



# **murang'a**

## **DISTRICT ENVIRONMENTAL ASSESSMENT REPORT**

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Human Settlements Secretariat,  
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P.O. Box 67839  
Nairobi

in cooperation with Clark University  
and the United States Agency  
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In cooperation with:  
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## FOREWORD

This is the fifth in a series of District Environmental Assessment Reports, following the already published reports for Kajiado, Nyeri, Kisii and Kitui Districts. A report on Nakuru District is expected to be published early in 1983. Subsequent reports on Kilifi, Kisumu, Bungoma, Meru and Kirinyaga are in preparation.

This Environmental Assessment Report for Murang'a District is the result of a collaborative effort between the National Environment and Settlements Secretariat (NEHSS) of the Ministry of Environment and Natural Resources of the Government of Kenya, and the Programme for International Development Program of Clark University (USA). The project on District Environmental Assessment was initiated in 1978 with the principal objective of finding ways of incorporating environmental considerations into the process of district planning and decision-making. Funding has come from the Kenyan Government and the United States Agency for International Development. The project itself derives its motivation from a number of considerations, chief among them being:

- (i) that it is a facet of Government policy to bring environmental factors into the mainstream of Government policy-making in order to optimise the use of scarce resources for the overall national good.
- (ii) that the Government has recognised the district as the primary unit of planning in order to effectively bridge the gap between the grassroots and the higher policy-making levels. To this end, the Government has established district development committees to decentralise decision-making and policy administration.
- (iii) that the incorporation of environmental considerations at the planning stages of any project or programme would help avoid the costly correction of environmental degradation that would otherwise ensue. This makes clear the need to ensure the integration of development planning and environmental management objectives at the district level.

Thus this report, parallel to others in the series, is geared toward making a contribution to the implementation and future formulation of the District Development Plan for Murang'a District. Its aim is that the development of the district take place without destruction of the resource base upon which it depends so as to ensure a sustained and enhanced quality of life for the people of Murang'a. To this end, the report is complementary not only to others in the series but also to other parallel exercises being undertaken by the NEHSS at the provincial and national levels.

The basic framework of the project itself derives directly from the Guidelines for Environmental Management (GEM) developed by the NEHSS and tailored to meet the specific requirements of the district exercise. It is hoped therefore that the recommendations contained in this report, and as they will be refined by a seminar to be organised soon, will form a truly useful basis for the management of the environment of Murang'a District in the dynamic context of the development of the district.

I would like sincerely to thank all those persons who made contributions to the success of this exercise including the following: the District political leadership whose enthusiasm boosted the morale of our researchers; the District Heads of Departments and Ministries who accorded unqualified cooperation and assistance to the researchers; the people of Murang'a District who provided insights which helped to attune the report to the realities of the district; and finally, the multi-disciplinary NEHSS research team whose contributions helped make this report possible. The NEHSS team who carried out the research and preparation of this report include:

Mr. M. Wanga (Agricultural Project Secretary)  
Mr. N. Muttunga (Economist/Statistician)  
Miss N. Mwendar (Physical Planner)  
Miss S. Ngala (Research Assistant)  
Miss N. Njogu (Sociologist)

Mr. G. Ondenge (Agriculturalist)  
Miss L. Togo (Research Assistant)

In addition, Suzanne Kilner, Abe Goldman and Tom Downing offered valuable editorial assistance and advice.

It is my sincere hope that the work and the cooperative spirit shown by the above groups will be sustained during the more important phase of the implementation of the recommendations and findings contained in this report.

H. J. Nyamu  
Director  
National Environment and  
Human Settlements Secretariat

## CHAPTER I: INTRODUCTION

This report considers the relationship between environment and development in Murang'a District. The purpose of the report is to:

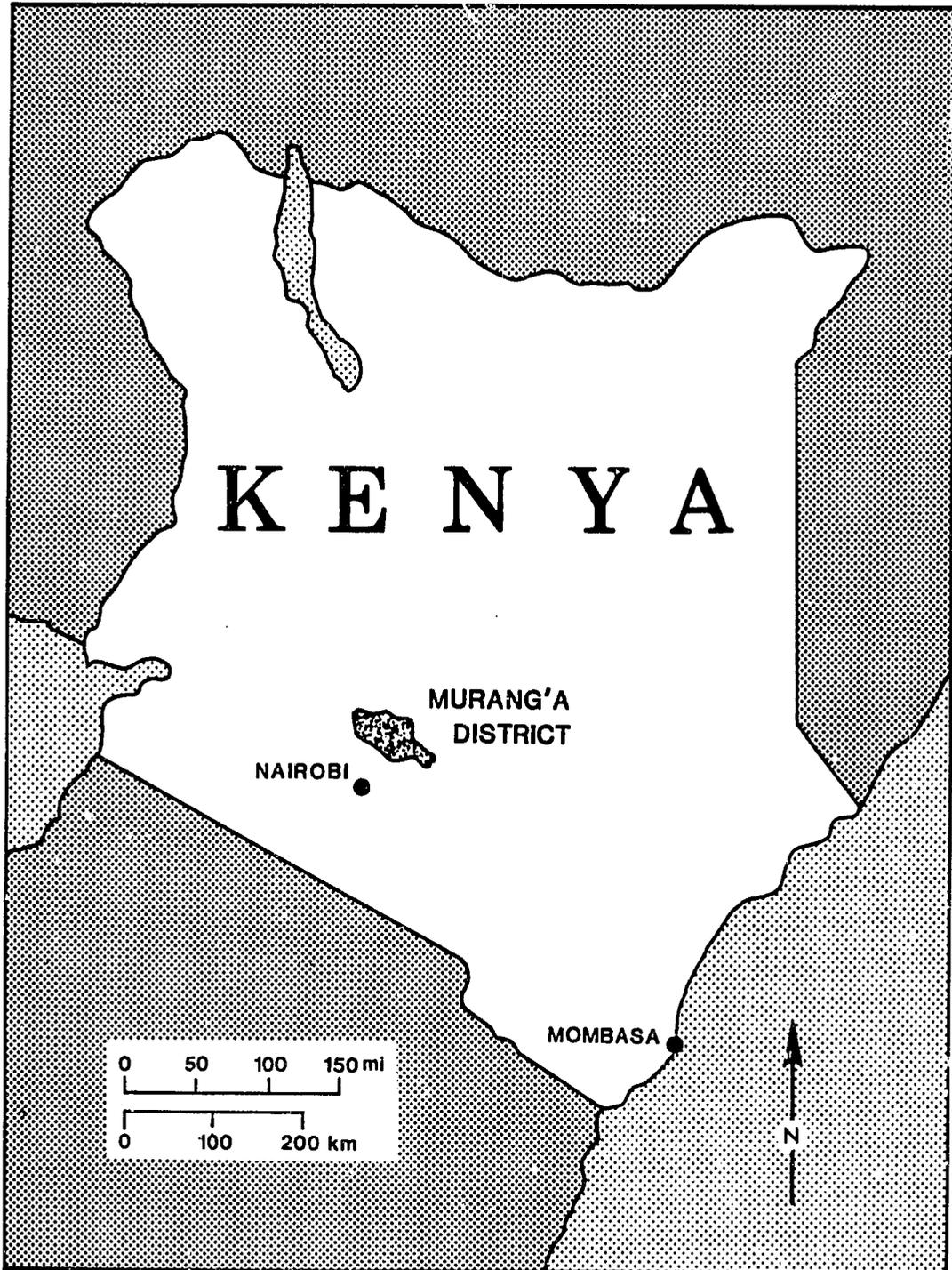
- i) Identify environmental consequences of development, and
- ii) Identify the potential environmental constraints on development.

Murang'a District, a high potential area in Central Province, suffers from environmental problems related to increasing population, accelerated land fragmentation, reduced production of food crops at the expense of cash crops, accelerated deforestation and increased rates of migration and urbanisation. All these trends have direct environmental consequences as available services become acutely overburdened, and resources in the district are depleted instead of being managed on a sustained yield basis.

The report concludes with suggestions and recommendations which note that there is need for greater devotion to the conservation and management of the natural resources, especially in minimising both soil erosion and deforestation. The report also urges improvement in services in order to match the current demand and at the same time develop systems for abating pollution in the district.

FIGURE 1

# LOCATION MAP



SOURCE: Survey of Kenya 1970.

## CHAPTER 2: PHYSICAL AND NATURAL ENVIRONMENT

### 2.1 TERRAIN

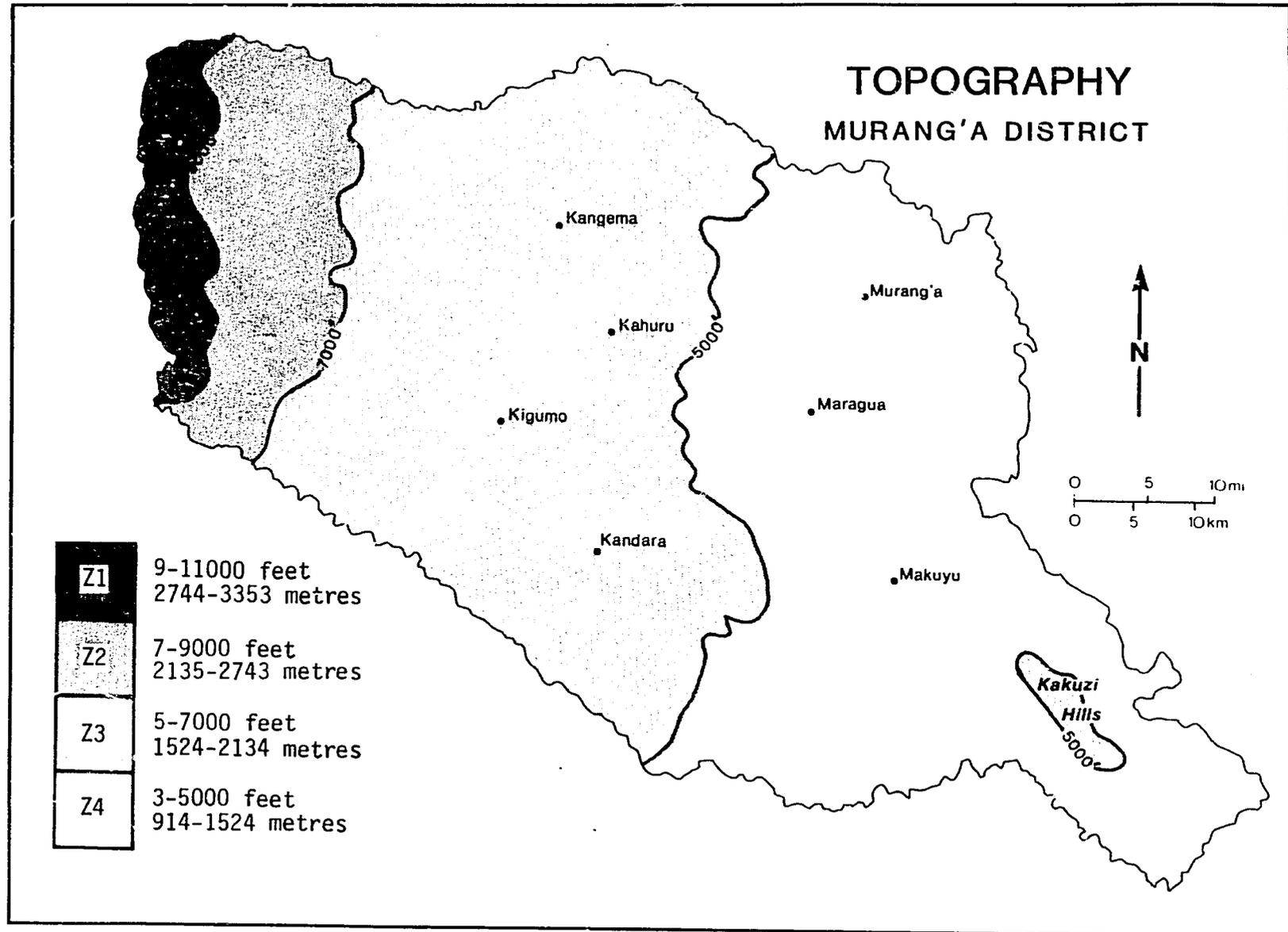
In Murang'a District, the land generally rises gradually from east to west, culminating in the slopes of the Aberdare ranges. The highest areas in the west have a deeply dissected topography and are drained by several rivers. Altitude of the district varies from about 914 m (3000 ft) to about 3353 m (11,000 ft). The topography of the lower eastern portion ranges from gently rolling to level land around the Kakuzi Hills.

Figures 2, 3, and 4 show the main physiographical features of the district. The area referred to as zone 1 in Figure 2 is the highest area (altitude 2743 - 3353 m) covering the upper reaches of the Aberdares. Most rivers draining the district originate in this region, in which mountains and major scarps are common features. The relief intensity is 300 metres or more and the slopes can be over 30% but are in places between 3 and 8%.

The area referred to as zone 2 forms part of the lower slopes of the Aberdares. Altitude is between 2134 and 2743 metres above sea level. This area is also mountainous with major scarps. Relief intensity is 300 metres or more, while the slopes are commonly over 30% but also range between 3 and 8% in some areas.

The area referred to as zone 3 cuts across major portions of Kangema, Kiharu, Kigumo and Kandara Divisions. Altitude is between 1524 m (5000 ft) and 2134 m (7000 ft) above sea level. This is the area of mountain foot ridges and it consists of dissected lower slopes of major older volcanoes

FIGURE 2



SOURCE: Survey of Kenya 1970.

and mountains with difference between high and low-lying areas of up to 100 m and slopes of up to 16%.

The area referred to as zone 4 represents the lower regions of the district. A major portion constitutes Makuyu Division, although minor portions of Kigumo and Kiharu Divisions are also included. Altitude is between 914 m (3000 ft) and 1524 m (5000 ft) above sea level. In this zone, although topography is generally level, there are variations in topographical features. These are better illustrated in Figure 5. The area designated Hb in Figure 5 is an erosional and depositional area of hills and minor scarps with relief difference between 100 and 300 m and slopes of between 8 and 30%. The areas Ln and Lv are plateaus with large flat areas bound by scarps. The difference between high and lowland areas is not more than 50 metres and slopes are commonly 0 to 8% but are occasionally between 8 and 16%.

The areas designated Hr in Figure 5 are the hilly areas of the lower zone. Represented in these areas are the Kakuzi Hills and a continuation of Ithanga Hills. The Kakuzi Hills rise to about 5,400 ft (1645 m) above sea level. These areas are occupied by hills and minor scarps. The relief difference is 100-300 metres, and the slopes are mainly between 8 and 30%. The areas are erosional and depositional.

The areas labelled Fa east of Makuyu and south of the Kakuzi foothills have a difference between high and low terrain of about 10 metres and slopes of between 2 and 8% while the areas designated Uf are upland areas with erosional land surfaces and with incised rivers (including dissected peneplains). In these areas relief difference is up to 50 metres while slopes are between 0 to 16%.

Figure 3 illustrates the drainage and vegetation of the district. Most of the rivers draining the district originate in the western side of the district occupied by the Aberdare ranges. Relatively high precipitation is retained as groundwater in the volcanics of the western side. Runoff is also stabilised and regularised by the forest vegetation in the elevated region so that most rivers are permanent. Seasonal rivers and streams are found only in the southeastern part of the district where the porous Basement System soils tend to drain freely. The whole district is well drained by the numerous rivers and streams which are a part of the Upper Tana drainage system. The main rivers are the Mathioya with its tributaries, the south and north Mathioya Rivers and Karichiungu River; the Maragua River with its tributaries, the Irati and Gathigie Rivers; the Saba Saba River; and the Thika River and its tributaries, the Ngenya, Kabuku, Githuru and Kimakia Rivers.

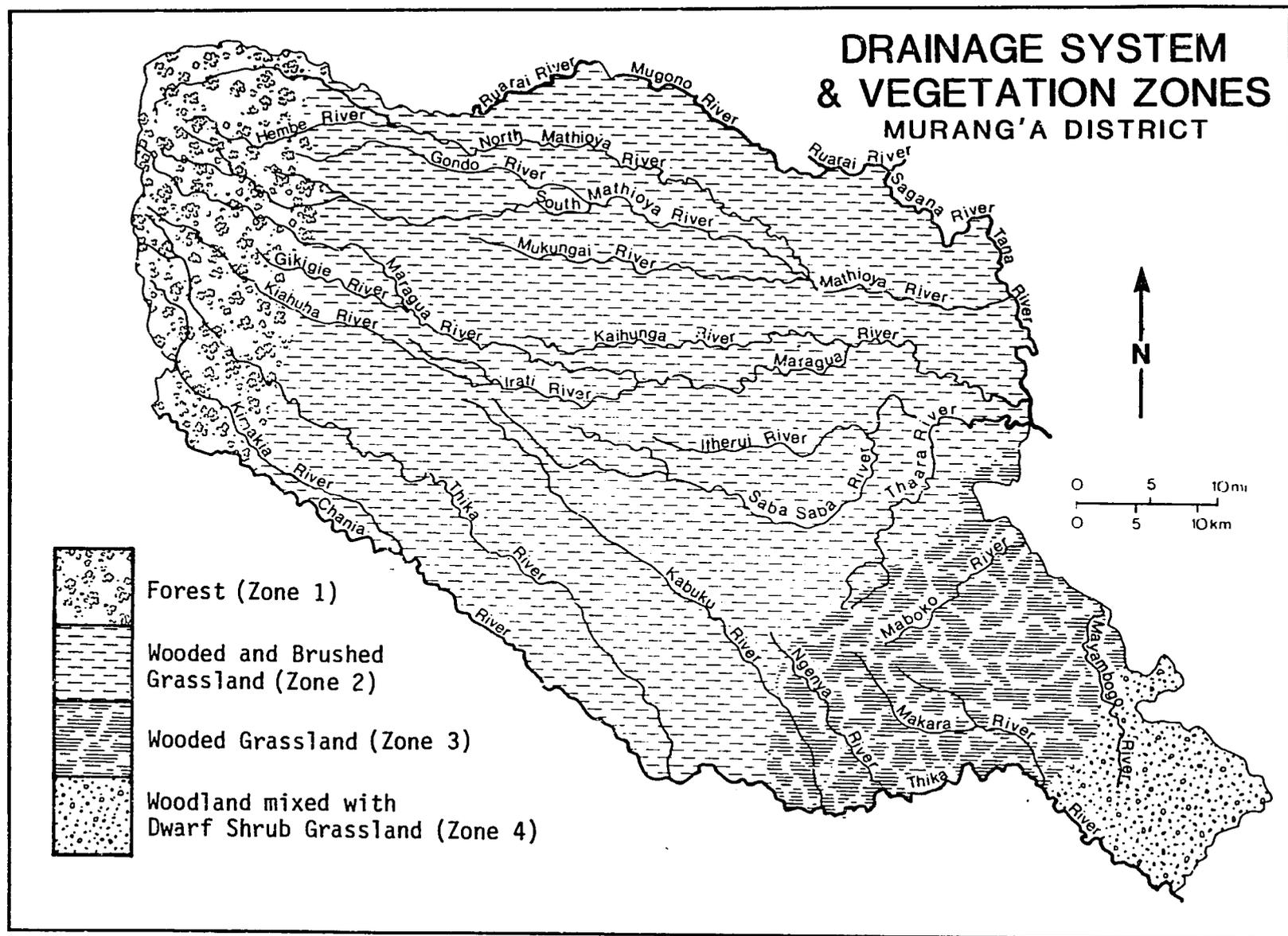
Small permanent springs are common in many of the higher valleys in the volcanic area where they are tapped by piped outlets. They are located along the nonconformity between the Basement System and overlying volcanic formations. Springs are less common in the Basement System except where aquifers are provided by overlying deposits of sand and gravel.

Due to the hilly nature of most of the district, soil erosion and earth movement are common features.

## 2.2 GEOLOGY

The geology of Murang'a District consists of volcanic rocks of Pleistocene to Recent and Tertiary eras and Basement System rocks of Archean type. No intrusive rocks are found in the district. The volcanic rocks occupy the

FIGURE 3



SOURCE: Kenya, Ministry of Finance and Economic Planning 1980c.

western part of the district bordering the Aberdares while the rock of the Basement System occupies the eastern portion of the district.

The volcanic accumulations originated from the Rift Valley and Mount Kenya; the earliest of them, the phonolites, flowed from the west during the Miocene period. These were subsequently covered by deposits of ash and basalt. Further extrusions of phonolite, trachyte and basalt originated from the Mount Kenya area during the Tertiary and Pleistocene periods. The Precambrian rocks of the Basement System including granitoid gneisses in the eastern side of the district have suffered advanced metamorphism.

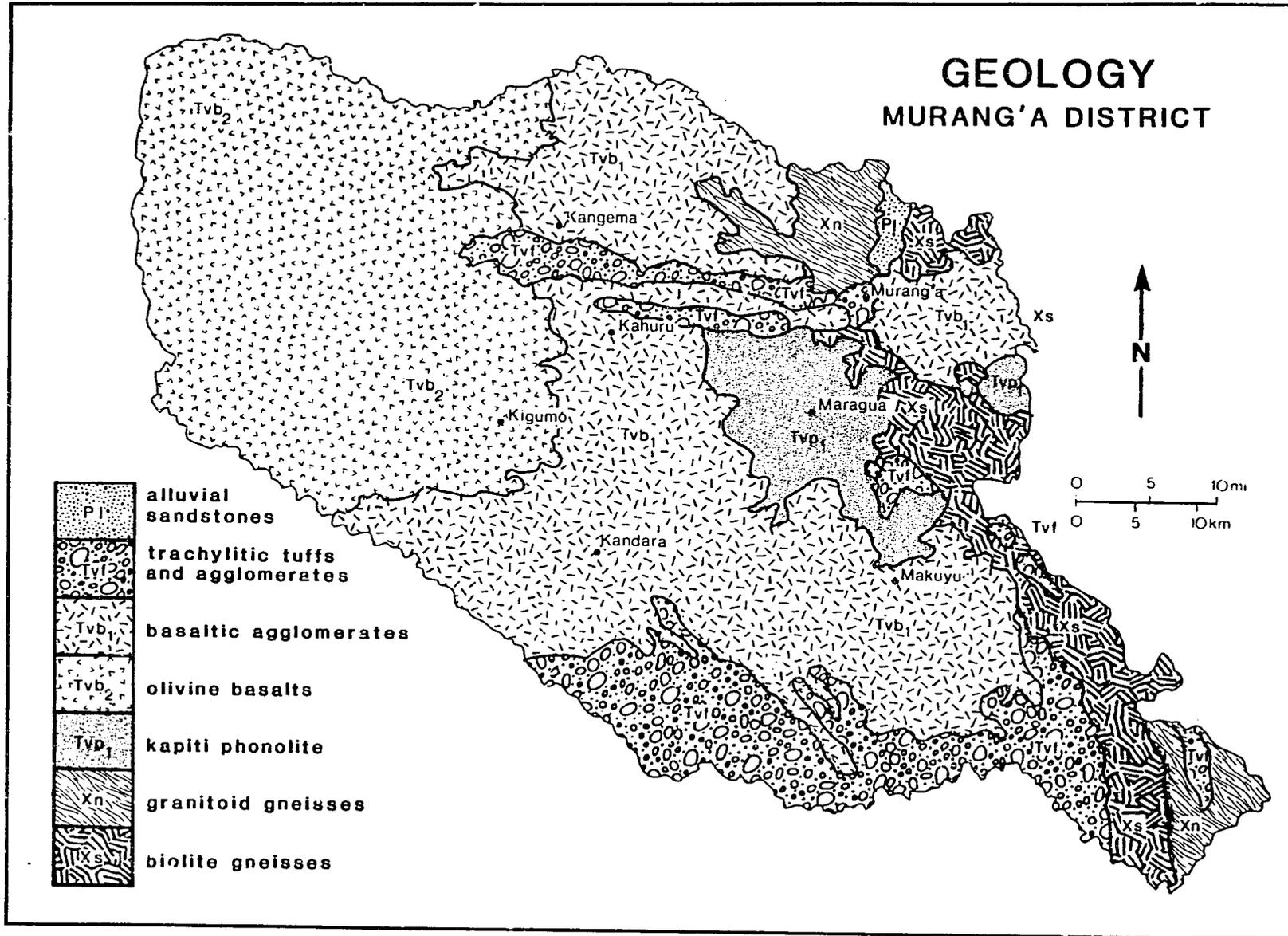
The main rock formations are described according to Figure 4 as follows:

Area designated P1: the area east of Kimathe centre and south of Sagana River to the northeast of Murang'a township. This area is underlain by alluvial sandstones overlying Thiba basalts and deposited during temporary damming of the Sagana drainage by the Thiba basalts.

Areas designated Tvf: trachytic tuffs and agglomerates underlying mainly the southern portion (Makuyu Division) of the district. They also occur in the area around Murang'a township and in pockets in the area east of Makuyu centre, between the Kakuzi and Ithanga Hills. The rocks belong to the Laikipian series and were formed during the Tertiary period. Commonly the tuffs overlie basalt agglomerates as is the case north of Thika and near Murang'a township but they also rest directly on the Basement System gneisses in the Kakuzi region. The rocks found in these areas include building stones.

Areas designated Tvb<sub>1</sub>: these areas are underlain by basaltic agglomerates. The rocks occupy substantial portions of Makuyu, Kangema, Kandara, Kigumo and Kiharu Divisions. In the Mathioya valleys, the rocks overlie granitoid gneisses of the Basement System while in the Maragua gap and over a considerable area south of Maragua River, they overlie the Kapiti phonolites. Feldspar is common in the rocks of this series, although olivine, iron ores, carbonates and analcite are also present. In some places highly weathered basalts have been worked for building stone. The basalt agglomerates are well exposed in road cuttings between Saba Saba and Thika and in rail cuttings near Makuyu.

FIGURE 4



Areas designated Tv<sub>b2</sub>: these areas are underlain by the olivine basalts of the Simbara series formed during the Tertiary period. The porphyritic olivine basalts occupy the western portion of the district (the Aberdares) where they overlie the basalt agglomerates. Although olivine is the most abundant mineral, felspar-rich and magnesium-rich basalts also occur. Accessory minerals include iron ore.

Areas designated X<sub>n</sub> and X<sub>s</sub>: these are underlain by granitoid and biolite gneisses of the Basement System. These rocks occupy the southeastern portion of the district up to the Murang'a township area and the northeastern part of the district. Granitoid gneisses (X<sub>n</sub>) especially underlie the area of Ithanga in the southeast and the area around Kangure in the northeast, while biolite gneisses (X<sub>s</sub>) underlie the area around Kiambicho south of the Sagana township and the area extending southwards from Maragua ridge and Saba Saba to the Kakuzi Hill area. These rocks were formed during the Precambrian period and their essential minerals include microcline, orthoclase, sodaplagioclase, quartz and biolite with necessary iron ore, muscovite, apalite, hornblende and others. They were formed by metamorphism and granitisation.

There are no mineral deposits of economic importance in the district. The only minerals within the Basement System area are scattered occurrences of garnet and sillimanite, too small for economic exploitation, and kaolinite. The volcanic rocks, however, provide material suitable for quarrying as building stone while the coarse granitoid gneisses available north of Murang'a township and west of Ithanga provide an unlimited supply of material for road ballast and concrete aggregate. Claystones occur in the southwest of the area, north of Thika, and also west of Murang'a township. These are quarried from Gathamba valley and Kianochi southwest of Murang'a township. Similar building material is available in the western slopes of Ithanga. Clay for brick making and pottery is worked at Kangocho north of Murang'a township and at Mukangai valley and near Maragua centre. Abandoned stone and clay quarries fill with water, creating breeding grounds for disease vectors and potential accident scenes.

Porous beds and disconformities within the volcanic rock system are important as aquifers for collection and movement of groundwater and are therefore important for regulating water supply from wells and boreholes. Most boreholes are sunk in the areas underlain by volcanic phonolites, basaltic agglomerates and trachytic tuffs.

## 2.3 SOILS

### 2.3.1 Soil Categories and Properties

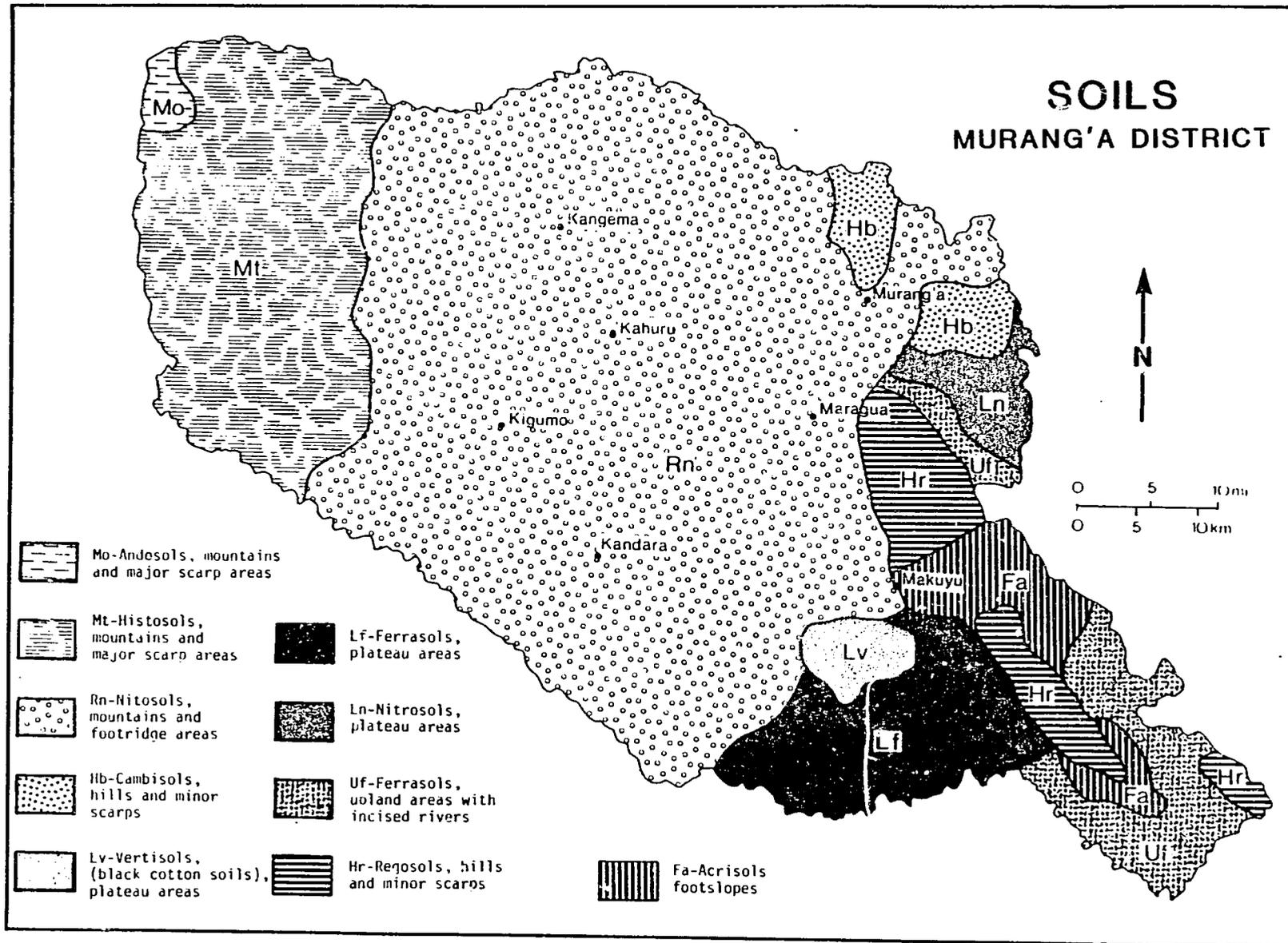
Generally, the soils developed over volcanic rocks in the western and northern side of the district are richer and deeper than those developed over the rocks of the Basement Complex to the southeastern side of the district. The soils of the Basement Complex are poorer and shallower and are rich in quartz. They generally overlies deeply weathered granitoid gneisses which in places have decomposed to kaolin, quartz and vermiculite and have a low humus content. The soils of the volcanic rocks are generally of high humus content.

Figure 5 shows the main soil categories in the district.

Mt: Andosols, in mountainous and major scarp regions. These predominate in the high western areas of the district in the Aberdares. The soils are strong brown loams with high humus content developed from volcanic, especially glassy materials. They are often shallow with rock outcrops. These are erosional areas with relief intensity of 300 m or more and slopes frequently of over 30% but 8-30% in some areas.

Mo: Histosols, in mountainous and major scarp regions. These are found in the northwestern corner of the district in the Aberdares. The soils are acid peaty loams, rich in fresh or partly decomposed organic matter often occurring with rock outcrops, lithosols, and ice.

FIGURE 5



SOURCE: Kenya Soil Survey, 1978.

Rn: Nitosols, in mountain footridges. These are the main soils in the district, covering large portions of all the divisions except Makuyu. They are dark red, slightly firm clays, generally well drained, fairly rich in organic matter, and very deep with moderately high to high natural fertility. There is little decrease in clay content in the upper 150 cm. The volcanic footridge regions generally have a relief range between high and low-lying areas of up to 100 m and slopes of 0-5% and 5-16%.

Hb: Cambisols in hills and minor scarp areas. These are rich young soils with little profile development, found in some northeastern portions of the district. They are generally dark reddish brown friable loams to clay loams, moderately deep and well drained. There are many stones and boulders. These are hilly erosional and depositional areas with relief differences of 100-300 m and slopes mainly of 8-30%.

Lv: Vertisols, in plateau areas. These are black cotton soils found in some parts of Makuyu Division in areas that are relatively flat and poorly drained. The soils are dark grey to black, with 30% or greater clay content and generally crack when dry and swell when moist. The plateau areas have a difference of not more than 50 m between high and low areas and slopes usually of 0-8% and occasionally of 8-16%.

Lf: Ferralsols, in plateau areas. These are friable red to reddish clays of low fertility found in some southern portions of Makuyu Division. The humus content is medium (1.5-3% carbon) and the A horizon overlies a weak sub-angular blocky friable clay. The soils are generally moderately deep to deep and well drained.

Ln: Nitosols, in plateau areas. These are reddish brown, firm clays of moderate fertility found east of Murang'a and Maragua towns. They are well drained, deep to very deep, and slightly cracking soils.

Fa: Acrisols in footslope regions. These are soils exhibiting an increase of clay in the sub-soil and base saturation of less than 50%. They are of low to moderate fertility and are found east of Makuyu centre surrounding the Kakuzi hill area. The footslope areas generally have slopes of between 2-8% and relief differences of up to 10 m.

### 2.3.2 Soil Degradation and Conservation

In Murang'a District soil degradation and loss is due largely to erosion caused by running water, rainfall, earth movements (mainly landslides),

slope, and land management. This degradation is especially prominent in the higher zones in the western part of the district where the terrain is hilly with slope gradients of over 30%. The extent of soil erosion is evidenced by the siltation of the Tana River and the dams downstream. Landslides are a common occurrence during the rainy season, particularly in Kangema Division.

Another cause of soil degradation in the district is overcultivation. Due to land pressure, especially in the high and medium potential areas of the district, there is a constant tendency toward overcultivation unless appropriate measures are taken to preserve soil fertility and retard erosion. Although it is difficult to establish land productivity trends, it seems that the use of fertilisers will continue for the purpose of maintaining land productivity. Soil analyses have revealed that the soils of Murang'a are deficient in some nutrients so that chemical fertilisers must be used to maintain or increase land productivity. Organic manures are not readily available in the district and will not replace chemical fertilisers in the near future because crop residues are used to feed livestock. Moreover, the use of chemical fertilisers is inevitable in the southeastern side of the district where the soil has low fertility and where large-scale farming of coffee and pineapples is practised.

The problem of soil erosion in the district is also aggravated by over-grazing, deforestation by bush burning and clearing, and cultivation of unsuitable areas without erosion control measures. Erosion is most serious in the grass/coffee zone on steep slopes and is least serious in the marginal area in the southeast, except around Kakuzi-Ithanga, where a

combination of agricultural practices and topography aggravates the situation.

Soil and water conservation has received considerable attention in the district. The following amounts were allotted to soil conservation in recent years:

1974/75	Kshs 138,000
1975/76	154,000
1976/77	168,000
1977/78	178,000

For the plan period 1979/83, the allocation for soil conservation has been increased, since about 43 sublocations are supposed to be covered under the plan. Soil conservation activities are being increased in the district each year. In 1975, efforts were concentrated on simple measures such as trash lines, mulching, planting of Napier grass, rotation of crops and related agronomic practices. During 1976, emphasis was placed on measures such as terracing, cut-off drains and improved livestock husbandry in addition to those previously practised. During 1977, emphasis was on cut-off drains, waterways, fanya juu terracing, cover crops and planting of trees on slopes. In 1978, emphasis was given to training of farmers in soil conservation techniques and afforestation in addition to the measures previously emphasised. During the 1979 and 1980 period, conservation measures were stressed in addition to increased training of farmers, local leaders, administrators and technical staff. The accomplishments since 1974 are given in Table 2.1. Under the Rural Afforestation Programmes, emphasis has been placed on incorporating tree crops for the conservation of the environment and other

TABLE 2.1: SOIL CONSERVATION MEASURES IN MURANG'A DISTRICT, 1974-80

MEASURE	YEAR						
	1974	1975	1976	1977	1978	1979	1980
Trash lines (m)	62,789	25,970	86,232	-	-	N/A	
Grass strips planted (m)	103,899	199,805	57,449	53,594	51,266	"	64,938
N.B. terraces constructed (m)	10,830	60,753	154,343	419,084	-	"	
Bench terraces constructd (m)	76,529	183,483	106,084	158,810	124,724	"	453,985
Cover crops planted (ha)	128.88	80.00	48.55	494.25	-	"	-
Grass planted (ha)	247	44	23.3	-	-	"	-
N.B. terraces reconditioned (m)	193,250	206,678	68,121	-	-	"	-
N.B. terraces measured (m)	342,438	120,387	277,272	-	-	"	-
Bench terraces measured (m)	107,295	177,029	184,814	202,337	-	"	-
Terraces reconditioned (m)	-	-	-	727,116	-	"	-
Cut-off drains (m)	-	-	N/A	N/A	517	"	597,173

SOURCE: Kenya, Ministry of Agriculture, for the years cited.

purposes. Details regarding afforestation are given in Section 4.3 on Forest Resources.

Construction of conservation devices such as cut-offs and narrow base terraces (graded) is undertaken by the Soil Conservation Service of the Ministry of Agriculture at a charge to the farmer. The cost of digging terraces and cut-offs range from shs. 6.75 per 7.5 m dug to shs. 1.10 per m dug in the district. During the year 1975, the areas covered by soil conservation projects were Iyego and Gitugi Locations (Kangema), Gaturi Location (Kiharu) and Kandani Soil Conservation Project. During 1976-77, the areas covered were Mbiri, Gikindu, Mugoiri, Gature, Maruka, Gakarara, Gatanga, Ruchu, Kigumo, Gatheru, Iyego and Gitugi. These areas were covered by the Rural Development Fund. In addition, the Kandaini Pilot Scheme on Soil Erosion Control, which involves 400 families, was run by the Ministry of Agriculture. For the 1979-83 period, 14 sublocations have been planned for conservation in Kandara Division, nine in Kiharu Division, nine in Kigumo Division, seven in Kangema Division, and four in Makuyu Division.

#### 2.4 CLIMATE

Murang'a District can broadly be divided into three climatic regions: the western part with an equatorial-type climate, the central region with a sub-tropical climate, and the eastern part with semi-arid conditions. These three climatic regions roughly correspond to agro-ecological zones 1 and 2 (high potential), 3 (medium potential) and 4, 5, 6 (low potential), respectively.

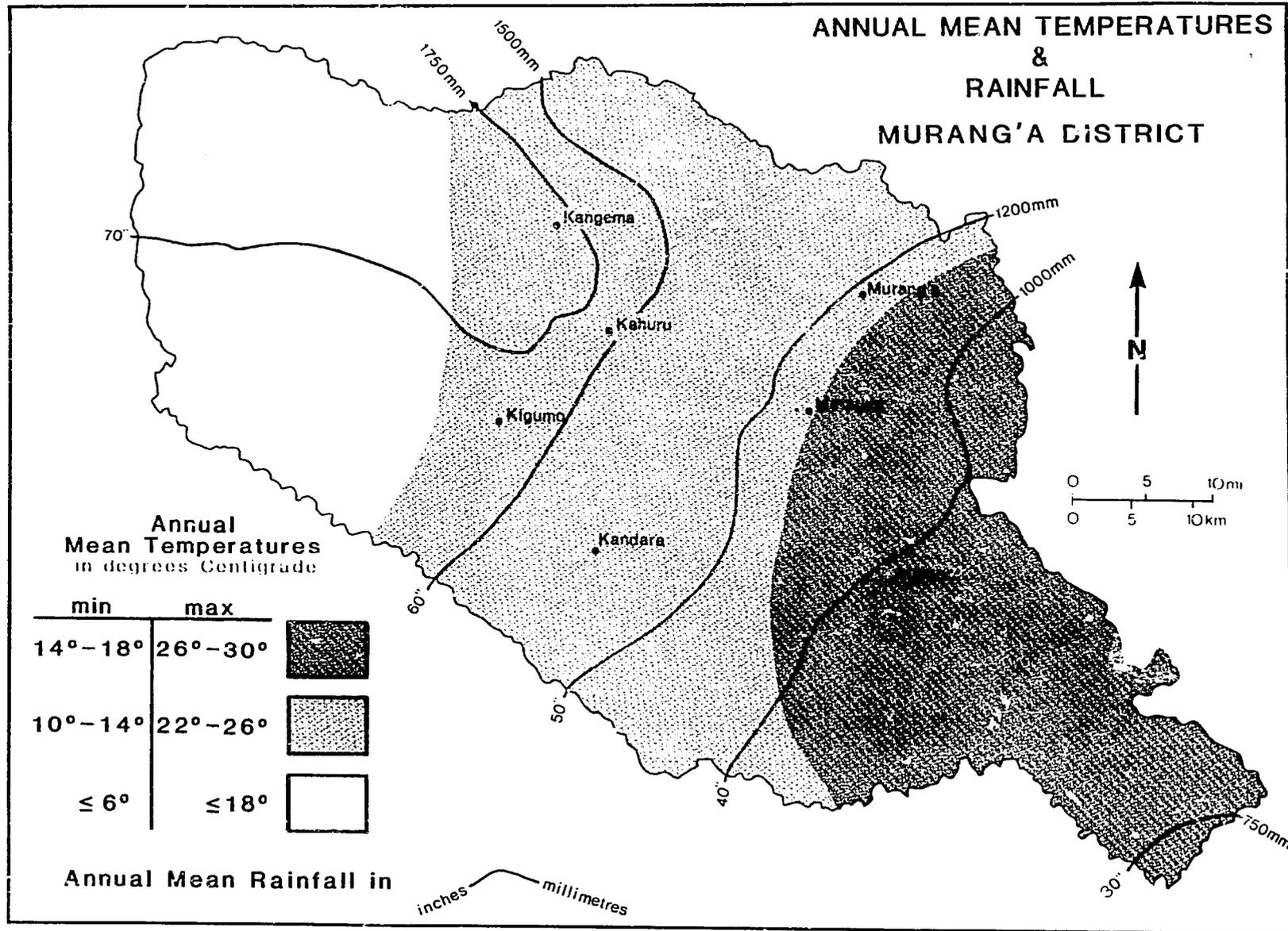
The eastern region which extends to about 37°E longitude has a near semi-arid type of climate. The probability of crop failure is rather high here. The western region with an equatorial climate is generally wet and very humid due to the influence of the Aberdares and Mt. Kenya. The district at times experiences temporary flooding, particularly in the neighbourhood of water courses and flat areas. A case in point is the flooding experienced in 1981. Though the probability of drought is low in most of the district, the year 1980 was particularly dry.

Rainfall in the district is due to the movement of the intertropical convergence zone of the southern and northern hemisphere air masses. This gives rise to two rainy seasons, the short rains (October-November) and the long rains (March-May), though another season, the Gathano (mainly in the upper zone) overlaps with the long rains. The amount of rainfall is largely dictated by relief. Rainfall distribution in the district is as follows:

High potential	1400 mm - 1600 mm
Medium potential	900 mm - 1400 mm
Marginal	500 mm - 900 mm
Rangeland	below 500 mm

Figure 6 illustrates this distribution (also see Table 2.2). Rainfall in high potential and medium potential areas is reliable, well distributed throughout the year, and is adequate for cultivation as well as livestock raising. Marginal (low potential) areas receive low, unreliable rainfall, adequate only for a limited number of crops under rainfed agriculture. Kanyenyaini and Kangema stations in the high potential areas have mean annual rainfall of about 2,107 mm and 1850.9 mm respectively. Muriranjas station which is situated in the medium potential area has a mean annual

FIGURE 6



SOURCE: Survey of Kenya 1970.

rainfall of 1,273.8 mm, while Makuyu station in the low potential area has a mean annual rainfall of about 1,119.4 mm (see Table 2.2).

Rainfall data for the five divisions (see Appendix Table A) indicates that for the divisions in the high zone (Kangema, Kigumo, Kiharo and Kandara) the long rains continue into the short ones forming the Gathano season, whereas for Makuyu Division there is a dry period between the two seasons. The data in Table 2.3 represent average rainfall and rain days distribution for 14 stations in the district during the year 1978. This shows that about 49% of the total rain during the year fell during March through May while about 20% fell during the October-November period. Comparable figures exist for the Tana Experimental Fish Farm, situated north-east of Murang'a township, where between 1976 and 1980 about 54% of the mean annual rain fell during March through May while about 24% fell during October through November (see Appendix Table 3). Apparently, the amount of rainfall varies considerably from year to year and from month to month. Data for Tana Fish Farm show that the highest monthly rainfall recorded over the past five years was 717.1 mm in April 1977 and the lowest 0.0 mm in January, 1976.

The district can be divided into temperature zones which roughly correspond to agro-ecological zones as shown in Figure 6. In the eastern areas, the mean maximum annual temperatures are 26°-30°C while the mean minimum annual temperatures are 14°-18°C. In the western wetter and colder areas, the mean minimum annual temperatures are 6°C or below and the mean maximum annual temperatures are 18°C or less. The central area is midway between the two. Figure 6 shows the average mean maximum and minimum monthly air temperatures at Sagana State Lodge in the eastern outskirts of the district for the period 1976-80 (see also Appendix Tables C and D).

TABLE 2.2: RAINFALL FIGURES FOR 13 STATIONS, MURANG'A DISTRICT, 1975-79  
(Figures in mm)

<u>STATION</u>	<u>YEAR</u>					Average
	1975	1976	1977	1978	1979	
Mugeka	-	-	1377.75	1587.4	1847.07	1604.1
Muriranjias	903.9	687.0	-	2230.5	-	1273.8
Kahuro	-	415.9	-	2243.4	1796.5	1485.2
Kariara	931.7	1391.8	2233.25	1854.1	1537.85	1589.7
Ruchu	-	1191.8	2017.26	1868.88	2381.05	1864.7
Kangema	1104.0	913.5	-	2005.4	3381.05	1850.9
Kiriani	745.9	933.8	-	1690.1	3372.95	1685.6
Ichic'hi	-	1211.8	-	2574.6	-	1893.2
Gitugi	797.3	1302.0	1193.8	783.0	770.5	969.3
Kanyenyaini	1128.9	-	2784.9	2407.3	-	2107.0
Kihoya	941.5	1220.4	2146.75	2227.5	-	1633.9
Makuyu	1030	-	-	1223.32	-	1119.4
Ithanga	-	-	-	1353.6	-	1544.2
AVERAGE	947.9	1029.7	1958.9	1849.9	2023.7	1544.2

SOURCE: Kenya, Ministry of Agriculture, for the years cited.

**TABLE 2.3: AVERAGE RAINFALL AND RAIN DAYS FOR 14 STATIONS IN MURANG'A DISTRICT, 1978**

MONTH	RAINFALL (mm)	NO. OF RAIN DAYS
January	91	7
February	80	6
March	330	17
April	521	19
May	148	9
June	38	9
July	52	9
August	34	6
September	62	6
October	184	10
November	127	11
December	68	5
<b>TOTAL RAINFALL</b>	<b>1735</b>	<b>114</b>

**SOURCE:** Based on Kenya, Ministry of Agriculture, Murang'a District, Annual Report, 1978.

The wind run measured at Thika and Kimatia shows average monthly values between 35 and 110 miles per day (see Appendix Table E). Generally speaking, the greatest amount of wind occurs in the summer dry season, January to February, whilst June to August is calmer.

The average monthly humidity ranges between 45% and 60% during the evening and between 60% and 90% in the morning.

## 2.5 WATER RESOURCES

### 2.5.1 Surface Water

Since most of the district receives rainfall of more than 875 mm annually and since relatively high precipitation is retained as ground water in the volcanic rocks, most of the rivers in the district carry flows throughout the year. This perennial flow is further regulated through the hydrological stabilisation generated by the forest vegetation in the elevated areas of the district. Seasonal rivers and streams are found only in the southeastern part of the district where the porous Basement System soils drain freely.

Although the district is relatively unindustrialized and most surface waters do not show signs of evident pollution, there are areas where water pollution from coffee processing is a problem. There are no major sewage systems discharging into the rivers in Murang'a, hence the bacteriological quality of the water is acceptable for treatment to obtain good quality water. Data on some parameters of surface water quality of rivers and springs in the district is given in Appendix Table F. The data show that there are incidences of high iron (up to 40 mg  $\text{Fe}^{2+}/\text{l}$ ) and manganese (up to 2 mg  $\text{Mn}^{2+}/\text{l}$ ) in rivers at certain times of the year. These are due to the surface geology rather than human activity. The colour and turbidity

of the surface water increases during the rainy season due to loading with silt and suspended materials. This calls for soil conservation measures to be intensified in the district. The pH of surface waters on average is 7.45.

Pollution by coffee wastes during coffee processing can reach extremely high levels at times. Analysis of raw water of the Maragua River in 1980 showed that there was much organic matter in the water (permanganate no. 144.67 mg O<sub>2</sub>/l). Analysis of the Maragua township water on the same data showed a permanganate number of 59.02 mg O<sub>2</sub>/l. Because of this pollution, the Ministry of Water Development is requiring all coffee factories to install water recirculation systems and to have no wastewater returned into any water courses. (See also Section 4.4.4 on Water Supplies). In general, the water in the rivers and springs is chemically suitable for irrigation, livestock watering, and fisheries development and can be economically treated by conventional methods to make it safe for drinking.

### 2.5.2 Underground Water

Appendix Table G gives the names, depth and yield of some of the boreholes in Murang'a District as well as the depth at which water is struck and rest levels. Although the average borehole yield in the district is 7.13 m<sup>3</sup>/hr (roughly 1542 gallons/hr), borehole yields may actually vary from nil to over 50 m<sup>3</sup>/hr. The average borehole depth is 117.0 metres, but water is commonly found at a depth of about 84.04 metres, although this varies. The average rest level of the water in boreholes is 42.85 metres.

Most of the boreholes are sited in the Kapiti phonolite or in basaltic agglomerate and trachytic tuffs, and they are numerous between Makuyu and

Thika, where yields of between 1000 and 5000 gals/hr are common from aquifers and from the base of volcanic formations. On the other hand, boreholes sunk in the gneisses of the basement System give relatively low yields, rarely exceeding 500 gals/hr. Rest levels of boreholes in the area show a westward rise of water table in the volcanic rock and a sharp fall in water table towards the Makuyu area.

Appendix Table H gives data on the groundwater quality in the district. The data show that the pH of the groundwater is nearly neutral and that the chemical quality is fair except for the high iron, manganese and fluoride content. The fluoride content may be as high as 3.8 mg F<sup>-</sup>/l, the iron content as high as 30.8 mg Fe<sup>2+</sup>/l, while the manganese content can be as high as 3.53 mg Mn<sup>2+</sup>/l in certain areas. The high fluoride content is of concern as there are numerous cases of dental fluorosis in residents of the district. Research into methods of defluoridation of water is being carried out but so far no economical and efficient method has been developed.

## 2.6 VEGETATION

The major vegetation zones in Murang'a correspond to climatic conditions of the district. The area falls into four generalized vegetation zones as defined in the National Atlas of Kenya (Figure 3, see page 7). More detailed agro-ecological zones are shown in Figure 9.

### Zone II - Forest

This covers the area around and on the slopes of the Aberdare Ranges, consisting primarily of forest vegetation forming the Aberdare Forest Reserve. The forest vegetation is composed of closed stands of trees of one

or more storeys, with an interlaced upper canopy, rising to 7.5 - 40 metres or more in height. The ground cover is dominated by herbs and shrubs. On the fringes where the forest has been cleared for cultivation, intensive agriculture is practised, including the growing of pyrethrum, coffee and tea.

#### Zone III - Wooded and Bushed Grassland

This occurs in the central part of the district, neighbouring the Aberdare Forest to the west. The zone covers Kangema, Kigumo and parts of both Kiharu and Kandara Divisions. Land is dominated by bracken and sedges. The pastures are Kikuyu grass with a high percentage of molasses grass. Here a tall species of sateria and panicum grass are also common.

Agricultural potential is highest in this zone. Intensive agriculture is practised, with crops including pyrethrum, coffee, tea, tobacco and maize. Livestock is also reared in the area, which is generally capable of supporting one stock unit per 1 - 1-1/2 hectares.

#### Zone IV - Wooded Grassland

Occurring in parts of Kiharu and Makuyu Divisions, this zone has a variable vegetation cover. Wooded grassland vegetation is common, as characterised by broad-leaved combretum species and other closely related shrubs that are mostly evergreen. The agricultural potential is high, soil and topography permitting. Areas under range use are still extensive, and under close management their stock carrying capacity is high, at less than two hectares per stock unit.

#### Zone V - Woodland and Shrub Grassland

This covers the extreme southeastern portion of the district. This zone has woodland mixed with dwarf shrub grassland. Land is of marginal

agricultural potential, carrying as natural vegetation dry forms of woodland and 'savanna' or derived semi-evergreen or deciduous bushland. The zone is characterised by Acacia-Themedra association. It is potentially productive rangeland, usually requiring less than 4 ha per stock unit.

## 2.7 FISHERIES

The district is endowed with many rivers and streams flowing from the Aberdares which are inhabited by various species of fish. The fisheries potential is unquestionably high in the district although it is underutilised. To a large extent, the under-exploitation of the fishery resources has been related to local nutritional habits. People in the area are not interested in eating fish, let alone rearing them.

Available information indicates that only about half a dozen farmers in the district have fish ponds and all keep tilapia species. A few institutions, namely a farmer training centre and one or two secondary schools, have started fish farming. The schools do this through their wildlife clubs.

With a diminishing food base, one way of diversifying food production in this overpopulated, small-scale farming district is through fish farming. This activity offers the cheapest source of valuable animal proteins, which are badly needed in this area. Fish farming should be strongly encouraged in the district, particularly in the higher zone. This could be undertaken at the individual or community levels, or through the co-operative societies. Since most of the co-operative societies in Murang'a are coffee societies and have coffee factories located near streams and rivers, fish

farming could potentially be integrated with their water circulation systems. The fish could then be cheaply available to society members. However, pollution of streams and rivers by coffee wastes have probably decreased fish population in many of these areas. Pollution by pesticides and fertilisers from runoff may also be affecting fish populations in the district (see Section 4.2 on Agriculture).

## 2.8 WILDLIFE

Wildlife population in the lower zones of Murang'a District is generally low but high populations are found in the Aberdares park and forest areas located in the northwest of the district. This area is protected for many species of wildlife. It also acts as a major water catchment area, supplying water to various systems in the district, and as a source of timber and timber products. The tourist potential of the park is considerable: about 50,000 tourists visited the park last year (1980) and brought about 1.5 million shillings in park charges as registered through the Nyeri offices.

The wildlife found within the park includes rhinos (the highest population in Kenya), elephants, buffaloes, hyenas, zebras, tigers, giraffes, gazelle, impala, lesser kudu, ostrich, and others, as well as the rare bongo which is extinct elsewhere in Kenya. Because the natural ecosystem has largely been undisturbed, the park still maintains large numbers of wildlife. The Aberdares consists of 760 sq. km of national park and 800 sq. km of national forest, but the two are contiguous and administered together. The animals have access to the entire area.

Wildlife diseases have not been very common in the parks, and major causes of wildlife reduction in the district, other than disease, can be identified as:

- (1) poaching, especially for valuable species such as rhino;
- (2) changes in habitat emanating from conflicting land uses in the park/forest neighbourhood;
- (3) changes in habitat, perhaps resulting from climatic changes and natural resource depletion.

Other associated problems stem from crop destruction by wild animals such as elephants and buffaloes which are reportedly common in the district, especially the area neighbouring the lower parts of the forest.

As the poaching problem is common in most wildlife areas, the Department of Wildlife has taken appropriate action to ensure that existing wildlife is not threatened by poaching activity. The problems resulting from changes in habitat are potentially serious in this particular area. In the lower parts of the forest, farmers have embarked on intensive farming due to the land shortage problem. These new farming units destroy the natural environment and create physical changes that can affect the habitat for wildlife. The remaining wildlife species are also denied access to these lowland areas and remain restricted to the highlands.

The ongoing afforestation programme is not commensurate with the high rate at which trees are being cut. This could threaten or endanger wildlife in the area. The resulting conditions may not guarantee the sustained yield formerly obtained from the natural habitat. Thus, this high rate of tree depletion may be reducing the area's capability to support wildlife species.

In this respect, an integrated land use programme should be initiated in the district. This would ameliorate the problem of people migrating to the forest areas. A permanent programme of controlling tree cutting and ensuring the maintenance of the original natural environment is called for as part of the existing programmes on afforestation.

In the continuing problem of safeguarding farmers' crops from the destruction by wild animals, the Wildlife Department should ensure that a permanent base be established for staff working on poaching and wildlife conservation problems. In this connection, the new station at Kangaita for monitoring the movement of animals from the Aberdares down to the lowlands could be expanded. The department should also put up moats or fence barriers around the park to reduce the current problem of crop destruction by animals. A destabilisation of the natural environment may cause severe regional consequences such as climatic changes in this area. The park, with a high tourist potential, is a resource of national importance. These factors highlight the importance of preserving the wilderness areas in Murang'a District.

## 2.9 PROBLEM SUMMARY

### A. Terrain

1. Because of the hilly terrain, soil erosion due to running water is a serious problem, particularly in the high western zone.
2. Landslides and other earth movements are common in the hilly regions.

3. Road construction and maintenance are made difficult by the rugged terrain in parts of the district, and many bridges are required because of the numerous rivers and streams.

## B. Geology

1. Areas underlain by rocks of the Basement Complex System often have limited groundwater reserves and seasonal rivers.
2. The geological structure in some areas makes the sinking of boreholes difficult.
3. Abandoned stone and clay quarries fill with water and can be breeding grounds for disease vectors and scenes of accidents.

## C. Soils

1. Low soil fertility in some areas, particularly in the southeastern side of the district, makes the use of large amounts of fertilisers necessary.
2. Overcultivation and soil erosion decrease land productivity in many areas.
3. The stoniness of the soil in certain areas makes cultivation difficult.
4. Farmers are sometimes reluctant to devote portions of their land for the construction of cut-off drains.
5. Casual labourers for the implementation of conservation measures are often unavailable. This is particularly evident in areas such as Gikundo and Kigumo.
6. Established soil conservation works are often poorly maintained.

7. There is frequently a lack of effective follow-up by extension officers in the implementation of soil conservation measures.

D. Climate

1. Rainfall in the eastern low-lying areas of the district is inadequate and unreliable.

E. Water Resources

1. Rivers and streams in the district are subject to heavy siltation during the rainy season due to soil erosion.
2. The high fluoride content of underground water in many parts of the district can cause dental and other health problems.
3. Surface waters in many areas are polluted by organic wastes from coffee processing.
4. Both surface and groundwater supplies have high iron and manganese content, which may cause long-term health problems.
5. The rivers and streams in the southeastern portion of the district are seasonal. Water supplies limit agricultural productivity and economic development.

F. Fisheries

1. Potential development of fisheries in the district has been hindered by the local population's nutritional habits.
2. Fish populations in a number of rivers and streams in the district may have been affected by pollution from coffee processing

factories as well as from agricultural chemicals washed into the waterways by runoff.

G. Wildlife

1. Some species, such as the rhinoceros, have been subject to extensive poaching.
2. Encroachment of farmers on forest land has reduced the range and affected the habitat of wildlife populations.
3. Cutting trees in forest areas for fuelwood and timber has affected wildlife habitat. In general, the afforestation programme has not kept pace with the rate of tree cutting.
4. In areas neighbouring the forest, crop destruction by wildlife is often a serious problem.

## CHAPTER 3: HUMAN ENVIRONMENT

### 3.1 POPULATION

#### 3.1.1 Ethnic Composition

The predominant ethnic group of Murang'a District are the Kikuyu who comprise over 95% of the population. The Kamba are the second largest group, with about 2.9% of the total. Table 3.1 gives the ethnic structure of the population of Murang'a, including people of non-Kenyan origin.

TABLE 3.1: ETHNIC STRUCTURE OF MURANG'A POPULATION

	<u>Male</u>	<u>Female</u>	<u>Total</u>
District Total	310,632	337,701	648,333
Kenyan African	310,143	337,313	647,456
Kikuyu	294,422	324,849	619,271
Kamba	9,812	8,855	18,667
Luhya	1,851	1,011	2,862
Luo	1,476	934	2,411
Meru	479	270	749
Embu	369	265	634
Others	1,734	1,128	2,862
Kenyan Non-African	122	109	231
Non-Kenyan	367	279	646

SOURCE: Kenya, Ministry of Economic Planning and Development, 1981.

### 3.1.1 Population Density and Distribution

Much of Murang'a District is very densely populated, with four out of the five divisions having densities of over 300 persons per square kilometre. This approaches the levels found in the most densely populated rural areas in Kenya. Overall, Murang'a District has the fourth highest population density in the country, following Kisii, Kakamega, and Kiambu Districts. Table 3.2 and Figure 7 present the population by division for 1969 and 1979.

TABLE 3.2: POPULATION DISTRIBUTION BY DIVISION, 1969 and 1979

DIVISION	AREA (sq. km)	1969 Population	1979 Population	DENSITY (1979)	POPULATION % Increase
Kandara	421	125,805	181,721	430	44.4
Kigumo	438	96,773*	135,116	308	39.6
Kangema	341	89,315	132,912	388	48.8
Kiharu	407	96,425*	138,182	339	43.3
Makuyu	643	36,992	60,402	93	63.3
<b>TOTAL</b>	<b>2,476**</b>	<b>445,310</b>	<b>648,333</b>	<b>261</b>	<b>45.6</b>

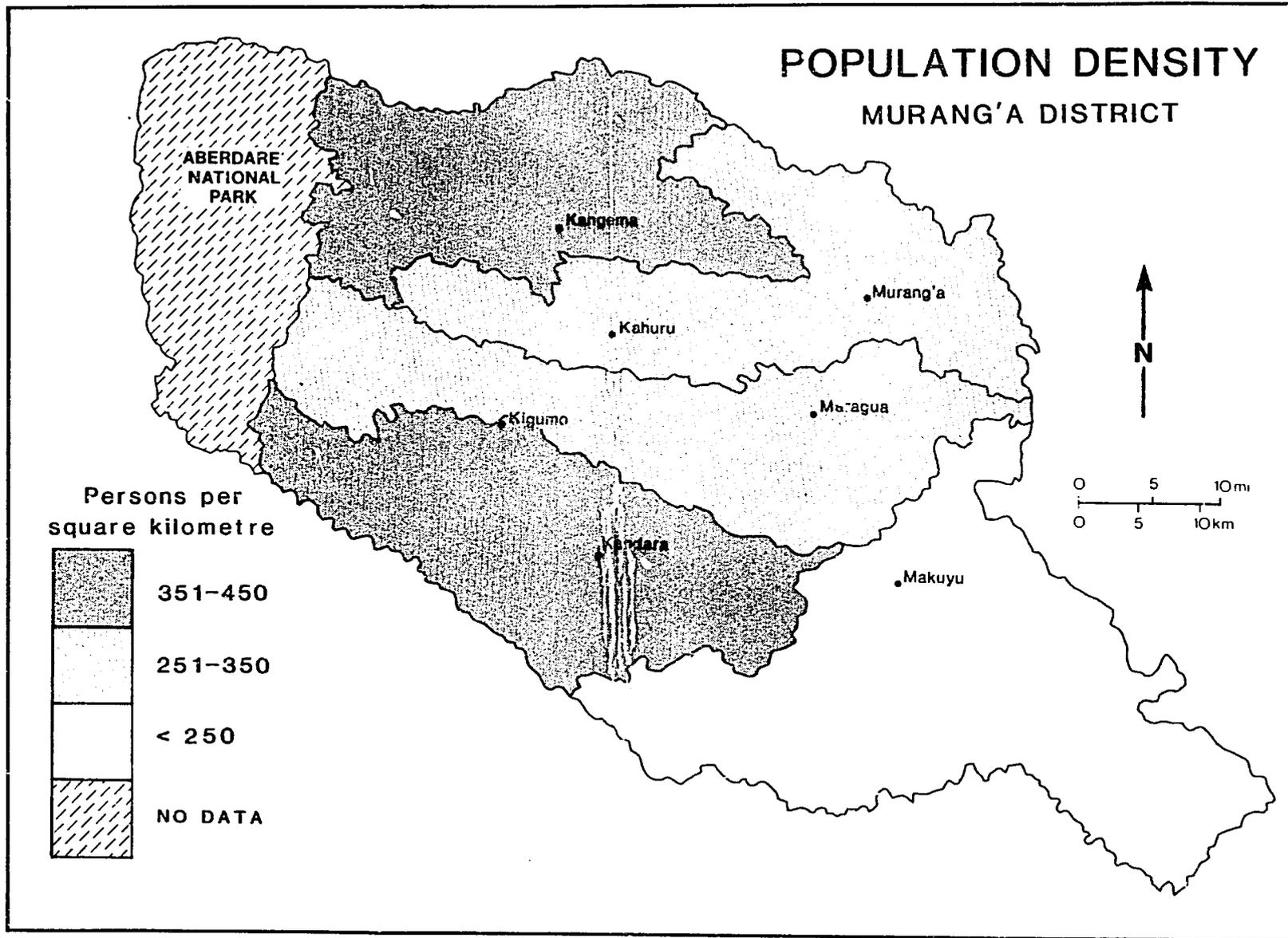
SOURCES: Kenya, Ministry of Economic Planning and Development, 1981.  
Kenya, Ministry of Finance and Economic Planning, 1970.

\* Figures have been adjusted to include Maragua and Murang'a town populations which were listed separately in the 1969 Census.

\*\* Total area of the district includes forest reserve land which is not officially included in the various divisions.

Kandara, Kigumo, Kangema, and Kiharu Divisions are areas of intensive small-scale farming with a large proportion of high-potential land. Land pressure has been very high in these areas with much fragmentation of the

FIGURE 7



SOURCE: Kenya, Ministry of Economic Planning and Development, 1981.

holdings, and this has resulted in considerable emigration in search of employment and land settlement opportunities. In contrast, Makuyu Division, which experienced the highest rate of growth over the period, is a region of marginal land which was only included into what was then Fort Hall District after Independence. It has been relatively sparsely populated, but the recent expansion of pineapple, sisal, and other plantation agriculture has attracted immigrants and has been responsible for the area's exceptionally high growth.

The largest urban area in the district is Murang'a township, with a population of 15,290. Other towns, and their 1979 populations, are Makuyu (2128), Sabasaba (1501), and Maragua (1298).

### 3.1.3 Growth Rate and Projection

The overall annual growth rate for the district during the ten years between 1969 and 1979 was 3.8%. This is somewhat lower than the national growth rate over the period of 4.0%, but it would have been even higher were it not for the emigration from the district. Makuyu was the fastest growing division with an annual growth rate of over 5.0%. The lowest rate of growth, 3.4%, was in Kigumo Division. Murang'a township grew from a population of 4750 in 1969 to 15,290 in 1979, although much of this growth was due to the large expansion of its boundaries.

Detailed population projects based on analysis of fertility rates in 1979 are not yet available at the time this is being written. They would in any case be difficult to make because of their sensitivity to the pattern of migration. However, a rough calculation assuming a continuation of a 3.83%

growth rate for the district gives the following projected population figures:

1985	812,335
1990	980,278
1995	1,182,942
2000	1,427,505

It is clear that at this rate of growth, the district's population carrying capacity will have been exceeded long before the year 2000. Thus, either the natural rate of increase will have to decline, or there will be greater migration out of the district, or there will have to be significant changes in the structure of the district's economy as a result of the growing population pressure over the next 20 years.

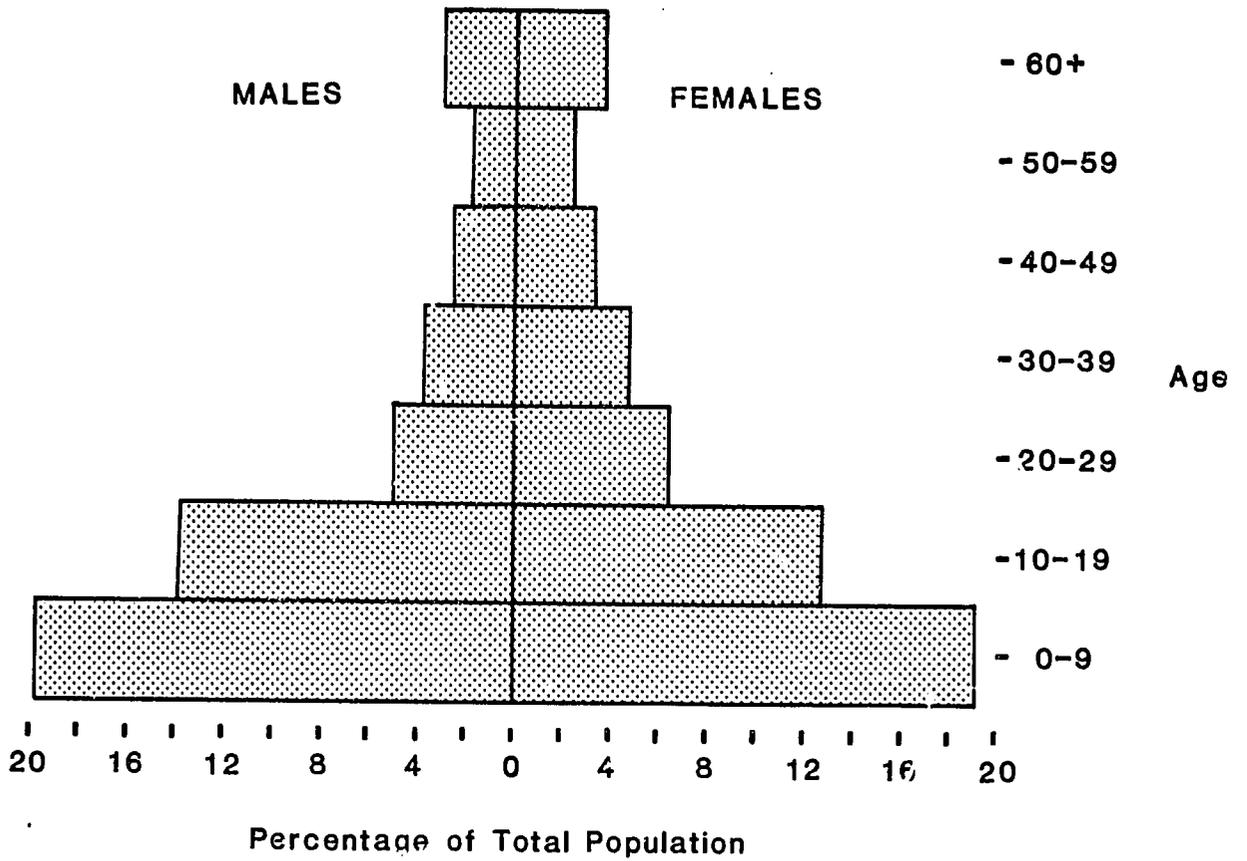
#### 3.1.4 Age-Sex Proportions and Migration Patterns

Table 3.3 and Figure 8 give the age-sex proportions and the age-sex pyramid for Murang'a District. The figures illustrate the very high dependency rate in the district: over 57% of the population is under 15 or over 65 years of age. This means that not only are current resources in the district under heavy stress to support the population, but in the future the resource base will be subject to even greater population pressure.

One response to resource and economic pressures in an area like Murang'a is migration out of the district. The sex ratio, which is the proportion of males to females, gives an indication of this trend. Significant female majorities begin to appear in the 20-24 age group and continue at least until age 65. This is a common situation in regions where males have migrated to urban or other rural areas in search of employment. Females often stay behind to continue working the family farms, thus giving rise to the disproportionate sex ratios. The sex ratio can also be used to distinguish regions of emigration, which will usually have female majorities, from

FIGURE 8

**AGE/SEX PYRAMID**  
**Murang'a District**  
**1979**



SOURCE: Kenya, Ministry of Economic Planning and Development, 1981.

TABLE 3.3: AGE-SEX PROPORTIONS

AGE	MALES	FEMALES	TOTAL	SEX RATIO	AGE GROUP AS PERCENTAGE OF TOTAL POPULATION
0-4	63,833	63,159	126,792	101.1	19.56
5-9	58,499	57,566	116,065	101.6	17.90
10-14	48,861	48,159	97,020	101.5	14.96
15-19	34,165	34,973	69,138	97.7	10.66
20-24	17,851	22,617	40,468	78.9	6.24
25-29	15,005	19,776	34,781	75.9	5.36
30-34	13,780	16,427	30,207	83.9	4.65
35-39	10,180	14,461	24,491	70.4	3.79
40-44	8,745	11,695	20,440	74.8	3.15
45-49	7,304	9,197	16,501	79.4	2.54
50-54	6,421	8,629	15,050	74.4	2.32
55-59	5,658	6,796	12,454	83.3	1.92
60-64	4,551	6,187	10,738	73.6	1.65
65-69	5,062	5,310	10,372	95.3	1.59
70-74	3,532	4,058	7,590	87.0	1.17
75+	6,578	7,898	14,476	83.3	2.23
Others (Not Stated)	857	793	1,650		0.25
<b>TOTAL</b>	<b>310,632</b>	<b>337,701</b>	<b>648,333</b>	<b>92.0</b>	<b>100.00</b>

SOURCE: Kenya, Ministry of Economic Planning and Development, 1981.

regions of immigration, which will usually have male majorities. The sex proportions for various areas in Murang'a are shown in Table 3.4

TABLE 3.4: SEX PROPORTIONS BY DISTRICT DIVISIONS, 1969 and 1979

AREA	MALES (1979)	FEMALES (1979)	SEX RATIO	1969 SEX RATIO
Kandara Division	86,928	94,793	91.7	88.1
Kigumo "	64,640	70,476	91.7	88.4
Kangema "	61,938	70,974	87.3	80.3
Kiharu " *	58,213	64,679	90.0	86.0
Makuyu "	31,192	29,210	106.8	113.6
Murang'a Township	7,721	7,569	102.0	134.2

SOURCE: Kenya, Ministry of Economic Planning and Development, 1970.

\* Excludes Murang'a Township.

All of the divisions in the district, except Makuyu, have significant female majorities. As discussed above, this is an indication of migration into Makuyu for employment on the large plantation farms, which contrasts with the general pattern of migration out of the densely populated rural areas in the remainder of the district. Murang'a township also has a small majority of males, indicating immigration by males in search of urban employment. Interestingly, the same pattern existed in 1969 when it was even more pronounced, especially for Murang'a township. This suggests that either an increasing number of women have moved into the town over the decade or the change in the township's boundaries has affected the sex ratios.

Similarly, the lower 1969 sex ratios in the areas of emigration could indicate either a decline in the relative rate of male immigration or an increase in female emigration. Given the level of intensified land pressure, it seems likely that more women than before are joining men in moving out of the district to find employment or land elsewhere.

A detailed analysis of interdistrict migration is not yet available at the time this report is being written but a general picture can be obtained from the 1979 Census data. Table 3.5 gives the number of people born in Murang'a District who were resident in other areas of Kenya at the time of the 1979 Census (only the main areas of migration are included).

Because of its proximity, Nairobi has been a powerful magnet for migration from Murang'a District. Altogether, about 8% of the total 1979 Nairobi population of almost 828,000 was born in Murang'a. The other main areas of migration are to Central and Rift Valley Provinces. Most of this movement has been for land in areas opened for settlement, as in Nakuru, Nyandarua, Laikipia, and other districts that were part of the white highlands, or for agricultural and other employment in large farm areas such as Kericho and Kiambu Districts. Interestingly, there is a large preponderance of males over females in the population that has moved to Nairobi, but in the agricultural areas of Central and Rift Valley Provinces, the proportions are more nearly equal, with female majorities in some cases. This indicates that migration to large urban areas involves mainly males searching for employment, generally leaving women behind to care for the family land, while migration to agricultural areas usually involves movement of the entire family. The significant female majorities in Nyandarua and Nyeri suggest the possibility that in these areas there has been a secondary

wave of migration to urban areas following the first wave for agricultural settlement.

TABLE 3.5: POPULATION BORN IN MURANG'A AND RESIDENT IN OTHER AREAS, 1979

AREA OF RESIDENCE	MALES	FEMALE	TOTAL
Nairobi	40,899	23,897	64,796
Central Province (excl. Murang'a)	26,579	29,004	55,583
Kiambu District	13,332	13,183	26,515
Kirinyaga District	2,513	2,542	5,055
Nyandarua "	7,486	8,707	16,193
Nyeri "	3,248	4,572	7,820
Rift Valley Province	22,650	21,061	43,711
Laikipia District	2,388	2,163	4,551
Nakuru "	11,583	11,463	23,046
Uasin Gishu "	2,318	2,093	4,411
Kericho "	1,567	1,409	2,976
Trans Nzoia "	1,085	993	2,078
Other districts	3,709	2,940	6,649
Mombasa	2,205	1,369	3,574

SOURCE: Kenya, Ministry of Economic Planning and Development, 1981.

### 3.1.5 Conclusion

Most of Murang'a District has very high population density, resulting in severe pressure on land and other resources. High rates of soil erosion and other environmental problems are some of the consequences of the process

as land on hill slopes and other marginal areas is brought under intensive cultivation. In addition, over half of the population of the district is under 15; thus, population pressure will further increase in the coming years. Some of this pressure will be alleviated by movement to the still relatively sparsely populated areas of Makuyu Division and to other rural areas in neighbouring districts. However, with the era of settlement schemes coming to a close, migration to urban areas in search of employment will increasingly become the main option for those who cannot support themselves and their families through small-scale farming alone. This threatens to create very serious problems in these areas and underlines the need for rural development and family planning programmes in areas such as Murang'a.

### 3.2 ENVIRONMENTAL PERCEPTION

The people of Murang'a are traditionally attached to and dependent on the land for their livelihood. As Mzee Jomo Kenyatta states in his book Facing Mount Kenya (1961):

'The Gikuyu people as agriculturalists depend entirely on land. It supplies them with the material needs of life through which spiritual and mental contentment is achieved. Communication with ancestral spirits is perpetuated through contact with the soil in which the ancestors of the tribe lie buried. The Gikuyu consider the earth as the mother of the tribe for ... it is the soil that feeds the child through lifetime, and again after death it is the soil that nurses the spirits of the dead for eternity.'

It is no wonder therefore that the Kikuyu people have strong beliefs related to their immediate environment. Mount Kenya is considered the most sacred mountain in Kikuyuland for it is believed that 'Mwene Nyaga,' the God

of Kikuyu, lives there. This is the reason why the independent churches founded by the Kikuyu people hold their prayers while facing Mount Kenya.

The following is a summary of the results of a series of interviews carried out in Kiharu, Kangema, and Kigumo Divisions in Murang'a District in 1981. Eighteen people were interviewed about their attitudes and perceptions of various environmental problems. The respondents included ten retired chiefs, three retired agricultural officers, and five elders. Four specific topics were discussed: soil erosion, local environmental organisation, population and family planning, and food and hygiene.

Soil Erosion: Efforts at curbing soil erosion in Murang'a District were started in the colonial period. The problem then was not as prominent as it is today. During the colonial period people were forced to take measures to prevent the loss of soil. Although the purpose of the policy was good, the colonial approach was considered brutal, and the enforced construction of terraces was at its height during the struggle for independence. Peoples' resentment against anything that had colonial implications was therefore extended to the forced labour connected with the soil conservation measures.

After Independence, there was a relaxation of soil conservation practices and neglect of erosion control. Many areas where terraces were built, however, still retained soil. Had this exercise been preserved throughout the country, the problem of soil erosion today would not be so serious.

In many areas of Murang'a District, the soil erosion problem has been accelerating, especially as the intensity of cultivation increases. In the southern parts of Kiharu, for example, the situation has been severe because the soils are sandy. Big gullies exist, and although people realised the

problem was acute nothing was done until the National Soil Conservation Week in February 1981. During this week, people worked in groups to implement soil conservation measures in areas most affected by soil erosion. Since then, people have continued to call on agricultural technicians for their advice on how to conserve soil.

Most of the people interviewed felt it would be a good idea if the soil conservation week were repeated each year. It was also felt that peoples' attitudes about conserving soil have changed. The problem of soil erosion has become so acute that any ideas on conserving the soil are welcomed.

Environmental Organisation: The existence of Murang'a Environmental Action Group (MEAG) illustrates the Murang'a people's environmental awareness. MEAG is a local movement concerned with environmental management in the district. It is four years old and composed mainly of local teachers both at primary and secondary school levels. The group's patrons include the District Commissioner, the District Forester, and the District Education, Community Development, and Water Development Officers.

The primary objective of the group is to curb soil erosion, which it has identified as a major environmental hazard. The group also considers other aspects of environmental management. MEAG has already been involved in a number of soil conservation and afforestation projects in the district. Using students, the group has collected seeds from trees in villages and sorted them into different species before planting. The plan is to plant economically useful trees which will provide fruit, firewood and building materials while curbing the soil erosion problem. The plan also aims at reforesting degraded areas such as those along the Tana River where silt

carried from the river banks clogs the hydroelectric plants. The group is also concerned with promotion of fish farming in the district.

Population and Family Planning: Traditionally, the number of children per family was the criterion used for measuring wealth. Rapidly growing economic constraints have changed this attitude somewhat. Because of the increased cost of living and land pressure, even rural people now often prefer a limited number of children whom they can afford to support. However, the willingness to accept family planning is beset by a number of problems relating to birth control methods and campaigns in the district:

- there are very few social workers to go round in villages;
- there are rumoured fears as to the safety of various contraceptives;
- there is a total lack of birth control infrastructure in the rural areas.

Partly as a result of these problems, there are too many young girls dropping out of schools prematurely, adding to the already high population of young mothers between 13 and 20 years of age.

Many of the people interviewed lamented that the old ways of passing on life education have been neglected. In the old days, young girls and boys used to learn sexual practices and mores during the circumcision ceremonies. Girls were strongly warned that to have children outside wedlock was taboo. A girl who had given birth outside marriage and therefore, traditionally, could not remarry a young man was called a gicokio. She could only be a second wife to an old man. Today no such education is given. It was observed that unless girls and boys are given sex education in schools, the problem will persist. It is hoped that such education will also help reduce

the number of suicides and deaths due to abortions that result from accidental and unwanted pregnancies.

Food and Hygiene: The traditional crops of the district were cowpeas, pigeon peas, sugarcane, maize and beans, pumpkins, arrowroot, sweet potatoes, and cassava. In pre-colonial days, people were generally nutritionally self-reliant, in that they ate what they grew. Most of the people agreed that today's food habits have improved because of the commercialised market and the accessibility of different foods from other parts of the country and even from other countries.

There is also much improvement in the way people prepare food in terms of cleanliness and hygiene. This has been due to easy accessibility of water in most areas and greater awareness of hygienic practices.

### 3.3 PROBLEM SUMMARY

#### A. Population

1. The high population density and growth rate in most of Murang'a District contribute to severe pressure on land and other resources. Intensified soil erosion and other symptoms of environmental degradation are caused in part by the population pressures.
2. The age structure of the population implies a high dependency rate. This contributes to economic stresses on the family which has high income and cash needs for such expenses as school fees. It also means that population pressures on resources will further increase over at least the next twenty years.

3. Migration out of the district in search of employment and land may become less successful as a safety valve over the coming years as fewer settlement areas are available and if employment opportunities in Nairobi and other urban areas become more scarce.

B. Environmental Perception

1. Although soil conservation measures were often viewed negatively in the post-Independence period because of colonial practices, people are now recognising conservation's importance again. Events such as the National Anti-Soil Erosion week are important in increasing peoples' awareness of the problem, but these need to be held regularly and with follow-up activities.
2. Sex education and family planning programs in the district need more support and should be expanded. Traditional means of sex education are breaking down; family planning programs in the district are hindered by lack of staff and supplies and are unable to serve rural areas adequately. People also sometimes hesitate to use some of the contraceptive methods available because of fears about their safety. Sex education programs in the schools should be expanded so that schools can assume a major role in this field.

## CHAPTER 4: LAND USE

### 4.1 LAND TENURE

As in most parts of Kenya, land is a vital factor in the economy of Murang'a District, affecting most economic activities and population distribution and movement. The main categories of land ownership are shown in Table 4.1. Freehold land is land that was formerly owned by European settlers and has since been adjudicated to private ownership, often through the establishment of smallholder schemes. This comprises only about 2.6% of the total land area of the district. Government land in Murang'a includes forest and other reserves, the Aberdare National Park, and alienated and unalienated land that formerly belonged to European farmers in the 'Scheduled Areas' and is now leased to individual small- and large-scale holders. Altogether, government land comprises almost 36% of the district's land area. Within this, alienated land, the largest category, comprises almost 20% of district land area. Trust land that has been registered for ownership by smallholders is the largest single category of land ownership in the district. These areas were former 'Native Reserves' and are now owned by smallholder farmers, often with very fragmented plots. Registered smallholder land comprises almost 60% of the total district land area.

Some of the environmental and other problems associated with this pattern of land ownership are discussed below in the section on agriculture.

TABLE 4.1: LAND TENURE, MURANG'A DISTRICT, 1976

CATEGORY	AMOUNT (sq. km)	PERCENTAGE OF TOTAL LAND
<b>1. <u>Freehold Land</u></b>		
Smallholder schemes	24	1.0
Other	<u>41</u>	<u>1.6</u>
TOTAL	65	2.6
<b>2. <u>Government Land</u></b>		
Forest Reserves	267	10.8
Other Government Reserves	62	2.5
Townships	--	--
Alienated Land	493	19.9
Unalienated Land	40	1.6
National Parks	26	1.1
Open Water	--	--
TOTAL	<u>888</u>	<u>35.9</u>
<b>3. <u>Trust Land</u></b>		
Forest	9	0.4
Government Reserves	2	0.1
Townships	29	1.2
Alienated Land	1	0.0
Game Reserves	--	--
National Parks	--	--
TOTAL	<u>41</u>	<u>1.7</u>
Available for Small Holder Registration:		
Already Registered	1482	59.8
Not Yet Registered	<u>--</u>	<u>--</u>
TOTAL TRUST LAND	<u>1523</u>	<u>61.5</u>
TOTAL DISTRICT LAND	2476	100.0

SOURCE: Kenya, Ministry of Finance and Economic Planning, 1981b.

## 4.2 AGRICULTURE

### 4.2.1 General Aspects

Data on agricultural potential, irrigation, agricultural land use and employment are given in Table 4.2. This shows that about 87% of the total area is suited to agriculture. About 24% of this agricultural land is in Makuyu Division, 19% in Kandara Division, 18% in Kangema Division, and 19% in Kiharu Division. Of the total agricultural land area, about 59% is of high potential (agroecological zones 1 and 2), about 23% is of medium potential (agroecological zone 3), about 8% is marginal (agroecological zone 4), and about 9% is rangeland and semi-desert (agroecological zones 5 and 6).

Generally the agricultural potential of the district decreases from the northwestern to the southeastern side of the district. Marginal, range and semi-desert land (agroecological zones 4, 5, and 6) does not exist in Kandara, Kangema and Kigumo Divisions but forms significant portions of Makuyu and Kiharu Divisions. About 34% of the total area of Makuyu Division is marginal, range and semi-arid land, while 33% of the total area of Kiharu Division falls under zones 4, 5, and 6.

Agriculture forms the backbone of the district's economy. It is estimated that 95% of the families in Murang'a District derive their livelihood from agriculture. Farming in the district is mainly small-scale, with subsistence, cash crop and dairy activities. Small-scale farming covers about 62% of the district and 64% of the agricultural land. There are about 12,334 smallholdings covering about 151,886 hectares of land distributed in all the divisions. There are 56 large-scale farms in Makuyu and Kandara Divisions. The sizes of these large-scale farms range from 25 to 800

**TABLE 4.2: AGRICULTURAL DATA, MURANG'A DISTRICT - 1979**

	TOTAL DISTRICT	MAKUYU DIV.	KANDARA DIV.	KANGEMA DIV.	KIHARU DIV.	KIGUMO DIV.
<b>A. AREA</b>						
1. Total area (ha.)	219,897	62,600	41,600	35,500	38,297	41,900
2. Agricultural area (ha.)	191,133	46,950	36,848	34,311	35,865	37,158
High potential (agro-ecological zones 1,2)	113,213	-	33,164	31,836	16,501	28,018
Medium potential (agro-ecological zone 3)	44,148	25,737	3,684	2,475	6,797	9,138
Marginal (agro-ecological zone 4)	15,606	6,181	-	-	9,425	-
Range & Desert (agro-ecological zones 5,6)	18,173	15,031	-	-	3,143	-
3. Total irrigated land to date (ha.)	8,414					
<b>B. LAND USE/POPULATION/EMPLOYMENT</b>						
1. Smallholdings						
Size Range (ha.)	0-5-20.0	2.0-4.0	1.3-2.3	0.5-3.0	0.8-20.0	1.5-6.5
Number of Smallholdings	121,334	1,837	30,306	34,566	51,342	13,213
Total Smallholder Area (ha.)	151,886	4,210	40,943	34,311	35,865	36,557
Portion of land multiple cropped (ha.)	96,849	-	24,011	13,679	18,391	34,557
No. of permanent non-family workers	3,670	-	900	2,000	300	470
Peak no. of casual nonfamily workers (March-April, October-November)	69,500	26,500	23,000	10,000	10,000	10,000
Average size of households	7	8	6	7	5	6
2. Large farms						
Size range (ha.)	25-500	25-800	-	-	-	-
Privately owned (up to 7 owners)	56	37	19	-	-	-
Ranches (no.)	5	5				

**SOURCE:** Kenya, Ministry of Finance and Economic Planning, 1980c.

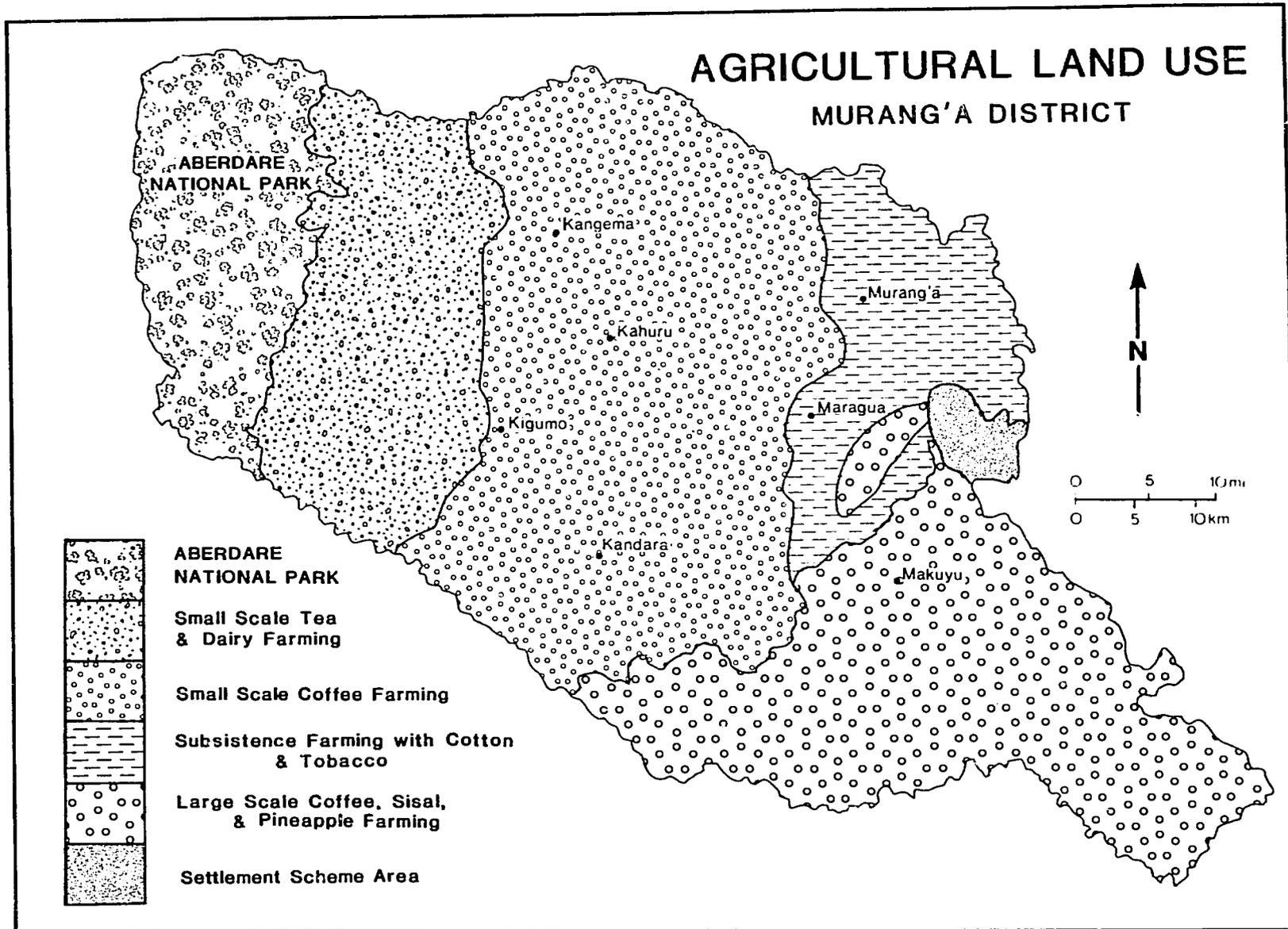
hectares (See Table 4.2). There are about 40 co-operative farms and five ranches. Developed large-scale farms in marginal areas (zones 4, 5, and 6) occupy 5416 hectares of the total 191,133 hectares of the agricultural land. Many of these farms are being subdivided.

Figure 9 illustrates the agricultural land use pattern in the district. The areas occupied by forest and where small-scale tea growing and dairy farming are practised correspond to the agroecological zones 1 and 2 (high potential). The middle zone where coffee farming is the main activity generally corresponds to zone 3 (medium potential), while the rest of the district, including areas of subsistence farming with cotton, tobacco and areas of large-scale coffee, sisal and pineapple farming, falls under agroecological zones 4, 5 and 6 (marginal, range and desert). The average farm size in the high potential zone is 2 hectares, although it varies from 0.5 to 20 hectares. In the low potential areas the average farm size is 4.2 hectares. Cotton, sunflower and tobacco could be sources of income although sisal, coffee and pineapples are grown on a large scale. In the small-scale farming areas, mixed farming is practised while in large-scale farms monocropping is the common practice.

There is a high rate of adoption of modern agricultural technology in the district. Fertilisers, pesticides and veterinary chemicals are widely used. Farm mechanisation is also relatively advanced, particularly in the large-scale farms in Makuyu Division where topography and the scale of farming permit it. As early as 1973, Makuyu Division had about 123 tractors and nine crawler-type tractors (for Kenya Cannery). There are attempts to encourage medium-sized power tillers for medium-scale farms and ox-driven implements for small-scale farms. Farmers in the district continue to use

FIGURE 9

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SOURCE: Kenya, Ministry of Finance and Economic Planning, 1980c.

farm inputs in increasing quantities. The main sources of farm inputs are the Kenya Farmers' Association depots at Maragua, Thika and Sagana urban centres and the Murang'a District Union.

Agricultural labour in the district is mainly family labour. Hired labour is used by only about 30% of the farmers. The labour shortage during the peak periods (e.g., harvesting, planting) results in produce loss through spoilage in the field and reduction of crop yields due to untimely operations. Because of land pressure, emphasis is laid on increasing both the land and labour intensity of agriculture (crop and livestock production) through the adoption of modern technology.

#### 4.2.2 Crop Production

A large proportion of the district is suited to crop production. The main limiting factor is rainfall. In a few areas where rainfall is inadequate, crop production by irrigation is practised. Only about 8,414 hectares are under small-scale irrigation in the district, although about 33,700 hectares in the low potential areas could be made productive with irrigation. These small-scale irrigation systems, using sprinkler methods, are mainly in estates in Makuyu Division and on individual farms in Gikindu and Maragua Ridge. Irrigation is also carried out by Murang'a County Council and Forest Department at Kamahindu, fruit and tree nurseries respectively, and the Horticultural Research Farm near Thika. In these irrigated areas, no serious problem of salinisation has yet been detected.

In the small-scale sector, land preparation is mainly by the use of jembe, panga, and fork jembe. Organic manures, which are in short supply because of the competition between livestock and crop production, are often

imported from other districts such as Kiambu. The use of chemical fertilizers is, however, on the increase in the district (see Section 4.2.4 on agrochemical use). Although it is not easy to establish land productivity trends in the district, it appears that land productivity, as evidenced by yield levels, is increasing. The yield levels are relatively high in most of the district. Yield levels of a few crops for some years are given in Table 4.3. These figures are, however, district averages with large standard errors and so must be viewed only as guidelines. A yield of about 2,500 kg/ha of maize during the year 1975 (Table 4.3) is below the yield of about 4,200 kg/ha reported from Kisii District, which is a high potential area. A yield of 12,400 kg/ha of bananas in the district during the year 1975 is also below the yield of 30,000 kg/ha of bananas reported for Kisii District, while of a yield of pineapples of 70,000 kg/ha during the same year in Murang'a (under intensive systems) is above a yield of 45,000 kg/ha of pineapples reported for Kisii (individual farmer production).

Much emphasis, both in the past and the present, has been put on the production of cash crops, particularly coffee, in the district. Table 4.3 gives crop production statistics from the years 1974 to 1980 for the main crops grown in the district. Tea and coffee are the main agricultural sources of cash income. Although maize and beans are still the crops to which the greatest amount of land in the district is devoted, tea and coffee are gradually displacing these and other food crops and livestock in the upper and middle zones, respectively. Pyrethrum, cotton, tobacco, sunflower, pineapples, sisal and macadamia nuts are other important cash crops in the district while citrus, passion fruit and temperate fruits are also

TABLE 4.3:  
MAJOR CROPS: HECTARAGE AND PRODUCTION, MURANG'A DISTRICT, 1974-80

CROP (variety)		1974	1975	1976	1977	1978	1979	1980
Maize (hybrid, Katumani, local)	ha	37,518	30,502	28,968	33,544	30,038	23,689	25,890
	tons	NA	76,263	78,300	75,492	67,602	39,024	48,799
Beans (Rosecoco, Canadian wonder, Mwezi Moja, Wairimu)	ha	10,466	16,343	15,250	15,370	13,802	12,196	22,799
	tons	8,772	11,544	8,235	11,093	8,695	4,540	16,638
Pigeon Peas	ha	NA	143	135	120	292	535	800
Cow Peas	ha	NA	NA	NA	700	570	105	68
Sweet Potatoes	ha	728	681	700	NA	1,014	NA	650
Irish Potatoes	ha	5,076	5,330	6,216	6,217	4,039	3,086	NA
Coffee	ha	8,772	9,384	9,500	11,416	16,607	NA	12,615
	tons	7,427	5,077	6,202	9,726	7,632	NA	10,034
Tea	ha	NA	5,785	6,126	6,805	7,698	NA	NA
	tons	10,450	NA	14,842	23,292	24,999	NA	24,452
Sisal	ha	5,340	5,444	NA	NA	7,860	8,075	1,760
Wattle	ha	NA	8,000	8,000	7,000	5,600	NA	NA
	tons	NA	5,600	8,146	5,897	5,538	NA	5,118
Cotton	ha	360	704	1,432	NA	NA	1,388	1,379
Pyrethrum	ha	129	186	182	109	52	30	11
Macadamia Nuts	ha	662	662	NA	617	430	410	259
Sunflower	ha	NA	14	16	115	100	264	12
Sugar Cane	ha	NA	143	135	120	292	535	800
Bananas	ha	3,402	3,627	2,780	3,792	4,867	4,646	4,646
	tons	NA	45,100	NA	32,684	41,953	40,050	38,000
Pineapples	ha	NA	3,057	3,172	2,000	3,188	3,607	4,160
Passion Fruit	ha	304	380	277	217	176	150	100
Plums	ha	158	161	136	173	196	190	190
Oranges	ha	164	173	NA	NA	NA	NA	NA
Mangoes	ha	139	142	145	164	180	180	180
Avocado	ha	7	10	10	80	100	115	140
Tomatoes	ha	121	205	196	274	198	228	200
Cabbages	ha	493	612	737	733	612	582	556
French Beans	ha	18	21	NA	84	120	130	NA
Tobacco	ha	68	140	NA	98	104	155	NA
	tons	NA	70	NA	70	89	102	59

SOURCE: Kenya, Ministry of Agriculture, for the years cited.

beginning to be important cash earners. Subsistence crops include maize, potatoes, beans, bananas, green grams and a variety of vegetables.

In addition to the main types of farming activities shown in Figure 9, various other crops are grown scattered throughout the district. Macadamia nuts are grown mainly in the middle zone. Maize, sweet potatoes and yams (a famine crop) are grown scattered all over the district whereas sugarcane and arrowroot (also a famine crop) are grown scattered in the river valleys. Millets, pigeon peas, cassava (a famine crop), sunflower and cotton are grown in the lower zone of the district. As can be seen from the data in Table 4.3, the production of coffee, tea, sugarcane, sunflower, cotton, tropical and temperate fruits, and tobacco have shown a general increase over the last seven years. The production (as shown by hectareage) of beans, pineapples and bananas has increased, though inconsistently, and horticultural crops are becoming more and more popular. On the other hand, the production of maize, wattle, and recently sisal has decreased.

The main crop pests and diseases in the district are as follows:

Cotton	Bollworms and stainers.
Coffee	Coffee berry disease, leaf rust, leaf miner, thrips, antestia bug, and scales.
Maize	Stalk borer, leaf blight, maize streak, mosaic.
Pyrethrum	Thrips.
Beans	Beanfly, bollworms, aphids, anthracnose, haloblight.
Bananas	Banana weevil.
Cassava	Cassava mosaic.

Citrus	Red and green scales, aphids and mites.
Potatoes	Blight.
Passion fruit	Brown spot.
Vegetables	Caterpillars, beetles, mites, aphids, bacterial wilt, blight and mildews.
Tea	Armillaria, red grevice, mites, red spider mites, sytitis.

#### 4.2.3 Livestock Production

Livestock farming is practised mainly on small-scale farms for cash and for household consumption. The main activity is rearing of grade and cross-bred dairy cattle in the high and medium potential areas of the district. In the marginal areas of Makuyu, Kiharu and Kigumo Divisions, indigenous cattle are predominant. Overall, however, the number of exotic animals is increasing as that of indigenous cattle is decreasing. There are five ranches in Makuyu Division with about 10,860 head of cattle. Sheep, goats, pigs, poultry, rabbits and bees are also kept in the district. Table 4.4(a) gives an inventory of livestock in the district for the period 1975-80, while Table 4.4(b) is a breakdown by divisions. The data in the table show that there were more animals in the district in 1980 than in other years. There are fluctuations in the number of animals from year to year because of disease mortality, livestock movement within and outside the district, and slaughter. Livestock numbers are higher in the higher potential areas. Cattle, sheep, goats, poultry, and rabbits are found throughout the district, although by 1980, Kangema Division had the highest number of cattle

TABLE 4.4(a):

## LIVESTOCK PRODUCTION STATISTICS, MURANG'A DISTRICT, 1975-80

Type of Livestock	1975	1976	1977	1978	1979	1980
Cattle	102,381	113,790	127,970	143,640	117,576	154,676
Pigs	11,038	15,832	10,500	11,890	13,324	NA
Poultry	50,265	44,530	44,910	46,370	NA	44,613
Sheep	24,812	15,685	16,690	28,858	93,038	62,480
Goats	29,291	25,010	24,114	28,729	27,011	69,660
Rabbits	NA	NA	NA	5,500	5,682	NA
Bee hives	3,831	3,823	3,597	3,603	3,823	NA

SOURCES: Kenya, Ministry of Agriculture, for the years cited.  
Kenya, Ministry of Livestock Development, for the years cited.

TABLE 4.4(b):

## LIVESTOCK DISTRIBUTION BY DIVISION, MURANG'A DISTRICT, 1975

Type of Livestock	Kiharu	Kandara	Kigumo	Kangema	Makuyu	Makuyu Ridge
Cattle	19,863	24,860	20,810	21,060	13,965	823
Pigs	3,072	3,852	3,006	800	275	33
Poultry	19,010	18,710	8,630	3,800	--	215
Sheep	4,900	6,214	4,894	5,490	3,000	314
Goats	8,890	7,542	8,257	3,264	1,000	338

SOURCES: Kenya, Ministry of Agriculture, 1975.  
Kenya, Ministry of Livestock Development, 1975.

and sheep, Kigumo had the highest number of birds, and Kiharu Division had the highest number of goats.

Cattle are reared on a free range system in the lower zone (Makuyu) where beef cattle predominate and in the higher zone, while in the middle coffee zone, stall raising is most common. A feed lot system exists at the Kenya Cannery Ltd. Enterprise. Sheep and goats are reared on a traditional free range system all over the district while rabbit-keeping is confined to 4-K clubs. Bee-keeping in the middle coffee zone has not been successful because of insecticide sprays, but it has been possible in the upper areas towards the Aberdares and in the lower zone.

Pasture and fodder distribution in the district during 1980 was as follows:

TABLE 4.5: PASTURE AND FODDER HECTARAGE, 1980

	<u>Kandara</u>	<u>Kigumo</u>	<u>Kiharu</u>	<u>Kangema</u>	<u>Makuyu</u>	<u>Total</u>
Pasture (ha)	1,996	5,268	2,908	5,833	4,538	20,543
Fodder (ha)	1,529	4,150	2,570	4,982	487	13,718
<u>Total (ha)</u>	<u>3,525</u>	<u>9,418</u>	<u>5,478</u>	<u>10,815</u>	<u>5,025</u>	<u>34,261</u>

SOURCE: Kenya, Ministry of Livestock Development, 1981.

In recent years, greater emphasis has been placed on fodder production and pasture improvement. The total hectareage under pasture and fodder crops has increased from 29,990 hectares in 1975 to 34,261 hectares in 1980. Kangema Division had the highest hectareage under pasture and fodder in 1980.

The fodder and pasture crops used for livestock feeding in the district are sweet potato vines, napier grass, bana grass, hay and maize stalks. These crop residues are in short supply since livestock feed and organic manuring are competitive uses for them. Supplemental feeding (involving the use of purchased feeds) is also practised by people who can afford it, mainly in the middle coffee zone where stall feeding is common. The purchased livestock feeds are mainly concentrates that include mineral salts and grain products. These are given to dairy cattle, pigs and poultry.

Livestock production in the district has increased both in terms of number and diversity due to improved veterinary services and artificial insemination. Approximately 100,000 animals have been inseminated each year over the last few years and, generally speaking, the number has increased over the past six years. This has considerably increased the number of crossbred animals in the district. The main types of cattle include the exotic Friesian, Guernsey, Ayrshire and Jersey breeds and the indigenous Boran and Zebu. Boran and Zebu cattle are kept mainly in the lower zones although grade cattle are currently also kept in these areas. Rabbit breeds in the district include New Zealand, Kenya white, and various crosses, while chickens, ducks and geese are the main poultry types.

Improved veterinary services including disease control and dipping facilities have played an important role in the increase of livestock in the district. Cattle population has increased steadily since a tick control project was introduced in the district in 1977. However, tick control is made difficult by livestock movement from neighbouring districts and by problems associated with dip facilities, which include lack of water, flooding of dips, lack of acaricides, and tick resistance. Besides dips, there

are also spray races and foot baths. Table 4.6 gives data on the number of dips, the number of animals dipped and the number of operational spray races for the period 1976-1980.

The data in the table show that since 1976, both the number of dips and the number of cattle dipped have increased annually. In 1980, more than twice as many animals were dipped as in 1976. In recent years, there has been an intensification of vaccination, and meat inspection was taken over

TABLE 4.6: CATTLE DIPS, SPRAY RACES AND NUMBERS OF CATTLE DIPPED, 1976-80

	1976	1977	1978	1979	1980
Number of Dips Operating	218	229	230	259	260
Number of Animals Dipped	2,182,182	2,299,260	3,240,836	4,368,279	4,631,809
Number of Spray Races	NA	6	NA	16	NA

SOURCES: Kenya, Ministry of Agriculture, for the years cited.  
Kenya, Ministry of Livestock Development, for the years cited.

in 1980 by the Ministry of Livestock Development from the Ministry of Health. The capacity to treat sick animals also increased substantially. Table 4.7 gives details concerning the main livestock diseases in the district (1975-80). The types of chemicals and veterinary preparations used in the district are discussed below in Section 4.2.4. The data show that over the past six years the tick borne diseases -- East Coast fever,

LIVESTOCK DISEASE STATISTICS, MURANG'A DISTRICT, 1975-80  
(number of cases reported per year)

Disease	1975	1976	1977	1978	1979	1980
Foot and Mouth	5(C)	1(C)	--	--	--	2(C)
Johnes Disease	--	--	--	--	1	--
Trypanosomiasis	--	225	11	3	--	1
Rinderpest	--	--	--	--	1	--
East Coast Fever	373(C)	314(C)	260(C)	67(C)	43(C)	52(C)
Anaplasmosis	943(C)	752(C)	NA	299(C)	68(C)	49(C)
Redwater	32	16(C)	NA	11(C)	2(C)	1(C)
Newcastle Disease	1(F)	1(F)	1(F)	--	--	--
Marek's Disease	--	--	u(F)	2(F)	u(F)	--
Fowl typhoid	1(F)	1 (F)	2(F)	3(F)	6(F)	2(F)
Scour	--	u	--	u	u(C)	40(C) 10(P)
Calf Pneumonia	--	--	--	--	u	13(C) u(S,G)
Mastitis	u(P)	u	--	u	134	570(P,C)
Foot Rot	--	--	--	--	--	34(C)
Hypocalcaemia	--	--	--	--	--	8(C)
Eye Infection	--	--	--	--	20	120(C)

KEY: C=cattle, F=fowl, P=pigs, G=goats, S=sheep, u=unspecified number of cases

SOURCES: Kenya, Ministry of Agriculture, for the years cited.

Kenya, Ministry of Livestock Development, for the years cited.

anaplasmosis, and redwater -- have been a major problem in the district. Anaplasmosis has had the highest incidence, but this has gradually been declining in recent years due to tick control campaigns. Trypanosomiasis also had a high incidence, but this has also decreased. At present it seems that mastitis, bracken fern poisoning, helminthiasis, fasciolosis, mange, malnutrition, agalactia (also present in pigs) and haemonchosis are major diseases and problems in the district. Poisoning of animals by organophosphorous and organochlorine based pesticides (including diazinon) and by the plant Lantana-Camara is also reported in the district.

Helminthiasis, fasciolosis and haemonchosis are in part due to the accumulation of contaminated water in places in the district. Organochlorine and organophosphate poisoning is due to the use of these pesticides for tick and insect control and the inadvertent exposure of animals to the residues. The two plants, Bracken fern and Latana Camara, that poison animals are both common in the district. Malnutrition and hypocalcaemia could both be corrected by supplemental feeding.

Table 4.8 gives data on livestock numbers in relation to fodder and pasture carrying capacity. Over the past six years, there has been an increase in the total area under pasture and fodder. Emphasis has been on the improvement of the land carrying capacity through better fodder and pasture management. This has involved a drive to encourage paddocking and fertilisation of fodder crops (e.g., coffee husks are being used to fertilise fodder crops). New fodder crops such as Guatemala and Nandi setaria grasses have also been introduced in the district in addition to those previously mentioned.

TABLE 4.8:

## LIVESTOCK NUMBERS IN RELATION TO THE LAND CARRYING CAPACITY

YEAR	Unit	1975	1976	1977	1978	1979	1980
Fodder and pasture	ha.	29,990	28,060	29,709	32,770	N/A	34,260
Stocking rate (overall)	ha/L.U.	0.21-0.3	0.2	0.29	0.29	N/A	N/A
Recommended overall stocking rate	ha/L.U.	0.5	0.5	0.5	0.5	0.5	0.5
Actual fodder stocking rate	ha/L.U. fodder	0.05	0.08	0.095	0.114	N/A	N/A
Targetted fodder stocking rate	ha/L.U. fodder	0.2	0.2	0.2	0.2	0.2	0.2
Fodder requirement deficit	ha.	N/A	N/A	N/A	9,732	N/A	N/A

SOURCE: Kenya, Ministry of Agriculture, for the years cited.

L.U. = Livestock Unit

The overall stocking rate indicates the number of hectares of land, including pasture and fodder crops, used to support a standard livestock unit (L.U.). The data in Table 4.8 show that the overall stocking rate decreased slightly from about 0.21 ha/L.U. in 1975 to about 0.29 ha/L.U. in 1978.\* However, for the system to be self-sustaining and to minimise environmental damage, it is recommended that there be 0.5 hectare to a livestock unit. Since emphasis is on increasing fodder production and the improvement of pastures and not on reducing livestock numbers, it is hoped that moving toward a system of zero grazing in the district will help forestall environmental damage from overgrazing. Fodder production is the component that can most readily be altered to match the stocking rate with the carrying capacity. Over the past six years, the fodder stocking rate (expressed as hectareage of fodder crop per livestock unit) has been higher than the recommended rate of 0.2 ha/L.U. but it has been approaching this level. It is estimated that to reach the recommended level in 1978 would have required about 9700 additional hectares of fodder crops, i.e., an increase of about 75% over the actual amount that year of 12,880 ha.

Although it might seem that the district stocking rates exceed the carrying capacity, it is difficult to say that the district is overstocked since under the existing management systems feeds in the form of fodder and supplemental feeds are imported from outside the district. Generally speaking, the district is not badly off in terms of overstocking and/or overgrazing. Emphasis, however, should remain on fodder production and pasture improvement.

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\*Note that the greater the number of hectares used, the lower is the stocking rate.

#### 4.2.4 The Use of Agricultural and Veterinary Chemicals and Products

Farmers in Murang'a District use substantial quantities of agricultural and veterinary chemicals together with other products. Appendix Table I lists the important chemicals together with vital statistics for the period 1974-81. The figures in the table are not inclusive of all the suppliers in the district but are mainly from the Kenya Farmers' Association (KFA) which supplies between 60% and 80% of chemicals used. The total quantities used in the district, thus, are higher than the figures quoted.

Fertilisers used in Murang'a District are mainly phosphatic, nitrogenous and compound fertilisers applied either foliarly or to the soil. While foliar fertilisers (e.g., Stinfal and Wuxal) are used mainly on large-scale coffee farms, the other fertilisers are used by small-scale farmers in the district. The available data show that Calcium Ammonium Nitrate (C.A.N.) is the most widely used fertiliser. This and compound 20:20:0 are used largely on maize. Diammonium Phosphate (D.A.P.) is used mainly on beans and potatoes. Other important fertilisers used include Single Superphosphate (S.S.P.) and Triple Super Phosphate (T.S.P.), Ammonium Sulphate Nitrate (A.S.N.), and the compound fertilisers. It seems that substantial amounts of nitrogen and phosphorous are being introduced into the district environment. Small amounts of calcium and potassium are also introduced to the system through the use of Calcium Ammonium Nitrate (C.A.N.) and compounds 15:15:15, 17:17:17 and 20:10:10.\* These might become environmentally

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\* The numbers represent weight percentages of nitrogen, phosphorus, and potassium, respectively.

significant, especially in causing eutrophication of bodies of water in the district and elsewhere. However, there is no monitoring of quantities released or environmental effects at present.

Over 40 different types of insecticides are used in the district. These are mainly organochlorines and organophosphates with small quantities of pyrethrins and carbamates. The data show that the organophosphates Gusathion, Sumithion and Diazinon are widely used, and DDT continues to be used mainly for stalk borer control in maize. The main storage insecticides are pyrethrum 0.2% and Malathion 2%. The main acaricides used for tick control in dips and spray races include Coopertox, Pfizertox, Supertox, Delnav DFF, Gardip, Bacdip, Toxaphene, and Sevin 85%. These often have to be changed because of the development of resistance.

Fungicides are very important in the district for the control of coffee berry disease and other fungal diseases. Over 18 different types of fungicides are used, of which various copper compounds are most important. Other important organic-based fungicides are Difolatan, Dithane M-45, Captafol and Delan. Herbicides are not extensively used in the district. They are used mainly on large scale farms. The most important herbicide is Gramoxone (paraquat). Round-up and Dowpon are also used.

No major environmental consequences of pesticides use in the district have yet been noticed, but there have been cases reported of organochlorine and organophosphate poisoning of cattle and poultry. Chemical effects on the district's environment are largely unknown, but they are probably affecting waterways and aquatic ecosystems and possibly birds and other wildlife. Farmers and agricultural workers can also be harmed by exposure to pesticide chemicals. Even if there is not immediately apparent effect;

long-term effects can be serious. Training and instruction in the proper use of these chemicals is extremely important. However, farmers often cannot afford adequate protective equipment, so it is important that the use of very toxic chemicals be minimised.

It is likely that the use of all types of agrochemicals in Murang'a District will continue to increase, particularly for cash crop production. Coffee, tea and horticultural crops will continue to involve the most intensive chemical use. As labour becomes more expensive and scarce in peak periods, herbicide use may also increase, although this will depend on trends in relative crop and input prices. Because of the increasing intensity of land use for crop production, use of chemical fertilisers is almost certain to continue increasing. The use of crop residues as organic manures may be limited because of the competitive need for livestock feeding, but the use of coffee husks to fertilise some cash and fodder crops is increasing. The environmental and health effects of all these chemicals can be serious, and their use and consequences should be monitored more closely.

#### 4.3 FOREST RESOURCES

It is estimated that between 15% and 16% of the total district land of Murang'a is covered by forests. As discussed in Section 2.6 these forests constitute zone II type of vegetation and occur in the western part of the district. The main forest area is part of the great Aberdare Forest which covers the Aberdare Range. An extension of this is Gatare/Wanjerere Forest. This extends from Thika River in the south to North Mathioya and Kiamuturi Rivers to the north and includes a total of 1110 hectares of productive forest.

Kimakia is another significant forest in the district. This extends from Thika River southwards to Chania River and connects with Kieni Forest in Kiambu District. It extends into Kariata Location in Kandara Division and forms its eastern limit. Kimakia Forest has 2000 hectares of softwood plantations.

Besides these main forests, there are smaller ones scattered through the district. Forested land in the district covers a total of 58,9000 hectares. Species composition of trees in these forests include indigenous hardwoods such as Musharagi, Mueri, Muchugu and many others. The exotic softwoods include cypress, pines and cedar.

Although there are no figures showing the extent of the forest five or ten years ago, it is certain that forested land continues to diminish. Deforestation in the district is caused by several factors, including accidental fires, the indiscriminate felling of trees, burning of charcoal and clearing of forest to make room for other land uses, especially arable agriculture and settlements. The diminution in forest cover in the district causes unfavourable environmental consequences. Water catchments are being affected, energy in form of woodfuel is becoming increasingly unavailable, timber for building material is becoming scarce, and perhaps worst of all, soil erosion is being exacerbated, with increased siltation of the Tana River hydroelectric power dams.

The Rural Afforestation Programme dates back to 1973 when the Forestry Department opened a rural office to promote afforestation in the district. This programme has been responsible for the gazettelement of several hills in the district, afforestation of some areas and the establishment of tree nur-

series. Gazettement of several hills including Kangure, Kiambicho, Kiamuti and Karua is completed pending afforestation. The programme has also managed to establish and maintain the only operational tree nursery in the district at Kamahindu. The following table shows the extent of afforestation in the district:

TABLE 4.9: AFFORESTATION PROGRAMME, MURANG'A DISTRICT, 1980

<u>Hill</u>	<u>Area Available (ha)</u>	<u>Area Afforested (ha)</u>
1. Kangure	189	30.0
2. Ithanga	809.4	134.7
3. Kiamuti	182	Nil
4. Karua ABC	210	Nil
5. Kiambicho	376	Nil

SOURCE: Kenya, Ministry of Environment and Natural Resources, 1980.

Despite its almost ten years of existence in the district, this programme has not promoted afforestation at the expected pace because of the following factors:

- district Development Committee funds, on which the programme has depended, are inadequate.
- lack of personnel and equipment.
- lack of follow-up to monitor the success of the seedlings acquired by farmers.

Another problem has been lack of adequate support for agroforestry, i.e., growing trees on farmers' shambas for their own uses such as fuelwood,

building materials, etc. Tree species have to be compatible with agriculture for this purpose. Unfortunately, the Forestry Department is mainly geared toward providing seedlings and information about forest species and has as yet been unable to effectively promote agroforestry. This would require either efforts by agricultural workers or a reorientation of some of the emphasis of the Forestry Department.

#### 4.4 PROBLEM SUMMARY

##### A. Land Tenure

1. Continued subdivision of land holdings, particularly in the high potential areas in the district, has frequently left farmers with holdings of uneconomic size. Subdivision is likely to continue because of population pressures, and as a result, farmers may have difficulty devoting adequate land and time to soil conservation and other resource management practices.

##### B. Agriculture

1. The increasing intensity of land use causes pressure on soil fertility and other resource inputs such as trees and water.
2. Labour shortages during peak periods cause reduction of yield levels and spoilage in the field.
3. Inadequate rainfall in the lower areas of the district limits the range and productivity of crops. Irrigation is used to some extent but could be increased.

4. The emphasis on cash crops such as coffee and tea in many parts of the district has limited production of food crops, making the district vulnerable to food shortages in poor harvest years. Further population growth will increase the vulnerability.
5. Numerous pests and diseases affect crops in the district, especially coffee, and make large-scale use of chemical pesticides necessary.
6. Ticks and various diseases affect livestock in the district. Adequate tick control is hindered by such problems as lack of water, flooding of dips, lack of acaricides, and the development of resistant tick varieties, and problems related to the administration of dip facilities.
7. The stocking rate of livestock on rangeland and the production of fodder crops could be improved in order to minimise ecological damage caused by livestock grazing.
8. The use of agrochemicals in the district has been increasing regularly and threatens to cause a number of environmental problems. Fertilisers may cause water pollution and eutrophication of bodies of water in the district. Pesticides can and have caused poisoning of livestock, water contamination, poisoning of farmers and agricultural workers, poisoning of bees, birds, fish, and other wildlife, and may leave food residues that can affect consumers. Regular monitoring of environmental levels of these agrochemicals, which does not take place at present, is needed. Farmers should also receive adequate training in their use so as to minimise health and environmental problems.

C. Forests

1. Deforestation for fuelwood, charcoal, and land clearing help cause soil erosion and water siltation.
2. The afforestation programme in the district is hindered by lack of funds, personnel and equipment. There is also a lack of follow-up in monitoring the success of farmers' seedling plantings.
3. The Forestry Department has, on the whole, not given adequate attention to agroforestry by individual farmers. The seedlings provided in nurseries are often more suitable for forests rather than agricultural use on farmers' plots.

## CHAPTER 5: INFRASTRUCTURE AND ECONOMY

### 5.1 HOUSING

Most of the houses in Murang'a District are semi-permanent with wooden or mud walls and corrugated iron roofs. Urban areas are mainly characterised by permanent structures, especially in the town centres. On the outskirts of these centres, however, lie slums with various temporary structures. Occasional permanent houses are also seen in rural areas of the district.

Housing problems in the district are most acute in urban centres such as Murang'a town, Kandara, Kangema and others, which are facing a great housing shortage. This is because there are not enough housing schemes in the district to cope with the large population movements of recent years. In 1979, the County Council in collaboration with the National Housing Corporation undertook to construct some rural housing schemes on an experimental basis. These included the Kandara, Kigumo, and Kangema Housing Schemes. They had capacities of only ten, six and six houses respectively and were intended to be owner occupied. Each scheme had over 40 applicants, illustrating the high demand for housing. The Murang'a town Council also undertook such a programme at the Mumbi Estate, but again this was inadequate, and slums are common even around the town itself. These slums lack most necessities such as proper sewerage, adequate water, lighting and general infrastructure. The nature of the dwellings themselves does not encourage most of these services since they are made of mud walls or cartons with

corrugated iron or grass thatched roofs. The majority of the squatters are people whose main source of income is from casual labour, either in the urban areas or in agriculture, e.g., coffee and tea picking and sisal cutting. Generally, they cannot afford better building materials. The problem of housing is becoming more acute now with increasing migration into urban areas in addition to natural population increase. As a result, more slums are developing in most of the urban centres which are characterised by severe overcrowding.

At the moment the County Council has no immediate plans for constructing additional housing either for rental or owner occupation. Thus the problem of housing will continue to be felt in the district if no relief programmes and schemes are established soon.

## 5.2 HEALTH

Health units in Murang'a District include hospitals, health centres and dispensaries. Most are run by the Government, but some are also managed by other institutions, including missions, firms and private individuals. (See Table 5.1)

The distribution of these health units varies from one division to another, as shown in Table 5.2 and in Figure 10. Some areas, especially in Makuyu Division and in some of the more remote regions in other divisions, have very inadequate facilities to cater for the existing population.

There is a total of 64 health units in the district which cater to a district population of 648,333, thus giving a ratio of one unit per 10,120

**TABLE 5.1: HEALTH UNITS, MURANG'A DISTRICT, 1980**

<u>Type of Unit</u>	<u>Government Maintained</u>	<u>Private</u>	<u>Mission</u>	<u>Total</u>
Hospital	2	-	2	4
Health Centre	6	-	1	7
Health Sub-Centre	4	2	-	6
Dispensary	32	5	10	47
<b>TOTAL</b>	<b>44</b>	<b>7</b>	<b>13</b>	<b>64</b>

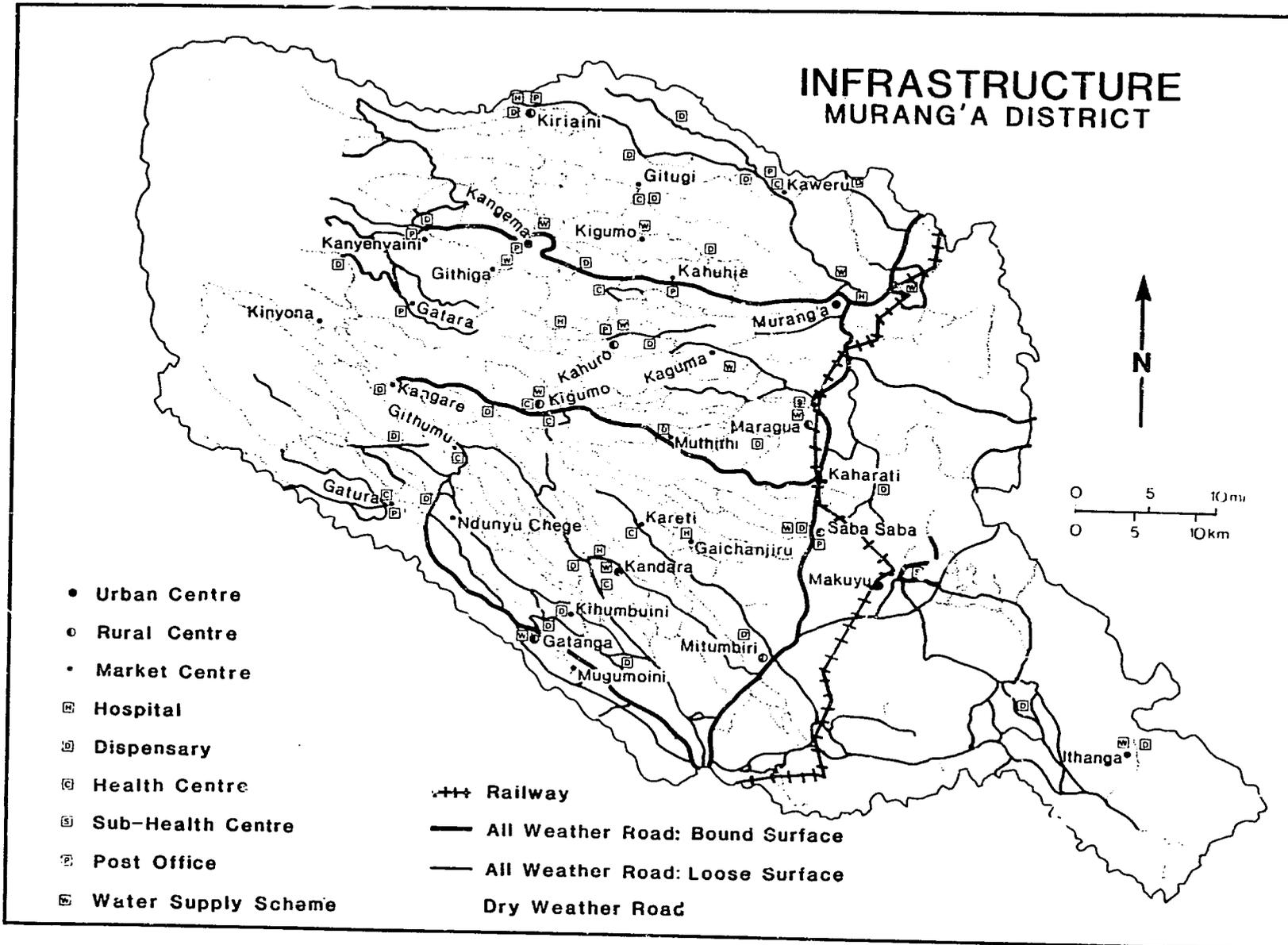
SOURCE: Kenya, Ministry of Health, 1981.

**TABLE 5.2: DISTRIBUTION OF HEALTH UNITS AND POPULATION**

<u>Division</u>	<u>Hospitals</u>	<u>Health Centres</u>	<u>Health Sub-Centres</u>	<u>Dispensary</u>	<u>Total Units</u>	<u>Total Population Served</u>
Kandara	1	2	1	10	14	181,721
Kiharu	2	1	-	15	18	138,182
Kangema	1	1	2	11	15	132,912
Kigumo	-	2	2	7	11	135,116
Makuyu	-	1	1	4	6	60,402
<b>TOTALS</b>	<b>4</b>	<b>7</b>	<b>6</b>	<b>47</b>	<b>64</b>	<b>648,333</b>

SOURCE: Kenya, Ministry of Health, 1981.

FIGURE 10



people. It is evident that the existing health units are inadequate. This is demonstrated by the long queues at the health units and the long distances most patients have to travel to a health unit especially in areas such as Ngoliba in Makuyu Division. The total bed capacity in the district is only 568, which is inadequate to cope with the large population.

To ease the congestion at the health units and save the people long treks, each health centre has one mobile clinic and staff team attached to it. These clinics treat illnesses, provide preventive care, and dispense health education and information. There is also a mobile clinic for mental illness, though since it was started very recently it operates only in Sabasaba, Kangema and Muriranjas.

The diseases with the highest incidence rates for the past two years in the district are shown in Table 5.3. It is evident from this table that clinical malaria, diarrhea and gonorrhoea are the most common diseases. Many of the diseases have an environmental component, especially where sanitation and water supply are relevant factors (e.g., malaria, diarrhea, dysentery, etc.). Among the health problems and diseases that have been increasing rapidly in recent years are mental illness, malnutrition and venereal disease. Table 5.4 shows mental illness cases treated at various health centres in the district in 1980.\*

Malnutrition was reported throughout the district, but it is most pronounced in Makuyu Division, Gikindu, Mbiri, and Gaturi locations, and

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\* It should be noted, however, that these figures are those available in the hospital records and that they represent only a fraction of the total number of people suffering from mental illnesses in Murang'a District.

**TABLE 5.3: HUMAN DISEASE INCIDENCE**

Name of Disease	1979		1980	
	Cases	Deaths	Cases	Deaths
Clinical malaria	56,778	17	54,929	8
Hoba pneumonia	9,356	16	7,805	-
Gonorrhoea	17,898	-	10,800	-
Diarrhea	21,363	-	21,922	-
URTI	15,162	-	4,644	-
Gastroenteritis	8,857	1	3,627	-
Measles	7,805	-	9,356	66
Dysentery	1,153	-	3,102	-
Influenza	5,281	-	3,713	-
Chicken pox	3,857	-	3,355	-
Tetanus	97	-	44	9
Tuberculosis	591	26	357	31
Meningitis	244	23	139	43

SOURCE: Kenya, Ministry of Health, 1980.

**TABLE 5.4: MENTAL ILLNESS IN MURANG'A, 1980**

DIVISION	HEALTH CENTRE	CASES TREATED
Kangema	Kangema	116
	Nyakianga	82
Kigumo	Kigumo	88
	Sabasaba	52
Kiharu	Muriranjias	80
	Murang'a	394
Kandara	Kandara	66
<b>TOTAL</b>		<b>878</b>

SOURCE: Kenya, Ministry of Health, 1980.

Murang'a town. To deal with the problem, various mobile clinics have been set up which visit most health centres and present lectures and demonstrations to patients on nutrition. However, trained nutritional staff and transport are both in short supply. There are only eight nutritionists in the district and the problem of transport is acute.

The increase in venereal disease in the district is most likely related to the growth in urban migration, especially among young males looking for work.

Acceptance of family planning practices in the district has been somewhat hindered by social and religious beliefs. Although there are a number of family planning health units, less than one-fifth of the appropriate population attend them. Of those who do attend many give up shortly afterwards for various reasons.

Major problems in the district in relation to health care include:

- (i) Inadequate staff and transport. The district has an acute shortage of trained medical staff which has resulted in closure of some health units. The transport available is insufficient to serve all areas; thus there are too few and poorly run mobile clinics.
- (ii) Lack of sufficient drugs in the health units is common. The health units also lack up to date hospital equipment.
- (iii) Lack of adequate food for hospitalised patients was also reported.
- (iv) Some health units are inadequately supplied with water. Out of 64 health units in the district, 23 of them suffer from water shortage; these include five each in Kigumo and Kiharu, eight in Kangema, one in Kandara, and four in Makuyu. The problem of water shortage not only paralyses the work of these units, but also results in poor cleanliness standards.
- (v) The inadequacy of health units in the district is especially severe in Makuyu Division which has only six widely spread

units. As a case in point, residents of the Ngoliba area have to travel over 15 miles to their nearest health unit.

### 5.3 EDUCATION

Murang'a District has a wide variety of educational institutions, the majority of which are primary and secondary schools as shown in Table 5.5. Other educational institutions found in the district include nurseries, village polytechnics, adult education centres and colleges.

TABLE 5.5: DISTRIBUTION OF EDUCATIONAL INSTITUTIONS

<u>Division</u>	<u>Primary Schools</u>	<u>Secondary Schools</u>		<u>Harambee and Private Schools</u>	
	<u>Govt</u>	<u>Govt</u>	<u>Govt/Har.</u>	<u>Primary</u>	<u>Secondary</u>
Kangema North	32	3	2	-	6
South	36	8	7	-	8
Kiharu East	38	3	-	-	6
West	46	5	14	-	6
Kandara East	36	3	4	-	14
West	44	4	10	-	13
Kigumo East	37	5	1	1	9
West	27	2	1	-	7
Makuyu	38	1	1	1	2
<b>TOTAL</b>	<b>334</b>	<b>34</b>	<b>40</b>	<b>2</b>	<b>71</b>

SOURCE: Kenya, Ministry of Education, 1980.

There are 530 nurseries in the district with a total enrollment of 28,862 pupils. There are about 400 adult educational centres and about 10

village polytechnics. There is only one college in the district giving technical courses, the Murang'a Institute of Technology. Total primary school enrollment for 1981 was recorded as 191,924 (see Table 5.6). This represents the large majority of the primary school age population (ages 5-14) of over 213,000 (figures on secondary school enrollment were not available).

TABLE 5.6: ENROLLMENT OF PRIMARY SCHOOLS BY SEX

Division	Total Number of Boys	Total Number of Girls	Total
Kangema	20,664	21,040	41,704
Kiharu	20,786	20,016	40,802
Kigumo	20,761	20,754	41,515
Kandara	26,715	25,861	52,576
Makuyu	8,028	7,299	15,327
<b>TOTAL</b>	<b>96,954</b>	<b>94,970</b>	<b>191,924</b>

SOURCE: Kenya, Ministry of Education, 1981.

In addition to the standard National Curriculum, agriculture courses focusing on both theoretical and practical work are required in many schools in the district. These are intended to equip the pupils with a sound agricultural background that they can use within their own homes for better crop production and their future livelihoods. Since 1979, tree nurseries in the schools have been developed, showing a growing awareness of the importance of trees in helping to conserve soil in the district. As a result of this, tree planting has now become a common activity in most schools. The establishment of fish ponds in schools is another possibility that may be

implemented in the future. It is hoped that this may begin in Kandara through the Muchuri Water project.

Apart from these, other extracurricular activities that can promote environmental awareness include the 4-K Clubs, craft groups, geographical and wildlife clubs, and scouting and girl guides, although these are not available in all schools.

As was noted above, there are 400 adult educational centres in Murang'a District. The curriculum followed in each centre depends on the people who attend, especially in the beginners' classes. The languages used in such classes are mainly Kikuyu and Kamba, although in post-literacy classes, Swahili and English are taught.

Most of the educational institutions in the district face similar problems. Untrained teaching staff, for instance, affects the primary and harambee schools especially. Of the 5054 primary school teachers in the district, 653 of them are untrained. Although the figure for untrained secondary school teachers is not available, it is evident that there are some harambee secondary schools with untrained teachers. However, each year a good number of the primary untrained teachers are taken for in-service training at the different teachers' training colleges in the country. This helps alleviate the situation, but because of the continuing increase in the number of primary age school children, the availability of trained teachers will continue to be a problem.

Overcrowding and understaffing is another problem related the shortage of teachers and classroom space. This is especially severe in primary schools where a teacher may have to teach a class of over 50 pupils.

The government provides most of the school equipment although this may be delayed due to management and communication problems. Transport problems also affect the school inspectors who are supposed to visit the schools in the district and check on quality of education, progress and needs. The District Education Officers have two cars which they sometimes lend to the inspectors, but the inspectors do not have their own transport, as they are supposed to.

Another educational problem is the seasonal variation of school attendance. A large percentage of pupils both in primary and secondary schools are absent from schools during the coffee picking season of September to November each year. Families often require such labour from their children, especially when their income does not allow for hiring of sufficient casual labourers. The adult literacy classes are also affected during this period since the students of these classes include many family breadwinners. Likewise, there is low attendance in adult literacy classes during March and April because this is the period for preparing the shambas. These seasonal demands also affect the majority of other educational institutions in the district such as the village polytechnics and the college.

#### 5.4 WATER SUPPLY AND POLLUTION

The rivers of the district are the main water sources. The major rivers are the Mathioya, Gondo, Thika, Maragwa, Tana, Makindi, Kiama, Irati, Kimakia and Chania. There are also seasonal rivers, mainly in Makuyu Division. Other water sources include boreholes and man-made dams, including Mathioya Dam, Kiboko Dam and Ngenye Dam.

Tables 5.7 and 5.8 provide details on the main urban and rural water supply projects and the location of many of them is shown in Figure 10. Most of these have been constructed through a combination of self-help support. On the whole, the production capacities of the rural supplies exceed those of the urban projects because they are meant to serve a larger population and area. The urban water supply needs for Murang'a Township are projected to grow about 6% per year, so that a considerable increase in supply capacity will be needed by 1984 when the population is expected to exceed 20,000.

TABLE 5.7: URBAN WATER SUPPLIES

NAME	PRODUCTION CAPACITIES (m <sup>3</sup> per month)	AREA SERVED
Murang'a	27,500	Township, Makuyu, Konguini
Sabasaba	2,400	Township, Kamahula (sub-locations)
Kangema	3,000	Township, Gakira market
Kigumo	2,000	Township, Kirere market
Maragwa	1,500	Township only
Kandara	1,200	Township only
Kahuro	1,000	Market only

SOURCE: Kenya, Ministry of Water Development, 1980.

TABLE 5.8: RURAL WATER SUPPLIES

NAME	PRODUCTION CAPACITIES (m <sup>3</sup> per month)	ESTIMATED POPULATION SERVED
Gatanga	44,500	40,000
Kahuti	15,500	127,505
Ithanga	14,000	28,000
Kandara	*	179,780
Kigumo	*	135,908
Mathioya	*	48,307
Gaturi	*	25,432

SOURCE: Kenya, Ministry of Water Development, 1980.

\* Still under construction

Additional water projects in the district are needed and are being encouraged. Also encouraged are small-scale water projects that will shorten the long distances people travel to water sources, as well as enhance personal hygiene. Obtaining adequate supplies of clear water is still a significant problem in many areas of the district. This is particularly true in areas such as Makuyu Division which do not have sufficient water supplies even for the existing population, let alone the new migrants. Small-scale projects which have been started to ease the congestion include

the Kiama water scheme, the Kinyangi water project, and Kambirwa and Mazira.

Most of the water schemes in the district have very old equipment which breaks down frequently. Among areas where old equipment causes problems with existing dams and piped water are Gatheru and Wanjengi in Withaga Location, Karuru and Kandengenye in Mugoiri Location, and Kaganda and Gatara in Murarandia Location.

Water pollution by industrial and agricultural wastes is an important environmental problem in the district, especially because so much of the population depends on untreated surface water supplies. Waste discharges from coffee factories contain both organic wastes and hazardous chemicals and are one of the main sources of pollution in the district. The wastewater from coffee processing can have an extremely high biological oxygen demand (BOD) if untreated: up to 9600 mg/l has been reported (Thitai, "Industrial Development and Recent Trends in Pollution Control in Kenya," 1981). When this wastewater is discharged directly into streams, as is common, water quality is severely degraded and the ecology of stream life is badly disrupted. In addition, coffee factory wastewater often contains toxic chemical residues from the fungicides and insecticides that are used extensively in coffee growing. These poisonous chemical residues can imperil human and animal health.

Recirculation systems and other waste treatment procedures can reduce the extent of water use by coffee factories and the associated pollution. It is estimated that coffee processing can require up to 20,000 gallons of water per ton of clean coffee without a recirculation system but as little as 100 gals/ton with efficient recirculation (Thitai, 1981). The Water Act

of 1976 requires that all coffee factories have recirculation systems and storage pits capable of holding all wastewater. In addition, water use is not supposed to exceed 5,000 gallons per ton of clean coffee, and none of this should be returned to any water course. Unfortunately, many of the factories in the district do not follow these standards. Many of the older factories, in particular, do not have any recirculation or pollution control systems, or have only partial systems. Table 5.9 gives the number of co-operative factories in the district with full, partial, and no recirculation systems. Only 40% of the 91 factories have full systems, while 22% have no recirculation systems. Major examples of factories without recirculation systems include Kigumo, Kiangoma, Kahuro, Kahaini, Wanjengi, Ndugamano, Kagundu-ini, Kagira, Kagumo-ini, Kabati, Gathigo, Kiru, Irati, Iyego, Kawanduma, and Mungana. In general, other means of treating coffee wastes, e.g., trickling filters or algal waste stabilisation ponds, are either too expensive or require too much land. Recirculation systems are generally more economically feasible, although not as efficient, and their installation in all coffee factories in the district should be enforced.

There is some recycling at present of coffee pulp and other wastes for use as mulch, fertiliser, and charcoal. Such uses of pulp should be expanded and extended through use of pulp as cattle feed, for biogas production, and other purposes. Support for research along these lines from both government and private sources should be enlarged.

There are also two sisal decortication factories in the district whose waste discharges can pollute waterways. Sisal wastewater has high BOD and is generally alkaline (low pH). The effluent is discharged into nearby ponds, which often overflow during the rainy season and contaminate

**TABLE 5.9: CO-OPERATIVE COFFEE FACTORIES IN MURANG'A DISTRICT  
WITH AND WITHOUT RECIRCULATION SYSTEMS**

Division	Full Recirculation	Partial Recirculation	No Recirculation	Total
Kangema	3	7	7	17
Kigumo	10	2	3	15
Kiharu	11	11	3	25
Kandara	12	15	7	34
District				
<b>TOTAL</b>	<b>36</b>	<b>35</b>	<b>20</b>	<b>91</b>

**SOURCES:** Kenya, Ministry of Co-operative Development, 1980.  
Kenya, Ministry of Agriculture, 1980.

neighbouring streams. As with coffee wastes, there is potential for using sisal wastes as cattle feed, agricultural mulch, in biogas production, or for other purposes. Research along these lines should be encouraged.

Agriculture also contributes to water pollution in the district. Much soil is washed into waterways during heavy rain periods, particularly in areas of intensive cultivation on steep hillslopes. In addition to increasing the silt load of streams, this runoff also often carries pesticide and fertiliser residues which lower water quality and threaten human and livestock health. Unfortunately, there is no systematic monitoring of water quality in the streams of the district. This should be a high priority activity, especially in areas where surface waterways are heavily used as sources of drinking water.

## 5.5 ENERGY

The main source of energy in both rural and urban areas in Murang'a District is wood, either burned directly or made into charcoal. Cooking is the major energy use, followed by heating and lighting. Approximate figures for consumption of various energy sources are available from the Household Energy Consumption Survey conducted by the Central Bureau of Statistics in 1978. This data is available only at a provincial level, not at the district level, but the data for Central Province can be considered indicative for Murang'a District. The total sample for Central Province consisted of 426 households, of which 328 were rural and 98 were urban (defined as centres with populations exceeding 2000). The survey included wood, charcoal, paraffin, gas and electricity as the main energy sources. Average monthly consumption of wood for those households that used wood was 443.2 kg (see Table 5.10). This consumption level for wood was the highest reported in any province in the country and was considerably above the national average of 389.6 kg. The main use for wood was for cooking, which accounted for over 84% of fuelwood use, while the remaining 10% was used for heating (see Table 5.11).

Charcoal usage averaged 62.1 kg per household that used charcoal. This was among the highest rates in the country, ranking slightly below that for Rift Valley and Western Provinces and Nairobi. As with fuelwood, most charcoal use, almost 83%, is for cooking and most of the remainder is for heating. People who use charcoal generally supplement it with fuelwood or gas for cooking. Overall in the sample for the province, charcoal use is

**TABLE 5.10: HOUSEHOLD ENERGY CONSUMPTION BY SOURCE,  
CENTRAL PROVINCE, 1978**

SOURCE	AVERAGE AMOUNT CONSUMED PER MONTH	
	A	B
Wood (kg)	443.2	326.3
Charcoal (kg)	62.1	19.8
Paraffin (l)	5.6	3.0
Gas (kg)	1.7	0.8
Electricity (kwh)	6.6	5.8

**NOTE:** A: All households reporting use of energy source  
 B: All households taking part in survey (these averages are substantially lower because households generally use either wood, charcoal, paraffin, electricity, etc.)

**SOURCE:** Kenya, Ministry of Finance and Economic Planning, 1981a.

**TABLE 5.11: PERCENTAGE DISTRIBUTION OF ENERGY USAGE,  
CENTRAL PROVINCE, 1978**

SOURCE	USE				Total
	Cooking	Heating	Lighting	Other	
Fuelwood	84.21	15.75	---	0.04	100.00
Charcoal	82.94	16.10	---	0.96	100.00
Paraffin	30.01	---	66.49	3.50	100.00
Electricity	2.17	---	97.83	---	100.00

**SOURCE:** Kenya, Ministry of Finance and Economic Planning, 1981a.

considerably less significant than fuelwood use. In terms of energy equivalents, over eight times as much fuelwood energy is used as charcoal.\*

Paraffin is principally for lighting and the remainder is mainly for cooking. Household paraffin consumption per month was 5.6 litres, slightly under the national average of 6.5 litres.

Electricity use in Central Province is almost entirely for lighting. Average monthly consumption by households using electricity was 6.6 kwh, which is considerably below the national average of 11.7 kwh. Electrification in the district is not complete but is more extensive than in many other rural areas. Electricity is available at three urban centres (Murang'a town, Kangema and Maragua), one rural centre (Sabasaba), two market centres (Kahuhia and Njumbi), and five local centres (Maragua Ridge, Muri, Ichagaki, Gitugu, and Mitubiri) (District Development Plan, 1979-83).

Gas is used almost entirely for cooking, and household consumption in the province averages 1.7 kg which is very close to the national average of 1.6 kg.

Table 5.12 shows the distribution of households by distance from sources of fuel. Over 70% of households in the sample were within one kilometre of their source of fuelwood, and over 88% were within two kilometres. These percentages are considerably higher than in other parts of the country. For charcoal, about 59% of households are within one kilometre and about 28% are between one and two kilometres. Sources of paraffin and gas are generally more distant, since these are usually purchased at markets.

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\* This is comparing average consumption for all households (column B in Table 5.10), using an approximate energy equivalent of charcoal to wood of two to one by weight.

**TABLE 5.12: PERCENTAGE DISTRIBUTION OF HOUSEHOLDS  
BY DISTANCE FROM SOURCES OF FUEL**

Distance	Wood	Charcoal	Paraffin	Gas
0-0.9 km.	70.81	59.18	18.30	53.40
1.0-1.9 km.	17.32	27.77	23.17	30.02
2.0-2.9 km.	5.56	6.78	13.68	-
3.0-3.9 km.	1.99	1.15	11.38	-
4.0-4.9 km.	3.35	2.97	5.47	-
5.0-5.9 km.	-	1.28	6.03	16.58
6.0-6.9 km.	0.21	-	2.78	-
7.0+ km.	0.70	0.87	18.59	-
<b>TOTAL</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

SOURCE: Kenya, Ministry of Finance and Economic Planning, 1981a.

Despite these figures, there is concern about depletion of woodfuel stocks in the district. This is a particular problem in areas of high population density where the land is used intensively for agriculture. In these areas, most forested lands have been depleted or are experiencing heavy pressure. As farmers' land is subdivided, less is left aside for fuelwood supplies from trees or shrubbery. In the future, people in both rural and urban areas will probably increase their reliance on charcoal brought from areas of more abundant wood supply, or they will need to plant more trees and hedges on their shambas for their own fuel use. This kind of agroforestry should be encouraged and seedlings of appropriate tree species should be made available to farmers as extensively as possible.

## 5.6 WASTE DISPOSAL

At present, there is only one sewerage system in the district, in Murang'a town. This is not adequate for the whole town since it has only one lagoon which is already overloaded. The lagoon was constructed in 1970 with an area of 0.843 acres and capacity of 40,000 gallons per day dry weather flow. The population then was 4,750 people. The present population of the town is over 15,000 people, and it is still served by this same lagoon. Thus there may be an environmental health problem in the near future if nothing is done soon. Plans for constructing another lagoon have existed since 1979 but so far they have not been carried out due to lack of funds. At the moment the sewers of Mjini Estate are being upgraded. If their wastes are channelled into the present lagoon then serious environmental problems may arise. In addition, the existing septic tank on the eastern side of the town is out of order, thus creating still another problem of waste disposal.

Encouragement of water-borne sanitation for human waste disposal has not been effective due to regular water shortages. As a result, people generally use pit latrines. In areas such as Kabatia, Sabasaba and Maragua, however, these often fill up rapidly because the underlying rock prevents pits much deeper than about seven feet. In some cases there is a lack of available land to dig any further pit latrines, which can result in potentially serious health problems.

Refuse from residential and commercial sources is usually disposed by burning or being buried at dump sites. In Murang'a town, municipal waste is dumped in old quarries. Other urban areas in the district do not have

organised refuse collection and disposal. In Maragua, the market organisers collect and burn the market refuse, but since the volume of refuse is very high, they do not do so effectively. Natural drainage is also poor, hampering any waste disposal projects that may be initiated in the town. In both Murang'a town and Maragua, as well as in other urban areas, health standards relating to waste disposal are poor and people may be exposed to health hazards as a result.

At Ithanga in Makuyu Division a latrine programme was initiated by UNICEF at the cost of Sh. 20,000/=. This was later taken up by the Ministry of Health. The area was selected because it was a new settlement area with poor settlers, and one aim of the project was to help eradicate hookworm diseases. Unfortunately, no other programmes of this kind have since been introduced in the district because of lack of donors and lack of funds from the Ministry of Health.

## 5.7 TRANSPORT AND COMMUNICATION

As shown in Figure 10 (see page 8), Murang'a District has a good road network which consists of both classified and unclassified roads. The classified roads have a total length of 2125 km (see Table 5.13 below) while the unclassified roads have a total length of 521 km.

Except for the comparatively sparsely populated areas of Makuyu Division and the forested zone, most of the district has an adequate road network, with heavier road concentrations in central locations with high population densities. As can be seen from Table 5.13, the majority of road length in the district consists of national trunk roads, minor roads and

TABLE 5.13: CLASSIFIED ROAD NETWORK IN MURANG'A DISTRICT

<u>ROAD CLASS</u>	<u>TOTAL LENGTH (km)</u>
International Trunk Roads	40.5
National Trunk Roads	583.9
Primary Roads	148.2
Secondary Roads	422.8
Minor Roads	611.9
Government Access Roads	3.7
Temporary Classified Roads	253.9
Tea Roads	38.9
Township Roads	21.2
<u>TOTAL</u>	<u>2125.0</u>

SOURCE: Kenya, Ministry of Finance and Economic Planning, 1980c.

secondary roads. Whereas the national roads link the major administrative and commercial centres, the minor roads dominate the agricultural regions. Unfortunately, they are frequently impassable during the rainy seasons. They are loosely surfaced, and often very uneven. The steep terrain and the soil structure of the district make the roads difficult to use and maintain, especially during rainy periods. Road maintenance in general is often inadequate, partly because of lack of finance. As a result, there are frequent problems in transporting agricultural produce to markets and in obtaining supplies. This is especially the case along roads crossed by rivers. Washed away bridges are common during the rainy season; affected

areas can then be completely cut off until repairs are made. There are also impassable roads in some of the forested areas, even outside the rainy season, leaving transportation in these areas almost at a standstill.

Transport of people and goods in the district is by private vehicles, buses, lorries, and matatus, as well as by carts. In addition, there is a railway line that passes through the district from Nairobi to Nanyuki. This serves Sabasaba, Maragua and Murang'a centres, although not as heavily as it ought to.

In all, there are more than 20 post offices in the district, found in the urban, rural and market centres. The majority of these are sub-post offices which are run either by agents or contractors and are therefore dependent on the larger and independent post offices of Maragua, Kangema and Murang'a which provide all the postal services. The main post offices are shown in Figure 10. In general, the postal services have deeply penetrated the rural areas, and each division is well served.

The use of telephones in the district is limited. Most of the telephones in the district are found in the major centres of Murang'a, Kigumo, Maragua, Makuyu, Kangema and Kandara. These centres are also the ones with public call boxes, which are few in number, and they are the only areas that have exchange telephone facilities.

## 5.8 COMMERCE AND INDUSTRY

Commerce and industry are, after agriculture, the second most important sources of income and employment in Murang'a District. They are likely to grow in importance as the population of the district increases. It is

estimated that slightly over 20% of the district labour force of about 230,000 is employed in some way in commerce or industry (District Development Plan, 1979-83). The major industries in the district involve processing its agricultural products, while commercial activity is carried out mainly through small retail shops in both urban and rural areas.

Table 5.14 lists the numbers of main industries in the district, all of which are related to processing of agricultural and other resource products. In addition to these, there are numerous small-scale industries scattered throughout the district. These include small timber mills, carpentry shops, stone quarries, pottery and brick-making shops, bakeries, welding and motor repair shops, blacksmiths and others. However, the growth and diversification of industry to serve more than local needs is hampered by the lack of adequate infrastructure such as roads, communications, and power. In the absence of development in these areas, industry in the district is likely to continue being primarily agriculture based, small-scale industries for local needs.

Some of the pollution problems associated with industries in Murang'a District were discussed above in Section 5.4 on Water Supply and Pollution. In addition, a number of the industries involve hazards to workers. In the tea processing factories, workers are exposed to gases and dust in factory air as the leaves are fermented, dried, graded and sorted. Generally, the workers are either not supplied with or don't make use of protective masks and clothing. Similarly, workers in the sawmills are exposed to high levels of sawdust. In both cases, serious health problems can result. These industries should be more closely regulated to control discharges into factory air and reduce the hazards to workers.

TABLE 5.14: INDUSTRIAL ENTERPRISES IN MURANG'A DISTRICT BY TYPE

<u>TYPE OF ESTABLISHMENT</u>	<u>NUMBER IN DISTRICT</u>
Co-operative coffee factories	91
Large estate coffee factories	68
Private small scale coffee factories	16
Tea factories (Kanyenya-ini, Githambo, Njunu, Ikumbi)	4
Sisal decortication factories (Kakuzi, Samar)	2
Major sawmills (Kimakia and Gatare)	2
Pinapple canning factory (Kenya Cannery)	1
Proposed fruit canning factory in Murang'a town (under construction)	1

SOURCES: Kenya, Ministry of Agriculture, 1980.  
Kenya, Ministry of Finance and Economic Planning, 1980c.

Rural commerce, involving small-scale retailing and hotel and food trades is estimated to generate up to 70% of off-farm income in the district (Kenya, Ministry of Finance and Economic Planning, 1980c). Most of the businesses are locally owned, such commercial enterprises being important avenues of investment for local farmers and others. In addition to the many small retail shops, there are over 50 periodic markets that take place about twice per week in the district where local produce, livestock, and various other goods are sold.

Credit availability is one of the main constraints to the expansion of commerce and industry in the district. Loans from the Industrial and Commercial Development Corporation (ICDC) are generally based on criteria more suitable for modern businesses in urban areas than small rural enterprises

in areas such as Murang'a. The District Trade Development Joint Loan Board, which provides loans to small African traders, has lacked adequate funds for the growing number of applicants. As a result, the commercial banks in the district have become the most important sources of loans. In general, more commercial enterprises could be established and expanded if credit were more readily available.

The Kenya National Trading Corporation has helped to stimulate rural commerce in the district through its network of agents for the distribution of various commodities, such as sugar, cement, soap, matches, batteries, iron sheets, textiles, and bicycle parts. The KNTC has a depot in Murang'a town that maintains about 95 district agents. It also sponsors trade courses to improve business skills of traders in the district.

Commercial activities generally do not directly affect environmental problems in the district, but they can have important indirect effects. The existence or lack of sufficient opportunities in commerce can affect the intensity and pattern of agricultural land use in the district. Alternative ways of making a living may help mitigate some of the environmental problems associated with intensive agriculture in the area. Certain kinds of commercial activities, though, may have negative effects on environmental quality. For example, expanding the sale of potentially hazardous products such as pesticides may encourage unnecessary use and associated environmental problems. Other commercial activities could increase the demand for agricultural or other products whose production might be environmentally damaging. There are no data that will show precise relationships between commerce and environmental quality, but increasing commercial opportunities in Murang'a

will probably help mitigate pressures on land resources in the district and thus slow the loss of soil and degradation of other agricultural resources.

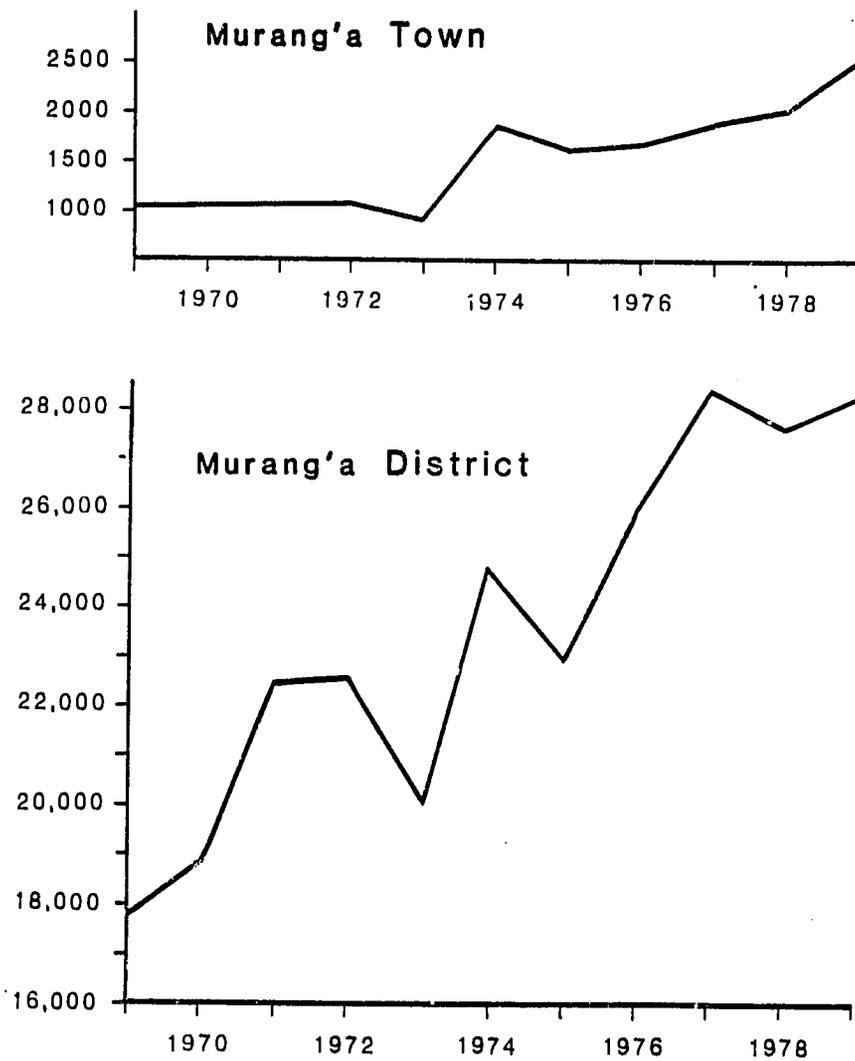
### 5.9 EMPLOYMENT PATTERNS

Although Murang'a District included over 4.2% of the total population of Kenya in 1979, only 3.2% of total modern sector wage employment in the nation was found in the district. This indicates the relative dearth of employment opportunities in Murang'a. Figure 11 shows the growth of wage employment in Murang'a District and Murang'a town between 1969 and 1979. The post-1976 growth spurt coincided with the boom in international coffee prices, and was probably closely related to it. Overall, the growth in wage employment over the decade has kept pace with population growth--wage employment increased by over 58% while total district population increased by about 46%. However, there has also been much migration out of the district in search of employment (see Section 3.1 on population), and so these figures do not really reflect the unmet demand for employment in the district.

The main categories of wage employment in the modern sector are given in Table 5.15. The largest category is agriculture and forestry, which accounts for approximately 60% of employment. However, the number of employees in this group has been declining in recent years. Community, social and personal services is the second largest category and employs about half as many people as agriculture and forestry. This grew both absolutely and proportionately over the period. Together, these two categories account for over 90% of modern sector wage employment in the district. Wholesale and retail trade, the third largest category, accounts for only about 4% of

FIGURE 11

**WAGE EMPLOYMENT  
MURANG'A DISTRICT AND TOWN, 1969-79**



SOURCE: Kenya, Ministry of Finance and Economic Planning, 1981b.

TABLE 5.15:

WAGE EMPLOYMENT BY INDUSTRY IN MURANG'A DISTRICT, 1977-79

	1977	1978	1979
Agriculture & Forestry	17,761	16,339	16,557
Mining & Quarrying	--	--	--
Manufacturing	490	522	563
Electricity & Water	25	86	37
Construction	77	417	425
Wholesale & Retail Trade, Restaurants & Hotels	1,244	1,123	1,182
Transport & Communications	89	106	108
Finance, Insurance, Real Estate & Business Services	102	92	106
Community, Social & Personal Services	8,676	8,871	9,305
TOTAL	28,447	27,556	28,303

SOURCE: Kenya, Ministry of Finance and Economic Planning, 1980a.

TABLE 5.16:

EMPLOYMENT IN THE INFORMAL SECTOR, 1980

Manufacturing	580
Construction	--
Wholesale & Retail Trade	1,565
Transport & Communications	4
Community, Social and Personal Services	400
TOTAL	<u>2,549</u>

SOURCE: Kenya, Ministry of Finance and Economic Planning, 1980b.

employment and remained fairly stagnant over the period. Manufacturing accounts for only 2% of wage employment, although there has been some recent growth. These figures indicate the dependence of the district's economy on agriculture and related activities. Employment in services and commercial trade, while important, is not likely to grow substantially without growth in the primary agricultural sector. Moreover, while manufacturing may continue increasing, its total size is too small to make a great difference to district employment levels. The lack of infrastructural development may also be a serious obstacle to large-scale manufacturing growth in the district.

The informal sector includes people in carpentry, tailoring, produce stalls and food kiosks, repair shops, iron and metal work, and so on, all usually on a very small scale. It is an important source of employment and income for those not employed in the modern sector. Table 5.16 gives the results of a 1980 survey of employment in the informal sector. Although the total is only about 10% of modern sector employment, this is likely to be a low estimate because of the difficulty of getting accurate figures. It is noteworthy, however, that the totals for manufacturing and for wholesale and retail trade rival or exceed those in the modern sector, which indicates the importance of the informal sector in these areas.

Table 5.17 shows the distribution of wage income in Murang'a District and town for the modern sector in 1979. While wages in the town are slightly higher than in the district as a whole, in both cases about 70% of employees earn less than Kshs. 700 per month, and under 15% of employees in the district earn over Kshs. 1000. Comparable figures for Kenya as a whole show that about 57% of wage earners receive less than Kshs. 700 per month

TABLE 5.17:

DISTRIBUTION OF WAGE EARNINGS, MURANG'A DISTRICT AND TOWN, 1979

<u>Monthly Income (Kshs.)</u>	<u>District</u>		<u>Town</u>	
	<u>Number</u>	<u>Percent</u>	<u>Number</u>	<u>Percent</u>
Under 150	22	0.1	-	-
150-199	1,148	4.4	50	2.1
200-399	8,359	31.9	419	18.3
400-699	8,687	33.1	1,126	49.1
700-999	4,197	16.0	258	11.3
1,000-1,499	2,294	8.7	210	9.2
1,500-1,999	980	3.7	116	5.1
2,000-2,999	353	1.3	79	3.4
3,000-5,999	152	0.6	30	1.3
6,000 and over	32	0.1	4	0.2
TOTAL	26,224	100.0	2,292	100.0

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SOURCE: Kenya, Ministry of Finance and Economic Planning, 1981b.

while almost 30% receive more than Kshs. 1000. This indicates that wage income in the district is lower than in the nation as a whole, and this is probably one of the factors that induces emigration from the district in search of employment opportunities.

Finally, it appears that employment in the district is generally quite dependent on the health of the coffee industry and other agricultural activities. This dependence is enhanced by the lack of many other significant economic enterprises in the district. As a result, employment in Murang'a is very vulnerable to fluctuations in coffee and other export agricultural markets. This vulnerability will continue unless the district's economy is able to diversify considerably.

## 5.10 CO-OPERATIVE AND SELF-HELP MOVEMENTS

### 5.10.1 Co-operatives

The co-operative movement in Murang'a dates back over 30 years and is one of the strongest in the country today. The movement has played an important role in the development of the area, especially in promoting agriculture. To date there are 71 co-operative societies and unions in the district, and this number continues to increase. Being an agricultural district, most of the Murang'a co-operatives are agricultural, with coffee societies dominating the co-operative sector. These operate 91 coffee factories serving a total of 40,180 farmers. Again, the number is increasing.

There are eight registered dairy co-operative societies but only four of these are active. The nine savings and credit societies mainly serve employed persons. They are all affiliated to Kenya Union of Savings and Credit Organisations.

Other co-operatives include fruit, pyrethrum and cotton growing, farm purchase co-operatives, and the Murang'a Co-operative Union which co-ordinates other societies by providing banking, bookkeeping, management advisory and merchandising services. Table 5.18 summarises the co-operative activities in the district.

Problems relating to co-operatives include a lack of qualified personnel and resulting mismanagement. In addition, individuals and groups sometimes break away from the co-operatives and build their own factories. This to a certain extent weakens the development of the movement. Political interference and leadership conflicts are also common. Finally, supervision of co-operative activities by the Ministry of Co-operative Development is often inadequate.

#### 5.10.2 Self-Help Movement

The self-help movement is a hallmark of development initiative in the country. Through the harambee spirit, people make contributions in form of cash, labour and in kind to identified projects. Much of the national development is attributed to this self-help movement.

In Murang'a, the self-help movement is concerned with a variety of welfare projects such as the construction of social halls, nurseries and

TABLE 5.18: CO-OPERATIVE ACTIVITIES IN MURANG'A

<u>Activity</u>	<u>Active</u>	<u>Dormant</u>	<u>In Liquidation</u>	<u>Total</u>	<u>1980 Turnover (K.Shs. '000)</u>
Coffee	16	-	2	18	295,048
Dairy	4	4	-	8	606
Pyrethrum	-	3	-	3	-
Cotton	1	-	-	1	68
Fruits and Vegetables	1	2	-	3	?
Pig Breeders	-	3	-	3	-
Farm Purchase	12	6	-	18	12,667
Housing	2	-	-	2	179
Savings	9	2	3	15	1,099
Mission	1	-	-	1	6,344
<b>TOTAL</b>	<b>46</b>	<b>20</b>	<b>5</b>	<b>72</b>	<b>316,011</b>

SOURCE: Kenya, Ministry of Co-operative Development, 1980.

schools, village polytechnics, individual houses, churches and water projects. The movement is also concerned with economic projects such as cattle dips and the construction of local bridges and roads. The government, sometimes in collaboration with national and international organisations, provides both technical and financial support to these projects.

The groups behind these projects are organised at different levels ranging from the sublocation to the district, depending on the magnitude of

the project. In 1980 there were about 926 self-help projects in the district. The numerous women's groups in the district make a notable contribution to the self-help movement. The Mabati women's groups, for example, are concerned mainly with improving the standard of housing in the district. Its members are assisted in the construction of permanent houses. To date there are over 500 such women's groups in the district.

The self-help movement is confronted with a number of problems which threaten its role in rural development. In most cases there is a lack of skilled workers to operate these projects, and some of the work is thus not done properly. This has tended to discourage and decrease voluntary contributions. The multiplicity of projects means that many remain incomplete due to scarcity of funds. Many are started without authority and therefore without government supervision. As in the co-operatives, the self-help movement is rife with leadership conflicts which threaten to crush the harambee spirit. In addition, government supervision has often not been totally effective, partly because of the lack of resources. In some cases government grants have not been forthcoming. Even where they have been available they have been inadequate. Training of management committees for these groups has been lax, a fact which has manifested itself in mismanagement of the projects.

#### 5.11 TOURISM

Murang'a has no significant tourist activities. This is possibly because the amount of wildlife in the district is very limited. Existing wildlife is found in the high zone of the Aberdares. Catering and lodging

facilities are also not developed to meet the demands of tourists who come to the area. Murang'a can, however, be a tourist stopover for those travelling to and from Mount Kenya and the Samburu and Marsabit areas, particularly if facilities are developed. There is no tourist hotel in the district at present, but one could be built in the western part of the district near the Aberdares.

In addition, there are a number of historical sites in the district which could attract tourists. These include:

- (1) Karia Ka Mbari ya Ngware - This is on the slopes of Aberdare ranges. It is a salty pond situated on four acres of flat ground to which wild animals come to drink water. It has been proposed that this is to be developed but so far nothing has been done. It would be important not only for tourism in the district but also as a historical site for future generations. Rural access roads leading to this place should be upgraded to make it more accessible.
- (2) Mukurwe-Wa-Nyagathanga - The Kikuyu people are said to have originated from this place at which Gikuyu and Mumbi, the tribe's parents, built their hut. It is situated 50 km from Murang'a town on the way to Nyeri via the Murang'a Othaya road. Although the original Mukurwe tree decayed, another was planted to replace it by the local people. This is an attractive site not only to visitors but also to the local people. Every Kikuyu has been taught that this place was the origin of their people, thus it is important for local as well as foreign tourism. A traditional museum could be developed here to attract tourists going to Mt. Kenya and the Aberdares.

(3) Karuri's Grave - Karuri was a historically important and well known chief. A gravesite memorial with a placard explaining his achievements would be of interest to local and foreign tourists.

Lastly, there are some trees with religious significance that are worth preserving. For instance, the Mugumo and Mutamaiyu trees were regarded as sacred by the older generation. Even younger people have respect for these trees. This is where the great-grandfathers offered their prayers in times of prolonged drought asking Mwene-Nyaga to provide them with rain. These trees, viewed for religious rites, should be preserved. Planting of seedlings should also be encouraged.

In sum, there is considerable potential in the district for the development of tourist-related activity. However, tourism's economic gains should not be allowed to overshadow its potential negative effects on social and ecological issues; local culture and values should be preserved above all, and the region's economy should not be allowed to become greatly distorted by tourism.

#### 5.12 PROBLEM SUMMARY:

##### A. Housing

1. There is a general shortage of urban housing, especially because of the influx of migrants from rural areas, resulting in slums and overcrowding. There are also inadequate services for existing housing, often causing health, sanitary, and other problems.

## B. Health

1. Many health units suffer from a general shortage of trained medical staff, and some have had to be closed as a result. A lack of drugs and modern equipment is also common in many health units.
2. Remote areas of the district, especially in Makuyu Division, have insufficient health facilities. Mobile clinics can be helpful, but they are few in number and sometimes poorly run.
3. Hospital bed capacity in the district as a whole is insufficient.
4. Health units have occasionally had to contend with lack of food for hospitalized patients and with water shortages, affecting sanitary conditions and patients' health.
5. Malnutrition exists in many parts of the district. The staff of trained nutritionists is inadequate to cope with the problems. They often face transport difficulties in trying to reach the rural population.

## C. Education

1. The availability of trained teachers is a problem. Overcrowding and understaffing in schools is common. The large increase in the primary school age population creates an ever increasing need for teachers, schools, and supplies.
2. Transport problems hinder the delivery of equipment to schools and the work of school inspectors.
3. Farm labor requirements at peak periods cause school attendance to be seasonal and can affect children's education. This also affects adult literacy classes.

#### D. Water Supply and Pollution

1. Existing urban and rural water projects may not be adequate to meet future increases in demand, especially in urban areas such as Murang'a town.
2. Current water supply problems are especially acute in Makuyu Division where clean water supplies are scarce. The problems are exacerbated by migration into Makuyu Division for agricultural employment.
3. Equipment in many existing water projects is old and breaks down frequently. Maintenance requirements and costs are high.
4. Water pollution by agricultural and industrial wastes is an important problem. Discharges from coffee and sisal factories are often inadequately treated, and many factories have been slow in installing required recirculation systems.
5. Erosion causes siltation of many waterways. Runoff also contains pesticides and fertiliser residues that can affect stream ecology and imperil human and animal health.

#### E. Energy

1. Cutting trees for fuelwood and charcoal is a major problem, especially in the densely populated rural areas. It can result in severe environmental effects, particularly soil erosion. There may also be a fuelwood crisis in some regions in coming years.

#### F. Waste Disposal

1. The sewerage system for Murang'a town is inadequate and may cause health problems. There is a lack of funds for increasing capacity by constructing another lagoon.

2. Pit latrines in some areas fill rapidly because underlying rock is close to the surface. Land for constructing additional latrines is often limited.
3. Refuse in many areas is not adequately disposed of and may expose people to health hazards.

G. Transport and Communication

1. Rural roads are often impassable during the rainy season and hinder the movement of people and goods. Bridges are also often washed away. Work in forested areas is often hindered or halted entirely because of road problems.
2. Road maintenance in general is often inadequate because of a lack of finances.

H. Commerce and Industry

1. Industrial development in the district is often hampered by inadequate infrastructure such as roads, communications, and power.
2. Workers in some industries are exposed to potentially dangerous environmental hazards, such as air discharges in tea factories and saw-mills.
3. Inadequate credit availability is one of the main constraints to the expansion of commerce and industry.

I. Employment

1. Employment opportunities in the district in general are inadequate. The district's share of modern sector wage employment is less than it should be relative to its population. Wage levels are also generally lower than in the nation as a whole. This encourages migration out of

the district and contributes to problems in Nairobi and other urban areas.

J. Co-operatives and Self-Help Movements

1. Many co-operatives and self-help groups suffer from mismanagement and a lack of qualified personnel. There are also instances of political interference, leadership conflicts and corruption..
2. Government supervision of both co-operatives and self-help groups is often inadequate.
3. Many self-help projects suffer from a scarcity of funds. Their work is often not authorized and supervised by responsible government officials.

K. Tourism

1. Hotel and other facilities for the potential development of tourism are inadequate.

## CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

The purpose of this chapter is threefold:

1. to review some of the main trends in resource use and related socio-economic factors in Murang'a District;
2. to identify the priority environmental problems in the district which need most immediate attention;
3. to propose a set of recommendations for dealing with these problems.

### 6.1 MAIN TRENDS OF ENVIRONMENTAL SIGNIFICANCE

From this study of Murang'a District, we can identify a number of trends in resource use, population patterns, and development that have important implications for the environmental and resource situation of the district. Five of these are discussed below:

#### (1) Population Growth

The rapid rate of population growth is probably the single most significant factor affecting the outlook for environment and development in the district. Over the last decade, the population of Murang'a has increased by more than 45%, with an average annual growth rate of over 3.8%, which is higher than the national average. If this rate of growth were to continue, the district's present population would more than double by the year 2000. It is hard to imagine that farming and animal husbandry--the main economic activities at present--would be able to support such a large increase in population. Population density in the high potential areas of the district is already very

high. Even in the drier areas of Makuyu District, population growth has been extremely rapid over the last decade and is likely in the near future to reach its upper limit of carrying capacity. Continued population growth will result in greater pressure on all of the district's natural resources, especially land, water, and forests. Unless these are carefully managed, they may be severely degraded or depleted in a short space of time. In addition, numerous social and economic stresses may develop as a result of population increases, and these also will have far-reaching implications for research use and availability in the district. In fact, virtually all of the district's problems will be exacerbated by the high rate of population growth. At the same time, potential solutions may become harder to implement as the human, financial and natural resources of the district are all strained in order to supply essential services for the expanding population. Thus, dealing with the growth of population and its consequences will be one of the central issues in the district for the coming years.

## (2) Land Fragmentation

Largely in response to population pressures, land holdings are being subdivided into smaller and smaller parcels, which often become uneconomical to farm. Moreover, farmers are cultivating more marginal land--e.g., land on steep slopes and along river banks as well as land of lower productivity. Smaller farm sizes are also inducing farmers to cultivate their holdings more intensively, making fallow periods and crop rotations less frequent and depleting the land's fertility and productivity. This trend is likely to accelerate over the coming years, especially as the half of the population that is now under 15 comes of age to inherit family property.

### (3) Cash Crop Production

Particularly in response to the boom in coffee prices in 1976-77, production of coffee and other cash crops for export has taken an increased proportion of the district's crop hectarage. Production of food crops, especially maize, has generally remained stable or decreased. If this trend continues, the district will be more dependent on outside sources of food and possibly more vulnerable to food shortages during periods of drought or other crop loss. In addition, cash crops generally involve greater use of agrochemicals. Coffee especially demands high pesticide usage, which can result in increased water pollution as well as hazards to agricultural workers. Serious water pollution is also caused by wastes from processing of coffee, sisal, and other agricultural products unless appropriate pollution control equipment is installed in the factories. Increased agricultural processing in the district, thus, threatens to aggravate the already serious pollution of many of the district's rivers and streams.

### (4) Urbanization

People from rural areas in the district are increasingly moving into towns and cities, both within Murang'a District itself and outside. The population of Murang'a town increased more than three-fold between 1969 and 1979 (although some of this increase was due to boundary changes). In addition, a large number of people from Murang'a District have migrated to Nairobi and other large urban centres. Much of this urban migration is in search of wage employment, and it can be expected to increase in response to population growth, land fragmentation, and other factors that make it difficult to earn sufficient income through farming and other rural occupations. The influx of people into urban areas has a variety of environmental consequences, including

increased problems with sewerage and waste disposal, water supply, and environmental health. There may also be a net effect on energy supplies and deforestation since urban populations tend to use relatively more charcoal. Increased charcoal demand may lead to increased tree cutting throughout surrounding areas, with significant potential environmental impacts.

#### (5) Socio-Economic Trends

Despite abundant natural resources, the general economic situation of Murang'a District is one of relatively slow development, particularly in commerce and industry, but also in small-scale agriculture. Brief economic booms have followed events such as the increase in coffee prices in 1976-77, but only some of the income generated has been reinvested in the district itself. Moreover, since much of the district's economy is tied to the sale of export crops such as coffee and tea, it is subject to unpredictable fluctuations in world market conditions. After 1977, for example, world coffee prices declined, and many of the growers who increased their coffee plantings will not realise the expected gains from their investments.

Agriculture remains the basis of the district's economy. However, because of population growth, land fragmentation, and other factors, a growing proportion of the district's population will have to seek employment and income from other sources. However, industrial and commercial development in the district has been slow and is hampered by the generally low state of infrastructural development. Wage employment and the level of wages are below the national average, resulting in a high rate of migration out of the district. While this may relieve some resource pressures in Murang'a District itself, it does so only at the cost of exporting them to other parts of the country. Emigration can also contribute to problems of environmental

management--e.g., it may leave insufficient labour in some rural areas for proper land maintenance and soil conservation practices. In addition, when there is a scarcity of economic opportunities in the modern sector, there may be few alternative means for people in rural areas to obtain cash income except by exploiting their natural resources. Production and sale of charcoal, for example, is often a major source of cash for people in rural areas, and it can be expected to increase unless measures are taken both to keep it under control and to provide alternative income sources.

In general, an improvement in agricultural income and non-farm employment and wage levels will probably have positive effects on the environment. However, industrial and infrastructure development can also introduce new sources of environmental and resource degradation, e.g., through water pollution by factories or gully erosion caused by road construction. The worst effects can usually be avoided or mitigated if they are anticipated and appropriate preventive measures are taken in advance. Thus, it is extremely important that the environmental effects of new development projects be assessed in the planning stage and then monitored afterwards. If not, the district, and the nation, could find that the environmental destructiveness of development has simply been added to that of under-development.

## 6.2 PRIORITY ENVIRONMENTAL PROBLEMS

Among the problems and issues discussed in this district environmental assessment report, there are four that seem to hold the most serious threats to the future well-being of the people of Murang'a District. These are: soil erosion and land degradation; deforestation and fuelwood shortage; water pollution; and urban sewerage, water supply, and environmental health. These are the problem areas that ought to receive priority attention in order that

development of the district occur without undermining the natural and human resources on which it depends. All of these particular problems, however, have multiple causes and mechanisms, and thus they each require co-ordinated action from a variety of ministries and departments as well as non-governmental groups if they are to be dealt with effectively. This section concentrates on identifying the problem areas and some of the underlying factors. The final section of this chapter will then make a number of recommendations for action.

#### (1) Soil Erosion and Land Degradation

Topography, soil structure, climate and land use practices all contribute to making soil erosion one of the main environmental problems of Murang'a District. Acute erosion problems occur in many of the high potential areas of the district because of the combination of steep slopes, high rainfall, and intensive cultivation. In addition to lowering land productivity, the high rate of erosion causes heavy siltation of the district's rivers and streams, which has lowered water quality and has seriously affected hydroelectric power production on the rivers passing through the district. When farmers take appropriate conservation measures, such as constructing bench terraces and cutoff drains, soil loss can be held in check. Thus, actual erosion may vary considerably from farm to farm even within an area where erosion potential is quite similar. In assessing causes of erosion, both the factors that contribute to high erosion potential and those that impede farmers from adopting conservation measures should be considered. Among the former are the following:

- (a) High levels and intensity of rainfall in most of the high potential areas of the district, coupled with hilly topography.

- (b) Extensive cultivation on hillslopes and along river banks and roadsides. This is encouraged by the high population densities and general land shortages in much of the district, which will increase with population growth over the coming years.
- (c) Overgrazing, especially in drier areas, which destroys ground vegetation.
- (d) Cutting of trees in forest areas and on farms, which can reduce soil and water retention.
- (e) Road construction without proper drainage channels to protect neighbouring farmland, which can lead to severe gulley erosion.

Factors that may keep farmers from taking appropriate soil conservation measures include the following:

- (a) Lack of knowledge of proper soil conservation techniques for their farms.
- (b) Insufficient money or labour power to construct and maintain terraces, cutoff drains, and other conservation measures.
- (c) Insufficient land to devote to such conservation measures as cutoff drains which take some of the farmland out of cultivation.
- (d) Insufficient funds, equipment, and personnel for the Ministry of Agriculture to provide adequate soil conservation assistance, advice, and regulation in some areas.
- (e) Reluctance by farmers to reduce the size of their livestock herds, and/or insufficient land for fodder production.
- (f) Lack of incentive for the Ministry of Transport to devote extra funds for the construction of proper road drainage works to protect farmland from gulley erosion.

In addition, in some cases farmers may not themselves consider erosion a serious concern because their land still seems productive, but the erosion and resulting river siltation may be silting up dams downstream. All of these are serious problems in at least some areas of the district. One of the difficulties in ameliorating soil erosion is obviously that it results from the accumulation of many individual-scale problems throughout the district. Some possible corrective measures are discussed in Section 6.3 below.

## (2) Deforestation and Fuelwood Shortage

Trees and hedges, both in forest and on farmland, provide numerous important products and services in the district. They are extremely important in maintaining the quality of both soil and water resources since they help retain moisture in the soil, inhibit erosion and runoff, and they tap deeper sources of water and nutrients than most other vegetation in arid areas. They also provide shade for humans and livestock, serve as windbreaks and fencing on farms, and provide valuable wildlife habitats in areas such as the Aberdares. In addition, they are sources of fuelwood and charcoal, animal fodder, mulch, poles for fencing, and timber for construction. In many areas of the district, however, trees are being cut down faster than they are replaced. This may result in serious and irreversible environmental damage as land quality declines. In addition, fuelwood shortages are beginning to appear and people are having greater difficulties in collecting or buying fuelwood. This often strains both their labour and cash resources, making it harder to provide other basic needs such as water and food.

The main purposes for which trees are cut down in the district are for fuelwood, charcoal and land-clearing. Fuelwood and charcoal are the main energy sources throughout the district. In addition, charcoal production is

an important source of cash income for many people. Thus, both population and economic pressures play an important role in promoting tree-cutting and deforestation. In addition, land fragmentation and population growth are driving people to clear more land for cultivation, especially in areas that have been forested. This may result in increased erosion and other problems in areas that were not previously used for agriculture.

### (3) Water Pollution

Water pollution in Murang'a District is of particular concern because many of the district's people obtain their water supplies from surface streams and rivers. They often have no alternative but to use this untreated water for themselves and their livestock and thus are vulnerable to the health hazards and other dangers of polluted water. In addition, water pollution affects stream ecology and fish populations, and can prevent development of fisheries and other biological resources.

Soil erosion causes heavy siltation of most of the streams and rivers in the district, especially during the rainy seasons. High silt content lowers the quality of water for human consumption and has other important effects, such as silting up both large and small dams along the rivers. In addition, surface runoff often carries agricultural chemical residues into the streams. Fertiliser residues can stimulate growth of algae and cause other undesirable changes in the ecology of streams and ponds. Pesticide residues are even more serious since they can poison fish and other organisms and can be consumed by people either in drinking water or in fish, meat, milk, or other animal products. Many pesticides are concentrated and stored for long periods in human and animal tissues and may have long-term health effects even when no immediate effect is noted. In addition, these chemicals can have other important

environmental effects, such as altering soil ecology, poisoning birds, bees, and other animals, and threatening the health of agricultural workers. Thus it is important that their use be limited to as low a level as is necessary.

The other major source of water pollution in Murang'a District is wastewater from the many coffee, sisal, and other agricultural processing factories in the district. These wastes can severely degrade the quality of the water in general, in addition to introducing potentially harmful chemical residues from the pesticides and other chemicals used on the crops. The many coffee factories in the district are major sources of pollution because unless they contain efficient recirculation systems, they use large amounts of fresh water and discharge large quantities of wastes into streams and rivers. Many of the older coffee factories do not have the recirculation systems that are now required by the 1976 Water Act, and the owners are reluctant to install them because of the high expense involved. According to recent information, only 40% of the district's coffee factories have full recirculation systems, and 22% have no recirculation systems whatsoever. With population increases and growing needs for water in the rural areas of the district, the pollution caused by these factories is becoming increasingly critical and will have to be stemmed.

Another problem with water supplies in Murang'a District is the high fluoride content in many areas. This affects people's teeth and in serious cases can affect bone structure, especially of children, as fluoride replaces calcium in bone. Children in high fluoride areas should be screened for such effects to prevent the development of serious health problems.

Monitoring of water quality is an important activity to identify areas where there may be potential problems and help prevent serious effects. Some monitoring is carried on at present by the Ministry of Water Development, but

this generally does not include testing for pesticide and other chemical residues. Testing should also be done more regularly to help prevent long-term degradation of water quality in the district.

#### (4) Urban Sewerage, Water Supply, and Environmental Health

The population of the urban areas of the district has been increasing extremely rapidly, and with this increase has come a growing need to provide adequate services, especially water supply, sewerage and waste disposal. All of these are now strained to near capacity in Murang'a town and the other urban areas in the district. Pollution in these towns is likely to continue increasing at a rapid rate, and unless there is a commensurate growth in these basic services, the people of the towns will face serious threats of environmental diseases. Water-borne diseases which are promoted by poor sanitation and can spread easily, such as cholera, may become particularly severe threats.

Inadequacies in the supply and delivery of health care throughout the district enhance the threat of environmentally-promoted diseases. Hospital capacity and medical services are often insufficient to meet the needs and are not expanding at a rate to keep pace with population growth and needs. In addition, malnutrition is common in many parts of the district, making people more susceptible to many diseases. Some nutritional services are provided, but are generally inadequate and suffer from lack of trained personnel, transport and supplies. Good nutrition is one of the main aspects of preventive health care, and nutritional services are, thus, an important component of health delivery services.

### 6.3 RECOMMENDATIONS FOR ACTION

#### A. General Recommendations

Besides the recommended policies for dealing with specific priority problem areas, which are discussed below, there are a number of general policies that would be extremely important for the district's environmental welfare:

1. The expansion of family planning services throughout the district can be one of the main means of slowing population growth. Existing family planning clinics and offices need to be expanded, new ones need to be set up in areas not yet served, and the number of mobile clinics should be increased considerably in order to reach the more remote rural areas. These programmes should help to reduce long-term pressures on resources and the environment in the district.
2. Rural development programmes in the district should be expanded. This will increase employment opportunities and should reduce peoples' dependence on the exploitation of natural resources. Improvement of infrastructural facilities such as roads, communication systems, energy supplies, and banking and credit institutions would be critical in attracting new industries to the district. At the same time, all development planning should include a significant environmental component in order to ensure that the important environmental resources of the district do not suffer serious degradation as a result of development.
3. Food crop production should be encouraged in order to minimise the district's vulnerability to food shortages and famines. Higher prices and less delay in payment to farmers for food crops and easier provision of credit, especially to small farmers, can help revive

food production in areas where it has become stagnant or is being displaced by cash crops. Such policies could be very important to the future welfare of the nation.

4. There should be an expansion of environmental education in schools at all levels. Teacher training programmes should also emphasise environmental education, conservation techniques, and the importance of environmental and resource issues. There should be active involvement of schools and students in practical conservation programmes such as tree-planting, soil conservation, agroforestry, and water quality monitoring.

#### B. Soil Erosion

Reducing erosion problems in Murang'a District will require both the devotion of greater resources to assisting soil conservation work and the establishment of mechanisms to encourage and reward individual conservation efforts. Some of the measures that could be most helpful include the following:

1. Increased extension and conservation work by Ministry of Agriculture employees. Extension workers can provide information and advice on soil conservation as well as technical assistance. The Soil Conservation Unit assists some farmers with construction of terraces, drainage ditches and other measures. However, they are often short of machinery, petrol and manpower to meet the demand. In addition, poorer families often cannot afford to pay for such assistance. Increased funding for equipment, petrol and manpower training and subsidized conservation assistance for poorer farmers should help

reduce soil loss in the district. The social costs saved in terms of loss of fertile top soil and siltation of waterways and dams should more than balance the expenditure required.

2. Loans to farmers for soil conservation work should be readily available on easy terms. Cash for hiring labour or equipment for building terraces, cut-off drains and other conservation work is often a critical bottleneck. Providing loan funds especially earmarked for this purpose through the co-operative societies, Agricultural Finance Corporation, or other institutions can help encourage farmers to undertake these efforts.
3. Institutions such as the Tana River Development Authority, East African Power and Lighting Company, and others involved in hydro-electric power production in the district should provide various forms of conservation assistance to farmers, particularly in areas where siltation of waterways is a significant problem. The aim would be to provide incentives for farmers to undertake conservation measures, especially those who might otherwise not do so. Priority should be given to:
  - a) farmers in hilly areas adjacent to waterways;
  - b) those who could otherwise not afford soil conservation measures;  
and
  - c) those on farmland where erosion is not yet decreasing productivity significantly but is contributing to stream siltation.

Expenditures of this type by private and parastatal bodies would be more cost effective than subsequent expenditures to maintain and build new dams and dredge river beds.

4. Afforestation programmes, both in gazetted forests and on farmland, should be encouraged and expanded. Current afforestation work by the Forest Department often requires additional funding and personnel. In addition, agroforestry can make a major contribution to improving both soil and tree resources in the district. This is discussed further below in the section on fuelwood and forestry.
5. All road construction by the Ministry of Transport and Communication should be required to include proper drainage facilities so that the roads do not cause gulley erosion on adjacent farmland. Drainage works should also be added to existing roads in the district that are major causes of gulley erosion. Farmers whose land is damaged by gulleys from road construction should be offered compensation or assistance in rehabilitating their land.
6. Measures should be taken to discourage or limit land sub-division beyond the point at which it cannot be farmed on an economic and sustainable basis. Certain minimal soil conservation practices should also be required on all arable land, irrespective of the size of the holding.
7. Fodder production and stall feeding of livestock should be encouraged, especially in areas that are being overgrazed. There are often surpluses of crop residues and other suitable fodder materials in areas of lower livestock densities, while there are scarcities in higher density areas. Government efforts could assist in transporting and marketing these fodder-crops in order to limit excessive grazing.
8. There should be regular, systematic monitoring of soil erosion throughout the district so that areas and sites of particular

severity can be identified and corrective measures can be efficiently targeted.

In general, soil conservation efforts should be concentrated in areas of highest erosion potential--i.e., densely populated, intensively cultivated, hilly areas from which valuable soil is being lost at a rapid rate. Much of the high potential area of Murang'a District faces these problems. In addition, smaller farmers who are less able to afford the labour, material, and financial resources required for effective soil conservation should be especially targeted for assistance programmes.

### C. Deforestation and Fuelwood

Controlling problems of deforestation and fuelwood supply in Murang'a District requires policies for both appropriate management of forests on public lands and productive land use on private farmland. On public lands, primarily the gazetted forests and the Aberdare National Park, the aim should be to devise management strategies for the sustainable use of forests for fuelwood, charcoal and timber production by the rural population, as well as simultaneously providing environmental catchment protection. On private farmland, the basic goal is to encourage agroforestry--i.e., growing trees on farmland for a variety of purposes in ways that are compatible with crop production. Specific policy recommendations include the following:

1. Areas should be set aside within gazetted forests, the National Park, and other public lands as 'energy woodlots' for fuelwood and charcoal production on a sustainable basis. Siting and management of these woodlots should be consistent with protection of catchment areas and should be guided by principles of maximum usable production of

fuelwood on a continuing basis. This will require management strategies quite different from those currently employed for traditional forestry, which is geared mainly toward timber production. Access to these energy woodlots for harvesting should be regulated, and priority should be given to local rural residents and small-scale charcoal producers.

2. On forested public lands outside these woodlots, harvesting of trees and branches for fuelwood and charcoal should be permitted, but should be regulated for environmental protection and sustainable use. Charcoal production in particular should be more strictly controlled to prevent excessive deforestation. One possible method would involve licensing charcoal producers and identifying specific areas and trees for them to harvest. This should be done in accordance with accepted principles of sustained-use forestry.
3. There should be co-operative programmes among the Ministries of Agriculture and Energy and the Forestry Department to encourage agroforestry by farmers in the district. Farmers could usefully grow trees on their shambas together with their crops, but they are badly in need of seedlings for planting as well as advice on appropriate species and cultivation techniques. A successful agroforestry programme in the district would require most of the following measures:
  - a) establishing seedling nurseries at numerous sites throughout the district at which seedlings and information would be available to farmers;
  - b) training programmes in agroforestry techniques for Agriculture and Forestry extension workers who would then incorporate these into their extension work with farmers;

- c) inclusion of agroforestry training into the Farmers' Training Centre courses as well as encouraging farmers to adopt these techniques through barazas and other public meetings;
- d) follow-up extension work with farmers who have obtained seedlings from the nurseries to see if agroforestry techniques are being applied successfully and to learn from the problems that are encountered.

A co-ordinated and integrated programme of this sort among the relevant Government departments and local-level authorities would go a long way toward ameliorating some of the serious fuelwood problems in the district.

#### D. Water Quality and Pollution

In order to deal with the problems arising from water pollution, actions need to be taken to reduce sources of pollution, improve detection, and prevent serious effects. Appropriate measures would include the following:

1. The policies to reduce soil erosion which were discussed earlier would also reduce the silt load and agrochemical residues that enter streams in the district through agricultural runoff. This is an additional important reason to encourage soil conservation and provide incentives for farmers to adopt these techniques.
2. Pesticide usage should be reduced to the extent possible, especially in the coffee-growing areas of the district where such chemicals are used most extensively. One way of doing this is by developing integrated pest-management strategies whereby various cultural, biological

and chemical techniques are used to keep populations of insect pests below levels at which they can cause economically significant damage. The Coffee Research Foundation is trying to encourage farmers to monitor pest populations and spray only when necessary rather than spraying routinely. Such efforts should be expanded, and extension workers should give advice to both small- and large-scale farmers on ways of reducing pesticide usage.

3. Factory waste discharges should be more strictly controlled through a rigorous enforcement of current water pollution regulations. Violators of the regulations should be severely penalized, and factories without recirculation systems should be required to install them on a strict timetable. Where such improvements would be a major financial strain on the co-operative or company, loans should be made available for this purpose on reasonable terms. In addition, reprocessing of coffee, sisal and other wastes should be encouraged through support of related research and product development.
4. There should be increased and expanded monitoring of water quality throughout the district, particularly along waterways that are extensively used for household consumption and are subject to pollution dangers. Monitoring should include testing for residues of pesticides and other dangerous chemical substances, in addition to the pollutants that are currently tested for. In areas where water is found to be very polluted, appropriate warnings should be issued to the population and steps should be taken rapidly to provide alternative water sources for the local population.

5. Children should be regularly screened for fluoride intake in water and the development of related health problems. If serious problems are detected, the affected people should be warned and steps should be taken to provide them with alternative water sources.

E. Urban Sewerage, Water Supply and Environmental Health

The major needs in this area are for additional funds and improved long-range planning to provide adequate services to the district's population, particularly those living in urban areas. If the needs of the growing urban population are not met, there could be a marked increase in environmental disease, possibly including epidemics of cholera and other major diseases. The social costs of dealing with these at a late stage would far outweigh the cost of planning and investing in appropriate preventive measures. The most important steps required include the following:

1. There should be increased funding for water supply, sewerage and waste disposal facilities for all the main urban areas in the district, especially Murang'a town. Planning should anticipate likely population growth in these areas over the coming two to three decades, and the goal should be to provide adequate water and sewerage for all of the urban population.
2. Anti-pollution regulations should be reviewed and more strictly enforced, especially in urban areas where pollution may directly affect the health of the population. There should also be expanded monitoring of water quality and sewerage facilities especially in the poorer sections of the towns where people have to rely on untreated water sources and often have inadequate sewerage.

3. Medical facilities should be expanded throughout the district. In addition to urban hospitals and other health centres, mobile clinics should receive greater support to provide health care services to remote areas in the district.
  
4. Nutrition programmes throughout the district should be expanded. Nutrition workers in urban areas should make home visits to provide information and advice, especially to families with young children. Mobile nutrition units should travel through the rural areas to provide advice and assistance to rural populations. In addition, nutrition education should be made an important part of the school curriculum at all levels.

F. Summary

Murang'a District remains an area of great potential. However, the problems of soil erosion, deforestation and fuelwood shortages, water quality, and urbanisation and environmental health will erode that resource base as the population continues to expand in the next decades. Poverty continues to be the greatest enemy of development, but wise development must endeavor to preserve the environment upon which we all depend.

## BIBLIOGRAPHY

East African Meteorological Department. 1975. Climatological Statistics for East Africa. Part 1, Kenya.

Kenya, Ministry of Agriculture.

- 1975. Murang'a District Annual Report 1974.
- 1976. Murang'a District Annual Report 1975.
- 1977. Murang'a District Annual Report 1976.
- 1978. Murang'a District Annual Report 1977.
- 1979. Murang'a District Annual Report 1978.
- 1980. Murang'a District Annual Report 1979.
- 1981. Murang'a District Annual Report 1980.

Kenya, Ministry of Co-operative Development. 1980. Reports.

Kenya, Ministry of Economic Planning and Development. 1981. Kenya Population Census, 1979 vol. 1. Nairobi: GOK Printer.

Kenya, Ministry of Education.

- 1980. Annual District Report.
- 1981. District Survey.

Kenya, Ministry of Environment and Natural Resources, Forestry Department. 1980. Report.

Kenya, Ministry of Finance and Economic Planning.

- 1970. Kenya Population Census, 1969. Volume 1. Nairobi: Statistics Division, MEPD.
- 1980a. Employment and Earnings in the Modern Sector. Nairobi: Central Bureau of Statistics, MEPD.
- 1980b. Employment in the Informal Sector. Nairobi: Central Bureau of Statistics, MEPD.
- 1980c. Murang'a District Development Plan, 1979-83. Nairobi: MEPD.
- 1981a. Household Energy Survey, 1980. Nairobi: Central Bureau of Statistics.
- 1981b. Statistical Abstract, 1980. Nairobi: Central Bureau of Statistics.

Kenya, Ministry of Health. 1981. Murang'a District, Annual Report, 1980.

Kenya, Ministry of Livestock Development.

- 1975. Murang'a District Annual Report.
- 1976. Murang'a District Annual Report.
- 1977. Murang'a District Annual Report.
- 1978. Murang'a District Annual Report.
- 1979. Murang'a District Annual Report.
- 1980. Murang'a District Annual Report.
- 1981. Murang'a District Annual Report.

Kenya, Ministry of Transport and Communication. Meteorological  
Department Reports. n.d.

Kenya, Ministry of Water Development. 1980. Reports.

Kenya Soil Survey. 1978. Miscellaneous Soil Paper M19 Nairobi.

Survey of Kenya. 1970. National Atlas of Kenya. Nairobi: Survey of Kenya.

Thitai, W. 1981. "Industrial Development and Recent Trends in Pollution  
Control in Kenya". Nairobi, mimeo.

APPENDIX TABLE A:

MONTHLY RAINFALL BY DIVISION, MURANG'A DISTRICT, 1980

MONTH	KIHARU		KIGUMO		KANDARA		KANGEMA		MAKUYU	
	mm	days	mm	days	mm	days	mm	days	mm	days
JANUARY	-	-	-	-	131.1	8	41.5	3	42.4	3
FEBRUARY	-	-	23.1	3	10.6	2	98.6	3	4.8	2
MARCH	-	-	1.9	3	78.8	6	40.1	5	34.2	3
APRIL	114.7	4	159.0	9	137.8	10	103.0	12	159.2	11
MAY	461.7	17	-	-	302.4	18	339.5	19	255.8	11
JUNE	20.0	4	NOT RECORDED		116.4	4	52.2	8	-	-
JULY	-	-	-	-	17.7	4	33.8	7	-	-
AUGUST	59.0	8	23.3	9	77.0	10	88.0	11	10.8	2
SEPTEMBER	45.5	2	NOT RECORDED		40.0	2	53.0	4	-	-
OCTOBER	163.2	6	-	-	120.8	8	103.3	6	47.1	3
NOVEMBER	231.8	14	430.0	14	369.0	21	316.6	17	488.9	14
DECEMBER	82.0	4	42.4	7	94.6	8	110.7	9	8.0	1
TOTALS	1177.9	59	-	-	1496.2	101	1380.3	106	1051.2	50

SOURCE: Kenya, Ministry of Agriculture, 1981.

APPENDIX TABLE B:

MONTHLY RAINFALL TOTALS FOR TANA EXPERIMENTAL FISH FARM, 1976-80

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTALS
1976	0.0	35.2	12.2	223.1	75.4	82.5	66.8	4.2	12.7	44.7	59.7	70.2	686.7
1977	29.2	20.0	86.3	717.1	274.8	15.7	5.8	16.9	40.9	101.3	279.0	72.2	1659.2
1978	23.4	73.3	109.9	496.9	96.1	33.7	23.8	10.7	59.5	224.1	73.7	147.0	1372.1
1979	104.1	89.7	106.5	275.1	263.1	51.2	18.9	13.1	3.6	109.3	219.5	52.4	1306.5
1980	12.4	0.1	56.1	200.1	211.8	1.6	8.7	44.3	5.7	84.6	217.5	38.1	881.3
MEANS	33.8	43.7	74.2	382.4	184.2	36.9	24.8	17.8	24.5	112.9	169.9	76.0	1181.2

SOURCE: Kenya, Ministry of Transport and Communication, Meteorological Department, for the years cited.

APPENDIX TABLE C:

MEAN MONTHLY MINIMUM AIR TEMPERATURE (°C) FOR SAGANA STATE LODGE, 1976-80

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1976	7.5	8.7	8.6	10.9	13.3	11.0	10.6	10.8	11.1	10.2	10.2	10.2
1977	9.9	9.4	10.8	13.2	13.0	11.7	11.5	10.6	11.3	12.5	12.1	10.6
1978	9.3	9.6	11.7	13.7	12.7	12.2	12.0	11.3	11.8	11.7	11.2	12.2
1979	11.1	11.0	10.2	12.8	14.8	12.3	10.9	11.3	11.2	11.6	--	10.1
1980	8.8	5.7	9.1	12.0	13.6	10.6	11.3	--	11.2	11.4	11.9	9.8
MEANS	9.3	8.9	10.1	12.5	13.5	11.5	11.3	11.0	11.3	11.5	11.4	10.6

SOURCE: Kenya, Ministry of Transport and Communication, Meteorological Department, for the years cited.

APPENDIX TABLE D:

MEAN MONTHLY MAXIMUM AIR TEMPERATURE (°C) FOR SAGANA STATE LODGE, 1976-80

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1976	25.7	25.4	27.7	24.5	23.9	23.5	21.9	22.6	24.8	26.1	25.0	23.8
1977	24.7	27.4	25.6	24.0	23.5	22.6	21.9	23.9	25.5	26.0	23.1	23.7
1978	25.3	26.3	25.0	23.1	22.5	22.5	21.6	21.8	25.4	24.3	23.0	23.9
1979	23.3	24.1	25.8	23.7	22.6	22.0	20.9	22.2	25.3	25.1	24.3	24.6
1980	26.6	27.2	28.1	26.3	23.9	22.4	21.9	--	25.3	26.2	23.5	25.0
MEANS	25.1	26.1	26.4	24.3	23.3	22.6	21.6	22.6	25.3	25.5	23.8	24.2

SOURCE: Kenya, Ministry of Transport and Communication, Meteorological Department, for the years cited.

APPENDIX TABLE E:

MEAN MONTHLY WIND RUN AT SAGANA STATE LODGE, 1976-80 (metres per second)

YEAR	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
1976	36.0	62.2	40.2	38.5	57.4	50.9	45.0	58.9	69.3	63.9	46.5	29.4
1977	24.9	32.1	40.5	27.9	38.4	46.3	46.9	63.2	67.9	63.2	28.8	23.7
1978	57.6	60.8	--	44.5	42.4	47.0	37.0	43.6	57.9	47.8	50.1	62.3
1979	32.0	21.0	32.1	25.0	46.7	40.8	43.8	48.0	58.9	57.8	28.5	24.9
1980	26.9	35.2	35.8	32.4	35.5	42.3	56.4	61.0	63.8	60.2	26.5	29.9
MEANS	34.5	42.3	37.2	33.7	44.1	45.5	45.8	54.9	63.6	58.6	36.1	34.0

SOURCE: Kenya, Ministry of Transport and Communication, Meteorological Department, for the years cited.

APPENDIX TABLE F:

QUALITY OF SURFACE WATER, MURANG'A DISTRICT

Name of Sources	Date Sampled	pH	Colour	Turb.	Cond.	T.H.	Cl <sup>-</sup>	SO <sub>4</sub> <sup>-</sup>	NO <sub>2</sub> <sup>-</sup>	F <sup>-</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Fe <sup>2+</sup>	Mn <sup>2+</sup>
Chania River	24-5-75	6.5	150	78	44	14	4.0	2.5	Ni1	0.25	4.0	1.0	2.4	1.0
	26-6-75	7.6	10	Ni1	72	32	3.0	Ni1	Ni1	0.5	6.4	3.8	0.3	Ni1
	21-8-75	7.0	10	Ni1	77	24	4.0	-	-	-	-	-	-	-
	15-7-75	6.7	10	Ni1	85	28	6.0	1.0	0.01	0.2	6.4	2.9	0.4	0.1
	15-9-75	9.4	5	161	86	35	-	-	-	-	-	-	-	-
	8-10-79	7.6	10	<5	-	22	-	10	-	-	1.8	2.6	2.6	Ni1
	2-10-78	7.0	50	20	56	3.8	1.0	-	-	-	-	-	-	-
	22-2-80	7.2	-	-	155	58	11.99	-	-	-	-	-	-	-
	11-6-80	7.4	400	0.5	-	89	0.04	0.25	-	-	0.2	0.8	3.4	0.2
Kiariara Spring	7-1-75	7.6	30	Ni1	-	-	40	5.0	Ni1	0.8	72	3.6	0.4	0.7
Kiamukuri Spring	10-9-76	6.9	80	30	105	18	12.5	-	-	-	-	-	-	-
Maragua	23-4-75	7.4	600	320	73	26	3.0	3.0	Ni1	0.3	6.4	2.4	20.1	0.1
	24-5-75	6.5	375	324	43	18	2.0	2.5	Ni1	0.2	5.5	1.0	6.4	2.0
	26-6-75	7.1	40	Ni1	54	22	1.0	3.0	Ni1	0.2	5.5	2.0	2.0	Ni1
	13-8-75	6.8	15	4	78	26	6.0	Ni1	Ni1	0.2	6.5	2.6	2.0	Ni1
	15-9-75	7.1	10	Ni1	64	26	1.1	Ni1	0.01	0.01	6.4	2.4	0.2	Ni1
	15-9-75	9.1	15	45	55	20	-	-	-	-	-	-	-	-

TABLE F: (continued)

Name of Sources	Date Sampled	pH	Colour	Turb.	Cond.	T.H.	Cl <sup>-</sup>	SO <sub>4</sub> <sup>-</sup>	NO <sub>2</sub> <sup>-</sup>	F <sup>-</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Fe <sup>2+</sup>	Mn <sup>2+</sup>
Maragua (cont.)	25-9-75	7.8	15	15	78	53.2	-	-	-	0.12	4.5	10.2	0.9	0.13
	3-4-80	9.0	8.7	8.7	-	-	4.4	-	-	-	5.9	0.9	-	0.1
Mathioya	24-4-75	6.8	14,000	650	42	16	3.0	1.0	Nil	0.2	1.6	1.9	8.0	0.5
	24-5-75	7.0	500	295	59	26	3.0	4.0	Nil	0.3	5.5	3.0	11.0	0.5
	26-6-75	7.5	30	Nil	71	30.0	3.0	3.0	Nil	0.2	5.5	2.0	2.0	Nil
	15-7-75	6.9	5	Nil	81	34	3.0	Nil	0.01	0.1	7.2	3.4	0.2	Nil
	13-8-75	7.2	280	55	85	32	6.0	Nil	Nil	0.2	7.5	3.5	2.0	Nil
	15-9-75	9.2	125	1.35	62	26	-	-	-	-	-	-	-	-
	23-9-78	8.0	5	12	8	22.4	2.0	-	-	0.14	3.2	3.5	1.4	0.03
	25-9-78	8.0	5	12	80	22.4	2.0	-	-	0.14	3.2	3.5	1.4	0.03
	26-9-78	8.0	5	12	80	22.4	9.0	-	-	0.14	3.2	3.5	1.4	0.03
	19-6-79	7.3	150	31.5	70	-	1.0	-	-	-	-	-	-	-
	18-4-75	7.7	<5	Nil	-	-	5.0	-	Nil	0.2	8.0	4.5	0.4	Nil
Sagana River	24-4-75	6.4	1400	850	63	16	5.0	4.0	Nil	0.1	1.6	1.9	40.0	0.5
	24-5-75	6.6	3000	370	58	16	8.0	4.0	Nil	0.2	4.0	1.0	18.0	3.0
	21-6-75	7.5	150	40	90	22.0	10.0	Nil	Nil	0.2	6.4	1.4	1.6	Nil
	26-6-75	7.4	80	32	69	24.0	6.0	3.0	Nil	0.2	6.4	1.9	2.2	Nil
	13-8-75	6.2	100	20	79	24	7.0	Nil	Trace	0.2	7.5	4.8	4.0	0.2

TABLE F: (continued)

Name of Sources	Date Sampled	pH	Colour	Turb.	Cond.	T.H.	Cl <sup>-</sup>	SO <sub>4</sub> <sup>-</sup>	NO <sub>2</sub> <sup>-</sup>	F <sup>-</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Fe <sup>2+</sup>	Mn <sup>2+</sup>
Sagana River (cont'd)	16-5-76	7.5	-	6.5	80	-	-	-	-	-	-	-	-	-
	25-9-78	7.2	40	26	104	9.09	8.0	-	-	0.18	2.7	23.0	2.75	0.25
Saba Saba	24-4-75	7.8	150	100	280	92	8.0	15.0	Nil	0.02	20.8	9.6	24.0	0.4
	24-5-75	7.3	250	185	240	D92	6.0	10.0	Nil	0.1	17.0	11.5	5.4	2.0
	26-6-75	8.1	120	120	270	116	5.05	3.0	Nil	0.6	22.4	14.4	1.2	Nil
	15-7-75	7.9	2500	80	256	116	6.0	5.0	0.03	0.4	20.8	15.4	0.8	0.05
	13-8-75	7.7	500	45	79	118	9.0	1.0	Nil	0.8	25.6	13.0	1.0	Nil
	15-9-75	7.5	60	62	245	93	-	-	-	-	-	-	-	-
	14-1-80	-	170	66	500	-	0	-	-	0.25	-	-	-	-
	21-6-75	7.3	<5	Nil	64	14.0	6.0	1.0	Nil	0.5	4.0	1.0	0.2	Nil
Thika	13-8-75	6.5	30	Nil	60	20	7.0	Nil	Nil	0.2	1.5	3.8	0.2	Nil
Thaera	17-10-74	7.8	40	Nil	430	196	4.0	3.0	<0.01	0.5	3.2	2.8	0.4	Nil

SOURCE: Kenya, Ministry of Water Development, 1980.

APPENDIX TABLE G:

BOREHOLES IN MURANG'A DISTRICT, 1981

BOREHOLE NUMBER	LOCALITY	TOTAL DEPTH (m)	WATER STRUCK (m)	REST LEVEL (m)	TESTED YIELD (m <sup>3</sup> /h)	REMARKS
C2783	Makuyu	41	31	3	4.09	Volcanics and basement, good quality
C2788	"	79	49	2	0.49	Basement, good
C2826	"	61	9	0	0.091	Basement, quality N/A
C2802	"	47	37	3	11.38	Volcanics, good
C2835	Mitubiri	105	101	22	3.64	Basement, good, slightly milky
C2856	Makuyu	15	0	0	DRY	Basement, dry B/H
C2868	"	122	98	16	50.05	Volcanics, good
C2981	"	52	17	0	2.64	"
C2982	"	77.1	54.8	2.1	20.48	"
C3049	Kabati	87	79	12	9.1	"
C3034	Muranga	134	122	18	28.8	"
C3124	Makuyu	185	183	9	1.73	"
C3131	"	49	45	3	16.28	"
C3160	N/A	115	107	2	1	Basement, good
C3199	Gitura	137	0	39	4.7	Volcanics, good
C3285	Makuyu	76	67	27	13.7	T. Volcanics, good
C3293	Kangema	76	76	0	-	Volcanics, artesian B/H
C3359	Githunguri	153	148	46	243	Volcanics, good
C3471	Kagunduini	143	122	35	0.27	"
C3603	Thika	110	0	0	9.83	Basement, good
C2002	"	122	73	62	13.7	Volcanics, good
C2005	Kinangop	225	249.45	241.5	0.7	Abandoned

APPENDIX TABLE G: (continued)

BOREHOLE NUMBER	LOCALITY	TOTAL DEPTH (m)	WATER STRUCK (m)	REST LEVEL (m)	TESTED YIELD (m <sup>3</sup> /h)	REMARKS
C2013	Kakuzi	63	60	27	2.18	Volcanics, clear
C2062	Kijabi	261	260	228	2.05	"
C2063	Kinangop	129	119	99	5.46	Volcanics, fair
C2154	Kamahuha	172	166	30	0.91	N/A, Dry B/H
C2171	Kitibanga	64	32	30	5.46	Volcanics, good
C2176	Kijabe	77	73	39	9.83	"
C2204	Thika	183	0	0	Nil	Abandoned
C2263	Kinangop	273	103,119 219	149	Nil	Volcanics, Good
C2264	"	243	103 119-219	149	4.1	"
C2392	Kangema	182.9	0	0	0.41	Artesian
C2417	Thika	204	49	79	0.32	Volcanics, good
C2418	Makindi	104	100	35	9.1	"
C2420	Kinangop	123	118	68	19.4	"
C2421	"	194	194	189	9.65	"
C2530	Koorali	121	117	63	10.9	"
C2663	Kijabi	137	110	98	11.4	"
C2820	"	301	216.5	276	2.30	"
C2748	Gwalumba	131	119	2	2.73	Basement system
C118	Makuyu	181	68	64	0.84	T. Volcanics, good
C1123	"	68.96	60.96	2.43	7.3	Volcanics, good
C1153	"	69	62	29	9.1	T. Volcanics, good
C1154	Maragwa	87	18	12	0.46	Basement system, good quality

APPENDIX TABLE G: (continued)

BOREHOLE NUMBER	LOCALITY	TOTAL DEPTH (m)	WATER STRUCK (m)	REST LEVEL (m)	TESTED YIELD (m <sup>3</sup> /h)	REMARKS
C1158	Maragwa	55	20	2	16.38	Basement system, good quality
C1169	Mitubiri	121	95.7 110	27	15	T. Volcanics, good
C1196	Thika	139	113	38	9.6	Volcanics, good
C1212	Maragua	121	21	0	0.68	Basement system, good
C1213	"	45	0	0	Nil	N/A, B/H
C1254	Wango Est.	194	92	26	3.4	Volcanics, good
C1271	Makuyu	76	70	40	8.2	T. Volcanics, good
C1273	"	104	98	2	13.65	T. Volcanics, good
C1338	Gitura	188	0	17	3.3	Volcanics, good
C1344	Maragua	53	50	3	6.83	Basement system, good
C1345	Makuyu	24	21	19	2.73	T. Volcanics, good
C1394	"	93	19	13	3.4	"
C1421	Thika	133	116	29	13.6	T. Volcanics, good
C1457	"	82	72	32	1.92	Volcanics, good
C1547	"	180	154	41	1.59	T. Volcanic, good
C1587	"	124	117	41	9.1	"
C1601	Mukuka	183	170	14	3.79	"
C1602	Kinangop	172	164/167	150	1.5	Volcanics, good
C1616	Mukuka	162	162	33	6.8	"
C1633	Kitibanga	54	32	30	5.46	"
C1635	Makuyu	4.53	34.94	24	2.3	Volcanic, good
C1636	"	104	34/37	5.8	7.7	Volcanic, good

APPENDIX TABLE G: (continued)

BOREHOLE NUMBER	LOCALITY	TOTAL DEPTH (m)	WATER STRUCK (m)	REST LEVEL (m)	TESTED YIELD (m <sup>3</sup> /h)	REMARKS
C1650	Makindu	143	56	36	2.46	Volcanics, good
C1660	Thika	153	149	41	9.1	T. Volcanics, good
C1683	"	150	31	29	0.9	"
C1718	"	178	146	37	3.4	Volcanics, good
C1739	Mitubiri	110	82	66	13.7	"
C1794	Kijabe	236	227	132	7.74	Abandoned
C1894	Mitubiri	69	58	24	3.5	Volcanic, good
C1900	"	159	158	30	14.7	"
C1901	Makuyu	46	37	2	8.19	Volcanic, good
C1929	Kinangop	136	125	100	3	"
C1976	Kandara	218	81	81	2.28	"
C1985	Kangema	153.3	21.3 143/152	0.4	-	"
C1996	Mitubiri	137	125	30	1.40	Volcanics, clear
C1997	Kijabe	224	220	200	0.187	Volcanics, fair
P65	"	100.58	22.9 89.92	60.96	2.2	Volcanic formation, good
P69	"	122.88	-	-	-	"
P80	"					"
C144	Kabati	53	49	38	12.3	Volcanics, very good quality
C386	Makuyu	105	56/96	48.8	6.8	"
C387	Mitubiri	137	107	2	3.09	Volcanics, good quality
C403	"	159	158	30	14.7	Volcanics, poor quality

APPENDIX TABLE G: (continued)

BOREHOLE NUMBER	LOCALITY	TOTAL DEPTH (m)	WATER STRUCK (m)	REST LEVEL (m)	TESTED YIELD (m <sup>3</sup> /h)	REMARKS
C494	Matikaboko	27	23	11	13.7	Volcanics, good
C491	Dundamalla	72	21	4	22.75	T. Volcanics, good quality
C495	Makuyu	27	23	13	13.7	"
C549	Kijabe	159	-	-	-	Volcanics, good
C633	"	183	180	109	4	"
C634	"	104	92	39	6.8	"
C703	"	93	85	24	2.75	"
C829	Makuyu	57.9	56.4 57.9	0.61	18.2	"
C840	"	45.7	32	16.5	3.2	T. Volcanics, good
C841	"	80.8	45.7	1.8	5.3	Volcanics, good
C842	"	45.7	28.5	13.7	2.3	T. Volcanics, good
C994	Kitabi	101	92	43	2.06	Volcanics, good
C1000	Kamura	149	142	125	3.87	"
C1007	Kiasi	61	45	23	11.4	"
C1083	Makuyu	46	31	2	15.93	"
C1119	Mitubiri	40	26	16	2.34	"
03640	Kagunduini	124	k&4 110	26	1.5	"
03662	Kamuea	153	40	12	1.14	"
03663	"	46	43	4	13.6	"
08716	Thika	70.4	22.4/64	16.2	9.1	"
03876	Forthall	122	62.8	8	0.82	"
03921	Kijabe	61	16.76	15.85	31.33	"

APPENDIX TABLE G: (continued)

BOREHOLE NUMBER	LOCALITY	TOTAL DEPTH (m)	WATER STRUCK (m)	REST LEVEL (m)	TESTED YIELD (m <sup>3</sup> /h)	REMARKS
04051	Sabasaba	140.8	130-140	32.75 24.3	0.2 4.3	Good, green rocks
04976	Ithanga	103	89/94	8	3.4	
04110	Maragua	124	12&94	9	3.28	Gravels mixed with salty water
04479	Mitubiri	122	31.1	28	13.64	Volcanics, good
AVERAGES		117.0	84.04	42.85	7.13	

SOURCES: Kenya, Ministry of Water Development, 1980.

APPENDIX TABLE H:

QUALITY OF GROUNDWATER, MURANG'A DISTRICT, 1975-79

Name of Sources	Date Sampled	pH	Colour	Turb.	Cond.	T.H.	Cl <sup>-</sup>	SO <sub>4</sub> <sup>-</sup>	NO <sub>2</sub> <sup>-</sup>	F <sup>-</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Fe <sup>2+</sup>	Mn <sup>2+</sup>
Githunguri C4279	20-11-76	6.0	5	36	-	-	-	-	-	-	-	-	0.09	-
Githunguri C4279	2-11-77	7.0	30	-	730	250	6.9	-	-	1.1	-	-	-	-
	5-11-77	8.1	5	9	700	25.5	8.9	-	-	0.86	-	-	1.17	-
Ithanga C4076	29-1-75	7.8	<5	N11	4800	112	1630	1.0	N11	3.8	56.0	N11	0.4	N11
Kathira Well	1-4-75	7.2	60	88	225	46	26	13	N11	0.6	10.4	4.8	1.6	N11
Kabatini C4369	9-2-78	8.1	5	2.5	318	62	-	-	-	1.56	-	-	0.27	1.17
Kabatini C4369	9-2-78	8.2	50	120	339	86	-	8.0	-	1.9	-	-	30.8	0.46
Kaboi Sec. B/H	9-7-79	6.9	-	14	600	180	12.3	0.4	-	-	34.8	22.4	0.3	0.6
Karurumo C45571	1-3-79	7.0	200	85	95	10	2.28	-	-	0.22	0.3	0.4	14.8	1.2
Kabare B/H School	6-8-79	7.2	-	6	55	18.0	1.0	-	-	-	-	2.30	0.5	0.1
	6-1-76	8.15	1400	-	1925	-	-	-	-	-	-	-	-	-
	18-6-75	6.6	50	21	400	70.0	35	53.0	N11	0.3	17.6	6.2	1.5	1.5
	10-2-76	6.22	560	-	168	24	-	-	-	-	-	-	-	-
Kibichoi	27-4-77	7.0	5	16	230	-	175	-	-	<0.01	-	-	N11	N11
Makuyu C4175	22-10-75	8.7	<5	-	508	32	-	-	-	-	-	-	-	-
Maragua 352	9-5-77	7.3	100	126	330	88	62.5	-	-	0.12	-	-	2.25	3.53

SOURCE: Ministry of Water Development.

Chemical	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80	1980/81
<b>A. Insecticides<sup>(1)</sup></b>							
Fenitrothion (L)	16,001	12,839	12,724	6,534	14,007	21,073	18,033
Dieldrin (L)	588	455	917	849	N/A	1,009	1,073
Diazinon (L)	952	453	240	1,094	2,199	6,991	10,704
Fenthion (L)	1,997	N/A	1,636	13,746	N/A	N/A	17,049
White Oil (L)	52	44	96	904	N/A	N/A	145
Tar Oil (L)	61	1,150	1,054	1,254	N/A	N/A	156
Gusathion (Azinphosmethyl) (L)	N/A	N/A	N/A	N/A	N/A	N/A	5,820
<b>B. Fungicides<sup>(1)</sup></b>							
Copper 50-6 (kg)	171,806	208,402	220,911	231,800	362,500	N/A	352,478
Captafol (kg)	9,304	19,319	18,597	5,900	25,700	N/A	20,037
Cuprous Oxide (kg)	3,216	N/A	N/A	1,470	N/A	N/A	N/A
Bavistin (kg)	1,528	2,881	5,950	490	-	-	-
Derosol (L)	-	628	961	-	-	-	-
Bravo 6F (L)	-	-	-	31	9,340	-	-
Delan (Dithionan) (kg)	-	-	-	29,600	1,075	N/A	1,560
Benlate (Benomyl) (kg)	-	-	274	1,670	13	-	-
Sicarol (kg)	-	-	-	-	-	-	348
<b>C. Herbicides<sup>(1)</sup></b>							
Gramoxone (Paraquat) (L)	-	30	133	504	598	N/A	3,353
Roundup (Glyphosphate) (L)	-	-	-	N/A	204	348	202
<b>D. Fertilisers<sup>(2)</sup></b>							
<b>Calcium Ammonium</b>							
Nitrate (CAN) (kg)	214,090	974,188	649,463	711,500	N/A	N/A	1,821,800
<b>Ammonium Sulphate</b>							
Nitrate (ASN) (kg)	166,540	40,017	119,150	56,300	N/A	104,600	300,100
Wuxal (10:10:75) (L)	-	887	30	1,229	N/A	5,143	7,016
Compound 20:20:0 (kg)	98,000	199,800	N/A	1,633,000	N/A	N/A	N/A
Compound 23:23:0 (kg)	47,000	102,900	N/A	19,500	N/A	N/A	N/A
<b>Diammonium Phosphate</b>							
(DAP) (kg)	43,000	49,450	N/A	-	N/A	N/A	N/A
<b>Triple Super</b>							
Phosphate (TSP) (kg)	33,000	36,300	17,500	7,250	28,250	61,900	N/A

NOTES: <sup>(1)</sup> Includes sales and use only by the Coffee Societies.

<sup>(2)</sup> CAN, ASN, and Wuxal figures include sales only to Coffee Societies. Others include sales through Kenya Farmers' Association and District Union.

SOURCE: Kenya, Ministry of Agriculture, for the years cited.

APPENDIX TABLE J:

MAJOR HISTORICAL EVENTS RELEVANT TO ENVIRONMENT,  
MURANG'A DISTRICT, 1900-80

<u>YEAR</u>	<u>EVENT</u>
1900	Famine of Europe.
1905	Arrival of large Asian trading safari and subsequent disturbance at Othaya.
1913	Aberdare Forest Reserve created.
1914	Outbreak of World War I.
1916	Chief Kariuki died.
1917	Employment of forest guards.
1922	Harry Thuku arrested. Outbreak of Rinderpest in the district.
1923	Outbreak of plague.
1924	Fort Hall Agricultural show.
1928	Earth tremor.
1929	Locusts destroyed all the crops in district, causing famine.
1930	"Morobo" dance; return of Jomo Kenyatta. Outbreak of plague.
1931	Sale of wattle bark introduced.
1936	Clearing of villages by Mr. Dawson, the local DC. Ratproofing of grain stores.
1942	Raising of hut tax to shs. 14/=, with exemption of women.
1943	Famine "Ngaragu ya Mianga" - cassava famine.
1946	Return of demobilized soldiers.
1948	Women's revolt led by Wangu Makeri.
1951	Objection to rinderpest inoculation by local people and burning of cattle crushes.
1952	Emergency declared.
1953	Formation of home guard and building of administration posts in sub-locations.
1955	Start of land consolidation.

APPENDIX TABLE J: (continued)

<u>YEAR</u>	<u>EVENT</u>
1956	Return of detainees. Registration of "loyalist" voters.
1963	Independence.
1965	Famine, importation of yellow maize as relief supplies.
1980	Food shortage, importation of yellow maize.