MORTALITY AND MORBIDITY SITUATION IN SIAYA DISTRICT

THESIS SUBMITTED FOR PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN POPULATION STUDIES AT THE UNIVERSITY OF NAIROBI 1981/82

BY

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DECLARATION

I declare that this is my original work and that to the best of my knowledge, it has not been produced in any university or educational institution.

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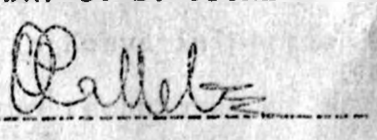

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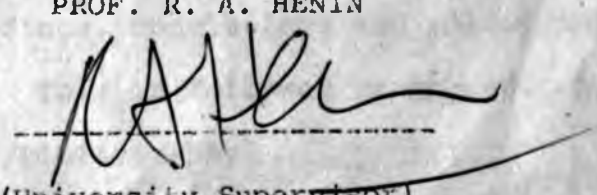

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ABSTRACT OF THE THESIS

This study is set to establish the mortality schedule and also to investigate the major causes of illness and death in Siaya District which is one of the rural districts in Kenya. The results obtained for child and adult mortality are patched to produce smooth complete mortality schedules for the females and males in the district. Divisional and seasonal occurence of the major diseases responsible for illness in the district are investigated. Cause-specific mortality rates by five year age group are also estimated for the district.

The study is divided into five chapters. Chapter 1 gives the background information of the study area and the mortality and morbidity in developing countries and in Kenya in particular. Chapter 2 discusses the data and the techniques of analysis utilized in this research. Chapter 3 presents and discusses the mortality estimates for the district. Chapter 4 presents and discusses the major causes of illness and death in the district. Chapter 5 gives a summary of the findings, conclusions and policy implications of the study. This is followed by appendices, figures and references/bibliography.

In this descriptive study, mortality rates are found to be high in the district. Life expectation at birth obtained for the males and females are 41.5 years and 46.6 years respectively. The results indicate that mortality rates are highest in the first five years of life. Mothers belonging to better off socio-economic group have lower child mortality. The leading cause of death in the district is the category "Air-borne" diseases. Infact, life expectation at birth for the females and males rises by 13.4 and 13.6 years respectively when measles, tuberculosis, respiratory diseases and meningitis are hypothetically eliminated in the constructed life tables. Cerebrovascular diseases, diarrhoel diseases and heart diseases are other major causes of death in the district. Malaria is the leading cause of illness in Siaya and is most dominant in the months of June and July.

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I am grateful to the Rockefeller Foundation for awarding me the scholarship that enabled me to undertake a full time study for the degree of Master of Science in Population Studies. I acknowledge the co-operation and assistance given to me by the staff of the Population Studies and Research Institute and in particular my two supervisors Prof. Henin and Dr. Oyuke whose invaluable advise made the writing of this thesis a success. My sincere thanks also go to the staff of Division of Health Information System (Ministry of Health) and Central Bureau of Statistics (Ministry of Economic Planning and Development) for kindly allowing me to use their data in this study. I take this opportunity to thank Mrs Agnes N. Macharia the typist whose tireless efforts made it possible to have the work handed in in time. Last but not least, I acknowledge the patience and moral support of my family - my wife Elizabeth and my children, Victor and Cynthia. To all the above mentioned people; my heartfelt tribute.

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CHAPTER 1

INTRODUCTION

1.1. INTRODUCTION

The Government of Kenya aspires to achieve the health target set by the World Health Organization, that is, the attainment by all citizens of the world by the year 2000, of a level of health that will permit them to lead a socially and economically productive life. Current programmes in the health sector in Kenya are directed towards identifying and overcoming major health problems. One of the major health objectives in Kenya is therefore the reduction of mortality and morbidity rates especially in regions with low expectation of life at birth. Reduction of mortality rates, especially of infant and child mortality, is also seen as one of the means that could be used to initiate decline in existing high fertility rate in Kenya.

The 1979 population census data indicate that Nyanza Province has the lowest life expectation at birth and hence the highest mortality rates in Kenya. Unfortunately the patterns of diseases responsible for illness and death in Kenya have not been studied in

details due to limited available data on morbidity and mortality by cause. This study focuses on mortality and morbidity conditions in Siaya District which is basically a rural district located in Nyanza Province. It is hoped that the findings of the study will assist the Government in formulating better health policies and strategies that will improve health conditions in Siaya and other rural districts in Kenya.

1.2. STATEMENT OF THE PROBLEM

Mortality and morbidity rates for Siaya District have not been established but the provincial mortality estimates are available. The 1979 population census data indicate that life expectation at birth at provincial level is highest in Central Province (60.9 years) and lowest in Nyanza Province (47.3 years) [CBS, 1981]. The national average life expectation at birth was 54 years by 1979 and this implied that the figure for Nyanza Province was 12 per cent lower than the national average. The average number of children dying in the first two years of life was 130 per thousand live births in 1979. The figure for Nyanza Province was 185 and was the highest recorded for any

province in Kenya [CBS, 1981]. The study was therefore set to establish mortality rates for Siaya District and also to establish patterns of diseases causing illness and death in the district.

1.3. PROBLEM JUSTIFICATION AND OBJECTIVES

High mortality and morbidity rates impose economic costs to individual families and to the nation as a whole. High morbidity rates have greater economic impact since it affects the productivity of workers'. Workers' strength, stamina and ability to concentrate suffers with ill health. Sickness impairs the ability to learn and hence reduces the cognitive achievement for school going population. Early mortality and disability due to illness reduces the period of time over which the payoff from an investment in human capital can be expected and hence diminishes the productivity of training. Diseases also lead to expenditures on treatment. High morbidity rate implies high costs of treatment which are a burden on the individuals and on the nation. It therefore consumes much of the limited resources available for development hence increasing pressure on

the already over-constrained economy.

The objectives of this study were to:-

(i) Establish mortality level for Siaya District.

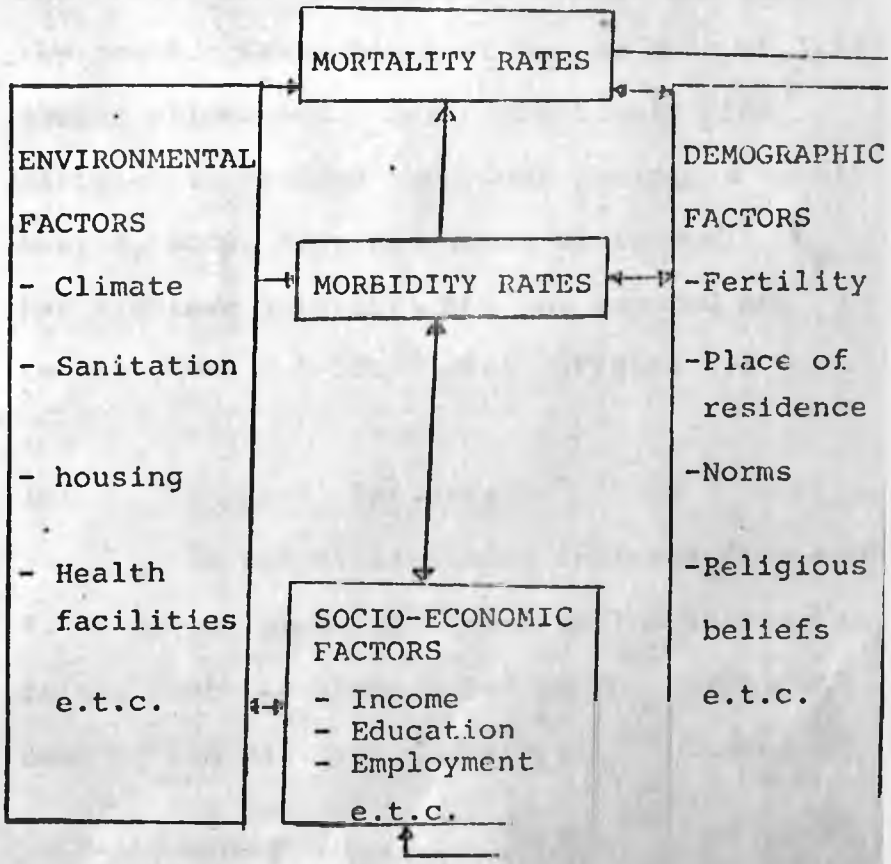
(ii) Estimate mortality and morbidity rates by major causes for the district.

(iii) Examine the health care system in the district and suggest in the light of the above how health services could be modified to lower the existing high mortality and morbidity rates.

1.4. CONCEPTUAL FRAME WORK

Death as an individual phenomenon has biological determinants whose mechanisms are the etio-pathogenesis of the diseases. But this biological conception cannot explain by itself the mortality considered at a collective level. The multi-causal approach of the epidemiology has permitted the description of the distribution and pattern of diseases in a population. According to the epidemiologic conception, health-disease is a process depending on a balance between man, various external pathogenic

factors and physical, biological and social environment. Mortality and morbidity rates are therefore related to demographic, socio-economic and environmental factors. Among the demographic factors are fertility rate, place of residence (rural or urban), societal norms and religious beliefs. Socio-economic factos are income, employment status and level of education attained. The environmental factors are climate, sanitation, housing and health care facilities. These factors in their turn are also closely correlated. The link among these factors is shown by the diagram below.



In this study, a descriptive approach was adopted and for that matter no hypotheses were tested, however, the estimated mortality and morbidity rates were discussed within the above mentioned frame-work.

1.5. BACKGROUND INFORMATION OF THE STUDY AREA

(a) Location and size

Siaya District is located in Nyanza Province of the Republic of Kenya. It was established in 1966 following the subdivision of Central Nyanza into Kisumu and Siaya Districts. The bordering districts are Busia on the north, Kakamega on the north-east, Kisumu on the south-east and south Nyanza across the gulf to the south. Siaya District has an area of 3,528 square kilometres. Administratively, the district is divided into four divisions namely Ukwala, Boro, Yala and Bondo Divisions. It has eighteen locations and one hundred and twenty seven sub-locations. [Figure 1].

(b) Physical features

In Siaya, altitudes increase from about 1,140 metres above sea level on the lakeshores in the south to about 1,300 on the north and east of the district. There are scattered

highland areas which rise between 1,200 m to 1,500 m. The district is traversed by two main rivers namely Nzoia and Yala rivers. These two rivers flow from north-eastern direction of the district and both enter Lake Victoria via the Yala swamp (Figure 2).

The district is along the equator and hence temperature maxima remains oscilating around high levels of 23 degrees centigrade in the higher cooler areas (Ukwala and Yala Divisions) to about 30 degrees centigrade in the lower, warmer areas (Boro and Bondo Divisions). Rainfall amounts and distribution are determined to a large extent by altitude and wind direction. Moving from north to south within the district, rainfall decreases progressively from an average of 1,450 mm annually in Ukwala and Yala Divisions to about 1,000 mm annually in parts of Boro and Bondo Divisions. The long rains come from March to May while the short rains come in September to October.

The soils in the district are predominantly red-brown friable clays and sandy loams. Figure 3 shows the distribution of soil types in Siaya. The natural vegetation consists mainly of low bushes or thickets and a few scattered tall

trees. The district could be divided into two main agro-economic zones on the basis of the physical conditions particularly the climatic factors and soil types. The two zones are the high and medium potential areas. Figure 4 shows the crops grown in the two zones.

(c) Transport and communication facilities

As shown in Figure 2, accessibility within the district is made possible by road, water, air and railway transport. Roads provide the major form of transport. Currently, there is almost an adequate road network system which covers a total distance of 1,128 kilometres. Telephone and postal services are found in a few centres within the district.

(d) Demographic situation

The 1979 population census gave a total of 474,516 people for Siaya District. The distribution of the population by divisions were Bondo (140,253), Ukwala (122,417), Boro (117,816) and Yala (94,030). Figure 5 shows the population densities by locations. The 1969/79 intercensal growth rate was estimated at 2.1 per cent. Table 1 (A) gives the population by sex and broad age groups for the district.

TABLE 1 (A): POPULATION OF SIAYA DISTRICT BY SEX AND BROAD AGE GROUP BASED ON 1979 CENSUS

(IN THOUSANDS)

SEX	BROAD AGE GROUPS IN YEARS					TOTAL
	0-4	5-14	15-49	50-59	60+	
Male	40	71	73	6	25	215
Female	41	70	116	7	26	260
Total	81	141	189	13	51	475

SOURCE: Central Bureau of Statistics - Ministry of Economic Planning and Development.

The above table indicate that there were more females than males especially in the age group (15-59) years. It also indicates that heavy dependency burdens exists on the working age population. About 135 people have to be supported by each 100 people in the working age group (15-59 years). By 1979, only Siaya Township had population size of over 2000. Other urban centres include Yala, Ukwala and Bondo urban centres. Siaya is also experiencing high out migration process especially for the active age group (15-59 years).

(e) Cultural Practices

The cultural practices of the Luo tribe that dominate the district are more or less uniform with only minor differences among clans. Regarding attitude towards child-bearing, large family size norm prevails and has been geared mainly towards counter-balancing the effects of high infant and child mortality rates. Male sex preference dominates since traditions restrict land ownership only to males. Acceptance of modern family planning methods is low although the traditional birth control practices such as long breastfeeding and

abstinence periods, polygamous marriages and other related taboos are on a rapid decline.

With regard to morbidity and mortality, some sections of the population still hold the traditional beliefs in witchcraft. Some religious sects such as Legio-Maria followers place more faith in prayers for the sick and hence do not believe in the powers of modern medicine. Traditional medicine is also widely utilized in the district.

(f) Economic status

A random sample survey conducted by the Siaya District Development Committee team in July 1978 revealed that most families had an average yearly income ranging between KShs 2,500 to KShs 4,500. This means that the majority of the people are poor. Economic activities in the district include agriculture, commerce and industry. Figure 4 shows agro-economic zones and crops grown in Siaya.

(g) Health facilities and other social services.

Siaya has one district hospital (New Siaya District Hospital) which started

functioning in late 1976. It has a capacity of 190 beds. There are seven more hospitals which are smaller and run by voluntary agencies mainly the Roman Catholic Church. There are also 4 Health Centres, 20 Health Sub-Centres and Dispensaries serving the entire population run by the Government. There are private clinics run by individuals scattered within the district. Table 1(B) and Figure 6 shows the distribution of the health units in Siaya.

Using hospital beds as a crude measure of the capacity to treat in-patients, there were about 500 hospital beds in the district or an average of 11 hospital beds per 10,000 population by 1982. This measure was also estimated for the divisions to be Boro (19), Bondo (9), Ukwala (9) and Yala (4) [DHIS, 1982].

By 1982, there were a total of 4 Doctors, 27 Clinical Officers and 105 Nurses of all kinds in the district. Family Health Educators numbered 22 while Public Health Officers and technicians serving the district were 3 and 17 respectively. During the same year, a total of 31 vehicles were in working conditions belonging to the Ministry of Health.

TABLE 1 (B) : DISTRIBUTION OF HEALTH UNITS IN SIAYA BY DIVISIONS

TYPE	ADMINISTRATIVE DIVISION				TOTAL
	BORO	BONDO	YALA	UKWALA	
Hospital	3	2	1	2	8
Health Centre	-	2	1	1	4
Sub-Health Centre	-	1	3	2	6
Dispensaries	3	6	3	2	14
ALL HEALTH UNITS	6	11	8	7	32

SOURCE: Divison of Health Information System - Ministry of Health.

The composition of the vehicles was as follows - 12 land rovers, 3 pick-ups, 3 ambulances, 4 staff-cars, 1 motor cycle and 8 bicycles. It was also reported that about 2,000 average visits per month was recorded in Maternal Child Health/ Family Planning Clinics for child welfare services and only an average of 50 were recruited monthly into family planning programme. Only about 5 per cent of the population had access to clean water in the district and about 50 per cent of the population had latrines by 1982.

Literacy Survey in Rural Kenya 1980/81 revealed that while 48 and 46 per cent of the rural population aged 12 years and above were found to be able to read and write respectively in at least one language, the corresponding figures for Siaya were 42 and 40 per cent respectively [CBS, 1982]. With regard to housing conditions, about 90 per cent of the houses in the district are made of mud and grass thatched.

1.6. LITERATURE REVIEW

Mortality is the least studied among the three demographic variables (fertility, mortality and migration) due to lack of reliable data hence very limited literature exist on the

subject for the developing countries. With regard to mortality rates in the developing countries, rural population tend to have a higher mortality rate than the urban population. The risk of death in the first two years of life in the urban and rural population in 12 Latin American countries was studied using estimates from the census information by way of the Brass method. In two-thirds of these countries, there existed an excess of 30 to 60 per cent of the rural risk of death as compared with the urban [Behm, 1979]. A survey conducted by Smith and Blacker in 1963 suggested that one out of three African children die before age five in the rural areas while in towns the figure was one out of four [U.N., 1973]. In Kenya rural women were found to have higher child mortality than the urban women [Henin and Mott, 1979].

Within countries of the developing regions, the groups which have achieved the highest socio-economic status as measured by indicators such as income, occupation and education, have a lower average mortality rates. Estimates of life expectation at birth by income groups utilizing population census for

Brazil in 1970 revealed that the lower income group had 12.1 years less than the higher income group [Carvalho, 1977]. In Kenya analysis of household data indicated that income and mothers education have significant positive effect on child survivorship even when other variables such as sources of water supply, toilet facilities and types of medical care utilized are controlled [Anker and Knowles, 1977].

With regard to patterns of diseases in developing regions, the model developed by United Nations attributed 43.7 per cent of deaths to "Infectious, parasitic and respiratory" category, 14.8 per cent to diseases of circulatory system, 3.7 per cent to cancer and 3.4 per cent to traumatic injury [U.N., 1963]. The most common diseases were those transmitted by human feces and are mainly intestinal parasitic and infectious diarrheal diseases. The category "All forms of dysentery" was most frequently notified communicable disease in Pakistan [WHO, 1974]. In a case study in Punjab, India, a crude death rate of 3446 per 100,000 infants from acute diarrheal diseases was reported [Scrimshaw, Tylor and Gordon, 1968]. In Egypt, Iran and Venezuela, the mortality incidence of

diarrhea among children of pre-school age was estimated to between 40 to 50 per cent [Van Zijl, 1966]. Intestinal parasitic diseases are frequently chronic and debilitating rather than causes of acute illness and death. A World Bank case study of the labour force engaged in civil construction at three sites in West Java, Indonesia, found 85 per cent infested with hook-worm [Basta and Churchill, 1974]. Studies in Sri Lanka, Bangladesh and Venezuela found an average infection rate in pre-school children of between 50 and 70 per cent for both round worm and whip worm. At the age of six, the infection rates for helminths were 95 per cent in Sri Lanka, 97 per cent in Bangladesh and 93 per cent in Venezuela [Van Zijl, 1966].

The second major disease group in the developing countries consists of the air-borne diseases. This group includes tuberculosis, pneumonia, diphtheria, bronchitis, whooping cough, menengitis, influenza, measles, small pox and chicken pox. These diseases are spread by inhaling the airborne respiratory secretations of infested person. A study of deaths among children of five years of age in selected areas of Latin America and the Caribbean

revealed that over 70 per cent of deaths beyond the perimatal period were due to fecally related diseases, airborne diseases or malnutrition [Puffer and Serrano, 1977].

Vector borne diseases are less widespread although significant in developing countries. The most common of these are malaria, trypanosomiasis, bilharzia and river blindness. Malaria is thought to have contributed much to the existing high mortality in the developing countries. In Sri Lanka, malaria eradication campaign in 1946 is said to have increased Sri Lanka's crude death rate by 4.2 per thousand population between 1936-45 and 1946-50 [Newman, 1970]. In Uganda and Congo, the population was estimated to have been cut in half by epidemics of trypanosomiasis in the early twentieth century [Burke, 1970].

Tetanus is also a real concern in many areas especially where animal dung is used as fertilizers. In Kenya, the incidence of tetanus increased rapidly and was highest in areas where agricultural activity was greatest [Fendall, 1965]. In the developing countries, infectious and parasitic diseases bear almost

exclusive responsibility of shortening life below the Western current standards of 69 years for males and 75 years for females. Life tables by cause of death for 165 population at varying levels of mortality were constructed and when the aggregate of infectious and parasitic diseases were hypothetically eliminated from the life tables, life expectancy short up drastically to between 65 and 70 years for males and between 70 and 75 years for females, regardless of a population's initial mortality level [Preston, Keyfitz and Schoem, 1973]. No study has been done on this subject in Siaya District.

CHAPTER 2

SOURCES AND USE OF THE DATA

2.1. SOURCES OF THE DATA

Secondary data was used in this study and was drawn from various sources. These were, the 1979 Population Census data for Siaya District obtained from Central Bureau of Statistics in the Ministry of Economic Planning and Development, the 1977 Vital Registration data on deaths for Siaya District obtained from Department of Registrar General in the Office of the Attorney General and the 1979 in-patient morbidity and mortality data as well as the 1980 out-patient morbidity data for health institutions in Siaya District obtained from Division of Health Information System in the Ministry of Health.

(a) Census data

Demographic data obtained from censuses in most developing countries are subject to various kinds of errors, Kenya being no exception. The 1979 Population Census data for Siaya contains clear evidence of misreporting of age, displacement and omission of events such as births and deaths of the children.

Whipples and UN Secretariat indices were used to assess the quality of age data for Siaya. Whipples index gives a measure of age preference ending with digits 0 and 5. It is obtained by summing the age returns between 23 and 62 years inclusive and finding what percentage is borne by the sum of the returns of years ending with 5 or 0, to one-fifth of the total sum. The computed Whipples index for male and female age data were 123.8 and 122.5 respectively as shown in table 2 (A). The figures for both the males and females fall under 'Approximate' category but very close to 'Rough' category which starts at 125.0.

UN Secretariat index provides an indication of the accuracy of the age statistics in the form in which they are used for most purposes, that is, in five-year age groups. The index is obtained by computing the sex-ratios and age ratios for five-year age groups of ages up to age 70. The successive differences of sex-ratios between one age group and the next are noted and taken, irrespective of sign. In the case of age-ratios, for either sex, deviations from 100 are noted and averaged irrespective of sign. The index is computed

TABLE 2 (A) : COMPUTATION OF WHIPPLES INDEX FOR SIAYA USING 1979 CENSUS

AGES	MALES	FEMALES	AGE	MALES	FEMALES
23	1904	3376	25	2074	4024
24	1799	3039	30	2430	4582
25-29	8865	16972	35	1395	2483
30-34	7868	14468	40	1879	3910
35-39	5939	12536	45	1486	2664
40-44	6736	13209	50	1752	2922
45-49	6859	12675	55	1316	1454
50-54	6685	9669	60	1631	1941
55-59	5763	7273			
60	1631	1941			
61	1729	2028			
62	627	652			
SUM	56,405	97,838		13,963	23,980

Index for males

$$\frac{5 \times 13963}{56.405} \times 100 = 123.8$$

Index for females

$$\frac{5 \times 23,980}{97,838} \times 100 = 122.$$

TABLE 2 (B) : COMPUTATION OF UN SECRETARIAT INDEX FOR SIAYA USING 1979 CENSUS DATA

AGE GROUP	REPORTED NUMBER		SEX - RATIOS		MALE AGE-RATIOS		FEMALE AGE-RATIOS	
	MALE	FEMALE	RATIOS	SUCCESSIVE DIFFERENCES	RATIOS	DEVIATIONS FROM 100	RATIOS	DEVIATIONS FROM 100
0-4	40814	41024	99.5	-	-	-	-	-
5-9	37164	37283	99.7	0.2	99.3	-0.7	101.0	1.0
10-14	34331	32469	105.7	6.0	106.7	6.7	100.9	0.9
15-19	25057	26802	93.5	-12.2	105.7	5.7	102.4	2.4
20-24	11735	19244	61.0	-32.5	77.1	-22.9	91.6	-8.4
25-29	8865	16972	52.2	- 8.8	93.4	- 6.6	100.5	0.5
30-34	7868	14468	54.4	2.2	80.3	-19.7	98.7	-1.3
35-39	5939	12536	47.4	- 7.0	86.7	-13.3	93.5	-6.5
40-44	6736	13209	51.0	3.6	103.5	3.5	103.1	3.1
45-49	6859	12675	54.1	3.1	101.5	1.5	107.0	7.0
50-54	6685	9669	69.1	15.0	103.9	3.9	97.9	-2.1
55-59	5763	7273	79.2	10.1	97.0	- 3.0	95.3	-4.7
60-64	3368	5951	56.6	11.0	97.9	- 2.1	102.6	2.6
65-69	3218	4173	127.5	37.3	112.6	12.6	97.1	-2.9
70-74	3420	2756	136.2	-1.3	-	-		
Total Irrespective of sign.				150.3		102.2		43.4
Mean				11.6		7.9		3.3

Index = (3 x 11.6) + (7.9 + 3.3) = 46.

by multiplying the average of sex-ratio differences by three and then adding the results to the two averages of deviations of age-ratios from 100. The computed UN Secretariat index for Siaya was 46 which places Siaya's age data on the lower bound of the 'Highly Inacurate' category which runs from 40 to 100.

The compendium to Volume 1 1979 Kenya Population Census reports that under - ennumeration occured in Nyanza Province and hence in Siaya District, but the census data used in the study was not adjusted to catter for this under-ennumeration. Perhaps this could have some effects on the obtained results. It was not possible to indicate the degree of misplacement and omissions of births and deaths of children reported for Siaya due to non availability of detailed birth histories of the women involved.

(b) Vital Registration data on deatns

Vital registration data are also subject to errors such as misreporting of ages of the dead, omission and displacement of death events. The 1977 Vital Registration data on deaths for Siaya District had these mentioned

shortcomings. The majority of the total deaths registered for the district that year were by non-medical personnel and are therefore likely to be of poor quality especially with respect to the reported causes of death. Brass' 'Growth Balance Method' was applied to indicate the degree of completeness of the 1977 vital registration data on deaths relative to the completeness of the 1979 population census data for Siaya [Appendix I (4)].

The 1977 Vital Registration data on deaths for females and males were found to be 47 and 112 per cent respectively complete relative to the completeness of 1979 Population census data for Siaya [Appendix II Tables 1 and 2]. This indicates that there was under-registration of the female deaths and over-reporting of the male deaths relative to the census.

(c) In-patient and out-patient medical reports

The medical or health statistics used were given by age, sex and various categories of diseases. They were also exposed to the risk of age misreporting, omissions and other problems associated with identification of the disease.

The medical personnel deal with patients who may not give their correct ages or those who sincerely do not know their ages, hence, the recorded ages used in the study are subject to errors. The diagnosis of disease especially in the Rural Dispensaries where proper medical equipment and staff are lacking, may not be accurate at times. It is also possible that the medical personnels giving the prescriptions might have been biased towards the most prevailing diseases in the area. Deaths caused by multiple causes are also difficult to classify.

It was not possible to adjust the medical data used in the study to cater for the above mentioned possible deficiencies and hence the morbidity and mortality rates derived from them are also subject to some error.

2.2. USE OF THE DATA

Since the data used in this study was found to contain errors such as misreporting of ages, displacement and omission of vital events, the techniques chosen for estimation of mortality rates and construction of complete life tables caters for the kind of errors mentioned. The 1979 Population Census data

was used to derive infant/child and adult mortality rates for the district. The 1977 Vital Registration data on deaths was used to derive mortality rates by cause and also to construct complete life tables for the district. The 1979 and 1980 medical reports were used to study the distribution and pattern of diseases in Siaya. Brief descriptions of each of the techniques and data used are given below.

Brass and Sullivan's methods were used to estimate infant and child mortality rates for the district, [Chapter 3 Tables 3(A) and 3(B)]. Information obtained from the 1979 population census on number of children ever born and children surviving to women in five-year age groups was used.

Brass and Hill method was used to estimate adult mortality and also to construct complete life tables for the district using 1979 population census data [Chapter 3- Tables (H) and (J)]. Orphanhood data collected by simple questions. "Is your mother alive?" and "Is your father alive?" by five year-age groups and sex of the respondents was used.

Logit life table system was used to patch infant/child mortality obtained by Brass method and adult mortality obtained from orphanhood data.

Brass' 'Growth Balance Method' was used to construct complete life tables for the district using the 1977 Vital Registration data on deaths by cause [Chapter 3 - Tables 3 (M) and 3 (N)].

Available statistical methods were used to estimate cause-specific mortality rates utilizing the 1977 vital registration data on deaths. The 1979 in-patient medical report was also used to establish morbidity and mortality patterns by cause for the district. The 1980 out-patient morbidity data was used to show the distribution of some of the major diseases in the district.

The population census and the vital registration data on deaths used treat Siaya District as a single unit and for this reason, mortality levels and mortality patterns by cause of death at divisional and locational levels, were not possible to estimate. The 1979 in-patient medical report also do not provide us

with the breakdown of the patient's admitted in hospitals in the district by their residential administrative units. It was therefore not possible to do analysis on mortality patterns by cause within the different regions of Siaya District.

CHAPTER 3

MORTALITY ESTIMATES

3.1. INFANT AND CHILD MORTALITY

The estimates of infant and child mortality based on 1979 census data were obtained by Brass and Sullivan's methods [Appendix I - (1) and (2)]. Table 3(A) gives the proportion of children dying from birth to age x ($_xq_o$) for Siaya District by Brass method. The proportion was estimated by the following equation:-

$$_xq_o = (1-Si)Ki \quad , i = 1, 2, 3, \text{---- } 7$$

where $x = 1, 2, 3, 5, 10, 15, 2$

Si is the proportion of children surviving belonging to women in age group i.

Ki is the appropriate multiplying factor obtained from Brass tables using $P_1/P_2 = 0.191$ for i = 1 and 2 as well as mean age of child-bearing ($\bar{m}$) = 28.9 for i = 3, 4,---- 7

Pi is the average number of children ever born to women in age group i.

Table 3(B) gives the proportion of children dying from birth to age x ($_xq_o$) for Siaya by Sullivan's method which utilizes the

TABLE 3 (A) : ESTIMATES OF PROPORTIONS OF CHILDREN DYING FROM BIRTH TO AGE x FOR SIAYA DISTRICT BY BRASS METHOD

INTERVAL i	AGE OF WOMEN	AVERAGE No. OF CHILDREN EVER BORN (Pi)	PROPORTION OF CHILDREN SURVIVING (Si)	PROPORTION OF CHILDREN DYING (1 - Si)	MULTIPLYING FACTOR (Ki)	AGE x	PROPORTION DEAD BY AGE x ($x^{q}o$)
1	15-19	0.396	0.828	0.172	0.991	1	0.170
2	20-24	2.075	0.768	0.232	1.017	2	0.236
3	25-29	3.774	0.761	0.239	0.998	3	0.238
4	30-34	5.462	0.720	0.280	1.019	5	0.285
5	35-39	6.393	0.691	0.309	1.029	10	0.318
6	40-44	6.832	0.660	0.340	1.007	15	0.342
7	45-49	6.823	0.700	0.300	1.025	20	0.308

TABLE 3 (B) : ESTIMATES OF PROPORTIONS OF CHILDREN DYING FROM BIRTH TO ACE x FOR SIAYA DISTRICT BY SULLIVAN'S METHOD

INTERVAL	AGE OF WOMEN	AVERAGE No. OF CHILDREN EVER BORN (P_i)	PROPORTION DEAD OF CHILDREN EVER BORN ($1 - S_i$)	$A + B(P_2/P_3)$ ($P_2/P_3 = 0.550$)		AGE x	$_xq_o$
2	20-24	2.075	0.232	W	1.003	2	0.233
				N	0.954		0.221
				E	1.018		0.236
				S	0.995		0.231
3	25-29	3.774	0.239	W	0.950	3	0.227
				N	0.895		0.213
				E	0.959		0.229
				S	0.958		0.229
4	30-34	5.462	0.260	W	0.949	5	0.265
				N	0.919		0.257
				E	0.967		0.271
				S	0.964		0.270

following equation:-

$$_xq_o = [A + B(P_2/P_3)][1 - Si] \quad , \quad i = 2, 3, 4$$
$$x = 2, 3, 5$$

where A and B are coefficients obtained from the table giving results of regression models developed by Sullivan

P_2 and P_3 are the average number of children ever born to women in age groups 2 and 3 respectively.

Si is the proportion of surviving children belonging to women in age group i.

W, N, E, S are the West, North, East and South models respectively.

The proportion of children dying from birth to age 2, $_2q_o$, from Brass method is 0.236 and 0.221 from Sullivan's North Model which is believed to hold for Kenya. The $_2q_o$ value from Sullivan's East Model is 0.236 while for Sullivan's West and South models are very close to the Brass' estimate. Since Brass and Hill method is later used to derive adult mortality, the proportion of children dying from birth to age two for the district is taken to be 236 per thousand live births.

However, the $_2q_o$ value adopted for the district may not be accurate for various

possible reasons regarding the quality of the data and the limitations of the methods used. First, mothers who died and are not included in these data may have had children that were subject to higher mortality risks than children whose mothers survived. Second, some of the dead children may have been omitted by the surviving mothers. Third, some cases of still births may have been reported having been born alive and subsequently dying. Lastly, the two methods are based on the assumption that mortality and fertility conditions have been constant in the recent past, yet, is unrealistic for a district like Siaya. Although the methods used caters for the above mentioned possible errors, we can still take the obtained results as mere estimates.

Divisional child mortality levels for the district were not calculated due to limitation of the data used. Estimates of the proportion of children dying before age two, $_2q_o$, were calculated by place of residence (urban/rural), by marital status and by the level of mothers education using Brass method. Table 3(C) gives the Brass estimates of the proportion dying by age two by place of residence.

TABLE 3 (C) : BRASS ESTIMATES OF PROPORTIONS OF CHILDREN DYING FROM BIRTH TO AGE 2 BY PLACE OF RESIDENCE

PLACE OF RESIDENCE	TOTAL No. OF WOMEN AGED 12 YEARS AND OVER	PROPORTION DYING BY AGE 2 (Per 1000 live births) ($_2q_0$)
Rural	165,564	211
Urban	1,906	177
Siaya District	167,470	236

The above table clearly indicates that infant and child mortality is higher in the rural than in the urban areas. The 2Go value for the rural area is lower than the whole district's figure possibly due to higher degree of misreporting or omissions of births and deaths of children for mothers in the rural, particularly those in the age group 20-24 years. The lower child mortality in the urban areas could be due to better sanitation, housing, shorter distances to health centres and higher income levels existing in the urban areas on the average. Rural women work long hours, especially in the farms, and therefore tend to have limited time to take care of their children. Education of the mother also has some influence on the level of child mortality as shown in table 3(D).

The table indicates that child mortality decreases as the level of education of the mothers increase. Educated women, especially those who attain secondary plus level, could be said to have better knowledge of child care. Many of such mothers are also likely to be in wage employment and are therefore supplementing their family's income. This enables them to provide better meals, good health care, better

TABLE 3 (D) : BRASS ESTIMATES OF PROPORTIONS OF CHILDREN DYING FROM BIRTH TO AGE 2 BY EDUCATION OF THE MOTHERS

LEVEL OF EDUCATION OF THE MOTHERS	TOTAL No. OF WOMEN AGED 12 YEARS AND OVER	PROPORTION DYING BY AGE 2. ($_2q_0$) (Per thousand live births)
NON	93,539	237
PRIMARY	66,261	191
SECONDARY +	7,125	123

housing and sanitary facilities to their children.

Differentials also exist in child mortality by marital status of the mothers. Table 3(E) gives child mortality by marital status of the mothers.

This table shows that widowed mothers have the highest child mortality while single mothers have the lowest child mortality in Siaya. Children belonging to widowed women are more likely to be liable to disease attacks, particularly of nutritional origin, since most of them live under poorer conditions after the death of the fathers. The majority of the single women aged 12 years and above are in school or have just left school so their parents assist in up-bringing their children.

The graduated ℓ_2, the life table survivors to age 2, for Siaya was estimated from the proportion of children surviving between birth and age 2, $_2P_0$, by the use of the logit system. The calculations are presented below:-

(a) From the Brass estimates, $_2P_0$, $_3P_0$, $_5P_0$, proportions of children surviving between birth and ages 2, 3 and 5 were found to be 0.764, 0.762 and 0.715 respectively.

TABLE 3 (E) : BRASS ESTIMATES OF PROPORTIONS OF CHILDREN DYING FROM BIRTH TO AGE 2 BY MARITAL STATUS OF THE MOTHERS

MARITAL STATUS OF THE MOTHERS	NUMBER OF WOMEN AGED 12 YEARS AND OVER	PROPORTION DYING BY AGE 2 $_2q_0$ (per thousand live births)
WIDOWED	21,479	264
MARRIED	101,987	192
DIVORCED OR SEPARATED	2,500	185
SINGLE	41,359	155

(b) The logit of proportion P, logit P, is defined as $\frac{1}{2} \log_e (\frac{P}{1-P})$. Hence the logits of the observed ${}_2P_0$, ${}_3P_0$ and ${}_5P_0$ were found to be 0.5869, 0.5817 and 0.4597 respectively.

(c) The corresponding standard logits obtained from Brass "African Standard Life Table" for ${}_2P_0$, ${}_3P_0$ and ${}_5P_0$ are 0.8052, 0.7252 and 0.6615 respectively. The mean of the difference between the observed and the standard logits was found to be -0.1879.

(d) The graduated logit ${}_2P_0$ was found to be 0.6173 by adding -0.1879 (the mean of the logit difference) to 0.8052 (the standard logit ${}_2P_0$).

(e) Using the interpolation formular $f(x) = \frac{f(a)(b-x) - f(b)(a-x)}{(b-x) - (a-x)}$

and 0.6173 (the graduated logit ${}_2P_0$), the graduated ${}_2P_0$ was found to be 0.772. Thus the graduated l_2 was 772 (l_0 = 1,000).

From Coale-Demeny North Model life tables, the estimated graduated l_2 value for the females and males are 787 and 758 respectively. This places Siaya at mortality level 8.5 in the North Model.

3.2. ADULT MORTALITY

The estimation of adult mortality was done using orphanhood data by Brass and Hill method [Appendix I - (3)]. The mean age of mothers and fathers at the birth of their children, $\bar{m}$, was fixed at 26 and 35 respectively. The convenient base age of mothers and fathers, B, was fixed at 25 and 32.5 respectively. The life table survivorship probabilities for the females and the males were then obtained using the equations below:-

$$\frac{l_{B+N}}{l_B} = (W_N \cdot {}_5P_{N-5}) + (1 - W_N)\,{}_5P_N \text{ for females}$$

and

$$\frac{l_{B+N+2.5}}{l_B} = (W_N \cdot {}_5P_{N-5}) + (1 - W_N)\,{}_5P_N \text{ for males}$$

where

${}_5P_N$ and ${}_5P_{N-5}$ are the proportions of respondents aged (5 to N + 5) and (N-5 to N) years respectively.

B is the convenient base age (fixed at 25 for females and at 32.5) for males.

W_N is the appropriate multiplying factor (from Brass tables).

N is the mid point of the two adjacent age groups

l_B, l_{B+N}, $l_{B+N+2.5}$ are the life table survivors at ages B, B+N, and B+N+2.5 respectively.

The life table survivorship probabilities for the females are given in Table 3(F) below.

TABLE 3 (F) : FEMALE ADULT MORTALITY FOR SIAYA DISTRICT BY BRASS AND HILL METHOD USING ORPHANHOOD DATA

$\bar{m}$ = 26, B = 25

AGE GROUP OF RESPONDENTS	PROPORTION WITH SURVIVING MOTHERS	N	W_N	$1-W_N$	$\frac{l_{25+N}}{l_{25}}$
5-9	0.9812	10	0.596	0.404	0.9759
10-14	0.9680	15	0.678	0.322	0.9604
15-19	0.9445	20	0.756	0.244	0.9322
20-24	0.8942	25	0.809	0.191	0.8821
25-29	0.8306	30	0.834	0.166	0.8108
30-34	0.7115	35	0.844	0.156	0.6947
35-39	0.6038	40	0.791	0.209	0.5773
40-44	0.4768	45	0.708	0.292	0.4386
45-49	0.3461	50	0.514	0.486	0.2808
50-54	0.2117	55	0.270	0.73	0.1486
55-59	0.1253	60	0.053	0.947	-

The life table survivorship probabilities for the males are given in table 3 (G)

TABLE 3 (G) : MALE ADULT MORTALITY FOR SIAYA DISTRICT BY BRASS AND HILL METHOD USING ORPHANHOOD DATA

$\bar{m} = 35$, $B = 32.5$

AGE GROUP OF RESPONDENTS	PROPORTION WITH SURVIVING FATHERS	N	W_N	$1-W_N$	$\frac{l_{35+N}}{l_{32.5}}$
5-9	0.9318	10	0.650	0.350	0.9172
10-14	0.8902	15	0.790	0.210	0.8766
15-19	0.8254	20	0.861	0.139	0.8098
20-24	0.7135	25	0.877	0.123	0.6971
25-29	0.5801	30	0.779	0.221	0.5460
30-34	0.4258	35	0.610	0.390	0.3841
35-39	0.3189	40	0.303	0.697	0.2412
40-44	0.2074	45	-0.024	1.024	0.1315
45-49	0.1332	50	-0.264	1.264	0.0561
50-54	0.0722	55	-0.397	1.397	0.0322
55-59	0.0436	60	-	-	-

The life table probabilities for Siaya shown in the two tables above do not include the mortality experience of respondents who never had children and those whose children had all died before the 1979 census date. The fixing of $\bar{m}$ at 26 and 35 for females and males respectively may have affected the accuracy of the obtained results.

The construction of complete life tables for Siaya was done using Brass and Hill Method and Brass' "Growth Balance Method" [Appendix I - (3) and (4)].

A summary equation of mortality schedule was developed using the relationship provided by the logit life table system $Y(x) = \alpha + \beta Y_S(x)$ where

$Y(x)$ is the observed logit l_x obtained from orphanhood data.

$Y_S(x)$ is the standard logit l_x obtained from standard life table α and β are coefficients.

Since we already know the l_2 values for both sexes from childhood mortality, the observed logit l_2 [Y(2)] was then calculated from the equation logit $l_x = Y(x) = \frac{1}{2} \log_e [(1-l_x)/l_x]$.

$Y(2)$ values for the females and males were found to be 0.6535 and -0.5709 respectively. The l_2 values were also used to obtain l_{25} and $l_{32.5}$ values ($l_{25} = .650$, $l_{32.5} = .595$) from a single parametre model life table.

The obtained l_{25} and $l_{32.5}$ values were then used to complete l_{25+N} and $l_{32.5+N}$ columns

in tables 3 (II) and 3 (I). The implied β values were then calculated using the equation

$$\hat{\beta} = \frac{Y(x) - Y(2)}{Y_s(x) - Y_s(2)}$$

The first estimate of β for females and males, obtained by averaging the values of β belonging to age groups between 20 and 45 years, were 0.7996 and 0.8831 respectively. From the first estimate of β and 1_2 values, new values of 1_{25} and $1_{32.5}$ were found (1_{25} = .638, $1_{32.5}$ = .622). The procedure was repeated and the second estimate of β for females and males became 0.803 and 0.858 respectively.

Thus the summary mortality equations became

$Y(x) = 0.043 + 0.858\ Y_s(x)$ for males

and $Y(x) = 0.079 + 0.803\ Y_s(x)$ for females.

TABLE 3 (H) : ESTIMATES OF FEMALE ADULT MORTALITY FOR SIAYA DISTRICT FROM CHILDHOOD MORTALITY AND ORPHANHOOD DATA - l_2 = .787, $\bar{m}$ = 26, Y_2 = -0.6535

AGE GROUP OF RESPONDENTS	PROPORTION WITH SURVIVING MOTHERS	N	W_N	$1-W_N$	$\frac{l_{25+N}}{l_{25}}$	$\frac{l_{25+N}}{(l_{25}=.650)}$	IMPLIED β	FIRST ESTIMATE OF β	$\frac{l_{25+N}}{(l_{25}=.648)}$	IMPLIED β	SECOND ESTIMATE OF β
5-9	0.9812	10	0.596	0.404	0.9759	0.6343	0.8121		0.6324	0.8209	
10-14	0.9680	15	0.678	0.322	0.9604	0.6243	0.7490		0.6223	0.7569	
15-19	0.9445	20	0.756	0.244	0.9322	0.6060	0.7208		0.6041	0.7274	
20-24	0.8942	25	0.809	0.191	0.8821	0.5734	0.7285		0.5716	0.7339	
25-29	0.8306	30	0.834	0.166	0.8108	0.5270	0.7508	0.7996	0.5254	0.7549	0.8029
30-34	0.7115	35	0.844	0.156	0.6947	0.4516	0.8113		0.4502	0.8143	
35-39	0.6038	40	0.791	0.209	0.5773	0.3752	0.8492		0.3741	0.8514	
40-44	0.4768	45	0.708	0.292	0.4386	0.2851	0.8583		0.2842	0.8600	
45-49	0.3461	50	0.514	0.486	0.2808	0.1825	0.8868		0.1820	0.8878	
50-54	0.2117	55	0.270	0.73	0.1486	0.0966	0.9018		0.0963	0.9027	
55-59	0.1253	60	0.053	0.947	-	-	-		-	-	

Therefore at any given age x,

$Y(x) = -0.079 + 0.803\ Y_s(x)$, where $Y(x)$ is logit l_x

$Y_s(x)$ is standard logit l_x

TABLE 3(I) : ESTIMATES OF MALE ADULT MORTALITY FOR SIAYA DISTRICT FROM CHILDHOOD MORTALITY AND ORPHANHOOD DATA

$l_2 = .758$, $\bar{m} = 35$, $Y_2 = 0.5709$

AGE GROUP OF RESPONDENTS	PROPORTION WITH SURVIVING FATHERS	N	W_N	$1-W_N$	$\frac{l_{35+N}}{l_{32.5}}$	l_{35+N} ($l_{32.5}$= .595)	IMPLIED β	FIRST ESTIMATE OF β	l_{35+N} ($l_{32.5}$= .622)	IMPLIED β	SECOND ESTIMATE OF $\bar{\beta}$
5-9	0.9318	10	0.650	0.35	0.9172	0.5457	0.7883		0.5705	0.7057	
10-14	0.8902	15	0.790	0.21	0.8766	0.5216	0.7604		0.5452	0.6921	
15-19	0.8254	20	0.861	0.139	0.8098	0.4818	0.7606		0.5037	0.7058	
20-24	0.7135	25	0.877	0.123	0.6971	0.4148	0.8031		0.4336	0.7615	
25-29	0.5801	30	0.779	0.221	0.5460	0.3249	0.8594	0.8831	0.3396	0.8290	0.858
30-34	0.4258	35	0.610	0.39	0.3841	0.2285	0.9093		0.2389	0.8869	
35-39	0.3189	40	0.303	0.697	0.2412	0.1435	0.9252		0.1500	0.9088	
40-44	0.2074	45	-0.024	1.024	0.1315	0.0782	0.9186		0.0818	0.9062	
45-49	0.1332	50	-0.264	1.264	0.0561	0.0334	0.9121		0.0349	0.9029	
50-54	0.0722	55	-0.397	1.397	0.0322	0.0192	0.7948		0.0200	0.7883	
55-59	0.0436	60	-	-	-	-	-		-	-	

Therefore at any given age x,

$Y(x) = 0.043 + 0.858\, Y_s(x)$, where $Y(x)$ is logit l_x

$Y_s(x)$ is standard logit l_x.

The corresponding l_x values to the obtained logit l_x [Y(x)] are given in table 3(J) below.

TABLE 3 (J) : CORRESPONDING l_x VALUES FOR THE OBTAINED LOGITS OF l_x[Y(x)]

MALES			FEMALES		
AGE x	Y(x)	l_x	AGE x	Y(x)	l_x
0	-	1,000	0	-	1,000
1	-0.7009	803	1	-0.7752	824
2	-0.5706	758	2	-0.6533	787
3	-0.5192	742	3	-0.6051	770
5	-0.4731	723	5	-0.5620	755
10	-0.4287	706	10	-0.5205	738
15	-0.3972	688	15	-0.4910	728
20	-0.3475	669	20	-0.4444	709
25	-0.2855	638	25	-0.3865	684
30	-0.2273	604	30	-0.3319	660
35	-0.1712	582	35	-0.2794	636
40	-0.1129	551	40	-0.2249	610
45	-0.0491	525	45	-0.1652	582
50	-0.0248	514	50	-0.0960	548
55	0.1144	443	55	-0.0122	506
60	0.2232	391	60	0.0896	455
65	0.3644	325	65	0.2218	391
70	0.5422	253	70	0.3882	315
75	0.7871	173	75	0.6174	226
80	1.1146	48	80	0.9239	137
85	1.5492	44	85	1.3307	67
90	2.1686	13	90	1.9104	2
95	3.0060	0	95	2.6941	0

The abridged life tables for Siaya District by sex are given in tables 3 (K) and 3 (L).

TABLE 3 (K) : ABRIDGED MALE LIFE TABLE FOR SIAYA DISTRICT OBTAINED BY BRASS AND HILL METHOD

AGE x	l_x	nL_x	T_x	e_x
0	1,000	862.1	41495.6	41.5
1	803	776.0	40633.5	50.6
2	758	750.0	39857.5	52.6
3	742	1465.0	39107.5	52.7
5	723	3572.5	37642.5	52.1
10	706	3485.0	34070.0	48.3
15	688	3392.5	30585.0	44.5
20	669	3267.5	27192.5	40.6
25	638	3105.0	23925.0	37.5
30	604	2965.0	20820.0	34.5
35	582	2832.5	17855.0	30.7
40	551	2690.0	15022.5	27.3
45	525	2597.5	12332.5	23.5
50	514	2392.5	9735.0	18.9
55	443	2085.0	7342.5	16.6
60	391	1790.0	5257.5	13.4
65	325	1445.0	3467.5	10.7
70	253	1065.0	2022.5	8.0
75	173	552.5	957.5	5.5
80	48	230.0	405.0	8.4
85	44	142.5	175.0	4.0
90	13	32.5	32.5	2.5
95	0	-	-	-

TABLE 3 (L) : ABRIDGED FEMALE LIFE TABLE FOR SIAYA DISTRICT OBTAINED BY BRASS AND HILL METHOD

AGE x	l_x	$_nL_x$	T_x	e_x
0	1,000	876.8	45814	45.8
1	824	801.8	44937.8	54.5
2	787	778.5	44136.0	56.1
3	770	1525.0	43357.5	56.3
5	755	3732.5	41832.5	55.4
10	738	3652.5	38100.0	51.6
15	723	3580.0	34447.5	47.6
20	709	3482.5	30867.5	43.5
25	684	3360.0	27385.0	40.0
30	660	3240.0	24025.0	36.4
35	636	3115.0	20785.0	32.7
40	610	2980.0	17670.0	29.0
45	582	2825.0	14690.0	25.2
50	548	2635.0	11865.0	21.7
55	506	2402.5	9230.0	18.2
60	455	2115.0	6827.5	15.0
65	391	1765.0	4712.5	12.1
70	315	1352.5	2947.5	9.4
75	226	907.5	1595.0	7.1
80	137	510.0	687.5	5.0
85	67	172.5	177.5	2.6
90	2	5.0	5.0	2.5
95	0	-	-	-

The construction of life tables for Siaya was also done using Brass "Growth Balance Method" [Appendix I - (4)]. The 1977 Vital Registration data on deaths and 1_5 (755 for females and 733 for males) obtained by Brass method were used. The analysis of the completeness of 1977 vital registration data on deaths relative to the 1979 population census data had earlier given adjustment factor, $\frac{1}{c}$, of 2.126 and 0.89 for females and males respectively [Appendix II tables 1 and 2]. Adjustment factor of 2.0 was used for the males since it gave closer result to the Brass estimate. The adjustment factors were applied on the reported mortality rates, $_5M_x$, from the vital registration data. The adjusted $_5M_x$ values were then used to develop the life tables. Tables 3(M) and 3(N) gives the life tables for females and males respectively using the method.

TABLE 3 (M) : FEMALE MODEL LIFE TABLE FOR SIAYA DISTRICT BY BRASS GROWTH BALANCE METHOD

$l_5 = 755$, $\frac{1}{C} = 2.126$

AGE x	REPORTED $_5M_x$	ADJUSTED $\frac{1}{C}\ _5M_x$	$_5q_x$	$_5P_x$	l_x	$_5L_x$	T_x	e_x
0	-	-	-	-	1,000	4387.5	47428.8	47.4
5	0.0038	0.0079	0.0387	0.9613	755	3702.5	43041.3	
10	0.0013	0.0028	0.0139	0.9861	726	3605.0	39338.8	
15	0.0012	0.0026	0.0129	0.9871	716	3557.5	35733.8	
20	0.0016	0.0034	0.0169	0.9831	707	3505.0	32176.3	
25	0.0012	0.0026	0.0129	0.9871	695	3452.5	28671.3	
30	0.0018	0.0038	0.0188	0.9812	686	3397.5	25218.8	
35	0.0025	0.0053	0.0262	0.9738	673	3320.0	21821.3	
40	0.0026	0.0055	0.0271	0.9729	655	3230.0	18501.3	
45	0.0050	0.0106	0.0516	0.9484	637	3102.5	15271.3	
50	0.0071	0.0151	0.0727	0.9273	604	2910.0	12168.8	
55	0.0085	0.0181	0.0864	0.9136	560	2680.0	9258.8	
60	0.0183	0.0389	0.1773	0.8227	512	2332.5	6578.8	
65	0.0216	0.0459	0.2058	0.7942	421	1887.5	4246.3	
70+	0.0666	0.1416	-	-	334	2358.8	2358.3	

TABLE 3 (N) : MALE MODEL LIFE TABLE FOR SIAYA DISTRICT BY BRASS GROWTH BALANCE METHOD

$l_5 = 723$, $\frac{1}{c} = 2.0$

AGE x	REPORTED $_5M_x$	ADJUSTED $\frac{1}{c}\ _5M_x$	$_5q_x$	$_5p_x$	l_x	$_5L_x$	T_x	e_x
0	-	-	-	-	1,000	4307.5	42395.4	42.4
5	0.0037	0.0074	0.0363	0.9637	723	3550.0	38087.9	
10	0.0014	0.0028	0.0139	0.9861	697	3460.0	34537.9	
15	0.0015	0.0030	0.0149	0.9851	687	3410.0	31077.9	
20	0.0023	0.0046	0.0227	0.9773	677	3347.5	27667.9	
25	0.0034	0.0068	0.0334	0.9666	662	3255.0	24320.4	
30	0.0041	0.0082	0.0402	0.9598	640	3135.0	21065.4	
35	0.0062	0.0124	0.0601	0.9399	614	2977.5	17930.4	
40	0.0068	0.0136	0.0658	0.9342	577	2790.0	14952.9	
45	0.0086	0.0178	0.0853	0.9147	539	2580.0	12162.9	
50	0.0091	0.0182	0.0870	0.9130	453	2357.5	9582.9	
55	0.0135	0.0270	0.1265	0.8735	450	2107.5	7225.4	
60	0.0197	0.0394	0.1793	0.8207	393	1790.0	5117.9	
65	0.0252	0.0504	0.2238	0.7762	323	1435.0	3327.9	
70+	0.0663	0.1326	-	-	251	1892.9	1892.9	

To harmonize the results from the two methods used, their average figures were taken. Life expectation at birth for males and females became 42.0 and 46.6 years respectively. Compared to the national life expectancy at birth of 52.6 and 55.4 years for males and females respectively, Siaya's life expectation at birth for males and females were about 10.6 and 9.0 years below the national average respectively. Life expectation at birth for Siaya males and females were also below the average for Nyanza Province by about 3.6 and 2.5 years respectively.

The mortality estimates obtained indicate that mortality rates in Siaya are highest during the first five years of life and also after age forty five years. The age specific mortality rates for both sexes are given in the life tables. The information is vital not only for planning purposes in the health sector but also for calculation of premium rates in the insurance industry.

CHAPTER 4

CAUSES OF ILLNESS AND DEATH

Reliable information on disease patterns was not available for Siaya as for the case of most rural areas in developing countries. However, the model developed by Preston on causes of death in less developing countries was used to analyse and to indicate the disease patterns for Siaya District. Table 4(A) gives dominant diseases and their mode of transmission in developing countries.

The classification of causes of illness and death used in this study was based on the recommendations of the World Health Organization. Many of the reported causes of death in Siaya were given by group and not by single causes because of the problem of identification of diseases.

4.1. MAJOR CAUSES OF ILLNESS

Analysis of the major causes of illness in Siaya was based on the 1979 in-patient morbidity data and on the 1980 out-patient morbidity data for the district. According to the 1979 in-patient morbidity data, a total

TABLE 4 (A) : DOMINANT DISEASES AND THEIR MODE OF TRANSMISSION IN DEVELOPING COUNTRIES

MODE OF TRANSMISSION	DISEASES
AIR-BORNE	Influenza/Pneumonia/Bronchitis Respiratory Tuberculosis Small pox Measles Menengitis, acute respiratory infections Diphtheria and Whooping cough
WATER, FOOD AND FECES BORNE	Diarrhea Typhoid Cholera
INSECT-BORNE	Malaria Typhus Plague Trypanosomiasis

SOURCE: Preston, S. "Causes and consequences of mortality decline in less developed countries during the Twentienth Centuary". Population and Economic change in Developing Countries, Univ. of Chicago Press (1980).

of 11,814 patients were admitted in health institutions within Siaya. Table 4 (B) gives the relative percentages of in-patients by cause of admission.

The table indicates that the majority of the in-patients in Siaya when delivery cases were excluded, suffered from rickettsiosis and arthropod-borne diseases which includes malaria, trypanosomiasis and leismaniasis. The second category was viral diseases such as acute poliamy leris, small pox, measles rubella etc. Intestinal infectious diseases was third and this category includes Cholera, typhoid fever, amoebiasis, intestinal infections etc. Signs, symptoms and ill-defined conditons came fourth. This category includes pyrexia of unknown origin, symptoms involving heart, abdominal pain etc. Aneamia came fifth and accounted for 4.3 percent of the total admissions. Direct obsteric causes which consists of heamorrhage of pregnancy and child birth, obstructed labour and complications of the puerperium, came sixth. The category of 'other bacterial diseases' which consists of plague, diptheria, whooping cough and tetenus came seventh.

TABLE 4 (B) : RELATIVE PERCENTAGES OF IN-PATIENTS BY CAUSE OF ADMISSION FOR SIAYA IN 1979

CAUSE OF ADMISSION	PERCENTAGE
Normal delivery	30.8
Rickettsiosis and other arthropod-borne diseases	13.0
Viral diseases	12.5
Intestinal infectious diseases	8.6
Signs, symptoms and ill-defined conditions	5.3
Anaemia	4.3
Direct obsteric cases	3.3
Other bacterial diseases	2.6
All other causes	19.6
TOTAL	100.0

The composition of the in-patients by broad age groups and by major causes of admission is given in Appendix II table 3. The table indicates that the major causes of illness for infants under one year were intestinal infectious diseases followed closely by viral diseases. In the age group one to four years, the major causes were viral diseases followed by rickettsiosis and other arthropod-borne diseases. The same applied to the next age group 5-9 years. Between ten and fourteen years, the major cause was rickttsiosis and other arthropod-borne diseases. About 49 per cent of all the cases admitted in the age group 15 and above years were for normal delivery.

It would, however, be misleading to use hospitalized cases to represent the morbidity situation in the entire district. This is because only a small percentage of those who fall sick are hospitalized. The 1980 out-patient morbidity data was therefore used to analyse the situation further. According to the 1980 out-patient morbidity data, the main causes of illness were malaria (319,263 cases), acute respiratory infections (11,126 cases), intestinal worms (69,114 cases),

diarrheal diseases (74,760 cases) and diseases of the skin (51,081 cases). Table 4 (C) gives the monthly occurrence of malaria in 1980 by administration divisions in Siaya.

Siaya is epidemiologically an endemic malaria region where transmission of malaria occurs throughout the year. Malarial occurrence is greatest in June and July during which green vegetation cover results from the long rains. The high-humid much vegetation cover conditions favour continuous mosquito breeding. Malarial occurrence is lowest in April. Yala and Ukwala Divisions have higher cases of malarial occurrence when compared to Boro and Bondo Divisions. Appendix II table 4 to 7 give the regional and seasonal distribution of acute respiratory infections, diarrheal diseases, intestinal worms and diseases of the skin respectively. There were no clear seasonal patterns of these diseases except for acute respiratory diseases which revealed a maximum occurrence during the months of June and July.

4.2. MAJOR CAUSES OF DEATH

The 1979 in-patient medical data and the 1977 vital registration data on deaths were

TABLE 4 (C) : 1980 MALARIAL CASES IN SIAYA BY MONTH AND BY ADMINISTRATIVE DIVISION

MONTH	ADMINISTRATIVE DIVISION				TOTAL
	UKWALA	BORO	BONDO	YALA	
JANUARY	7272	6426	6552	8582	28,832
FEBRUARY	7050	6426	7659	7189	28,324
MARCH	6522	5243	6615	8029	26,409
APRIL	5778	3745	4806	7385	21,714
MAY	8172	5257	6255	7525	27,209
JUNE	6990	5838	7875	8617	29,320
JULY	8040	6937	9054	9114	33,145
AUGUST	5274	5152	4887	7651	22,964
SEPTEMBER	6990	5446	5337	7630	25,403
OCTOBER	7236	5992	6066	7518	26,812
NOVEMBER	7314	6195	5335	6552	25,396
DECEMBER	5454	5985	4869	7427	23,735
TOTAL	82092	68642	75310	93219	319,263

used to analyse causes of death in Siaya District. Only 342 people died out of the 11,814 who were admitted in health institutions within Siaya in 1979. Table 4 (D) gives the breakdown of the major causes of death by sex according to 1979 in-patient medical data.

Since the 1979 in-patient data on deaths was unrepresentative sample of the entire district's deaths, further calculations of cause specific death ratios and cause specific mortality rates utilizing these data could have given misleading results. The 1977 vital registration data on deaths for the district was therefore used in the analysis of causes of death. Appendix II tables 8 and 9 give the breakdown of the major causes of death by age groups for females and males respectively.

The major causes of death based on the vital registration data were measles, respiratory diseases, cerebrovascular disease and diarrheal diseases. As in the case of the 1979 in-patient deaths, deaths belonging to the age group under 5 years accounted for over 50 per cent of all the registered deaths in 1977. Deaths occuring

TABLE 4 (D) : CAUSES OF DEATH BY SEX BASED ON 1979 IN-PATIENT DATA

CAUSE OF DEATH	MALES	FEMALES	TOTAL	% OF TOTAL DEATHS
Viral diseases	50	37	87	25.3
Intestinal infectious diseases	29	30	59	17.3
Rickettsiosis and other arthropod-borne diseases	25	18	43	12.6
Other bacterial infections	15	18	33	9.6
Aneamia	10	10	20	5.8
Signs, Symptoms and ill-defined conditions	11	8	19	5.6
SUB-TOTAL	140	121	261	76.3
ALL OTHER CAUSES	44	37	81	23.7
GRAND TOTAL	184	158	342	100.0

to under 5 years old accounted for 56.6 per cent of all the registered deaths. Other killer diseases were tuberculosis, heart disease and meningitis. All these seven categories of diseases accounted for about 70 per cent of the total registered deaths in 1977.

4.2.1. CAUSE-SPECIFIC DEATH RATIOS

Despite the poor quality of the data used, an attempt was made to calculate cause-specific death ratios by sex. Cause-specific death ratios are obtained by dividing the number of deaths due to a particular cause by the total number of deaths and then multiplying the result by one thousand. Table 4 (E) gives the obtained cause-specific death ratios by sex.

Although malarial cases were most dominant in the out-patient morbidity data for the district, only about 5 and 8 per thousand male and female deaths respectively were recorded in 1977. This indicates that better malarial treatment measures have been instituted in the district.

TABLE 4 (E) : CAUSE SPECIFIC DEATH RATIOS BY SEX FOR SIAYA DISTRICT

CAUSE OF DEATH	CAUSE SPECIFIC DEATH RATIOS (per 1,000)	
	FEMALES	MALES
Measles	128	118
Respiratory diseases	124	109
Cerebrovascular disease	100	97
Diarrhoel diseases	97	96
Tuberculosis	91	96
Heart disease	90	91
Meningitis	84	81
SUB-TOTAL	714	688
All other causes	266	312
GRAND TOTAL	1000	1000

4.2.2. CAUSE-SPECIFIC MORTALITY RATES

Cause-specific mortality rates were also calculated from 1977 vital registration data on deaths for the district. Cause-specific mortality rate is a measure giving the chance of dying from a particular cause at a particular age in a year or five year period or of eventually dying from this cause. It was calculated using the formular below

$$\text{Cause-specific mortality rate} = \frac{D_{CX}}{P_X + \frac{1}{2}D_X}$$

where

D_{CX} is the registered deaths from a particular cause in the given age group during that year.

D_X is the total deaths registered in that age group during that year.

P_X is the total population in that age group at the middle of the year.

The population age distribution obtained from the 1979 population census data was used in the calculation of cause-specific mortality rates using 1977 vital registration data on deaths. To cater for the two year difference in the base years (1977 and 1979), the valves which had earlier been obtained for the completenes

of the 1977 vital registration data relative to the 1979 population census data were also used. The adjustment factor of 2.126 was therefore applied on the cause-specific mortality rates for the females while 2.0 was applied on the males cause-specific mortality rates. Tables 4 (F) and 4(G) gives the estimated cause-specific mortality rates for the males and females respectively. The tables also depict that measles, respiratory diseases, cerebrovascular and diarrheal diseases have their highest rates in the first one year of life. Tuberculosis and heart diseases have high rates in the older ages (50 years and above).

The results obtained from this study on causes of death do not deviate much from Preston's model of causes of death in developing countries. The category "Air-borne diseases" was the leading cause of death in Siaya District. In this category measles, respiratory tuberculosis, respiratory diseases and meningitis were the major killer diseases. Small pox, diphtheria and whooping cough disease in this category, seem to be under control within Siaya. The killer diseases in this category could be controlled by deploying effective preventive methods such as immunization,

TABLE 4 (F) : CAUSE-SPECIFIC MORTALITY RATES FOR MALES BASED ON 1977 VITAL REGISTRATION DATA (per 10,000 people in the age groups)

CAUSE OF DEATH	AGE - GROUP IN YEARS																
	UNDER 1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75 +
Measles	335	121	9	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Cerebrovascular disease	340	43	11	2	4	3	2	10	10	15	15	33	14	41	37	62	146
Respiratory diseases	258	57	5	3	1	8	-	3	10	3	9	9	14	30	48	62	186
Diarrheal diseases	253	62	6	2	3	3	2	5	-	9	9	3	38	22	33	62	120
Heart disease	89	27	10	2	3	7	16	10	20	24	29	27	59	74	63	113	419
Tuberculosis	54	20	4	1	3	3	5	8	34	12	41	30	35	103	111	157	439
Meningitis	184	41	9	6	6	5	2	3	7	9	3	15	31	7	56	34	126
SUB-TOTAL	1513	371	54	18	20	29	27	39	81	72	106	117	191	277	348	490	1436
All other causes	682	129	20	11	10	15	41	43	44	65	67	66	79	114	149	259	479
GRAND TOTAL	2195	500	74	29	30	44	68	82	125	137	173	183	170	391	497	749	1915

TABLE 4 (G) : CAUSE-SPECIFIC MORTALITY RATES FOR FEMALES BASED ON 1977 VITAL REGISTRATION DATA (per 10,000 people in the age group)

CAUSE OF DEATH	AGE-GROUP IN YEARS																
	UNDER 1	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-70	70-74	75 +
Measles	296	118	15	1	-	-	-	-	-	-	-	2	-	-	-	-	-
Respiratory diseases	307	68	8	1	2	2	1	2	2	10	15	4	12	25	50	113	205
Cerebrovascular disease	288	25	7	3	5	3	4	6	7	5	15	13	18	46	35	38	214
Diarrheal diseases	182	43	9	3	4	-	4	4	7	3	8	20	20	53	50	113	166
Tuberculosis	44	18	5	5	2	3	1	3	12	8	27	44	32	81	106	151	429
Heart disease	55	31	5	3	2	4	3	6	3	10	12	18	32	74	86	159	468
Meningitis	169	44	9	3	2	3	1	4	9	3	7	11	18	25	25	45	166
SUB-TOTAL	1341	347	58	19	17	16	14	25	40	39	84	112	132	304	352	619	1648
All other causes	566	127	23	9	10	18	13	13	14	16	22	39	50	81	106	143	507
GRAND TOTAL	1907	474	81	28	27	34	27	38	54	55	106	151	182	385	458	762	2155

identification and isolation of the infected persons. When life tables were constructed for Siaya holding other things constant and hypothetically eliminating deaths in five year age groups due to measles, respiratory tuberculosis, respiratory and meningicis diseases by Brass 'Growth Balance' method using 1977 vital registration data, females and males life expectation at birth increased by 13.4 and 13.6 years respectively [Appendix II table 10 (A and B)].

The category "Water, food and feces borne diseases" came third after cerebrovascular diseases as major cause of death in Siaya. In this category typhoid and cholera appear to be under control but diarrheal diseases are still a major problem. Diarrheal diseases could be prevented by deploying preventive methods such as purification of water and improving sanitary condition. In Siaya, only about 5 per cent of the total population had access to clean water while 50 per cent of the population had latrines by 1982. When life tables for Siaya were constructed holding other things constant and hypothetically eliminating deaths due to diarrhoel diseases, females and males life

expectation at birth increased by 3.7 and 2.7 years respectively [Appendix table 11 (A and B)].

The category "Vector borne diseases" was not a major killer disease in Siaya. However, malaria was the major cause of illness in the district therefore preventive methods such as drainage of stagnant water and use of drugs and chemicals should be intensified to control the disease.

The unique aspect of the findings of the study on causes of death in Siaya was the dominance of heart diseases. Heart diseases are only expected to be more dominant in the developed countries having the majority of the population in older ages. Treatment of heart diseases require sophisticated medical technology which is lacking in Kenya and hence this increases the chances of dying of heart disease once attacked.

CHAPTER 5

CONCLUSIONS AND POLICY IMPLICATIONS

The study on mortality and morbidity conditions in Siaya District consisted of two parts. First, the mortality schedule for the district was established by patching the results obtained for child and adult mortality. Child mortality rates were established for mothers belonging to various socio-economic groups as indicated by level of education attained, rural and urban place of residence, and by marital status. Part two of the study established the major disease patterns responsible for illness and death in Siaya. Regional and seasonal distribution of the major diseases responsible for illness in the district were established. Cause-specific mortality rates for the district by five year age group were also estimated.

The data used in this study was found to be of poor quality especially data on mortality and morbidity by cause, however, attempt was made to obtain adjustment factors to correct the data. It was also not possible to have mortality by cause data broken down by locations in Siaya and hence locational analysis on causes of death was not done. Despite the short comings of the data used, Siaya District was found to have high mortality

and morbidity rates. Estimates obtained for life expectation at birth were found to be as low as 46.6 years for females and 41.5 years for males. Mortality rate was found to be heaviest during the first five years of life. Child mortality estimates obtained show that from a thousand male live births, only 758 and 723 reach age 2 and 5 respectively while from a thousand female live births only 787 and 755 reach age 2 and 5 respectively. These results on child mortality and life expectation at birth for Siaya confirm/are that females biologically a stronger sex compared/to males.

The results obtained for child mortality as measured by proportion of children dying from birth to age 2 for mothers belonging to various socio-economic groups, indicate that mothers in the better off group have lower child mortality. Child mortality was found to decrease with increase in educational attainment of the mothers. The proportions of children dying from birth to age two were 237, 191 and 123 per thousand for mothers with non, primary and secondary plus education respectively. This confirms the results of the earlier study done in Kenya on child mortality levels at provincial level by Henin and Mott (1979). Although Siaya is basically a rural district, mothers who resided in the urban areas had lower child mortality than other rural mothers. The proportions of children dying from

birth to age two were 211 and 177 per thousand for rural and urban resident mothers respectively. This also confirm the results of the study done in Latin America by Behm (1979). Child mortality was also found to be highest for widowed mothers than for any other group based on marital status in Siaya. The proportions of children dying from birth to age two were 264, 192, 185 and 155 per thousand for widowed, married, divorced or separated and single mothers respectively.

The results of the analysis done on major diseases responsible for illness and death in Siaya fits well into the model for causes of death in developing countries developed by Preston (1980). The category "Air-borne diseases" which includes measles, tuberculosis, respiratory diseases and meningitis was found to be the leading cause of death in Siaya. Life expectation at birth for females and males would shoot up by 13.4 and 13.6 years respectively if these diseases alone were controlled. The category "Water, food and feces borne diseases" was the third leading cause of death after cerebrovascular diseases. In this category diarrheal diseases were most dominant. Total control of diarrheal diseases alone would cause an increase in life expectation at birth by 3.7 and

2.7 years for females and males respectively in Siaya. Mortality rates due to "Air-borne" and "Water, food and feces borne" categories of diseases were higher during the first five years of life than in any other age groups. Heart diseases was also found to be one of the leading causes of death in Siaya District. The category "Vector-borne diseases" which consisted mainly of malaria was the leading cause of illness in Siaya. About 320 thousand cases of malaria were attended to in dispensaries and hospitals in 1980. Malaria was found to be most dominant in June-July months and in Yala-Ukwala Divisions.

Health problems in Siaya District could be attributed mainly to the environmental conditions and to the inadequate coverage of health services. Siaya's natural environment is well suited to the growth of disease vectors and to transmission of disease. Moist-warm climate is hospitable to insects and parasites. Inadequate clean water and drainage; poor sanitary, food preservation and hygienic conditions allow rapid transmission of disease. The inadequate coverage of health services is brought about mainly by the health facilities that are geographically inaccessible to the majority of the people due to long distances and poor road network; inefficient methods of procurement, distribution and control of drugs and pesticides which

frequently interrupt provision of health services; the inadequate health workers trained to provide these services; and lastly more emphasis that is currently placed upon curative health care while prevention and early treatment are neglected.

POLICY IMPLICATIONS

In order to reduce the high mortality and morbidity rates in Siaya District, the following policy issues apply:-

(1) Since the Government is already committed to providing free primary education to all children of primary school age in Kenya, all those people in places of authority such as chiefs and sub-chiefs in Siaya and elsewhere in Kenya should ensure that all children benefit from this programme. Education of girls beyond primary school level should be encouraged in Siaya and in other parts of the country since child mortality decline as the level of education of the mothers increase. The number of places available for girls in post primary institutions should be increased while parents should also be encouraged to pay for their daughters education.

(2) The approach of the provision of health services

should be changed to emphasize prevention and early treatment rather than curative. In Siaya, the Government in collaboration with the people should:-

(a) Improve road networks leading into remoter parts of the district to facilitate easier use of mobile clinics to supplement the existing health centres and hospitals.

(b) Increase primary health care facilities and trained manpower to:-

(i) Intensify immunization and other programmes to control diseases such as measles, tuberculosis, meningitis etc.

(ii) Intensify information and education campaign to create awareness to the people on the major health problems in the community and to mobilize community members to promote self-reliance in dealing with environmental health problems such as lack of clean water, poor drainage and poor sanitary

conditions by taking appropriate measures and also to accept other health programmes such as family planning.

(iii) Intensify check-ups on public health conditions in restaurants, market centres and in individual homes by Public Health Officers.

(c) Improve on the methods of procurement, distribution and control of drugs and pesticides to ensure that provision of health services are not interrupted on ground of lack of drugs.

(3) Medical research should be done on why many deaths resulting from health diseases and cerebrovascular diseases occur in Siaya District.

(4) Quality of health statistics and vital registration data for Siaya and for all other districts in Kenya should be improved in terms of coverage and other errors. Tabulations of these data should be made available at locational level to allow analysis of causes of illness and death for each district in Kenya at locational level.

APPENDIX I

TECHNICAL NOTES

(1) BRASS METHOD FOR ESTIMATION OF INFANT AND CHILD MORTALITY

This method converts the proportion of dead children born to women in particular age groups, which essentially is the women's total experience, into life table probabilities ($_xq_o$ valves). The method works under four assumptions. One, that age specific schedule of fertility is known and has been constant in the recent past. Two, that infant and child mortality rates are known to have been constant in the recent past. Three, that omission rates on the number of dead and surviving children are about the same for the recorded births and lastly, that there is no correlation between deaths of children and maternal survival (Brass et al., 1968).

The data required to use the method are:

(a) Number of women in five year-age groups (W_i), i = 1, 2, 3,----7

where W_1 corresponds to women in age group 15-19

W_2 corresponds to women in age group 20-24

W_7 " " " " " " 45-49

(b) Children ever born by the women in five year age groups (C_i).

(c) Births (12 months prior to the interview) by women in five year age groups (B_i).

(d) Average parity $\left(P_i = \frac{C_i}{W_i}\right)$.

(e) Observed fertility rate $\left(f_i = \frac{B_i}{W_i}\right)$.

(f) Proportion of the children surviving (S_i) belonging to women of five year age groups.

(g) Multiplying factor (K_i) obtained from the table based on the values of P_1/P_2, and $\bar{m}$ (mean age of the fertility distribution).

Therefore the life table probabilities ($_xq_o$) are obtained by the following equation

$$_xq_o = (1 - S_i)\, K_i \quad , \quad i = 1, 2, 3, \text{----}7$$

$$x = 1, 2, 3, 10, 15, 20.$$

(2) SULLIVAN'S METHOD FOR ESTIMATION OF CHILD MORTALITY

This method is essentially based on the same concepts as the Brass method, but utilizes

regression coefficients as the basis for obtaining multipliers (Sullivan, 1972). Life table probabilities are obtained by the following equation

$$ {}_xq_o = [A + B\ (P_2/P_3)][1 - S_i] \quad x = 2, 3, 5 \quad ,i = 2, 3, 4 $$

where

S_i is the number of children surviving for women in the five year age groups.

P_i is the average number of children ever born to women in the five year age groups

A and B are constants which are obtained from the regression coefficients provided in the table.

(3) BRASS AND HILL METHOD FOR ESTIMATION OF ADULT MORTALITY AND CONSTRUCTION OF COMPLETE LIFE TABLES

In estimation of adult mortality, this method utilizes orphanhood data and information pertaining to the shape of the age and fertility distribution patterns which determine the age of parents at the time of the birth of the children. The life table probabilities are obtained by the following equations

$$ \frac{l_{B+N}}{l_B} = (W_N \cdot {}_5P_{N-5}) + (1 - W_N)\ {}_5P_N \text{ for females} $$

and

$$\frac{l_{B+N+2.5}}{l_B} = (W_N \cdot {}_5P_{N-5}) + (1 - W_N)\ {}_5P_N \text{ for males}$$

where

${}_5P_N$ and ${}_5P_{N-5}$ are the proportions of respondents aged (5 to N+5) and N-5 to N) years respectively.

B is the convenient base age generally chosen as being close to the mean age of the parents at the time of birth of their children. Normally B is taken as 25 for females and 35 for males.

W_N is an appropriate multiplying factor obtained from the tables developed by Brass.

N is taken as the mid point of the two adjucent age groups.

l_B, l_{B+N}, $l_{B+N+2.5}$ are the life table survivors at ages B, B+N and B+N+2.5 respectively.

Then the logit life-table system is used to patch child mortality with the adult mortality obtained from orphanhood data. The logit life-table system relates the life table survivors to age x, l_x, through its logit, $Y(x)$, to a standard logit $Y_s(x)$, chosen as a suitable general average or adjusted to incorporate any special local characteristics believed to hold, through the use of two coefficients α and β.

At any age x, $Y(x) = \alpha + \beta\, Y_s(x)$----(1). The α in this linear relationship can be fixed from measures of childhood mortality, for instance from a known value of l_2. $Y(2)$ becomes $\alpha + \beta\, Y_s(2)$ and eliminating α for subsequent age groups gives

$$\hat{\beta} = \frac{Y(x) - Y(2)}{Y_s(x) - Y_2(2)} \quad \text{----- (2).}$$

The value of β may be obtained from the adult survivorship ratios, and the whole model life table be thus defined.

Estimation of the actual value of β from survivorship ratios is essentially a trial and error process. First, a value of l_{25} or l_{35} is obtained from a single parametre model life table having roughly the correct child mortality l_2. l_{25+N} and thus Y_{25+N} is then calculated from equation logit $l_x = Y(x) = \frac{1}{2} \log_e [1 - l_x)/l_x]$.

Values of β are calculated from equation (2) above and the standard life table values. The first estimate of β is then taken as an average over a range of estimates based on the reports from the most reliable groups of respondents (aged 20-45 years). From the first

estimate of β, a new value of l_{25} or l_{35} is calculated and the whole procedure is repeated to give a second estimate of β. The second estimate is sufficiently accurate for most purposes.

(4) BRASS' "GROWTH BALANCE METHOD"

Model life tables can be developed from vital registration data on deaths using this method. The basic data required are the Age-specific Death Rates and population age distribution. The method assumes no migration hence is based on the equation

$$R = B - D \text{ ----- (1)}$$

where R is the Growth Rate

B is the Birth Rate

D is the Death Rate.

Taking age group 30+ for illustration, $R_{30+} = B_{30+} - D_{30+}$. The death rate for the population aged 30+ can be estimated by summing up all the deaths belonging to the population in that age group and dividing by the total population in the age group

$$\text{Thus } D_{30+} = \frac{\Sigma \text{ deaths for pop. aged 30+}}{\Sigma \text{Population aged 30+}}$$

Birth rate for the population aged 30+ is estimated indirectly by dividing the new additions to the population aged 30-34 by the population aged 30+. It is important to note that these new additions will come from the population just about to enter age 30 (age group 25-29). The new additions is approximated by the equation

$$ {}_5B_{30} = \frac{\text{Pop (25-29)} + \text{Pop (30-34)}}{10} $$

and thus $\hat{B}_{30+} = \frac{{}_5B_{30}}{P_{30+}}$

Since we actually do not know D_{X+} because of under or over reporting, we need to establish the degree of completeness of the vital registration (c). The estimated Death Rate is therefore adjusted using the factor $\frac{1}{c}$ hence $D_{X+} = \frac{1}{c} \hat{D}_{X+}$.

Equation (1) can then be approximated by $\hat{B}_{X+} = R_{X+} + \frac{1}{c} \hat{D}_{X+}$ -------- (2)

$\frac{1}{c}$ can be found using regression analysis treating $\hat{B}_{X+}$ as dependent variable, $\hat{D}_{X+}$ as independent variable, R_{X+} and $\frac{1}{c}$ as coefficients.

The adjustment factor obtained is then used to adjust the reported mortality rates, ${}_5M_X$, from the vital registration data. The adjusted ${}_5M_X$ are then used to develop complete life tables using l5 obtained by Brass method.

APPENDIX II

TABLE 1: COMPLETENESS OF 1977 FEMALE VITAL REGISTRATION DATA ON DEATHS RELATIVE TO 1979 POPULATION CENSUS DATA FOR SIAYA

AGE x	$_5P_x$	$_5B_x$ $\frac{_5P_x + {}_5P_{x+5}}{10}$	$_5D_x$	$\sum_{y=x}^{\infty} {}_5D_y$	$\sum_{y=x}^{\infty} {}_5P_y$	$\hat{D}x+$ Column 5 / Column 6	$\hat{B}x+$ $\frac{_5D_x}{Px+}$
0	41024	-	1484	2556	258587	-	-
5	37283	7830.7	140	1076	217563	0.0049	0.0360
10	32469	6975.2	41	932	180280	0.0052	0.0387
15	26802	5927.1	33	891	147811	0.0060	0.0401
20	19244	4604.6	31	858	121009	0.0071	0.0381
25	16972	3621.6	21	827	101765	0.0081	0.0356
30	14468	3144.0	26	806	84793	0.0095	0.0371
35	12536	2700.4	31	780	70325	0.0109	0.0384
40	13209	2574.5	34	749	57789	0.0129	0.0446
45	12675	2588.4	63	715	44580	0.0160	0.0581
50	9669	2234.4	69	652	31905	0.0204	0.0700
55	7273	1694.2	62	583	22236	0.0262	0.0762
60	5953	1322.6	109	521	14963	0.0348	0.0884
65	4173	1012.6	90	412	9010	0.0457	0.1124
70+	4837	-	322	322	4837	-	-

From the table,

$\Sigma \hat{B}x+ = 0.714$, , $\Sigma \hat{D}x+ . \hat{B}x+ = 0.015$

$\Sigma \hat{D}x+ = 0.208$, $\Sigma \hat{D}^2x+ = 0.005$

Therefore using normal equations,

$0.714 = 13\alpha + 0.208\beta$ ..... (i)
$0.015 = 0.208\alpha + 0.005\beta$ ..... (ii)

Solutions are:

$\alpha = R = 2.1\%$ which is the growth rate

$\beta = \frac{1}{c}$ 1 2.126 implying that c = 47 per cent thus the completeness of female vital registration data relative to census data was 47 per cent.

TABLE 2: COMPLETENESS OF 1977 MALE VITAL REGISTRATION DATA ON DEATHS RELATIVE TO 1979 POPULATION DATA FOR SIAYA

AGE x	$5P_x$	$5B_x$ $\frac{5P_x + 5P_{x+5}}{10}$	$5D_x$	$\sum_{y=x}^{\infty} 5D_y$	$Px+$ $\sum_{y=x}^{\infty} 5P_y$	$\hat{D}x+$ Column 5 / Column 6	$\hat{B}x+$ $\frac{5B_x}{Px+}$
0	40814	-	1697	2952	214856	-	-
5	37164	7797.8	137	1255	174042	0.0072	0.0448
10	34331	7149.5	49	1118	136878	0.0082	0.0522
15	25057	5938.8	38	1069	102547	0.0104	0.0579
20	11735	3679.2	27	1031	77490	0.0133	0.0475
25	8865	2060.0	30	1004	65755	0.0153	0.0313
30	7868	1673.3	32	974	56890	0.0171	0.0294
35	5939	1380.7	37	942	49022	0.0192	0.0282
40	5736	1267.5	46	905	43083	0.0210	0.0294
45	6859	1359.5	59	859	36347	0.0236	0.0374
50	6685	1354.4	61	800	29488	0.0271	0.0459
55	5763	1244.8	78	739	22803	0.0324	0.0546
60	5363	1113.1	106	661	17040	0.0388	0.0653
65	5319	1068.7	134	555	11672	0.0475	0.0916
70+	6353	-	421	421	6353	-	-

From the table,

$\Sigma \hat{B}x+ = 0.616$ $\quad\quad$ $\Sigma \hat{D}x+ . \hat{B}x+ = 0.015$

$\Sigma \hat{D}x+ = 0.281$ $\quad\quad$ $\Sigma \hat{D}^2x+ = 0.008$

Using the normal equations

$0.616 = 1.3\alpha + 0.281\beta$ ..... (i)

$0.015 = 0.281\alpha + 0.008\beta$ ..... (ii)

Solutions are:-

$\alpha = R = 2.8\%$

$\beta = \frac{1}{c} = 0.891$ $\quad\quad$ $c = 112.2\%$

Therefore there was over-registration of vital registration data for males relative to census data.

TABLE 3: THE COMPOSITION OF 1979 IN-PATIENT DATA FOR SIAYA BY BROAD AGE GROUP AND BY CAUSE OF ADMISSION

CAUSE OF ADMISSION	AGE GROUP IN YEARS													
	UNDER 1	1-4	5-9	10-14	15-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	NS	TOTAL
Rickettsiosis and other arthropod-borne diseases	254	342	103	145	518	249	78	63	32	24	3	1	7	1539
Viral diseases	251	578	169	84	60	75	53	28	25	25	11	1	7	1471
Intestinal infectious diseases	420	287	41	25	36	53	54	28	24	25	3	-	1	1041
Signs, Symptoms and other ill-defined	65	68	16	39	132	166	57	31	21	25	2	1	6	629
Anaemia	104	126	51	21	29	61	47	16	21	8	2	-	2	504
Direct obsteric causes	-	-	1	2	106	180	79	21	-	-	-	-	2	391
Other bacterial diseases	40	181	23	7	2	7	24	9	9	3	-	-	1	306
SUB-TOTAL	1247	1582	404	325	703	791	383	207	132	110	21	3	26	5854
All other causes	209	306	122	140	1496	2329	816	226	152	107	21	3	23	5960
GRAND TOTAL	1456	1888	526	473	2121	3120	1199	433	284	217	42	6	49	11814

TABLE 4: OCCURENCE OF ACUTE RESPIRATORY INFECTIONS IN 1980 BY DIVISION IN SIAYA AND BY MONTH

MONTH	ADMINISTRATIVE DIVISION				SIAYA DISTRICT
	UKWALA	BORO	BONDO	YALA	
JANUARY	3318	2065	2610	3066	11059
FEBRUARY	3912	2401	2700	2310	11323
MARCH	3030	2170	2268	2177	9645
APRIL	2148	1029	1701	1904	6782
MAY	1530	1505	1953	2380	7368
JUNE	5668	1757	3168	2107	12720
JULY	3942	2387	3087	3073	12489
AUGUST	2364	2205	1944	2758	9271
SEPTEMBER	2628	1736	1494	2415	8273
OCTOBER	2574	2758	2160	2604	10096
NOVEMBER	2058	2226	1899	2884	9067
DECEMBER	1914	2093	1395	1631	7033
TOTAL	35106	24332	26379	29309	115126

Table 5: OCCURRENCE OF DIARRHOEAL DISEASES IN 1980 BY DIVISION IN SILVA AND BY MONTH

MONTH	ADMINISTRATIVE DIVISION				SILVA DISTRICT
	UKWALA	BORO	BONDO	YALA	
[illegible]RY	1638	1407	1584	1428	6057
[illegible]ARY	1776	1743	2142	2247	7908
[illegible]	1656	1456	1773	1743	6628
[illegible]	1212	966	1332	1463	4973
[illegible]	1614	1610	1467	1890	6581
[illegible]	1644	2128	2070	1855	7697
[illegible]	1782	1897	1296	2310	7285
[illegible]	1152	1673	747	1792	5364
[illegible]BER	1248	1204	972	2023	5447
[illegible]ER	1176	1953	666	2100	5895
[illegible]ER	1386	1869	585	1925	5765
[illegible]ER	1302	1673	567	1624	5166
TOTAL	17586	19579	15201	22400	74766

TABLE 6: OCCURENCE OF INTESTINAL WORMS IN 1980 BY DIVISION IN SIAYA AND BY MONTH

MONTH	ADMINISTRATIVE DIVISION				SIAYA DISTRICT
	UKWALA	BORO	BONDO	YALA	
JANUARY	1788	868	1143	1428	5227
FEBRUARY	1422	924	1188	973	4507
MARCH	1710	917	1044	2289	5960
APRIL	1332	707	837	1106	3982
MAY	1722	1043	1161	868	4794
JUNE	1794	1456	1800	1547	6597
JULY	1926	1806	1728	2149	7609
AUGUST	1326	1547	810	1925	5608
SEPTEMBER	1968	1358	1089	2121	6536
OCTOBER	1956	2023	945	1736	6660
NOVEMBER	2004	1687	1062	1624	6377
DECEMBER	1314	1624	576	1743	5277
TOTAL	20262	15960	13383	19509	69114

TABLE 7: OCCURENCE OF DISEASES OF THE SKIN IN 1980 BY DIVISION IN SIAYA AND BY MONTH

MONTH	ADMINISTRATIVE DIVISION				SIAYA DISTRICT
	UKWALA	BORO	BONDO	YALA	
JANUARY	1302	770	1053	1596	4721
FEBRUARY	954	791	1107	1610	4462
MARCH	984	896	981	2016	4877
APRIL	780	658	603	1785	3826
MAY	750	826	1188	1736	4500
JUNE	768	1127	945	1365	4205
JULY	1068	980	918	1736	4702
AUGUST	564	791	648	1666	3669
SEPTEMPER	1068	560	585	1743	3956
OCTOBER	972	1071	576	1736	4355
NOVEMBER	1296	700	567	1778	4341
DECEMBER	870	476	504	1617	3467
TOTAL	11376	9646	9675	20384	51081

TABLE 8: REPORTED FEMALE DEATHS IN SIAYA BY AGE GROUP AND BY MAJOR CAUSE BASED ON 1977 VITAL REGISTRATION DATA

CAUSE OF DEATH	AGE GROUP IN YEARS																			
	<1 MONTH	UNDER 1 YR	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+	NS	TOTAL
Measles	3	111	187	27	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	332
Respiratory diseases	26	92	108	14	2	3	2	1	1	1	6	9	2	4	7	10	15	11	10	-	324
Cerebrovas-cular diseases	77	34	39	12	5	6	3	3	4	4	3	9	6	6	13	7	5	4	18	3	261
Diarrhoel diseases	11	59	68	16	4	5	-	3	3	4	2	5	9	7	15	10	15	11	6	-	253
Tuberculosis	1	16	29	8	8	2	3	1	2	7	5	16	20	11	23	21	20	16	28	-	237
Heart diseases	6	15	49	8	4	2	4	2	4	2	6	7	8	11	21	17	21	12	36	-	235
Meningitis	16	49	69	15	4	2	3	1	3	5	2	4	5	6	7	5	6	6	11	-	219
SUB-TOTAL	140	376	549	100	29	20	15	11	17	23	24	50	51	45	86	70	82	60	109	4	1861
Other causes	93	125	201	40	13	13	16	10	9	8	10	13	18	17	23	20	19	18	34	44	774
GRAND TOTAL	233	501	750	140	42	33	31	21	26	31	34	63	68	62	109	90	101	78	143	49	2605

TABLE 9: REPORTED MALE DEATHS IN SIAYA BY AGE GROUP AND BY MAJOR CAUSE BASED ON 1977 VITAL REGISTRATION DATA

CAUSE OF DEATH	AGE GROUP IN YEARS																			
	UNDER 1 MONTH	UNDER 1 YR	1-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+	NS	TOTAL
Measles	5	126	204	16	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	356
Cerebro-vascular diseases	94	39	72	20	4	5	2	1	4	3	5	5	11	4	11	10	11	11	11	6	329
Respiratory diseases	15	86	96	10	5	1	5	-	1	3	1	3	3	4	8	13	11	10	18	1	294
Diarrhoel diseases	7	92	105	12	3	4	2	1	2	-	3	3	1	11	6	9	11	2	16	-	290
Heart diseases	5	30	45	13	3	4	4	7	4	6	8	10	9	17	20	17	20	20	43	-	290
Tuberculosis	1	20	34	7	2	4	2	2	3	10	4	14	10	10	28	30	28	15	51	-	275
Meningitis	23	49	70	17	10	7	3	1	1	2	3	1	5	9	2	15	6	8	11	1	244
SUB-TOTAL	150	442	626	100	31	25	18	12	15	24	24	36	39	55	75	94	87	66	150	9	2078
All other Causes	115	152	218	37	18	13	9	18	17	13	22	23	22	23	31	40	46	20	52	65	948
GRAND TOTAL	265	594	844	137	49	38	27	30	32	37	46	59	61	78	106	134	133	86	202	74	3026

TABLE 10: LIFE TABLES FOR SIAYA BY BRASS GROWTH BALANCE METHOD - MEASLES, TUBERCULOSIS, RESPIRATORY AND MENINGITIS DISEASES HYPOTHETICALLY ELIMINATED

A -- FEMALE

AGE x	ADJUSTED $_5M_x$	$_5q_x$	$_5p_x$	l_x	$_nL_x$	T_x	e_x
0	-	-	-	1000	4680.0	60785.4	60.8
5	0.0043	0.0213	0.9787	872	4312.5	56105.4	
10	0.0017	0.0085	0.9915	853	4247.5	51792.9	
15	0.0021	0.0104	0.9896	846	4207.5	47545.4	
20	0.0026	0.0129	0.9871	837	4157.5	43337.9	
25	0.0023	0.0114	0.9886	826	4107.5	39180.4	
30	0.0030	0.0149	0.9851	817	4055.0	35072.9	
35	0.0030	0.0149	0.9851	805	3995.0	31017.9	
40	0.0034	0.0169	0.9831	793	3932.5	27022.9	
45	0.0057	0.0283	0.9717	780	3845.0	23090.4	
50	0.0089	0.0435	0.9565	758	3707.5	19245.4	
55	0.0119	0.0578	0.9422	725	3520.0	15537.9	
60	0.0257	0.1207	0.8793	683	3210.0	12017.9	
65	0.0274	0.1282	0.8718	601	2812.5	8807.9	
70+	0.0874	0.3586	0.6414	524	5995.4	5995.4	

B - MALE

AGE x	ADJUSTED $_5M_x$	$_5q_x$	$_5p_x$	ℓ_x	$_nL_x$	T_x	e_x
0	-	-	-	1000	4605.0	55985.3	56.0
5	0.0046	0.0023	0.9977	842	4205.0	51380.3	
10	0.0016	0.0080	0.9920	840	4182.5	47175.3	
15	0.0020	0.0100	0.9900	833	4145.0	42992.8	
20	0.0028	0.0139	0.9861	825	4097.5	38847.8	
25	0.0060	0.0296	0.9704	814	4010.0	34750.3	
30	0.0068	0.0334	0.9666	790	3885.0	30740.3	
35	0.0074	0.364	0.9637	764	3750.0	26855.3	
40	0.0112	0.0545	0.9455	736	3580.0	23105.3	
45	0.0120	0.0583	0.9417	696	3377.5	19525.3	
50	0.0128	0.0620	0.9380	655	3172.5	16147.8	
55	0.0190	0.0907	0.9093	614	2930.0	12975.3	
60	0.0254	0.1194	0.8806	558	2622.5	10045.3	
65	0.0286	0.1335	0.8665	491	2290.0	7422.8	
70+	0.0828	0.3430	0.6570	425	5132.8	5132.8	

[illegible] 11: LIFE TABLES FOR SIAYA BY BRASS GROWTH BALANCE METHOD -- DIARRHOEAL DISEASES HYPOTHETICALLY ELIMINATED

[illegible] FEMALE

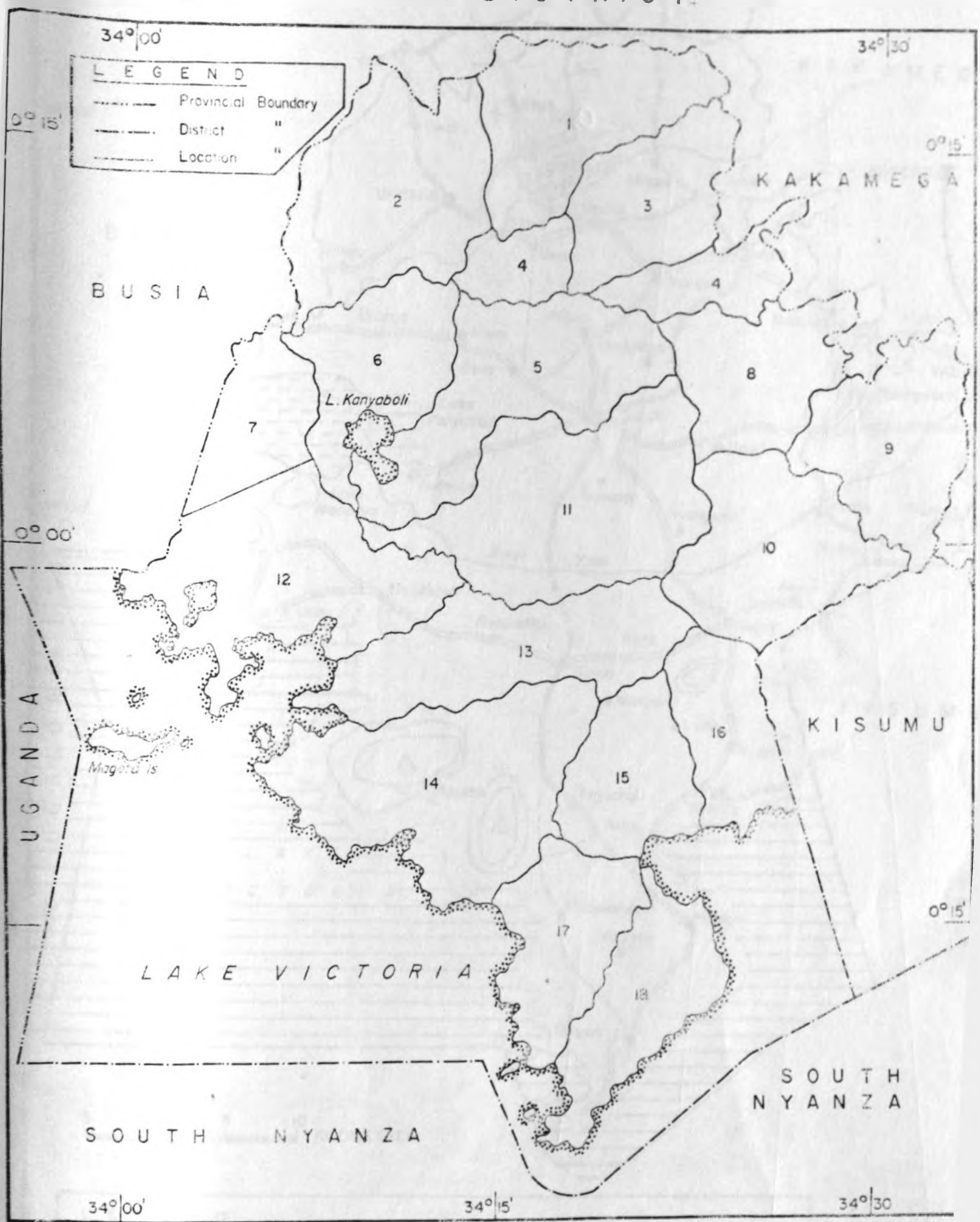
[illegible] x	ADJUSTED $5M_x$	$5q_x$	$5p_x$	ℓ_x	$5L_x$	T_x	e_x
0	-	-	-	1000	4445.0	50082.3	50.1
5	0.0070	0.0344	0.9656	778	3822.5	45637.3	
[illegible]	0.0026	0.0129	0.9871	751	3730.0	41814.8	
15	0.0021	0.0104	0.9896	741	3685.0	38084.8	
[illegible]	0.0034	0.0169	0.9831	733	3635.0	34399.8	
25	0.0023	0.0114	0.9886	721	3585.0	30764.8	
30	0.0034	0.0169	0.9831	713	3535.0	27179.8	
[illegible]	0 0047	0.0232	0.9768	701	3465.0	23644.8	
40	0.0051	0.0252	0.9748	685	3382.5	20179.8	
45	0.0098	0.0478	0.9522	668	3260.0	16797.3	
50	0.0132	0.0639	0.9361	636	3077.5	13537.3	
55	0.0162	0.0778	0.9222	595	2860.0	10459.8	
60	0.0336	0.1550	0.8450	549	2532.5	5067.3	
65	0.0408	0.1851	0.8149	464	2105.0	5067.3	
70+	0.1276	-	-	378	2962.3	2962.3	

B - MALES

AGE x	ADJUSTED $5M_x$	$5q_x$	$5p_x$	ℓ_x	$5L_x$	T_x	e_x
0	-	-	-	1000	4390.0	45064.0	45.1
5	0.0068	0.0334	0.9666	756	3717.5	40674.0	
10	0.0026	0.0129	0.9871	731	3632.5	36957.1	
15	0.0028	0.0139	0.9861	722	3585.0	33324.6	
20	0.0042	0.0208	0.9792	712	3522.5	29739.6	
25	0.0066	0.0325	0.9675	697	3427.5	26217.1	
30	0.0076	0.0373	0.9627	674	3307.5	22789.6	
35	0.0124	0.0601	0.9399	649	3147.5	19482.1	
40	0.0128	0.0620	0.9380	610	2955.0	16334.6	
45	0.0164	0.0788	0.9212	572	2747.5	13379.6	
50	0.0180	0.0861	0.9139	527	2522.5	10632.1	
55	0.0232	0.1096	0.8904	482	2277.5	8109.6	
60	0.0372	0.1702	0.8298	429	1902.5	5832.1	
65	0.0470	0.2103	0.7897	356	1592.5	3869.6	
70+	0.1234	-	-	281	2277.1	2277.1	

FIGURE 1

SIAYA DISTRICT



LOCATIONS

1 EAST UGENYA	2 NORTH UGENYA	3 UHOLO	4 SOUTH UGENYA
5 CENTRAL ALEGO	6 WEST ALEGO	7 USONGA	8 NORTH GEM
9 EAST GEM	10 SOUTH GEM	11 EAST ALEGO	12 YIMBO
13 NORTH SAKWA	14 SOUTH SAKWA	15 WEST ASEMBO	16 EAST ASEMBO
	17 WEST UYOMA	18 EAST UYOMA	

Fig 2 MAJOR RELIEF FEATURES AND TRANSPORT

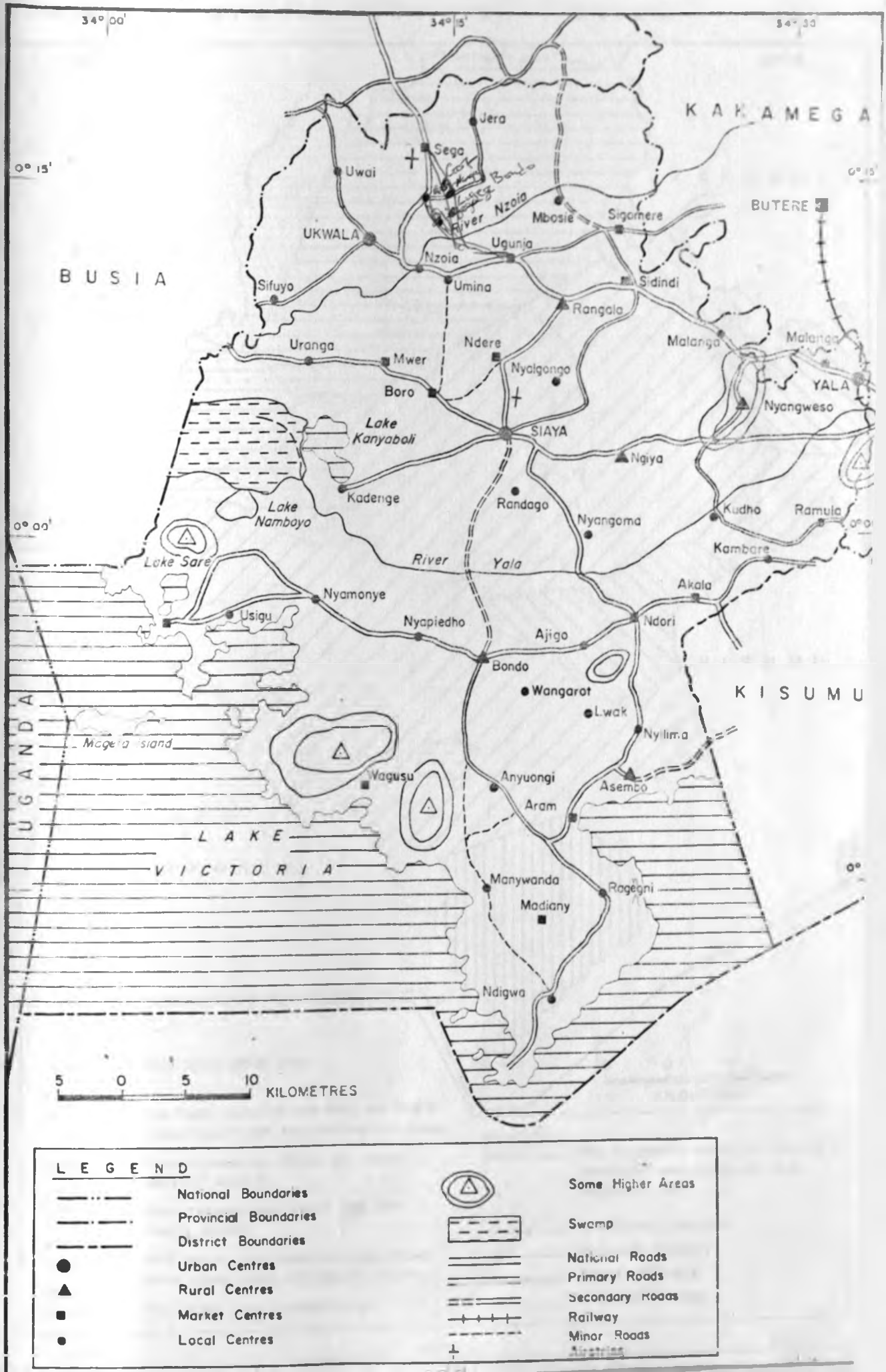


FIGURE 3 SIAYA DISTRICT : SOILS.

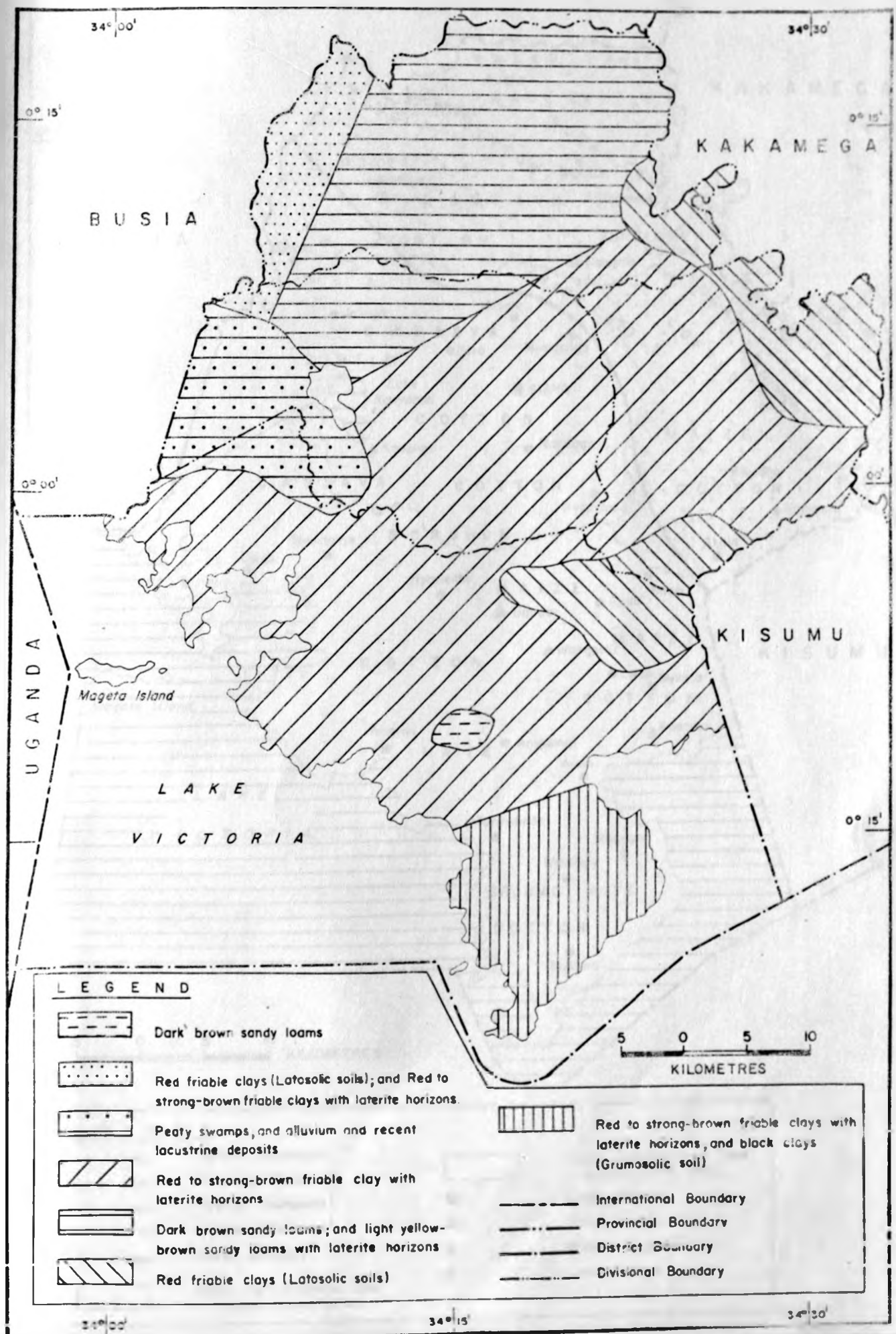


Fig 4 AGRO-ECONOMIC ZONES

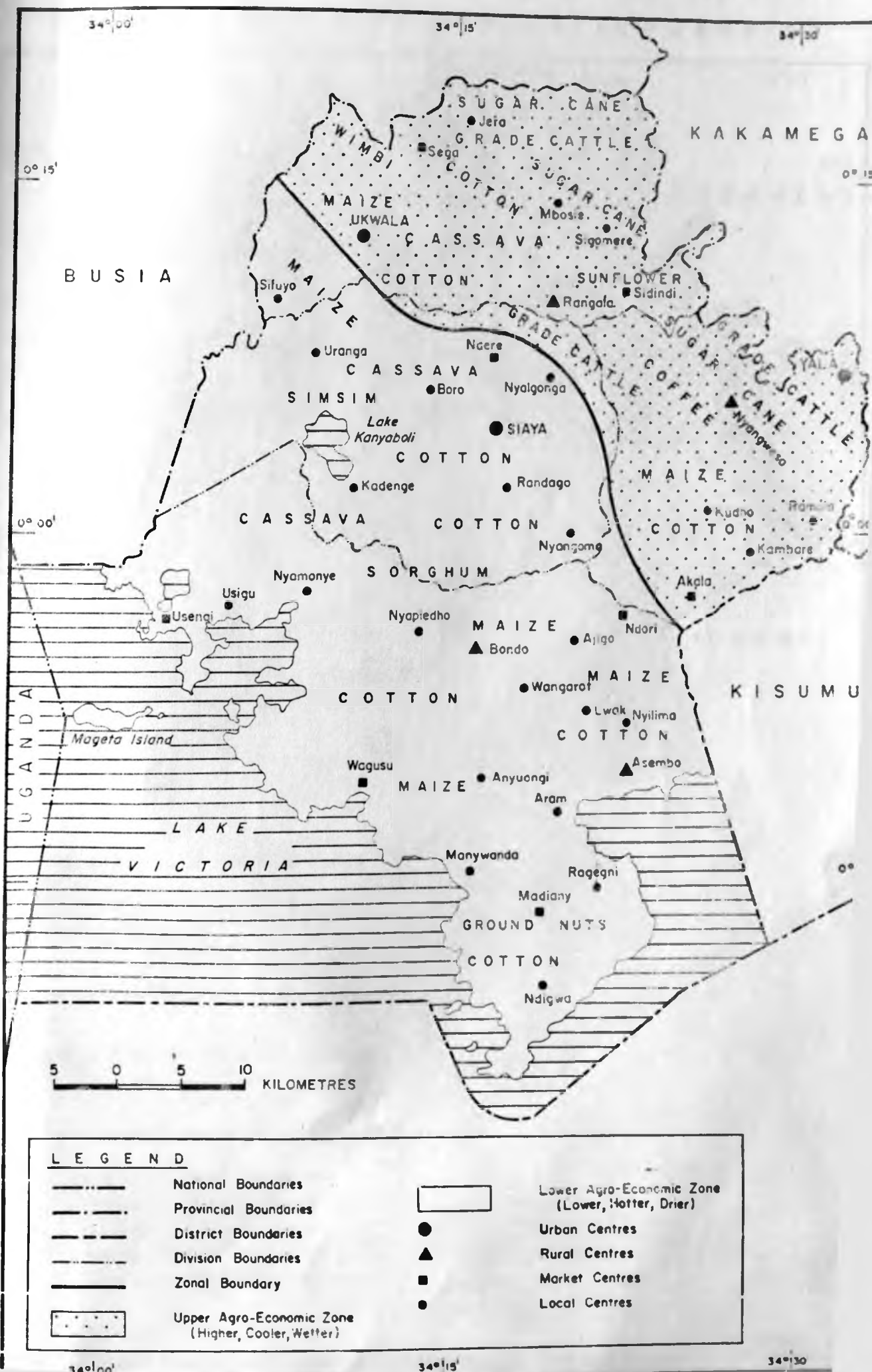
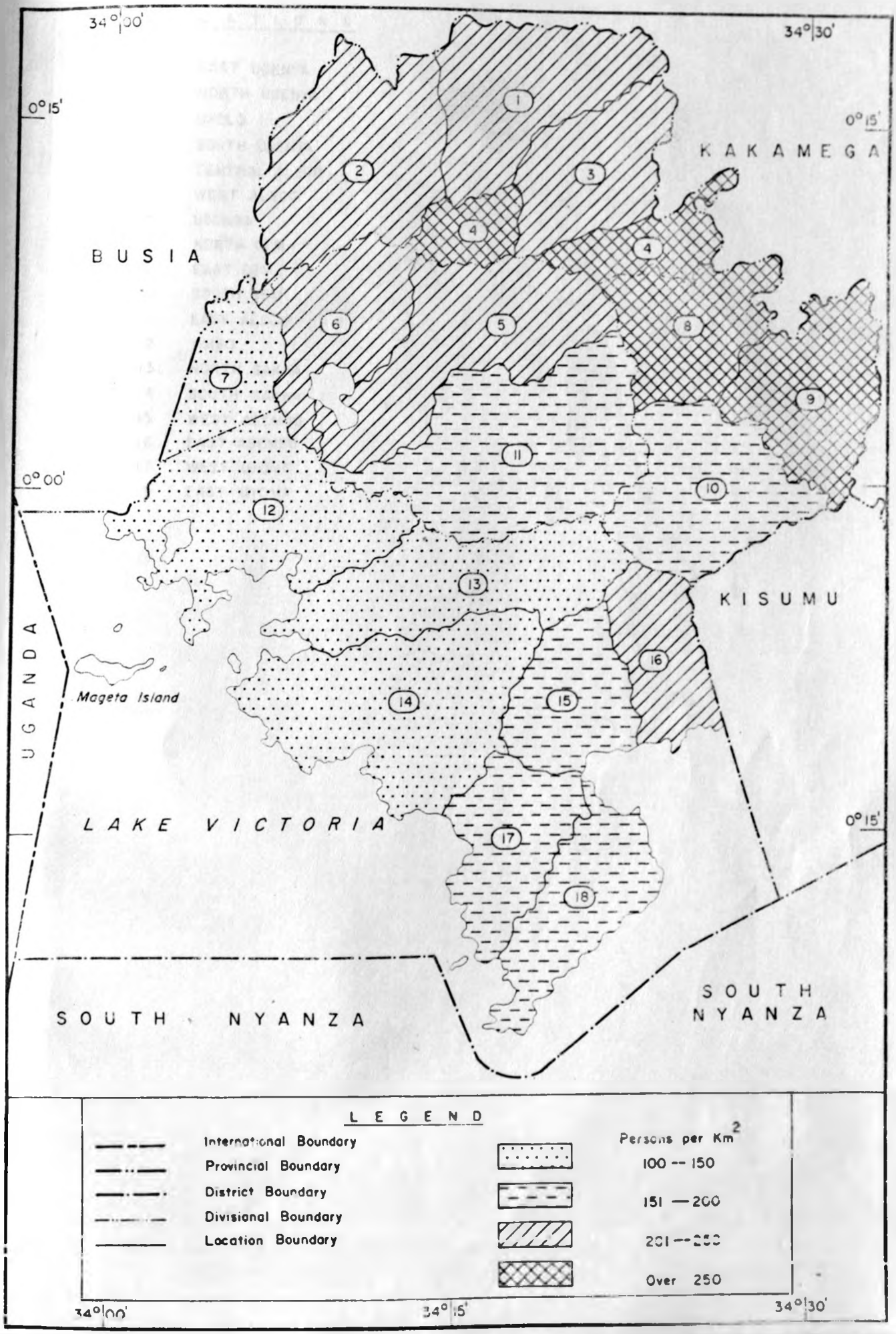


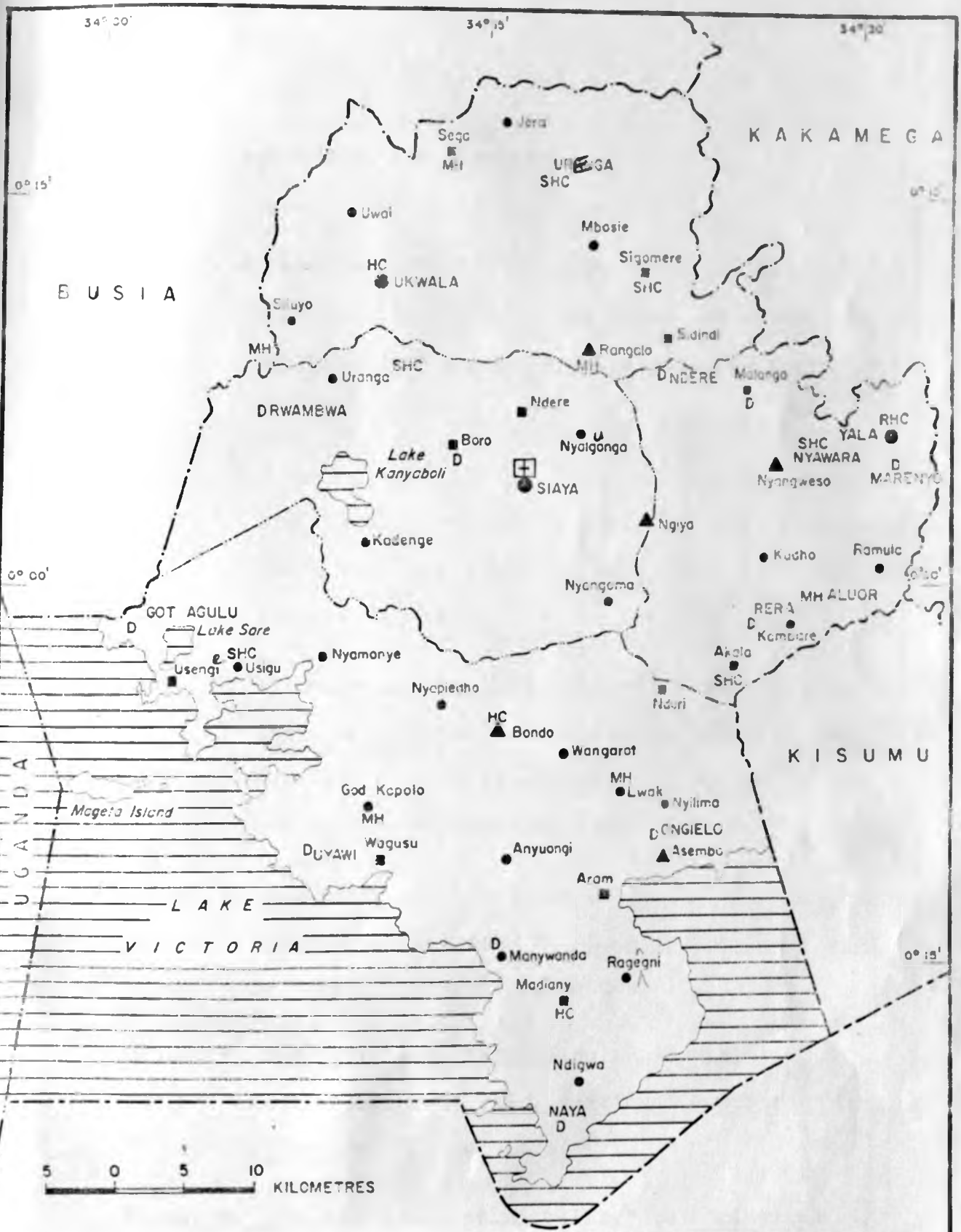
Fig 5 SIAYA DISTRICT: POPULATION DENSITY



L O C A T I O N S

1	EAST UGENYA
2	NORTH UGENYA
3	UHOLO
4	SOUTH UGENYA
5	CENTRAL ALEGO
6	WEST ALEGO
7	USONGA
8	NORTH GEM
9	EAST GEM
10	SOUTH GEM
11	EAST ALEGO
12	YIMBO
13	NORTH SAKWA
14	SOUTH SAKWA
15	WEST ASEMBO
16	EAST ASEMBO
17	WEST UYOMA
18	EAST UYOMA

Fig. 6 HEALTH UNITS



LEGEND

———	National Boundaries	●	Local Centres
——·——	Provincial Boundaries	⊞	Siaya District General Hospital
— — —	District Boundaries	MH	Mission Hospital
——··——	Division Boundaries	RMC	Rural Health Centre
◉	Urban Centres	HC	Health Centre
▲	Rural Centres	SHC	Sub-Health Centre
■	Market Centres	D	Dispensary

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