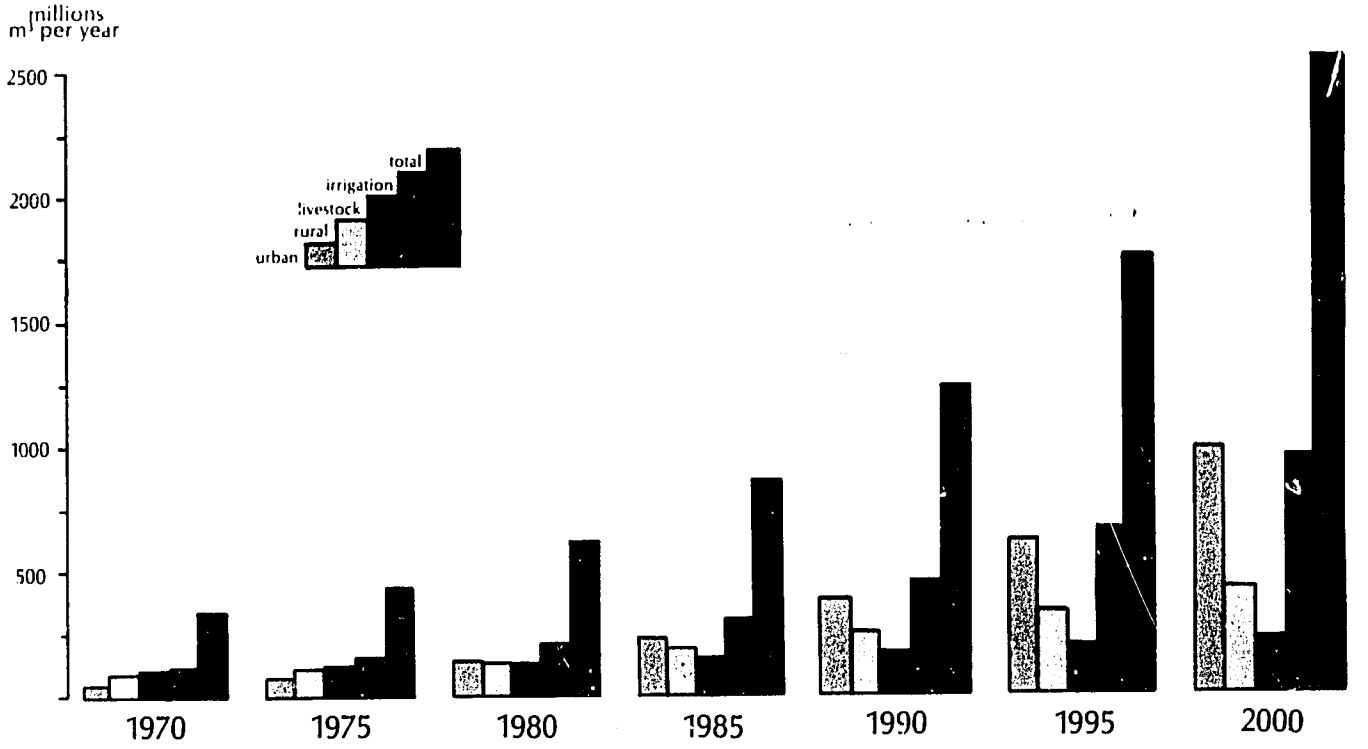
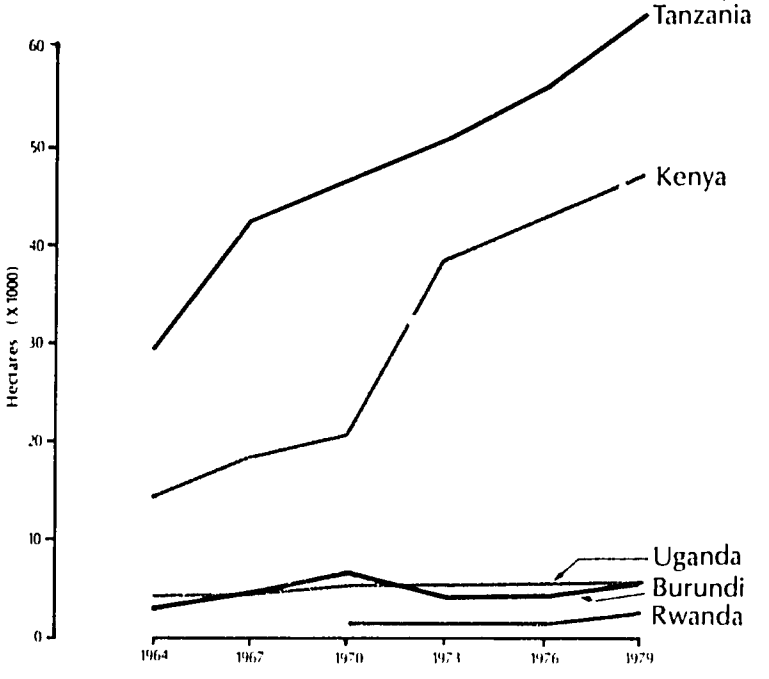


FIGURE 27

White, Bradley, White, 1972; et al.

Irrigated Land



FAO, 1975; et al.

Irrigation in East Africa is in infant stages yet there is considerable potential for expansion. Irrigation is of special interest because it is an effective means to raise the productivity of the already cultivated land, reduce dependence on unreliable rainfall, and bring new lands in lower rainfall regions into cultivation. There are presently less than ten large irrigation schemes in the region. The crops grown in those schemes are mainly commercial, high value products, based on high investment and operational costs.

In Uganda there is good potential to use swamps as sources for irrigation and cultivation, both by drainage and water control. Papyrus swamps cover about 5,200 square kilometers in Uganda. So far about 1,600 hectares have been converted for agriculture. The environmental consequences of additional land conversion are not known but difficulties have been encountered at one site where the soil became so acidic that it would not support any plant life. Eventually loss of land must be weighed against gains in agriculture.

Rwanda and Burundi are generally well endowed with surface water and enjoy abundant and well distributed rainfall. Their need for irrigation is less. On the other hand there are extensive swamps in the lowlands which could be transformed into agricultural land. Some efforts are underway and there are plans for draining additional acres and establishing human settlement in those sparsely populated parts of the country.

In Kenya, the Lake Victoria margins and the Tana River basin provide the most promising locations for irrigation. In Tanzania there are numerous possibilities

TABLE 18 LAND UNDER IRRIGATION (1980)

	Total Arable (000's ha.)	Total under irrigation (000's ha.)	Percent of total arable under irrigation
Kenya	1,790	46	2.5
Tanzania	4,110	64	1.5
Uganda	4,080	5	.1
Rwanda	720	3	.4
Burundi	1,110	5	.4
Region	11,810	123	1.0

Source: FAO Production Yearbook, 1981.

along the Rufiji River, in the Malagarasi basin, around the many lakes and in the basins of the Wami, Ruvu, Pangani and other rivers.

Figure 27 projects that water demand for irrigation in Kenya will rise more than 400 percent between 1980 and 2000. Current use at around 600 million m^3 is projected to reach 2600 million m^3 in the year 2000. Such drastic increases will place great pressure on other uses of water. Given these increasing demands and pressures, water may become the most scarce East African resource in the year 2000.

Water Use: Hydroelectricity

Hydroelectric generation is often the major, or one of the major reasons, together with irrigation, for the construction of dams. As the price of oil rises, so does the attractiveness of hydropower as a viable energy alternative. Even though the initial costs of such schemes are high, the annual savings realized in reducing oil imports and the opportunities for cheap energy for industrial development are substantial. The hydroelectric potential of East African rivers is one of the most valuable assets of the region as it represents the single most important indigenous energy source, other than fuelwood. All five countries have embarked on projects to assess and harness that potential.

The first major hydropower scheme to be constructed in East Africa was the dam at Owen Falls in Uganda in 1954. The power plant, with an installed capacity of 154 MW not only provides 99 percent of Uganda's electric power but also sells some of the surplus to Kenya.

Kenya itself has made considerable progress in hydropower. Most of this development has taken place in the Tana River where about 68 percent of the nation's total estimated potential of 1,260 MW is concentrated. The Seven Forks hydroelectric scheme, representing over 90 percent of the total installed hydroelectric capacity consists of four dams: Kindaruma (1968); Kamburu (1974); Ataru (1978) and Masinga (1980/81) with a total installed capacity of 321 MW. It is estimated that the Tana River has potential for additional schemes with a capacity of 500 MW. Other rivers with hydroelectric potential are the Turkwel, Ewaso Nyiro and Athi. The country's plans are to develop the greatest part of the existing potential by the year 1990. The new schemes have succeeded in decreasing the growth in use of imported oil fuels, though Kenya's fuel imports have still increased in the last two decades.

The hydro potential of river basins in Tanzania is only partially developed, although small hydroelectric schemes have been established on the Pangani since the 1930's. Since the 60's the river development priorities have shifted to the Rufiji and its tributaries, the Ruaha and the Kilombero. Tanzania's hydroelectric power potential is estimated to be 1400 MW but so far only 262.5 MW have been developed. The largest hydropower scheme is Kidatu on the Ruaha with a current capacity of 100 MW.

In Rwanda, many of the rivers are suitable for hydroelectric generation. Dams in Maruru and Nataruka have an installed capacity of 38 MW. A third is under construction in Makungwa and will soon be completed. In 1977 Rwanda imported only 4 percent of its energy needs.

Burundi has not developed major hydro facilities. However, the Kagera River has a considerable hydropower potential for the four member countries. The total potential is estimated at 900 MW, which if fully developed, could make a huge difference for development support in the region. Eight sites have been proposed and feasibility studies completed for three: Rusumo Falls, Kakere, and Kishanda.

Hydroelectricity schemes have their ecologic drawbacks and risks which are often neglected in favor of the economic benefits. One serious problem, especially in Kenya and Tanzania, is the high

TABLE 19 HYDROPOWER DEVELOPMENT

Country	Site	Capacity	Planned/Potential
Kenya	Tana/Wanjii	22 MW	
	Kiandaruma	44 MW	
	Kamburu	84 MW	
	Gitare	145 MW	
	Total	295 MW	
	Planned (other sites)		770 MW
Tanzania	Pangani Falls	17.5 MW	
	Hale	21 MW	
	Nyumba ya Mungu	8 MW	
	Moshi	1 MW	
	Buiko	2 MW	
	Mzimui	9 MW	
	Total	60 MW	
	Potential		1200 MW
Burundi	Bujumbura	15 MW	
	Other	12 MW	
	Total	27 MW	
	Planned		——
Rwanda	Nataruka	11 MW	
	Mukungwa	12 MW	
	Other	4 MW	
	Total	27 MW	
	Planned		——

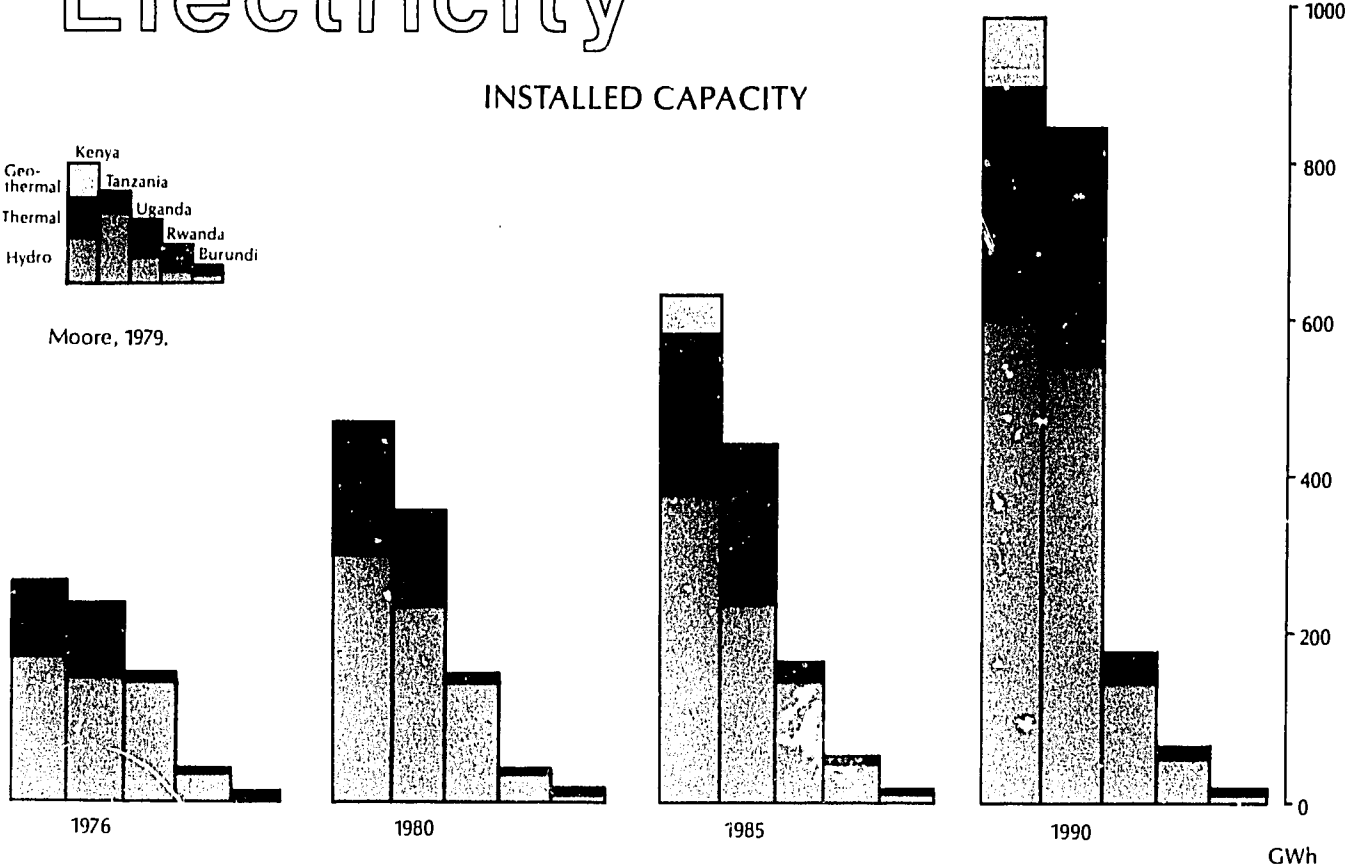
Source:
1) Official Handbook, Burundi
2) Berrow, S. and P.D. Raskin, 1982 Energy Development in Kenya: Problems and Opportunities p. 61
3) UNDP, World Bank, 1982 Rwanda: Issues and Options in the Energy Section, Annex IV, p. 62
4) Government of Tanzania, Second Five Year Plan, 1969-74, p. 12

FIGURE 28

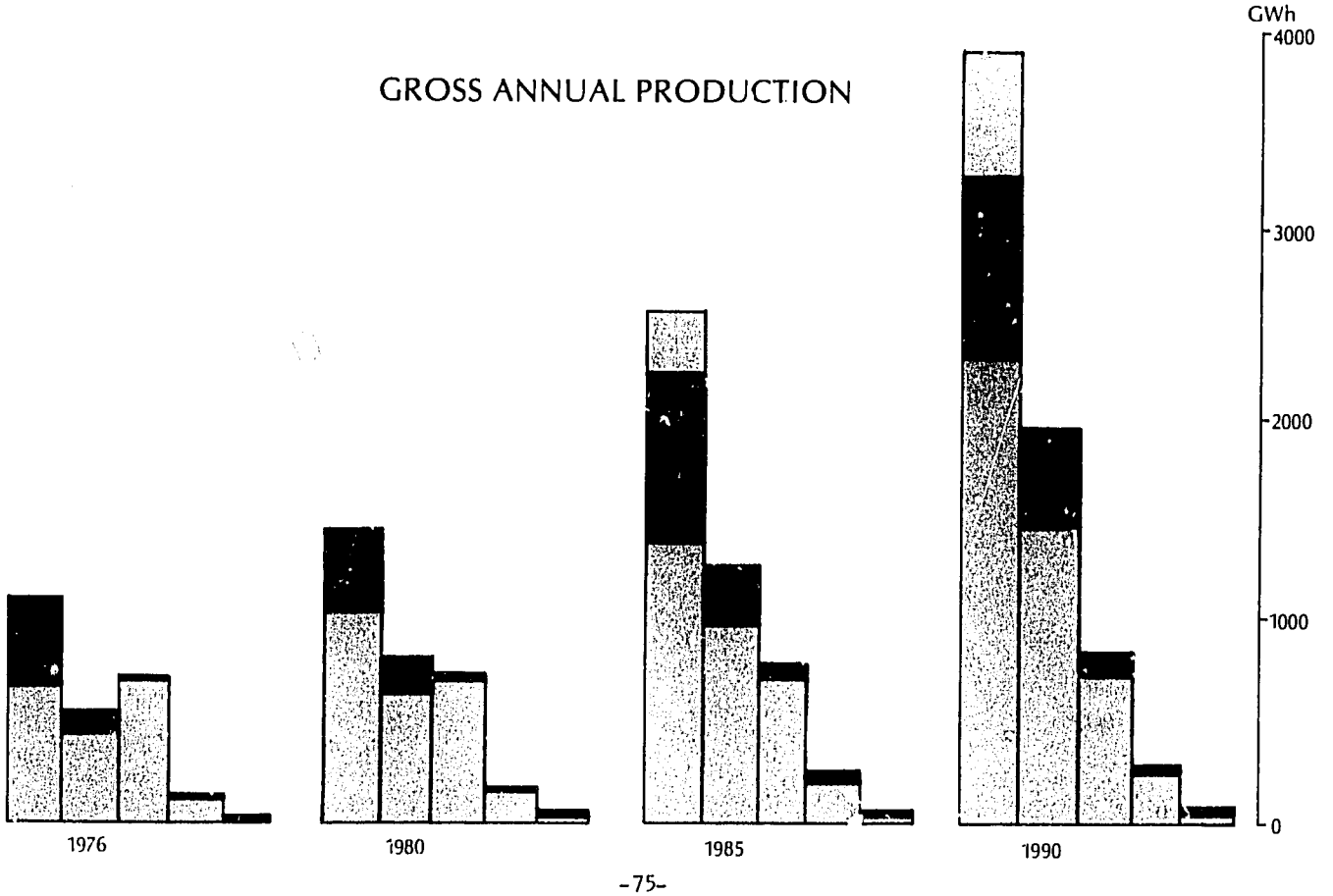
Electricity

INSTALLED CAPACITY

Moore, 1979.



GROSS ANNUAL PRODUCTION



siltation rate which reduces the useful life of the dams and comes from soil erosion and the consequent high sediment load of the river's waters. The existing tendency toward soil erosion and siltation are usually aggravated as a result of more intensive land use and settlement following dam construction Kenya's dams on the Tana River may have their useful life reduced by half because of siltation. Other problems, common to all tropical water development schemes are the higher risks of water-borne diseases, especially schistosomiasis and malaria.

Although total hydro capacity has been climbing steadily and is expected to continue rising, these increases have not kept pace with demand. For example, in 1960, fossil fuel imports to Kenya consumed 11 percent of its import bill; by 1979, fossil fuel amounted to 24 percent of its import bill. Although much of this imported fuel has gone to the transportation sector, it is clear that the region is still slipping behind in its struggle to provide energy. It is likely however that emphasis on hydropower will continue and that by the year 2000 a significant increase in control of East Africa rivers for hydropower is likely (Figure 28).

Water Use: Domestic Water Supplies

The vast majority of East Africans obtain their daily water supplies from traditional sources, mostly streams, water holes and unlined shallow wells. Based on the best available data, less than 50 percent of the population of East Africa is served by improved water supplies. The definition of "improved" includes systems with treated or otherwise controlled sources such as piped systems with house connections, common standpipes and protected wells. These figures say nothing about the quantities used or the equity of distribution. It is probable that poor urban dwellers who buy water at standpipes use less water than rural households who get free water from nearby streams. Practically all improved rural water supplies consist of standpipes or protected wells. The principal factor in rural water availability is the distance to the water source. Women and children normally provide household water, a task frequently consuming considerable walking time and effort.

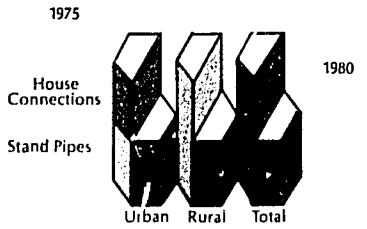
Quantities of improved urban water supplies, though initially appearing easier to achieve than rural, may in reality pose more of a problem (Figure 29 top half). Most urban Africans dwell in the peri-urban areas rather than in well defined residential areas and they are generally not served by reliable and safe water supplies. In this regard, the urban poor are in a disadvantaged position because they have limited access to traditional sources while open or "free" sources in and around urban areas are frequently polluted. Thus, urban dwellers have little choice but to purchase water from standpipes or water vendors, or as a poor alternative, to use polluted water.

Population growth also makes a difference. Figure 30 shows that per capita water availability will be greatly reduced by 2000. The figure deserves careful examination. The bottom category (water actually available) shows what is developed and useable. Actually available water is above the 100 m^3 level for only two countries in 1971 and none in 2000. The potentials are considerable for all five countries though somewhat less in 2000 (on a per capita basis) than in 1971. Perhaps the most significant point is that by 2000 Rwanda and Burundi, both countries with good water resources, may have a difficult time meeting basic water needs for each person in the country.

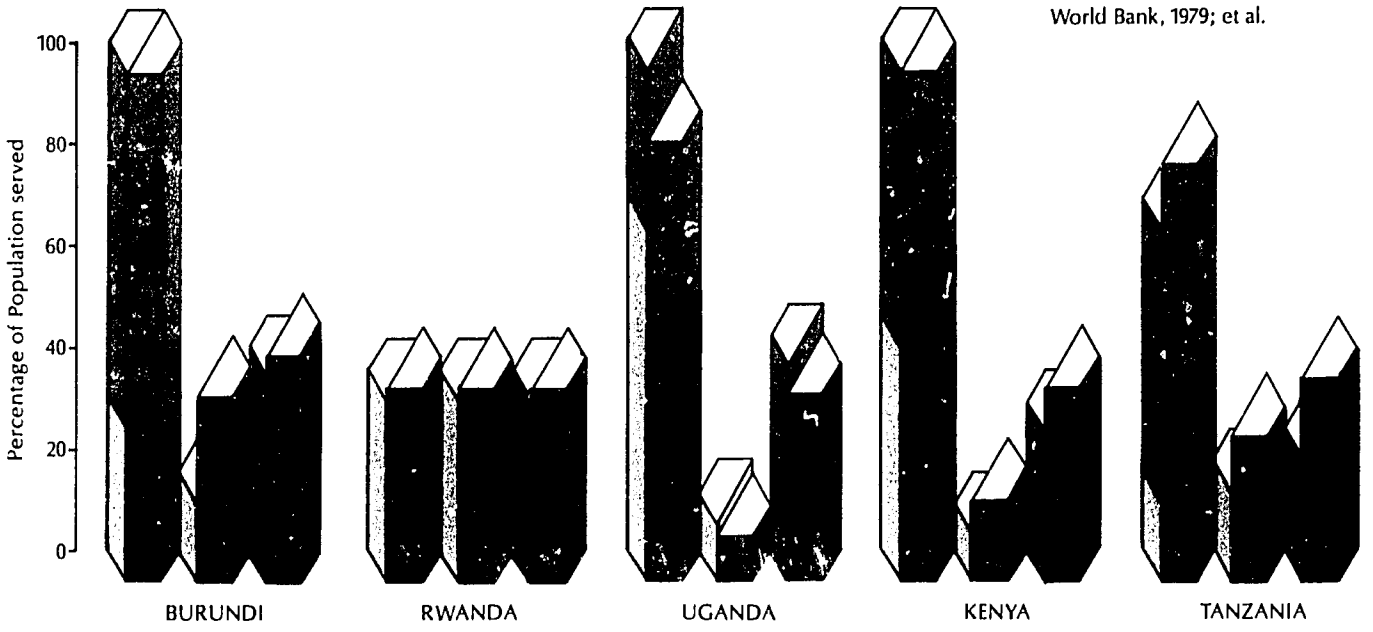
Both the Kenyan and Tanzanian governments are pledged to the goals of the United Nations Drinking Water Supply and Sanitation Decade and are placing high priority on achieving these goals. Kenya is committed to supply the entire population with good drinking water by the year 2000; Tanzania has a similar target for 1991. It is questionable whether these targets will be

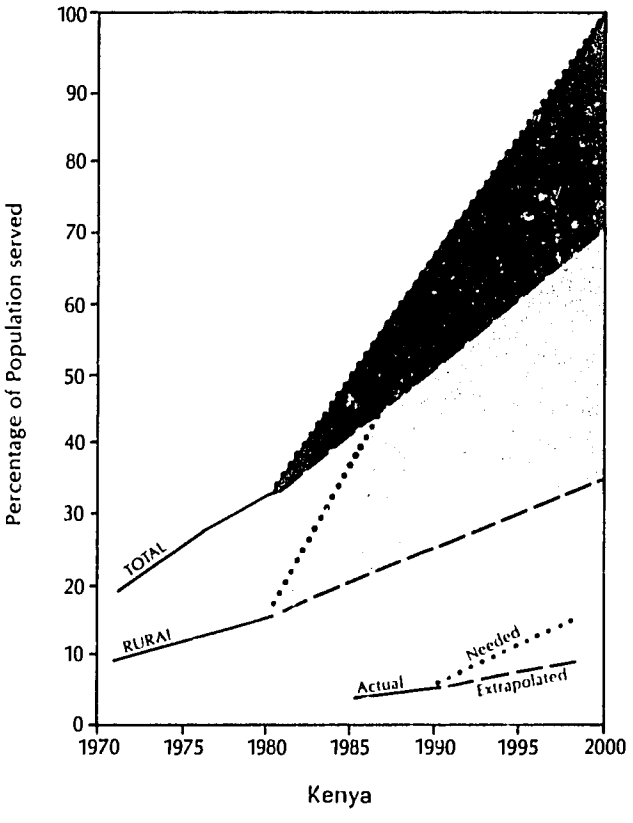
Figure 29

Improved Water Supply



World Bank, 1979; et al.





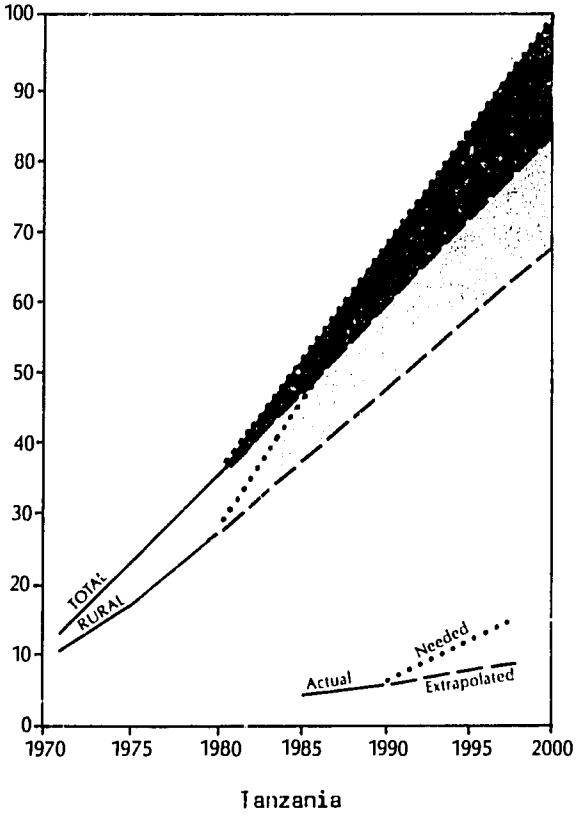
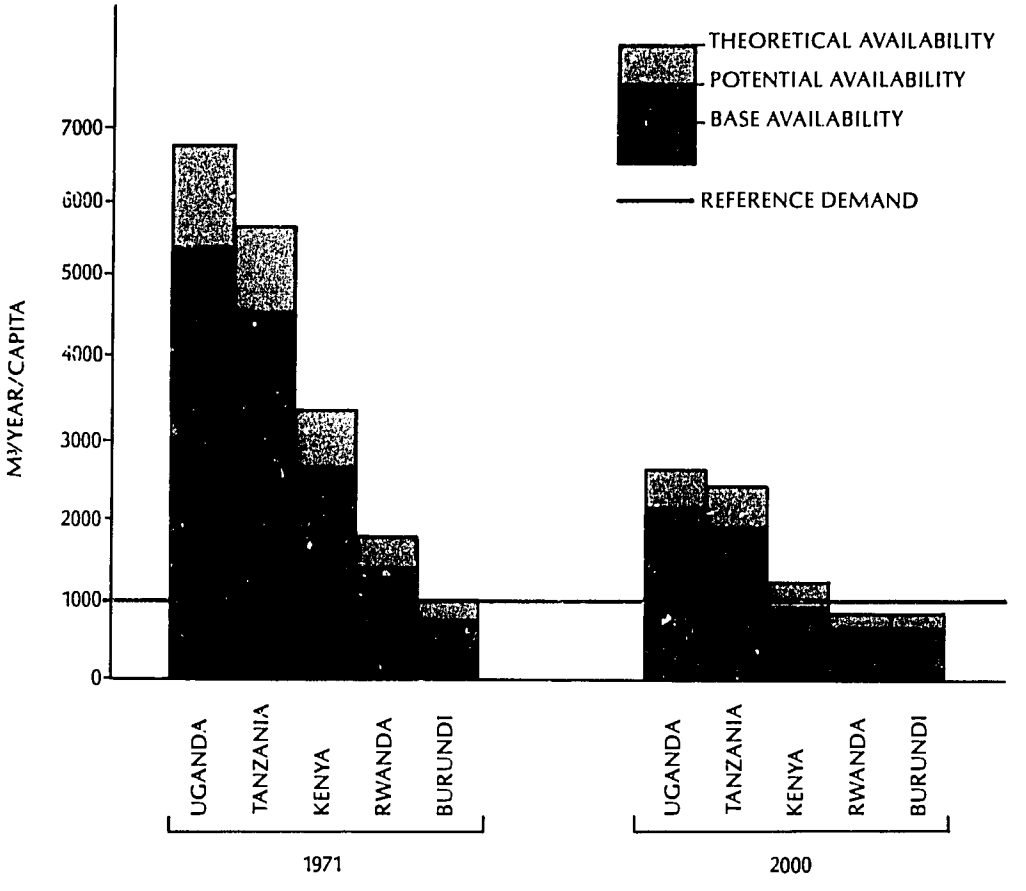


FIGURE 30

Per Capita Water Availability



Ward, 1979; et al.

achieved. All governments lack necessary finances as well as trained manpower. However, governments in all nations have recognized the difficulties of the task and have placed great attention on it.

Urban and Industrial Pressures

Chapter 2 established that urban growth was proceeding at rapid rates. On one hand, urban expansion means more wage employment, increased income levels, expanded assembly and manufacturing capability, and higher levels of service industries. On the other hand, increased urban-industrial growth means greater demands for water and higher potentials for pollution. Table 20 notes recent trends in percentages of urban residents.

Should these trends continue until 2000, Kenya will have 10.2 million urban residents (25 percent to 30 percent of total population). Urbanization is growing faster in other countries. Although the majority of the region's population will continue to be rural, the shift to cities has far reaching trends for potential resource impact.

Urban pollution will become an increasing problem. While Mombasa's human population is expected to double from 1974 to 1996 (324,000 to 665,000), its waste will increase more than 3 times (79,980 tons to 262,930 tons). Expressed in per capita terms, individual waste generation will rise from .247 to .395 tons during the same period.

In Dar es Salaam, the problem of urban sanitation is rapidly approaching crisis proportions. Many of its sewerage pumping stations are not working as the system is overloaded. As a result, large quantities of raw sewage are dumped in the sea directly at the mouth of the Dar harbor. Twice a day, when the tide flows inward, large quantities of refuse are carried directly into shore causing both foul odors and unhealthy conditions.

Nairobi's potential waste disposal problem is even greater as there is only one outlet for its sewage and solid waste disposal: the Athi-Galana-Sabaki River system. Simultaneously, major development plans are underway to use the waters of the Athi, downstream from Nairobi, for crop irrigation and as a new source of potable water for Mombasa. Costs of water treatment and waste disposal have yet to be factored into the equation for these developments.

Problems of waste disposal also exist for the Kisumu urban area as well as smaller manufacturing centers nearby. A series of industrial pollution inspections in July, 1982 found significant problems in Eldoret's textile industry (high pH and BOD and pretreatment plant not working); Kisumu's municipal treatment center (heavy oil and grease covering settling compartments of the pretreatment plant, BOD well controlled); Webuye's paper mill (good facilities though on day of visit all waste water was being diverted around the treatment plant and pumped directly into the

TABLE 20 PERCENTAGE OF URBAN POPULATION

	1960	1982
Kenya	7	15
Tanzania	5	13
Uganda	5	9
Rwanda	2	5
Burundi	2	2

Source: World Bank, 1984.

Nzoia River). Reliable trend data are simply not available for these installations as monitoring capabilities are scarce or unevenly applied. One must conclude, however, that the problems of industrial pollution will be increasing unless major changes take place in monitoring, regulation, and enforcement.

Urban water consumption is another problem. In recent years, Nairobi's population growth has outstretched its ability to supply water. Although the Nairobi water system is well run and well maintained, its total capacity has not kept pace with demand. New construction, financed in part by the World Bank, will soon come on line but it is not clear whether the new expansion will provide sufficient quantities to meet growing needs by the end of the decade.

Dar es Salaam has a different problem. Although total water supply is not now an issue for Dar, the pumping is. The city's water pump station, on the south bank of the Ruvu River, was built as a development project by the donor agency. When installed, its variable pitch blade pumps were as sophisticated as any system in the world. However, the city water department has been unable to maintain the costly and highly sensitive pumps. As a result, the pumps are frequently out of order and water quality, quantity, and pressure are a constant problem for Dar.

Waste disposal is also an issue. For Dar, it becomes all the more acute when one considers that an estimated 70 to 80 percent of all Tanzanian industry is located there. By one account, 127 factories or industries were identified as discharging untreated effluents into Dar's rivers and sewers. The primary dumping area is the Msimbaze River. Pollution from factories as well as ships waiting for berths has been reported to be increasing in Dar harbor. Similar problems have been described for Mombasa.

The region's two oil refineries are situated near Dar and Mombasa with a combined refinery capacity of 4.6 million tons per year. Petroleum movement includes imports, re-exports of refined products, regional transshipment as well as the heavy offshore oil tanker traffic moving around the Horn. Thus far, only two oil spills have been documented, one in Dar and one in Mombasa, accounting for a total discharge of 150 to 200 tons of oil.

Other sources of concern include coastal-based agricultural activities, specifically the large sisal industry and its decorticating processes, dumping of mine residues containing heavy metals, misuse of aerial spraying of DDT and other chemicals for tsetse fly control, and agricultural production in the coastal area.

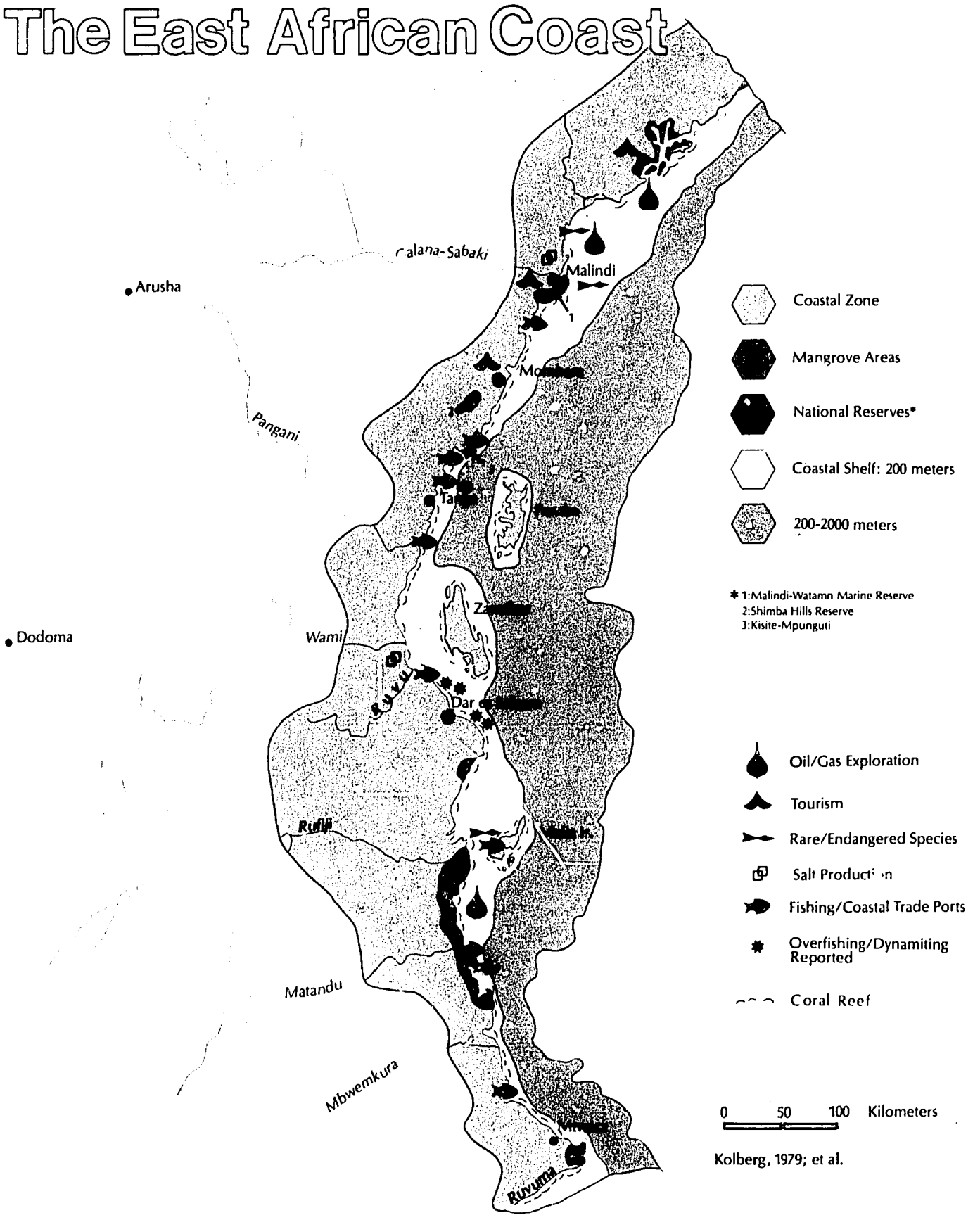
Newly proposed coastal-based production plants with potential for creating significant pollution problems include sugar and cashew plants (Ramisi and Kwale respectively) fish processing plants (Lamu, Shimoni, Varga), ammonia fertilizer plant (Zanzibar), cement and steel rolling mill (Tanga), textile mill (Zanzibar). There are also plans under consideration to double the capacity of the Dar es Salaam oil refinery.

Marine and Coastal Aspects

The East African coast contains several critical resource systems: human settlement, industry, agriculture, mining, fisheries, and tourism. As the physical and human charcteristics of the coast are quite distinctive, the region is given separate treatment.

The mainland coastal plain (Figure 31) consists of a narrow strip averaging 3-8 kilometers in width, with three physiographic features: a sand beach and dune system, raised reef out-croppings, and drowned river valleys. Mangroves are found near the river mouths. The beach dune

FIGURE 31


The East African Coast
Malindi
Arusha
Pangani
Dodoma
Wami
Rufiji
Matandu
Mbwemkura
Ruvuma
Coastal Zone
Mangrove Areas
National Reserves*
Coastal Shelf: 200 meters
200-2000 meters
* 1:Malindi-Watamn Marine Reserve
2:Shimba Hills Reserve
3:Kisite-Mpunguti
Oil/Gas Exploration
Tourism
Rare/Endangered Species
Salt Production
Fishing/Coastal Trade Ports
Overfishing/Dynamiting Reported
Coral Reef
0 50 100 Kilometers
Kolberg, 1979; et al.

system is unbroken from the Somali border to the Lamu archipelago while reef outcrops occur throughout the central and southern portion of the region. The three largest river systems along the coast, the Tana Athi, and Rufiji, are perennial and provide freshwater, nutrients, and sediment to the coastal area. The Tana and Rufiji open into the region's two largest estuaries while other wetland areas include Lamu, Ruvu, Rovuma, and Kilwa.

Offshore, the continental shelf is narrow with a width ranging between 6 and 64 kilometers (to 200 M isobath). The two predominant features of the shelf are a fringing coral reef and its offshore islands. The coral reef extends from the southern Tanzania border to Malindi before it begins to break up and assure a patchy distribution. Offshore islands and cays occur along most of the coast, the largest being Zanzibar, Mafia, and Pemba.

Of the physical processes which affect the coast, the quantity of rainfall and its distribution are probably most significant. The driving force behind most seasonal coastal processes is the monsoons. Rainfall on the coast reaches its maximum near south central Kenya, falling in two distinct periods similar to those for upcountry Kenya (see Figure 23). Rainfall decreases progressively inland and north and south of this area, as does the distinction between the two periods which gradually merge into one.

Coastal currents are driven by permanent ocean currents and influenced by the charcter of the monsoons. The South Equatorial Current splits near the Malagasy Republic into the southern Mozambique and northern East Africa (EA) currents. In the north, off the Somalia coast, a seasonal reversing current runs northeast during the SW monsoon and southwest during the NE monsoon. When flowing southwest, this current meets the northern East Africa Current and forms the eastward flowing Equatorial Counter Current. At this convergence, occasional up-welling occurs with a resulting increase in fish population productivity of coastal waters. While the effects from this convergence may reach the northern coastal waters of Kenya, East Africa's coastal waters are generally characterized as nutrient poor.

East Africa is fortunate to have a diverse abundance of productive coastal ecosystems. Mangroves, significant both as nutrients to coastal waters and as nursery grounds for many commercially important fish species, cover an area estimated between 100,000 and 125,000 ha. Major stands occur in Lamu, Pate, Manda, Kwale, Rufiji and Kilwa. Mangrove poles have traditionally been exported for their value as construction materials in the Middle East and used locally as sources of firewood, charcoal and tannin production. In recent years Kenya has been exporting half a million poles and Tanzania a like number. Other uses for mangrove areas include clearcutting and conversion of stands to areas suitable for salt and rice production. There are also indications that considerable illegal harvesting of mangrove occurs in the more inaccessible areas of the region. Specific data are not available.

Despite the importance and extent of East Africa's fringing reef, no estimate of total regional reef area exists. Heavy use and often misuse of the coral reef and its community appears to be increasing. The effects of overfishing, blast-fishing with dynamite, and coral and shell-collecting have been reported from sites ranging the length of the reef. Heavy fishing pressure on the reef has occurred near Tanga and Dar es Salaam, while die-off of fish and coral due to high sediment loads and pollution have been recorded at Malindi and Dar respectively.

Data on rare and endangered species habitat are scarce but sightings have been made of manatee, four species of marine turtles, and crocodile. Poaching of green turtles has been reported from the Watamu Marine Reserve.

Three coastal/marine reserves exist in the region, all in Kenya. Despite an inventory and list of recommended sites for reserve designation in Tanzania, no proposed area has yet to be gazetted for marine park status.

The contribution of marine fisheries is relatively small (10-20 percent) in contrast to the region's fresh water fishery production. Fishing is largely a small scale and individualistic activity concentrated on the fringing reef. The principal fishery areas are Lamu, Mombasa, Tanga and Mtwara. Tanzania also supports a small commercial trawler fishery where some of the productive areas are adjacent to estuaries where few reefs exist to tear nets. Tanzania also produces shrimp where forty percent (2,000 tons per year) of Tanzania's shrimp came from the Rufiji delta area. Tanzania's shrimp have an estimated nutritional potential of 5,000 tons/year. Other present or potential shrimp grounds include Bagamoyo, Formosa Bay, and Lamu.

The reef-dependent fishery currently appears to be exploiting the reef at or near sustainable limits. Comparing the generally accepted range for sustainable reef fish production of 4.5 to 5.5 m. tons per square kilometer per year, the southern Kenyan portion of the reef may already be above sustainable limits. Due to the natural constraints of coastal East African waters, there appear to be few available alternative fishery resources to meet projected consumer demands. However, some increased production could occur by use of presently underexploited stocks (nearshore pelagics), more efficient use of fish associated with the shrimp fishery, and further development of shrimp and sport fisheries.

CHAPTER 5 IMPLICATIONS OF RESOURCE USE TRENDS

East Africa will house 110 million people in the year 2000. Where will they live? What will they eat? Where will they work? Where will their water and fuel come from? What resources will support their needs in transportation, communication, social services, and employment? What will become of the soil, vegetation, wildlife, water, and forest resources which are becoming increasingly scarce?

Answers to these questions are critical to the well-being of these 110 million as well as to their children and grandchildren who will manage the region's resources in the 2 century. A summary of the major resource use trends and the recommended policies follows:

Summary of Trends

a) In high potential areas where roughly two-thirds of the people live, high population densities and high rates of population growth are dominant. Although the areas are highly productive, increasing land shortage and farms below one hectare in size are common. Intensification of agriculture, changes of crops, forest depletion, loss of top soil, and probable lowering of productivity are a first set of consequences. Though total numbers continue to increase, migration away from these areas is becoming commonplace.

b) In medium and lower potential areas, natural population growth is augmented by increasing in-migration from crowded high potential areas. In some areas this trend reverses the pattern of 30 years ago when migration to high potential areas was dominant. Some intensification in farming occurs as well as extension of farming into increasingly marginal areas. In addition previously reserved lands are being cultivated. Local energy supplies are a problem in areas where land clearing has reduced woodland cover. Soil loss and overgrazing are approaching critical proportions.

c) On grazing lands of generally lower potential, livestock numbers continue well beyond the carrying capacity of the range. A gradual deterioration of rangeland is typical of East African dry areas. In a number of localities there is severe degradation. Many of the new boreholes drilled to tap ground water supplies are in this zone and in some cases have contributed to the degradation of areas around them by attracting and concentrating grazing herds.

d) Surface water is a scarce resource and increasingly polluted. Lakes, rivers, and coastal areas are the recipients of mostly untreated industrial and domestic waste which harms wildlife and fisheries. Competition for use of water is already important in some urban areas. In selected coastal areas, coral, mangroves, and beach resources are showing early danger signs of destruction.

e) Total wood resources in East Africa are probably sufficient for fuel energy until about 2000. Local and regional deficiencies, however, are already a problem, especially in the drier areas and around major cities.

f) Protected areas have been mostly well maintained by the governments of the region but are increasingly under stress from the pressures noted above. Important species of plants and animals are endangered both within and outside the protected areas. Wildlife is increasingly being confined to game parks and management of these areas is made more difficult by this fact and the increasing pressures on the parks from competing land uses.

g) Urban growth continues at high rates and in the last decade or so

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secondary cities are growing as quickly as the primate cities, especially in Kenya and Tanzania. Accompanying this growth are the intensifying problems of urban umemployment and waste disposal.

h) Food production per capita is declining. The food deficit is not now compensated for by comparable increase in cash-earning exports and as a result a significant food deficit situation looms on the horizon. Although during years when rainfall is qood there will probably be little difficulty, drought years will be a major problem. In that the region's climate is prone to periodic rainfall deficits, intermittent and persistent food shortages will inevitably occur.

i) Population growth continues to lie beneath all of these resource issues. Although the implications of such growth are implicitly stated in all trends, it is important to make explicit mention as well.

Policy Implications

Policy recommendations emerge at two levels. Five broadly based needs are noted, followed by brief statements of more specific action proposals. The recommendations are stated in general terms rather than site specific or action specific terms. Before any actual implementation can take place, more detailed planning and policy consideration would need to be carried out by appropriate authorities.

The needs and recommendations are:

a) Productivity

There is need for overall policies directed at the maintenance and improvement in productivity of the natural resource base, especially in the high and medium potential zones. Needed actions:

... adjust pricing and incentives for food production. On one hand, some urban food subsidies are probably required. On the other hand, more food would be grown if prices paid to farmers were higher;

... make higher farm incomes available which will allow local producers to purchase fertilizer and other inputs to increase production as well as conserve land;

... expand access to agricultural credit and improve rural marketing to increase productivity and thereby decrease resource degradation;

... carry out a thorough review of incentives for soil conservation measures. Substantial success has been achieved in isolated places for soil conservation. These experiences should be evaluated and vigorously publicized;

... develop incentives for increased tree planting, not only to increase wood production but to preserve soil as well;

... review charcoal and fuelwood pricing so that price will both encourgae conservation of fuelwood and encourage adoption of fuel efficient devices for cooking and heating.

b) Resource use conflict

There is need for national mechanisms to identify key resource use conflicts as well as to develop means to mediate and perhaps resolve at least some of them. Needed actions:

... share land use planning for parks, park buffer areas, and agricultural/pastoral land in the vicinity of parks. The example in Tanzania of the Ngorongoro Conservation area is an excellent prototype;

... assess ways in which benefits from parks can be paid directly to residents in and around park areas;

... develop more economically productive uses of park resources, for example, culling of surplus animals to sell for meat;

... integrate land use planning whereby conflicts between plans to clear new land and goals to preserve habitat, forests, and protected areas are eased. Water use and coastal resources also require this integrated approach.

c) Resource issues in development planning

Increasingly the resource management perspective needs to be built into the process of development planning at every level. Personnel with appropriate skills need to be involved with the key planning and finance departments in government. Needed actions:

... better resource data needs to be made available to local planners, i.e., regions or provinces, districts, village councils, catchment planning units, etc.

... pre-project resource impact assessment needs to become a routine procedure, especially for activities related to water, soil, trees, and rangeland use.

... impact of development activities on resources requires close attention at every stage of the development process.

d) Institutional infrastructure

There is need for new forms of institutional development to deal with the emerging problems, both within government and within the private sector. Needed actions:

... growing urban areas call for new forms of monitoring, regulation, and enforcement with particular focus on industrial pressures;

... greater involvement of the private sector and voluntary organizations would help. Private groups in Kenya have had considerable success in tree planting; small businesses increasingly are engaged in industrial activity which is an important dimension of resource use;

... good resource development and management requires the understanding of key linkages between and among private and public sectors and the enhancement of resource utilization from the perspective of both resource user and resource manager. Such linkages are more effectively achieved at the district and local levels where development planning is increasingly taking place.

f) More and better information

The region needs improved resource information. It is trite to call for more data or more research. There is, however, need for a limited objective: on-the-ground assessment of some key issues outlined above on a sample basis as well as longitudinal data runs in a few selected areas. If specific information were available, based on a few case studies of changes in resource use, planners would be better able to generalize from these examples for a nation or even the region as a whole. Needed action:

... strengthen monitoring capability for university and research institutions;

... strengthen monitoring capability for national environmental institutions (i.e., Kenya's National Environment and Human Tanzania's Institute of Resource Assessment);

... strengthen data management capability for key ministries including water, agriculture, livestock, forestry, etc.;

... implement means to communicate nature of resource trends on regular basis to policy and planning officials.

Experience elsewhere in the world has shown that people and institutions adapt but slowly to changing resource situations. Already the people and governments of East Africa are adjusting to the new levels of land use and population density. But, in our judgment, the quickening pace of demographic change needs to be matched by new approaches to the management of the resource base on which the 110 million people will depend in the year 2000.

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