THE RURAL ENERGY SECTOR AND THE ENVIRONMENT

A CASE STUDY OF WEST GONJA DISTRICT, GHANA

A Thesis Submitted to the Board of Post graduate Studies

University of Science and Technology, Kumasi in

partial fulfilment of the requirements

for the degree of Master of Science

in Development Planning and

Management

By

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JULY, 1990

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V I T A

The Author was born on 18th October, 1962 in Mougu, Western province, Zambia. He received primary school education in Seshoke and Senanga districts and then proceeded to Kalabo Secondary School in 1977. In 1982 he was admitted to the University of Zambia in Lusaka where he graduated in 1986 with a Bachelor's degree in Geography.

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A B S T R A C T

Energy is an important basic input necessary in both households and economic activities. In West Gonja District of the Northern Region of Ghana more accurate information on the specific energy sources, needs, consumption patterns and their environmental impacts is lacking. Such data is necessary for planning towards the provison of reliable and cheap sources of energy based on a stable supply, for the over all development of the District.

This study, through a household survey of six sampled settlements in the District finds a very high dependency of the population on kerosene, firewood and charcoal as sources of energy. Consumption levels are found to vary with household size. Efficiency of energy utilisation is very low due to the inefficient end-use devices employed in most households.

Fuel scarcity in the District is perceived through increasing distances to sources of supply and longer collection time. Indications of environmental pressures are evident in the form of deforestation and soil erosion resulting not only from energy needs, but also from inappropriate farming practices. The implications of the findings are that planning is necessary to address the areas of energy conservation and environmental protection.

The recommendations suggested aim at improving the efficiency of energy utilisation, augmentation of available sources of energy, improving methods of fuel exploitation and improving farming practices in the District. If the recommendations are acted upon, taking into account suggestions made in the implementing institutional structure at District and local level, the District, will be on its way towards achieving a reliable energy base.

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CHAPTER ONE

INTRODUCTION

This chapter provides an introduction to the study beginning with a background to the problem and the significance of the study, statement of the problem, objectives, research methodology used and the scope and limitations of the study.

1.1 Background to the Problem and Significance of the Study.

The 1973 oil crisis put very severe constraints on the development of non-oil producing third world countries. Due to the, very high dependency on petroleum as a commercial energy, immediate adjustment was not possible. The amount of foreign exchange required to satisfy the petroleum requirements increased significantly as the oil bill grew. The increased diversion of resources towards the oil import bill meant that over all economic growth was sharply slowed down as fewer resources were available for other development activities. As a result, many developing countries found their indebtedness growing as they tried to secure alternative resources from international financial institutions to sustain their economic development.

The oil crisis revealed just how important a reliable and sustainable source of energy is to the overall socio-economic development of a country. Availability and control over energy resources can determine the pace and direction of development which a country takes. The crisis showed that imported energy resources are unreliable if a country wants to retain control and determine its own socio-economic direction of development.

The crisis also instilled in the minds of many people the importance of utilising energy efficiently in order to avoid the negative impacts on economic development of high energy costs. Finally, it was also realised that energy is a valuable commodity which must be conserved. Research into alternatives to petroleum, and locally obtainable energy sources have become prime targets of most developing countries.

In Ghana, the most important source of energy is biomass. According to available information, "a break down of energy consumption shows that the bulk is met from biomass - firewood, charcoal and agricultural residues which account for 75 per cent, followed by petroleum products, 23 per cent and electricity 3 per cent".[1] Although biomass is the most important source of energy in Ghana, and indeed in most of the developing countries, it is the energy source least known in terms of supply and consumption levels. It is therefore, important that sufficient and more accurate data base is established on the relationship between biomass, as a major source of energy and its impacts on the environment. It is with this foregoing view that this study is conducted.

1.2 Statement of the Problem

Very little is known about the state of the energy sector in West Gonja District of the Northern Region of Ghana. The situation is more acute with regard to household energy usage. Information concerning the exact types of energy sources in use in the District and the rate of consumption is important if the rural energy sector is to be integrated in the energy planning both at the regional and national levels.

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[1] C. Weroko-Brobby, Energy Research in Ghana: Review and Future Directions (Accra: CEHED, 1988), p. 19.

There is need for more information on the sustainability of the current and future energy demand with regard to the supply. The socio-cultural background of energy utilisation and other practices which impinge on energy resources, such as farming practices, must be properly researched into, in order that development programmes aimed at sustaining the energy demand and supply do not become 'white elephants'.

A proper investigation of the various activities involving energy consumption and the efficiency of energy utilisation in the District are areas which lack reliable data. Methods of energy utilisation and therefore, consumption levels are likely to vary spatially and socially, depending on social status. Consequently, it is vital that the various target groups are identified, as each group may be affected differently by energy scarcity. In this regard, measures taken to ameliorate the supply problem of energy will take into account the point of view of the people affected and consider their aspirations and capabilities. Alternative energy sources and conservation measures must also be based on a critical assessment of sustainability and social acceptability. This means that the social feelings must be seriously considered. Assessment of the impact of the exploitation and utilisation of energy resources must be comprehensive and wide in scope to include both the bio-physical and the socio-economic environment.

A break down of the specific objectives through which the problem is investigated follows in section 1.3.

1.3 Objectives of the Study

This study is aimed at satisfying the following objectives:

(i) to investigate the exact types of energy used in West Gonja District;

(ii) to find out the respective end-uses of each energy type;

(iii) to find out the end-use devices employed in relation to energy type;

(iv) to investigate the energy consumption levels in the District;

(v) to find out the efficiency of energy usage in the District;

(vi) to investigate possible alternative energy types; and

(vii) to investigate the physical and socio-economic environmental impacts of energy usage in the district.

1.4 Research Methodology

1.4.1 Data Sources and Collection Techniques

This study has drawn on various data sources both primary and secondary. Primary data was obtained from a household survey conducted by the author in the Study District. Another important source of primary data was a Household Survey Conducted earlier on in the District by SPRING II participants for the Development Workshop Report. The author was a member of the team.

Secondary sources of data included the National Energy Board (N.E.B) library in Accra. In addition, relevant information was obtained from specialised research institutes within the University of Science and Technology, Kumasi, namely the Forest Products Research Institute and the Institute of Renewable Natural Resources. A previous study on the energy sector in the Northern Region of Ghana[2] provided basic guiding information to this study.

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[2] D. Pluth, The Energy Sector in Northern Region, Ghana (Preliminary Report, 1985)

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Extensive review of these secondary sources of data provided important background information on the formulation of the research topic and the physical and socio-economic conditions of the District.

A third data source was the discussions the author held with regional and district heads of institutions whose activities directly or indirectly relate to the energy sector and environmental management, such as the Forestry Department, Department of Agriculture and members of the National Energy Board and Environmental Protection Council. A lot of insight and information to the problem was obtained from these informal discussions.

Lastly, personal observations by the author during the trips made to the study District was another valuable source of information.

The author was able to observe the direct dependence of the population on the forest as a source of energy, the kind of trees used for fuel, the cooking methods and devices, the other uses of forest products and the signs of environmental pressure in the form of deforestation and soil erosion.

1.4.2 Design and Administration of Interview Schedule

The Study District does not form distinct ecological zones even though there are slight spatial variations in rainfall and soils. Therefore, sampling was not based on ecological zones. Instead, a spatially representative sampling technique which entailed taking into account the geographical areas of the District was adopted.

Spatially representative sampling made it possible to gather information in all parts of the district.

The six settlements covered in the survey: Damongo, Daboya, Busunu, Yapei, Buipe and Mpaha each represent a geographical area of the District. See Fig. 1.1 for the geographical locations of the sampled settlements in the District.

The unit of sampling used was the Household. The household was found to be most appropriate for this study because it forms the smallest unit of production and consumption and therefore, has a strong influence on the energy resources and the environment as a whole. As much as possible efforts were made to interview the heads of households.

In all, 100 households were interviewed in the study. The sample size for each settlement was proportional to the total number of households in each settlement. Therefore, larger settlements, that is, those with many households had larger sample sizes than smaller ones. The sample size represented 0.87 per cent of the total number of households in the District[3]. The systematic random sampling method was used in all the settlements to arrive at the final selection of households for interview. The systematic random sampling method was selected because it was appropriate and also easy to be understood and used by the survey assistants. Table 1.1 sammaries the sampling procedure and the sample sizes in each of the six settlements.

The questions in the interview schedule were formulated under a framework of four themes. They are (1) Energy types and consumption levels (2) Energy resources and alternatives.

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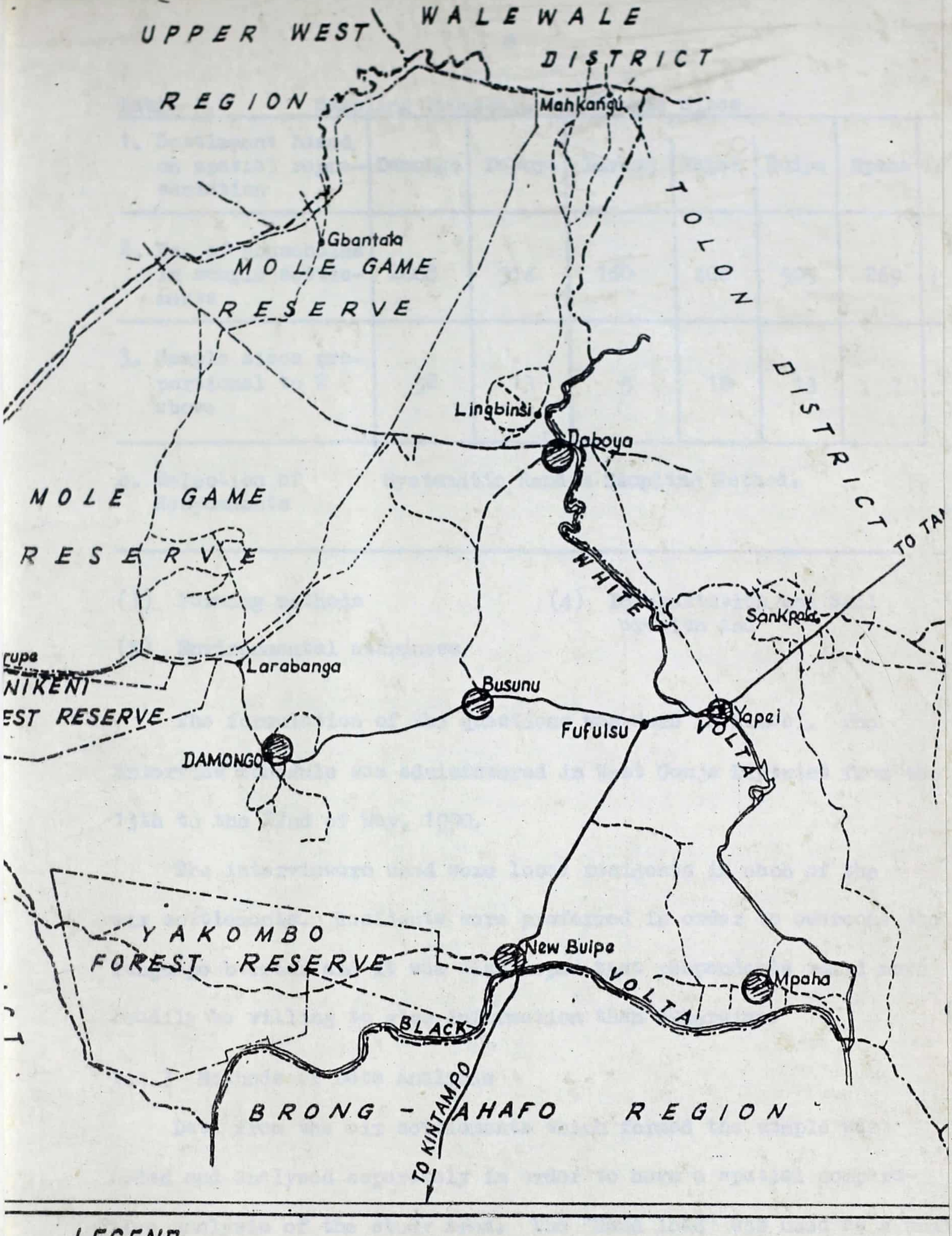
[3]The total number of households in West Gonja were estimated at 11 482, See SPRING II Participants, West Gonja District Study Preliminary Report (Kumasi : U.S.T., 1990) p. 9 and 13.

Fig. 1.1



LEGEND

— 1st Class Road

— 2nd Class Road

— 3rd Class Road

-- Tracks & Major footpath

--- District Boundary

LOCATION OF SAMPLED SETTLEMENTS

WEST GONJA DIS

N

- Scale 1:900

Table 1.1 Sampling Procedure and Sample Sizes

1. Settlement based on spatial representation	Damongo	Daboya	Busunu	Yapei	Buipe	Mpaha	TOTAL
2. No. of Households in sample settlements	2068	514	160	406	505	269	3922
3. Sample sizes proportional to 2 above	52	13	5	10	13	7	100
4. Selection of Respondents	Systematic Random Sampling Method.						

(3) Farming methods

(4) Deforestation and Soil erosion and

(5) Environmental awareness

The formulation of the questions was done in Kumasi. The interview Schedule was administered in West Gonja District from the 13th to the 22nd of May, 1990.

The interviewers used were local residents in each of the six settlements. Residents were preferred in order to overcome the language barrier and it was also hoped that respondents would more readily be willing to give information than otherwise.

1.4.3 Methods of Data Analysis

Data from the six settlements which formed the sample was coded and analysed separately in order to have a spatial comparative analysis of the study area. The "Head load" was used as a unit of measurement during the survey for household firewood consumption.

Despite its limitation, it was found to be an easily understandable measure by both the assistants and the respondents because most people in the District either collect or buy 'head loads' of firewood. During the analysis, headloads were converted into m^3 of firewood. A head load in the District contains on average $0.02832m^3$ of wood[4].

Charcoal is sold in bags in the District, therefore, measurement was done in the number of bags of charcoal consumed per specified period. Bags of charcoal in the area have been found to weigh 45kg on average[5]. 1kg of wood is equivalent to approximately $0.00135m^3$.[6] According to studies carried out, the charcoal processing methods employed in the area wastes about 50 per cent of the wood employed whereas charcoal itself is approximately 50 per cent as dense as the wood from which it came[7]. Therefore, a kilogramme of charcoal made means two kilogrammes of wood used and four kilogrammes of wood cut or $0.0054m^3$ of wood.

The measurement of kerosene consumption was done in gallons consumed in a specified period. The gallons were then converted into litres during the analysis. One gallon is equivalent to 4.5 litres. The gallon was found to be a convenient unit of measurement for kerosene because it is sold per gallon in the District by the Ghana Oil Company.

Analysis of efficiency of energy utilisation was based on the efficiency of the various end-use devices in the District which is dealt with in detail in section 3.2.

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[4] Forestry Department, Internal Communication Paper. (Tamale: 1989), p 1.

[5] Pluth, "The Energy Sector in Northern Region, Ghana" p 29.

[6] M. Raduer and A. Wad, EDI Training Material: Training Module, Wood, (New York: IBRD, 1985) p 1.

[7] Pluth, "The Energy Sector in Northern Region, Ghana", p. 29.

1.5 Scope and Limitations

The study is concerned with the energy situation and the environment in West Gonja District of Ghana. The findings and conclusions however, can be applicable in most parts of the Northern Region of Ghana or any area with similar physical and socio-economic characteristics.

The study covers domestic and other household energy consuming activities. However, other energy consumer activities are identified and their effect on energy consumption and the environment assessed.

Resource constraints, especially the very brief time available for the collection and analysis of data together with the write up has had some impact on the study, namely the limiting of the sample size to a manageable size.

1.6 Organisation of the Thesis

The first chapter introduces the study by outlining the problem, objectives and the methodology used together with the scope and limitations. The second chapter provides a biophysical and socio-economic description of the study area while the third chapter is devoted to a review of literature. The fourth chapter provides the theoretical framework to the study while the analysis of data and presentation of findings is the subject of chapter five. Chapter six looks at the existing planning institutional structure while the last chapter gives a summary, recommendations and the conclusion of the study.

CHAPTER TWO

DESCRIPTION OF THE STUDY AREA

This chapter describes the bio-physical and social characteristics of the area in which this study is undertaken. It examines the existing conditions regarding the location, size, relief and drainage patterns, temperature and rainfall, soils and vegetation characteristics, population and the general economic activities of the area.

2.1 Location and Size

West Gonja District is located in the Northern Region of Ghana. It occupies a position between 1°30' and 2°30' West and 8°-10° North. It covers an area of 16706km^2, making it one of the largest districts in the Country. The District shares boundaries with Brong Ahafo Region in the South, Bole District in the West, Upper West Region in the North-West, Walewale District in the North, Tolon and East Gonja District in the East. The map Fig 2.1 shows the location of the District in national and regional context.

2.2 Relief and Drainage

The District is generally undulating with altitude ranging from 180m to 300m above sea level.[1] Higher ground is formed by the Damango escarpment north of the District Capital. There are also a few outcrops of weathering resistant high rise grounds around Daboya which is an area composed of pre-carribrian granitic geological structure dissected mainly by the Volta drainage system. Several swamps and wet lands are found all over the District especially around Mankarigu and Busunu areas.

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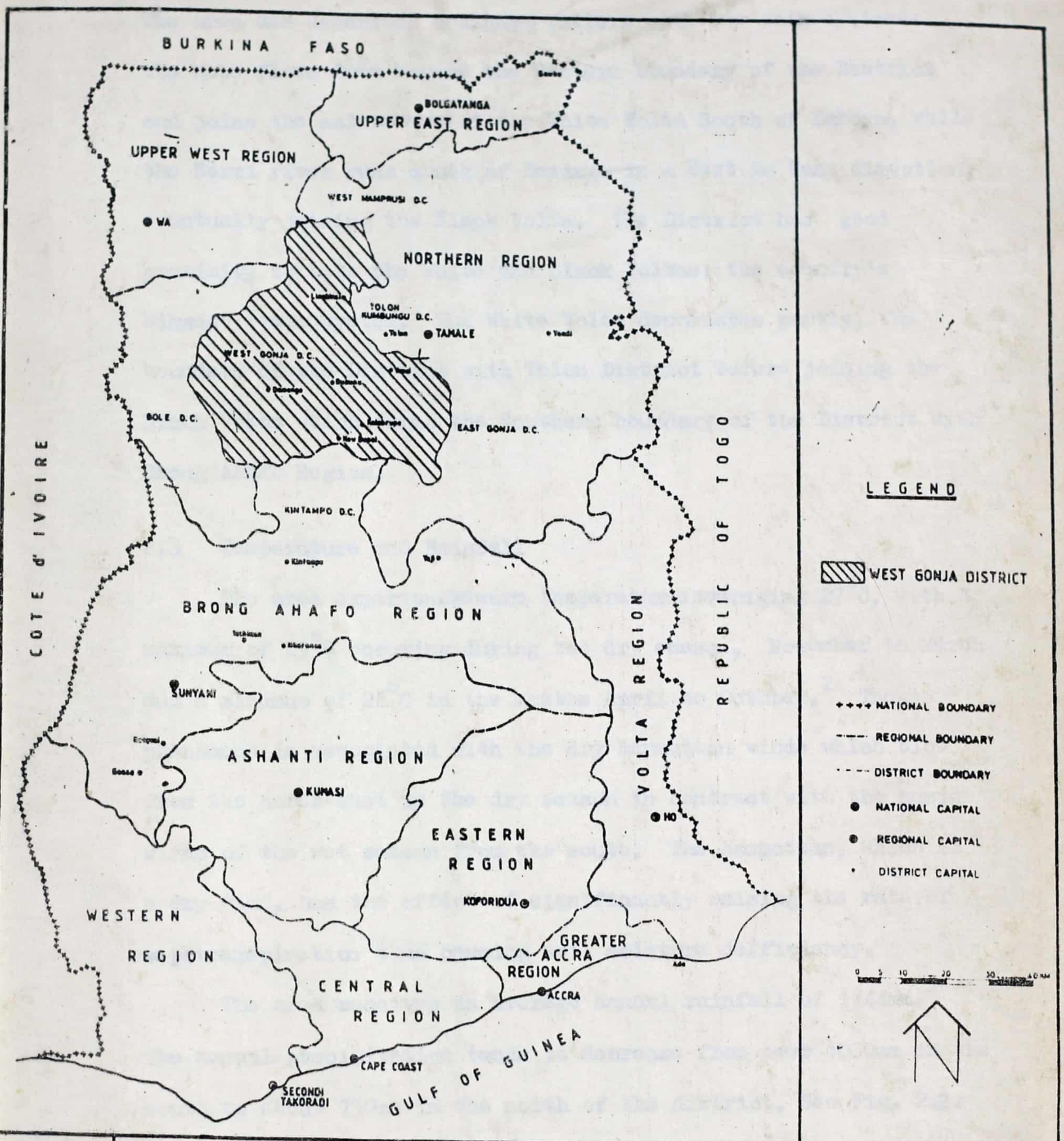
[1] R.P. Mendez and Others, Assessment of the Problem of Desertification in Ghana. (Accra: UNSO, 1985), p 18

Fig. 2.1



SPRING 1989/90 WEST GONJA DISTRICT STUDY	WEST GONJA DISTRICT IN REGIONAL & NATIONAL CONTEXT

The area has dendritic drainage pattern with two main systems: the Mole flows from beyond the Western boundary of the District and joins the mainstream of the White Volta South of Daboya, while the Sorri river runs south of Damango in a West to East direction, eventually joining the Black Volta. The District has good proximity to both the White and Black Voltas: the country's biggest river system. The White Volta demarcates partly, the boundary of the District with Tolon District before joining the Black Volta which forms the Southern boundary of the District with Brong Ahafo Region.

2.3 Temperature and Rainfall

The area experiences warm temperatures averaging 27°C, with a maximum of 29°C occuring during the dry season, November to March and a minimum of 26°C in the months April to October.[2] These phenomena is associated with the dry harmattan winds which blow from the north-east in the dry season in contrast with the humid winds of the wet season from the south. The harmattan, which is a dry wind, has the effect of significantly raising the rate of evapotranspiration thus causing soil moisture defficiency.

The area receives an average annual rainfall of 1144mm.[3] The annual precipitation tends to decrease from over 1000mm in the south to about 750mm in the north of the district, See Fig. 2.2. The rain season begins in late April and reaches its peak in June.

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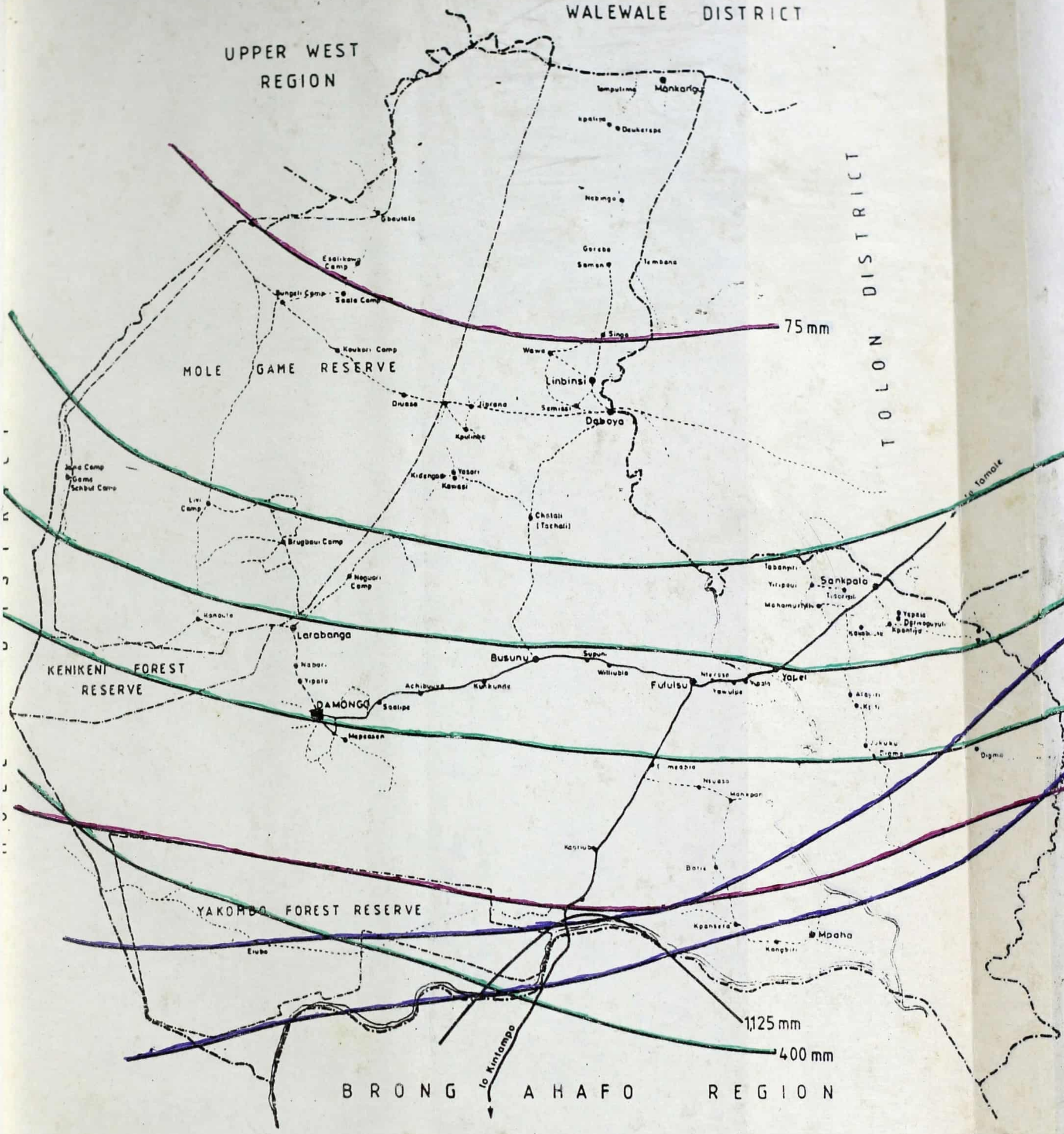
[2] Mendez and Others, "Assessment of the Problem of Desertification in Ghana", p 12

[3] NORRIP, Northern Region: A Descriptive Overview, (Tamale : Norrip, 1983)

FIG. 2.2



SPRING 1989/90 WEST GONJA DISTRICT STUDY	RAINFALL DISTRI

The pattern of fall is erratic at the beginning of the rain season. Another shortcoming is that the rains fall with very high intensity reaching 300mm per hour causing flash floods and erosion on unprotected soil. 10 per cent of the rain is lost in the form of run-off while 2-4 per cent is recharged as ground water and the rest is returned to the atmosphere through evapotranspiration.[4] Due to the irregularities in the rainfall pattern and the high rates of evapo-transpiration, there is a severe limitation to crops and vegetation growth periods.[5]

2.4 Soils and Vegetation

According to the NORRIP report,[6] the District is situated on an old geological area which has been subjected to extensive erosional processes over a long period of time. The soil distribution can be refered to as Voltaian Series. Damango formations are alluvial deposits of low inherent fertility. These series cover the entire district except where pre-carribrian crystalline formations are found.

In the central part of the District, shallow voltaian shales are found. Limestone outcrops occasionally occur between the middle and the lower Voltaian series as is the case around Daboya and Buipe, a factor which is responsible for the Saline Soil conditions in these areas.

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4 NORRIP, "Northern Region", P. 5.24

5 In the Northern Region, the period of adequate rainfall for crop growth is about 129 days, See Mendez and Others, "Assessment of the Problem of Desertification", p 13.

6 NORRIP, "Northern Region", P. 5.25

The extreme Western part of the District is composed of granitic soil type which is parallel to the Voltaian sandstones found in the north to south-central part of the District also of low fertility.

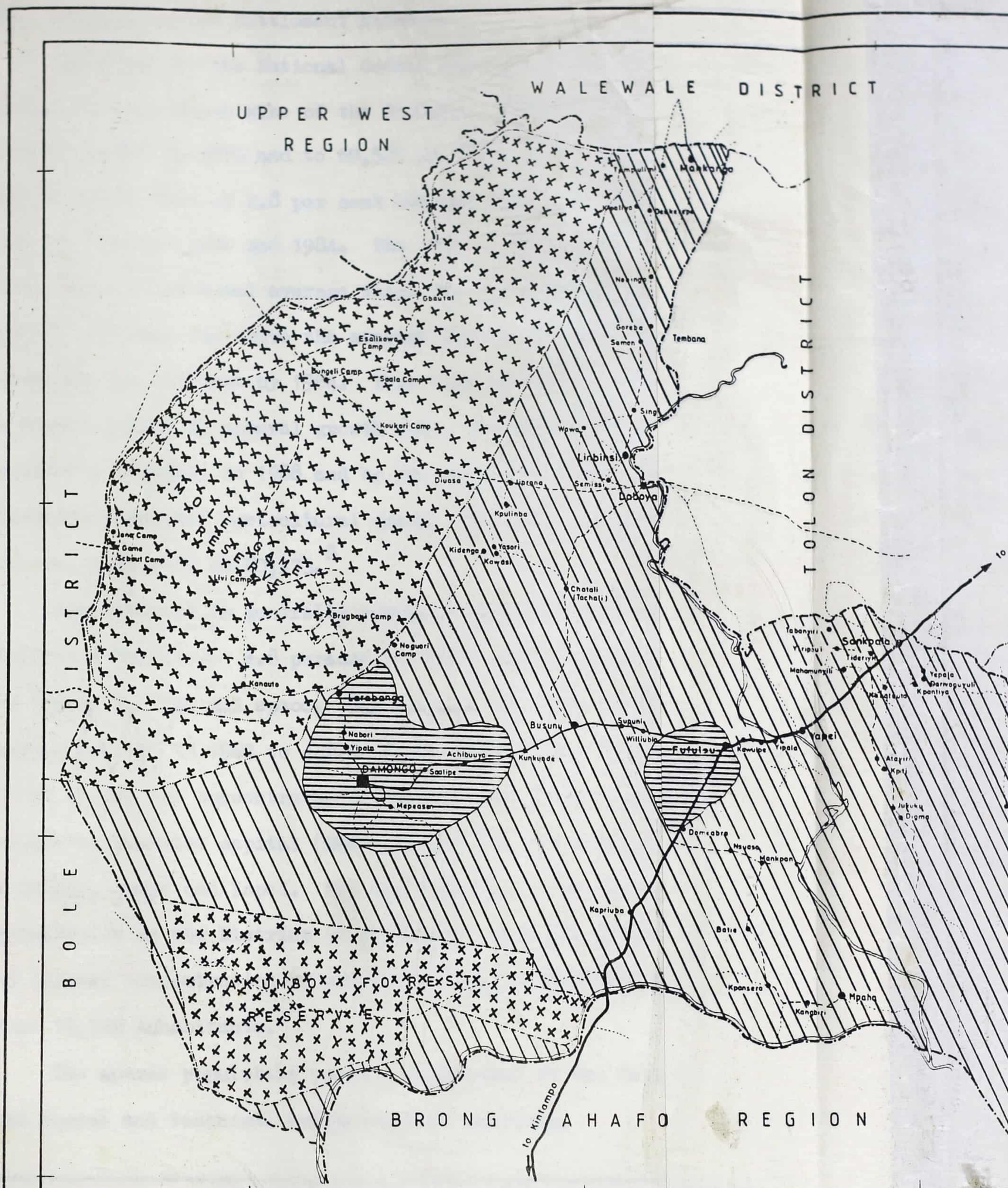
Although, most of the area has low inherent fertility, there is still a lot of potential for agricultural development due to the combination of the physiography which is gently undulating, moderate rainfall and abundance of wet lands. There are agriculturally suitable areas around Buipe, Mpaha, Tuluwe and around Yapei. A strip of land boundering Brong Ahafo occurs in this category.

There are also moderately fertile lands in the District. Such areas occur arround Daboya, Buipe, Kusaugu and Busunu.

The combinations of climate, edaphic (soil) factors and human activities are responsible for the type of Vegetation found in the District. The natural vegetation is Guinea Savanna Woodland. The main species which have adopted include Shea tree (Butrospermum Parkii), Baobab (Adansonia digitata) Acacia, and Dawadawa (Parkia-bicolor). Generally, they are scattered throughout the District except where dense woodland forest occurs in river valleys with enough water all year round.

Nearly all the tree species are deciduous. Regular bush fires, grazing of livestock and cultivation have resulted in a degradation of the original vegetation. The vegetation in most of the area is mainly very open woodland with short grass-degraded savanna.

In spatial context, more closed savanna is found in Mole National Park, Konikoni and Yakombo forest reserves which occupy an area of 5000km^2. See Fig. 2.3 showing the spatial distribution of vegetation.



SPRING 1989/90

WEST GONJA DISTRICT

STUDY

VEGETA

2.5 Population and Settlement Patterns

According to the National Census Reports (1960, 1970 and 1984,) the population size of the District increased from 29337 in 1960 to 38,638 in 1970 and to 69,505 in 1984.[7] This reflects an annual growth rate of 2.8 per cent between 1960 and 1970 and 4.2 per cent between 1970 and 1984. The 1970 - 1984 growth rate was well above the national average which was 2.6 per cent during the period. It was also above the average for the Northern Region which was 3.4 per cent by 1984. This high growth rate may be explained partly by natural growth rate, the redemarcation of the District's boundary in 1988 and by the movement of people into the District's potential agricultural areas. The 1989 population size has been estimated at 80,373.[8]

The District is generally sparsely populated with an average population density of 4.8 persons per km^2. The population density has varied in time and space. The density has risen from 1.8 persons per km^2 in 1960 to 4.8 in 1989. Spatially, the majority of the people are concentrated in the few accessible corridors: around the District capital (Damongo) and the major zonal areas of Daboya, Buipe and Yapei. The map Fig. 2.4 shows the population distribution in the District in settlement with 500 people and above. The largest concentration of people is found around Damongo with about 12,522 inhabitants.

The sparse population poses a constraint in the delivery of both social and technical infrastructure services.

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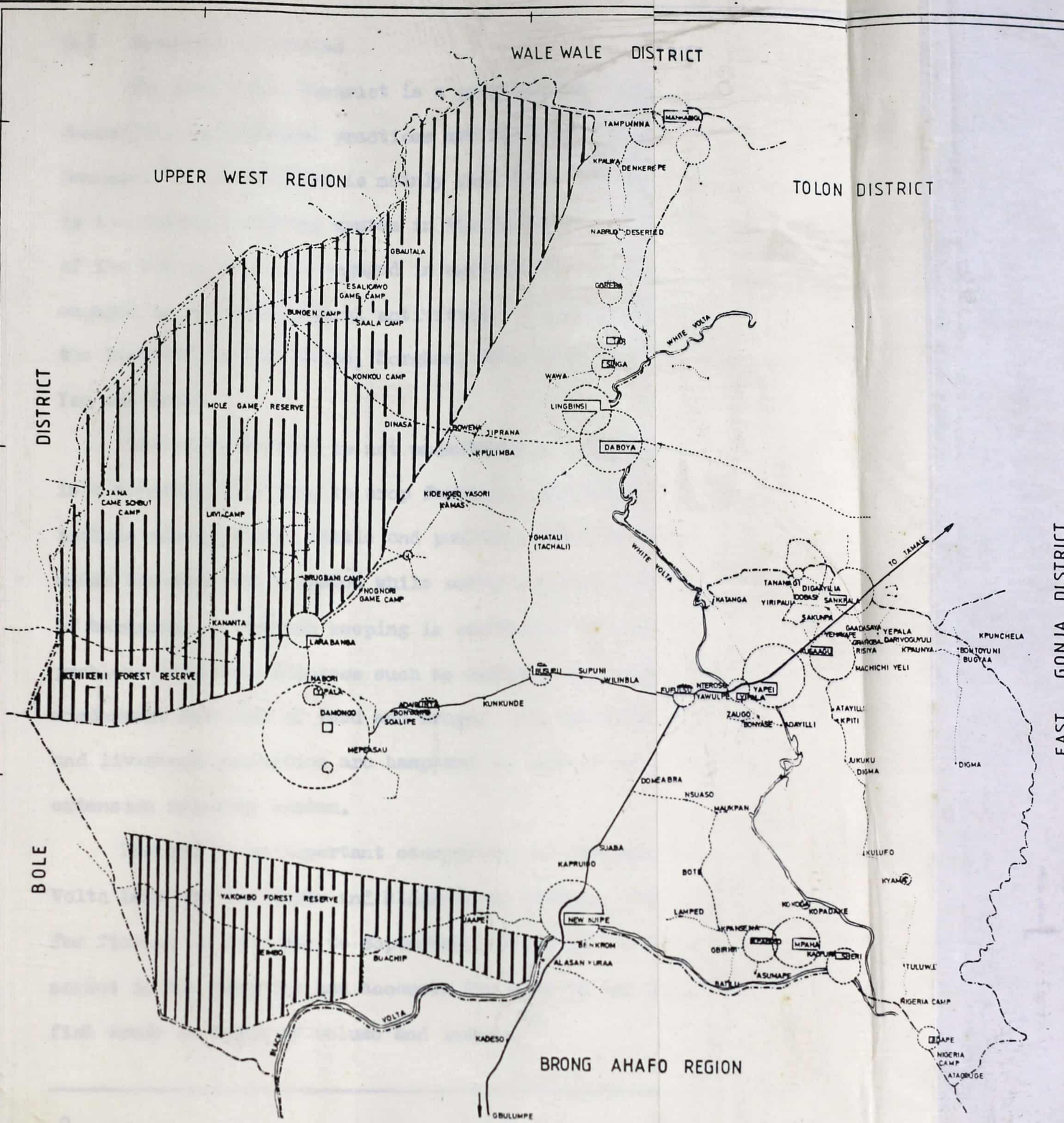
7 Statistical Board Service, National Census Report (Accra: SBS, 1960, 1970 and 1984)

8 SPRING II Participants, "West Gonja District Study", p. 10.

FIG. 2.4



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WEST GONJA DISTRICT
STUDY

DISTRIBUTION OF PO
BY SETTLEME

2.6 Economic Activities

The West Gonja District is a predominantly agricultural area. Generally, agricultural practices are expensive except around Damongo.[9] Agriculture is mainly rain fed. Shifting cultivation is the dominant farming system in the District. About 59 per cent of the labour force is engaged in agriculture and the rest is engaged in non-agricultural activities.[10] Important crops grown in the District include Maize, Sorghum, Groundnuts, Millet, Cassava, Yam and Beans.

Livestock rearing is not undertaken on commercial basis. It is a secondary activity to crop farming. Important livestock kept include sheep, goats, cattle and poultry. Most livestock is kept under the free range system while cattle is kept under the care of herdsmen. Livestock keeping is confronted by a number of problems including diseases such as anthrax, gastroentositis, rinderpest and lack of feed and drugs. In addition both crop and livestock production are hampered by lack of an efficient extension delivery system.

Fishing is an important occupation for settlements along the Volta Lake and the White and Black Volta rivers. The peak season for fishing is from May to September. Buipe is the major fish market in the District and accounts for over 90 per cent of the fish trade in terms of volume and income.[11]

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9 SPRING II Participants, "West Gonja District Study", p. 26.

10 SPRING II Participants, "West Gonja District Study", p. 17.

11 SPRING II Participants, "West Gonja District Study", p. 34

The industrial sector employs 7.7 per cent of the labour force.[12] It is mainly dominated by informal sector activities such as food processing, textiles, leather-works, soap making and cottage industries including basket and mat weaving, blacksmithing, wood works and metal works.

The low inherent fertility and in some places shallow soils, the sparse and deciduous vegetation together with the intensive and sometimes erratic rainfall show that the area is prone to environmental degradation if the natural resources of the District are not utilised sparingly. Although the area is sparsely populated, the high population growth rate and the high dependence of its population on agriculture - both for crops and livestock, may be causing pressure to the environment.

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[12] SPRING II Participants, "West Gonja District Study", p. 34.

CHAPTER THREE

LITERATURE REVIEW

This chapter tries to show the relationship that exist between the energy sector and development. It also undertakes a review of related studies and identifies relevant information from previous studies which has been useful in other parts of this study.

3.1 General: Energy and Development

Energy is a critical input in development. It comes in as an intermediate good essential for various household and economic activities. Energy is usually valued as an input in some process of production or utilisation which results in a final product. In the home, energy is essential for lighting, cooking, heating, and drying while outside the home, it is used to pursue productive activities such as in agriculture and industry. Energy is important in all activities which generate income and employment opportunities to people.

The sources of energy are varied. They include petroleum, hydropower, nuclear, solar, wind and woodfuels. In the developing countries, traditional sources of energy including dungs, crop residues, firewood and charcoal are by far the most important. According to Bassan , traditional sources account for about 85 per cent of total energy use in Africa, 65 per cent in Asia and 20 per cent in Latin America.[1] In the foreseable future therefore, the traditional sources of energy will continue to play a very

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[1] E. BASSAN and T. WOOD: Environmentally Sound Small Scale Energy Projects (New York: CODEL. VITA, 1985) p.1.

important role in the day to day life of the people and will constitute a major energy source in development activities.

There is nothing wrong in continued reliance on traditional sources of energy because they are all "renewable" fuels and therefore environmentally sound. Bassan points out that from an environmental point of view, continued reliance on traditional sources of energy may be good as the challenge for development is to provide energy necessary for socio-economic development and also to promote resource use that will allow for sustainable and reliable energy supplies. However, this holds true only where these energy sources are not used to such a point where they lose their ability to replace themselves, that is, their renewability.

World energy consumption figures indicate that wood fuel accounts for only 10 percent of the total energy used every year.[2] It ranks fourth, a considerable way behind the major fuels of oil, coal and natural gas. Wood and its derivative charcoal, is used widely in both rural and urban areas of the developing countries as domestic fuel in many homes. Wood-fuel is also used as a source of energy in many industrial ventures.

Although the share of woodfuels as a proportion of the total energy consumed varies from country to country, there is no doubt that its share forms an extremely high proportion. In some of the Sahel countries of Africa, wood fuel accounts for over 90 per cent of the total energy consumed for all purposes while in Nigeria, its share is 80 per cent.[3] In Zambia 84.2 per cent of all households in the country depend on woodfuel for their domestic energy requirements.[4]

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[2] Gerald Foley, World Fuel: "The Energy Crisis of the Poor", The Courier No. 95 (Jan - Feb. 1986), p 66

[3] Foley, "Woodfuel", p 66

[4] Central Statistical Office, Selected Socio-Economic Indicators (Lusaka: CSD, 1984) p 9.

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Unfortunately, in many countries, reliable information on woodfuel consumption is lacking. This high dependency on wood fuel is already manifesting itself in signs of environmental degradation in some parts of Africa particularly in the Sahel where desertification is already taking place.

The early initiatives towards solving the wood fuel problems were hampered by lack of accurate data on consumption levels. This is because, woodfuel consumption particularly in the rural areas does not pass through the "official" market. However, it has been observed that the causes of fuelwood problem are complex and patterns of use vary while the causes of scarcities differ from place to place and different people are affected in different ways.

There are also differences in levels of fuelwood consumption among countries, cultures and ecological regions. The position too changes with time as people respond towards increasing scarcity. The fuelwood problem is worsened by the other competing demands for land for instance, agriculture and other human wood requirements. As a result of the need to find additional land for growing crops, the supply situation of woodfuel comes under pressure. Another dimension to the fuelwood problem is added by the buying of wood from rural areas by urban dealers. The extension of an urban market into new rural areas adds to the pressure being experienced there and accelerates the depletion of resources.

3.2 Overview of Related Studies

A number of studies have been done on the rural energy sector in various parts of the developing world. This section aims to draw lessons from these previous studies for incorporation into this study and for the purposes of comparison. In particular three case studies are reviewed.

In Fiji, a rural energy study was undertaken there by Siwatibau.[5] The aims of the study were: to survey current energy use and needs in selected rural areas of Fiji; to evaluate alternative sources of energy supply especially the advisability of expanding the use of biogas and to evaluate the possibility of improving conditions of domestic cooking through conservation.

The study found that 92 per cent of the surveyed homes cooked with firewood over an open fire place. The annual mean consumption of firewood was found to be 506 kg (oven-dry weight) per - capita. It was also found that about 70 per cent of the per capita annual firewood consumption was used for home cooking and food preservation. The study noted that cooking over an open fire apart from causing eye irritations may also cause chest problems. In Tanzania, an energy study by Skutsch[6] found an annual firewood consumption of $2.2m^3$ (1629.6 kg) per capita for the rural areas. The survey also quoted a growth increment of the local forests of $2m^3$ per hectare per year. In Ghana, a survey by Pluth[7] in the Northern Region of which West Gonja is a part, found that 99 per cent of the households sampled used firewood and charcoal. The study quotes forest growth increment ranging between 4 to 15 m^3/ha for forest Estates and 3 to 7 m^3/ha for forest rangeland.

Other studies have focussed on the efficiencies of various fuels and end-use devices. This is an important element if the issue of substitutability of fuel is to be considered.

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5 S. Siwatibau, Rural Energy in Fiji: A survey of domestic energy use and potential (Ottawa: IDRC, 1981).

6 M.M. Skutsch, Sadcc Energy: Woodfuel study for Tanzania (Luanda: Sadcc 1987)

7 Pluth, "The Energy sector in Norther Region, Ghana

This was done by looking at the ratio of effective energy through a certain device and the total amount of energy released by a particular fuel. As such, the performance of the various fuelwood end-use devices can be compared on the basis of effective energy delivered.

Table 3.1 summarises the efficiencies of the various devices and the respective energy sources.

Table 3.1: Efficiency of Common End-Use Devices

	DEVICE	FUEL USED	EFFICIENCY %	HEAT/CALORIFIC VALUE MJ/kg
1.	3 Stone Fire	Firewood	5 - 10	18
2.	Improved mud/ brick stove	Firewood	20	18
3.	Traditional Brazier	Charcoal	15	30
4.	Improved charcoal stove	Charcoal	22	30
5.	Wick burner	Kerosene	37	42
6.	Pressure stove	Kerosene	50	42

Source: Sadcc Energy Vol VII No. 18 (1988) p. 4 and T.S. Wood and S. Baldwin, "Fuel and Charcoal Use in Developing Countries", Annual Reviews, (1985), p 421

The table shows that using an open fire is highly inefficient. The improved firewood stove is more efficient because the fire is protected from the wind. Charcoal has a higher calorific value per kilogram and when used in an improved charcoal stove is much more efficient than firewood. However, the question of substitutability is complex and involves much more than the calorific value of a

fuel and the efficiency of an end-use device. It involves in addition to the cost of the necessary end-use device for substitution, the cost of the fuel and its availability and also the cultural acceptability of the new fuel and its methods of usage. In Ghana, it has been found that there is a rural-urban variation in biomass consumption. In the urban areas, charcoal consumption predominates while the rural areas generally tend to depend more on firewood and agricultural residues. In urban areas of Ghana, 69 per cent of households use charcoal[8]. The production of charcoal is basically through the traditional earth mound kiln method. This method has been found to be very inefficient, in that, it wastes about 50 per cent of the wood used[9].

The Ghana Government, as a response towards the eminent environmental problems from a high dependence on biomass for energy, is promoting the substitution of liquified petroleum products (LPG) for woodfuel. To promote this change, cheaper and smaller cylinders of 5 and 2.5 litres capacity and bunsen burners are made available on the market, in addition to the conventional gas stoves and larger capacity cylinders. Bunsen burners and smaller capacity cylinders are expected to cater for the needs of the low income households. Furthermore, programmes promoting the use of more efficient charcoal stoves are going on in order to conserve energy.

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8 K.S. Nketia and Others, The Charcoal Cycle in Ghana - A Baseline Study (Accra: UNDP/NEB, 1988), P, vii

9 Pluth, "The Energy Sector in Northern Region, Ghana", p. 29

CHAPTER FOUR

CONCEPTUAL FRAMEWORK

This chapter looks at the theoritical framework under which the study is conducted and begins by examining the laws governing the behaviour of energy. The second section looks at the movement of energy in natural ecosystems while the last part deals with the need for incorporating environmental Impact Assessment in all development activites for sustainable development.

4.1 Review of the Laws of Thermodynamics

Energy is defined as the ability to do work.[1] The behaviour of energy is precisely described by the first and second laws of thermodynamics. The first law states that "energy may be transformed from one source to another but is neither created nor destroyed".[2] This law in its ultimate useful form is a conservation of energy statement. It deals with transformations and transfers of quantities of energy. When energy is transferred from one region to another or is transferred from one form to another, the total quantity of energy involved is the same, because none of it is destroyed. Sunlight is a form of energy which can be transformed into heat or potential energy in food by plants, but none of it is destroyed.

The second law of thermodynamic states that, "every process involving an energy transformation is accompanied by a degradation of the energy from a concentrated form into a dispersed form".[3] The second law deals with the quality of energy and it is essentially a non-conservation rule.

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1 E.P. Odum, Basic Ecology (New York: Holt-Saunder, 1983) p. 86

2 Odum, "Basic Ecology", p. 86

3 Odum, "Basic Ecology", p. 86

The conversion or transformation of energy from one form to another, for example, solar energy to potential energy in stored carbohydrates is never 100 per cent efficient because some of the energy is always lost out as unavailable heat energy in a more dispersed form. Certain features of an energy process leads to a degradation of energy or loss in quality. A hot object will tend to get cold as heat is dispersed from the object. The heat dispersed is of law quality because it has more or less no practical use. In the second law, the concept of optimization of energy usage is implied and that there are better and worse ways of using energy. In an energy transformation process, energy degradation can be measured in terms of efficiency of energy usage. Some devices, that is, end-use or conversion devices, are more efficient at energy usage or conversion respectively than others. In terms of practical energy usage, the second law of thermodynamics plays an increasingly important role in the analysis of new energy transformation processes and devices and in the improvement of old ones.

The efficiency of a system or device refers to the proportion of energy converted from one form to another as against that which is lost. The smaller the amount of energy lost as dispersed heat energy the more efficient a conversion system or device is. In practical terms, the efficiency of a device or system is measured as the ratio of energy output against the input. This ratio is always less than 1 as no 100 per cent efficient system has ever been developed yet. Efficiency is therefore, a measure of what is accomplished compared to what it costs. High energy efficient domestic appliances such as cooking stoves, and industrial tools mean less energy costs to the people and energy conservation.

Improvements in conversion efficiency of systems and devices are imperative if the impacts of rising energy costs on the people is to be minimised.

4.2 Ecosystems and Energy Flow

The ecosystem is the basic functional unit in ecology. An ecosystem is "any unit that includes all the organisms that function together (the biotic community) in a given area interacting with the physical environment so that a flow of energy leads to clearly defined biotic structures and cycling of materials between living and non-living parts".[4] From this definition, it can be seen that an ecosystem includes both the organisms and the non-living or physical environment. Each of them has an influence on the properties of the other and both of them are necessary for the maintainance of life. Ecosystems can range in size from large tropical forests or oceans to as small as a pond of water.

Generally, there are three basic components and processes that make an ecosystem function. The functioning of an ecosystem is due to the interaction of the three, namely, 1) the biological community or organisms, 2) the cycling of materials including nutrients such as carbon, nitrogen, phosphorous and 3) the flow of energy through ecosystem. Materials in the ecosystem are recycled over and over again between the living and the non-living parts of the ecosystem. The efficiency of material recycling and the magnitude of imports and exports of materials into and out of the ecosystem vary widely with the type of ecosystem.[5] Ecological processes in the warm and wet tropics tend to occur at a faster rate than in other areas.

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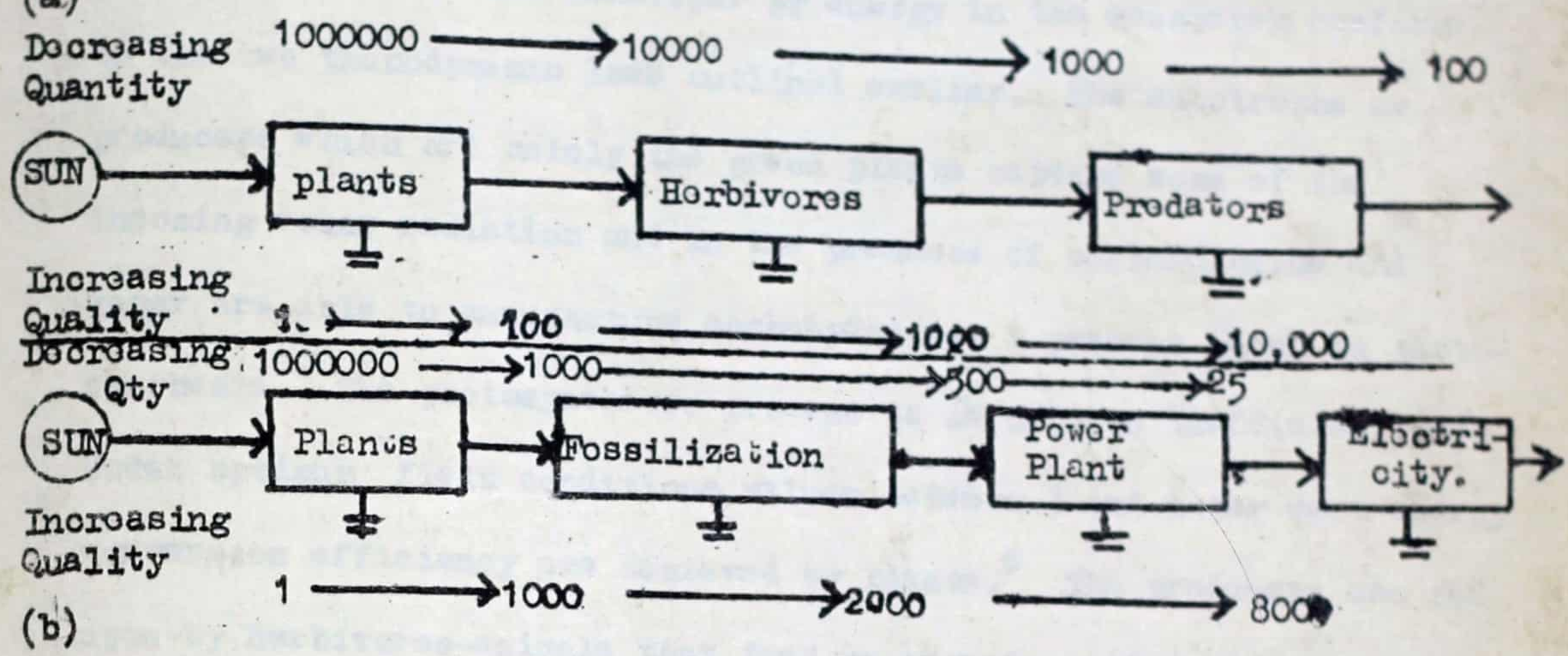
[4] Odum, "Basic Ecology", p. 13

[5] Odum, "Basic Ecology", p. 15

Two things happen to the quality and quantity of energy as it flows through the ecosystem. The total quantity converted from one trophic level to the other in the food chain decreases while the quality increases. The following diagram Fig. 4.1 illustrates this:

Fig.4.1 Energy Changes through an Ecosystem



Source: Odum, "Basic Ecology", p. 147

Fig.4.1(a) shows that, in a food chain, the decline in energy is from about 1 million Kcal/M^2 sun input down to only 100 Kcal/M^2 available at the predator level. Similarly, emergency chain leading to the production of electricity Fig.4.1(b) shows the decline in the quality of energy. On the other hand, in both cases the quality of energy increases at each conversion and becomes more concentrated. The concentration of energy in a given mass of predators is 100 times more than in a similar mass of herbivores. Similarly, fossil fuels have a work potential 200 times that of sunlight.

Energy flow in the ecosystem has a direct effect on the populations of the various organisms in existence. The numbers of the various organisms in an environment - producer plants, herbivores and the various carnivores are all limited and controlled by the flow of energy.

Energy flow into the ecosystem forms the basis for the functioning of the ecosystem. The various organisms in the ecosystem are specialised in various ways and each group performs specialised functions forming an interdependent delicately balanced and dynamic system. The most important source of energy to the ecosystems on earth is the sun. The behaviour of energy in the ecosystem conforms to the two thermodynamic laws outlined earlier. The autotrophs or producers which are mainly the green plants capture some of the incoming solar radiation and in the presence of carbondioxide and water are able to manufacture carbohydrates, a process known as photosynthesis. The photosynthesis process is largely an inefficient one. Under optimum field conditions, values between 3 and 5 per cent energy conversion efficiency are achieved by plants.[6] The producers are fed upon by herbivores-animals that feed on organic matter produced by plants. Herbivores are fed upon by carnivores, forming an interdependent chain. At the end of the food chain are found the osmotrophs or decomposers which are mainly bacteria and fungi that obtain their energy by absorbing dissolved organic matter extracted from plants or other dead organisms. The decomposition process releases the nutrients in dead bodies which become available for new life. The process also produces humus that make the soil texture favourably for plant growth. "The essence of life is the progression of such changes as growth, self duplication and synthesis of complex relationships of matter".[7] Energy transfers accompany such changes, without which there could be no life and no ecological systems.

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6 E. El-Hinnawi, Environmental Impacts of Production and Use of Energy (Dublin: Tycooly, 1981), p. 278

7 Odum "Basic Ecology", p 87

4.3 Incorporating Environmental Impact Assessment in Development Activities

The term environment is an all inclusive one. It refers to the bio-physical and socio-economic systems around the earth. It includes organisms and their surrounding habitat. The most serious threat to the ecosystems and the environment as a whole is posed by human activities. Generally, a considerable insight into the environmental condition can be gained by viewing environmental problems as the outcome of environmental resource extraction, processing and use.[8] Therefore, it follows that natural resource development policy is part of environmental policy. The rapidly growing population in the developing countries demands increasing quantities of resources from natural systems. As more households are formed, and development activities expand, large quantities of resources for energy and other purposes to support the population are extracted from the physical environment. In the area of agriculture, increasingly marginalised land is put into crop production. The land already under production is put into ever more intensive use. In the developing countries where the most important source of energy is biomass, the rapidly growing population may mean that in the near future large tracts of land will be left bare as a result of the need to satisfy energy needs and other requirements. El-Hinnani[9] points out that even long before the demand for firewood leads to complete destruction of the tree cover, it can have a markedly degrading environmental effect: excessive prunning of the branches may reduce a tree's capability for growth; removal of the more easily-felled

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8 J. Horberry, Summary Paper on Environmental Impact Assessment (Gland: IUCN, 1984) pp 1-2

9 El-Hinnani "Environmental Impacts of Production and Use of Energy" p 247

younger trees may reduce the regenerative ability of the forest while excessive opening of the canopy through the removal of too many trees can render the forest susceptible to damage from wind and sun and affect wildlife.

Environmental damage occurs when renewable resources such as forestry resources are treated and used faster than they can be replaced. Over exploitation of renewable resources disrupts the natural processes such as the mineral cycles taking place between the biomass and the abiotic environment. When these cycles are disrupted, the minerals are lost for ever and cannot be used for further production of biomass. Upsetting the ecological balance can lead to loss of catchment areas and the drying up of rivers. Soil degradation due to lack of plant cover to reduce soil erosion and provide humus for good soil structure and texture can lead to failures in crop production and increased frequency of flooding. This destroys the ability of the land to produce. Agricultural productivity and energy availability depend on the ecological well being of the environment. At the global level, excessive deforestation can disrupt global climatic regimes which are essential for the existence of man.

In the developing countries, environmental problems are due to a complex combination of factors. Agricultural practices, firewood collection and timber harvesting are linked to other more fundamental issues such as land tenure, rapid population growth, rising unemployment and the stagnation of agriculture itself. It is estimated that 30 per cent of forests in Africa South of the Sahara is under threat while West Africa alone has lost about 60 per cent of its original rain forests.[10]

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[10] C. Simpson, "The Battle of the Greens", West Africa (Oct 9-15, 1989), p. 1676

The issue at hand is how to promote development activities or resource utilization without causing environmental degradation and the consequent reduction in social welfare and loss of productivity of natural resources over time.

In order to mitigate environmental stress, it is important to assess the environmental effects of all development activities. Environmental effects are the measurable changes in the natural system productivity and environmental quality resulting from a development activity.[11] Negative bio-physical and socio-economic effects of development activites must be viewed as costs to society. The judgement or estimte of significance or economic valuation of environmental effects on natrual and socio-economic milieu in relation to an activity or proposed development is known as Environmental Impact Assessment (EIA). It is a process used to assess or predict the effects or likely effects on the surrounding area of a development activity or resource utilization.

Environmental Impact Assessment is both a tool and a procedure. It combines the policies and procedure that govern EIA system in a government or development agency and the methods and techniques used in applying EIA to development activities. Therefore, it can be used as a tool for analysing environmental effects and also as a procedure for bringing the analysis to bear on decisions.

EIA cannot function as a tool or procedure on its own. It has to be incorporated in the whole development process starting from planning implementation up to the monitoring and evaluation of programmes and projects. The results of the EIA must play a part in decision making at the various levels of development activities.

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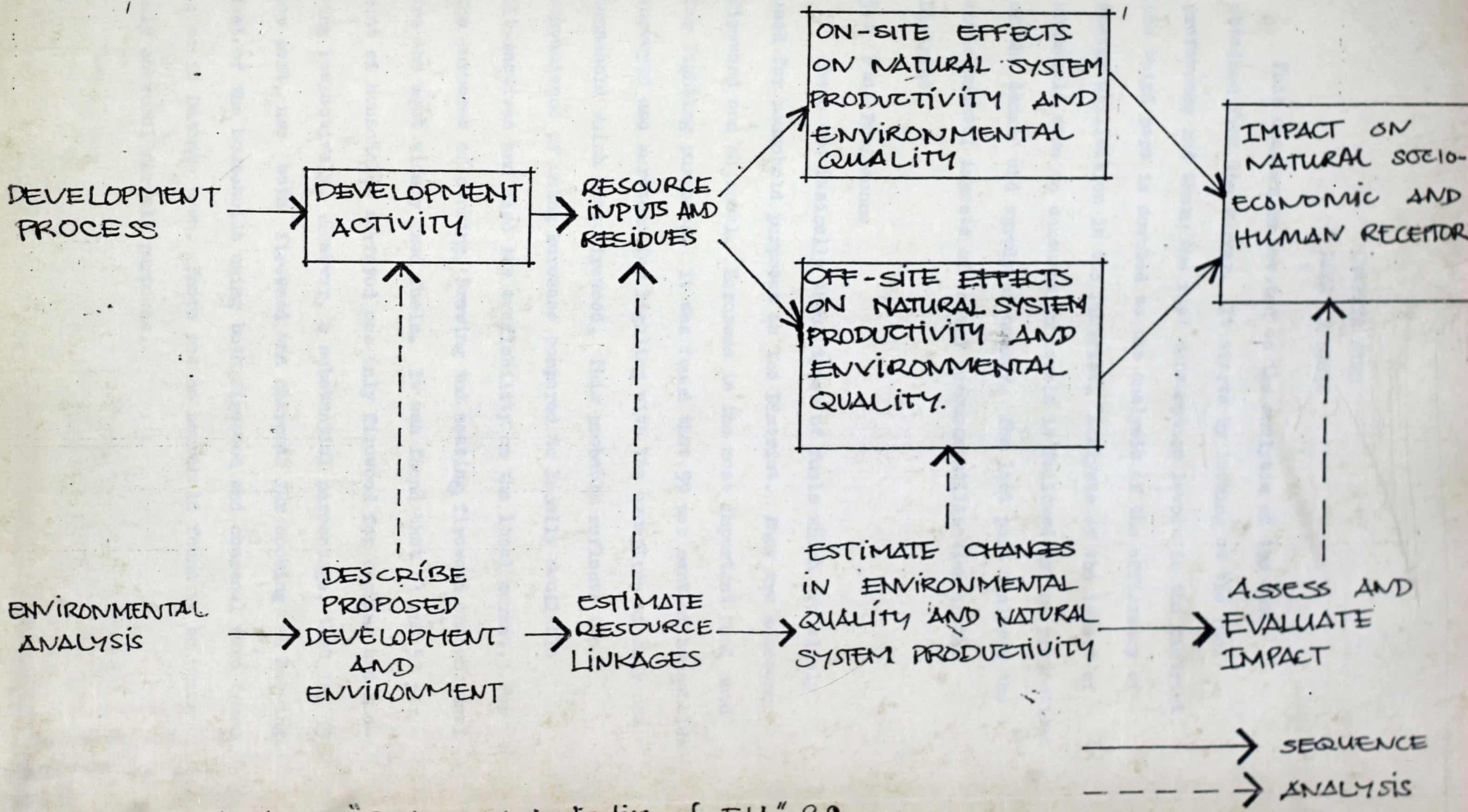
11 J. Horberry, Status and Application of Environmental Impact Assessment for Development (Gland: UCN, 1984), p (i)

The assessment must identify alternatives available for achieving the desired objective. The important linkages of an activity or proposed development with the natural and social environment and with other activities in existence must be identified. The need for EIA must be based on the evident natural and social implications of an activity both short and long term. The benefits and costs of a development activity must be properly assessed and possible trade-offs of the various options available made clear. Figure 4.2 shows a conceptual basis for EIA of development activity.

Environmental Impact Assessment should be institutionalised in decision making and in development planning and implementing agencies in order that it can be applied systematically as a tool for planning, management and evaluation of programmes and projects. A procedure to define the circumstances in which it must be undertaken, the rules on how it should be done and the communication of results to decision makers and interested parties must be clearly worked out. It is therefore important that in order for EIA to be effective, it must be legally backed so that its results can not be ignored. Proper application of EIA leads to sustainable development in the long term as it indicates the environmental resource limits.

Fig 4.2 Conceptual Basis for Environmental Impact Assessment of Development Activity



Source: Horberry, "Status and Application of EIA" P.9.

CHAPTER FIVE
DATA ANALYSIS

This chapter is devoted to the analysis of the data obtained from the survey. It starts by looking at the fuel preference and then the fuel consumption levels in the District. The third part is devoted to the analysis of the efficiency of energy utilisation in the District. Analysis of the impact of household size on consumption levels is followed by the projections of the demand and supply of energy. The last part analyses the environmental impacts of energy resource utilisation in the District.

5.1 Fuel Preference

There are basically three types of fuels which are widely used for household purposes in the District. They are kerosene, firewood and charcoal. Kerosene is the most important fuel used for lighting purposes. It was found that 99 per cent of households surveyed use kerosene for lighting with the exception of only one household which uses firewood. This probably reflects the convenience of using kerosene compared to locally available alternatives and also its availability on the local market. For the purposes of cooking, brewing and heating, firewood and charcoal are the most widely used fuels. It was found that 63 and 57 per cent of households surveyed use only firewood for cooking and heating respectively. However, a substantial percentage, that is, 35 per cent, use both firewood and charcoal for cooking and heating. Most of the households using both firewood and charcoal were found to be in Dzonzo town. There was no household found to be using only charcoal for all purposes.

Table 5.1

Fuel Preference

Activity	Using Kerosene H/holds	%	Using Firewood Only H/holds	%	Using Charcoal Only H/holds	%	Using, Both Firewood & Charcoal H/holds	%	Using Solar H/holds	%
Lighting	99	99	1	1	-	-	-	-	-	-
Cooking	2	2	63	63	-	-	35	35		
Heating	1	1	57	57	7	7	35	35		
Drying	-	-	-	-	-	-	-	-	100	100
Brewing	-	—	20	20	2	2	-	-	-	-

Source: Author's Survey.

In 7 per cent of households, only charcoal is used for heating while 2 per cent uses it for brewing only. The use of solar energy among the households is restricted to only drying purposes. However, solar energy is used by a limited number of institutions namely the Post and Telecommunications Corporation by means of photovoltaic system for their telephone system and the Veterinary Services Department for lighting purposes and medical storage. Table 5.1 summarises fuel preference by purpose in the households surveyed.

All the charcoal used in the surveyed households is purchased on the local markets. The purchasing of all the charcoal used shows that charcoal cannot be collected unlike firewood where this option may always be available to households. Kerosene is delivered for sale by the Ghana Oil Company periodically to each settlement. In all the settlements it was found that the Company normally delivers kerosene once every month. On the other hand, some households collect their own domestic firewood while others purchase. The majority of households, that is, 61 per cent purchase firewood while 39 per cent of the surveyed homes collect their own firewood. Firewood is mainly collected in the surrounding forest. The distances to the sources of supply are displayed in the following table:

Table 5.2

Distances to Sources of Firewood Collection.

Distances to sources of supply.

Name of Settlement	1km		1-5km		5km		Total
	H/holds	Area %	H/holds	Area %	H/holds	Area %	
Damongo	2	20	3	30	5	50	10
Daboya	2	25	5	63	1	12	8
Busunu	-	-	5	100	-	-	5
Yapei	-	-	-	-	-	-	
Buipe	1	11	4	44	4	44	9
Mpaha			4	57	3	43	7
No. and % of households which collect firewood	5	13	21	54	13	33	= 39

Source: Author's Household Survey.

The table shows that 54 per cent of households which collect firewood, do it at a distance of between 1-5 km while 33 per cent walk up to more than 5 km. It must be noted however, that there is a fairly large degree of overlap between those who collect and those who purchase firewood. Some households, although they mainly purchase firewood, from time to time, collect their own.

The collection of firewood in most households is the responsibility of women and children. They are responsible for firewood collection in 36 out of the 39 households which collect their own firewood. However, for those who purchase, it is mainly the responsibility of heads of households to provide the necessary money. In 45 out of 61 households which purchase their firewood, it is the heads of households who raise the money.

The type of firewood used in most households is a mixture of branches, trunks and barks of trees in that order of importance. The following table gives more details:

Table 5.3

Type of Firewood used

	Branches	Trunks	Barks	Branches and Trunks	All three	Total
% of households	38	20	17	11	14	100

Source: Author's Household Survey.

Households using all the three types of wood are found only in Damongo. This is an indication of increasing scarcity of firewood there because the survey revealed that where there is an abundance of firewood, households tend to prefer branches of trees to any other type.

There is some slight variations in the type of fuel used depending on the season. There is a tendency to use slightly more charcoal during the rainy season than in the dry season.

Households using both firewood and charcoal increase by 9 per cent during the rainy season, as can be seen from Table 5.4. The increase in the use of charcoal during the rainy season is because this is the farming season and it is associated with labour shortages due to agricultural demands. Therefore, households prefer to use charcoal because of its easiness in acquisition, usage and storage.

Table 5.4

Seasonal Variation in Fuel Usage

	Using Only Firewood All Seasons	Using Charcoal All Seasons	Using Both Firewwod and Charcoal	
			Wet Season	Dry Season
Households (%)	65	-	22	13

Source: Author's Household Survey.

It was found during the survey that households in the District stock pile firewood just before the beginning of the rainy season when firewood is more readily available to last through to the next dry season. The stock piling of firewood was noted to have a moderation effect on the seasonal variations in energy usage. Apart from shortages during the rainy season, the other reason for stock piling firewood is for the women and children who are the main firewood collectors to devote their labour and time to farming.

Apart from the household sector, other users of fuel are industrial activities. These include Pito brewing, Gari processing, Shea butter extraction, Blacksmithing and Smock weaving at the colouring stage. There are 48 registered Pito brewing units, 48 Gari processing units and 25 Shea butter extraction units in Damongo alone. A total of 22 Blacksmiths exist in Damongo and Buipe and about 25 Smock weaving units in Daboya. Most of them use substantial quantities of firewood and charcoal.

In the process of Pito brewing for instance, the guinea corn has to be boiled for about 12 hours. However, it was observed during the survey that these small scale industries are normally undertaken at household level. Therefore, their impact on consumption is reflected in the household consumption levels. Fuel consumption levels is the subject of the next section.

5.2 Fuel Consumption Levels

5.2.1 Kerosene Comsumption

The findings on Kerosene consumption in the District are displayed in Table 5.5. A total of 10,692 litres of kerosene are consumed annually by the 100 households sampled. The average annual per capita consumption of the surveyed households amount to 15.7 litres. As mentioned in Section 5.1, the kerosene consumed in the District is mainly for lighting purposes, with the exception of two households where its use extends to cooking as well. Kerosene consumption was found to vary with household size. Household sizes averaging 3 members consume an average of 23.6 litres per capita/annum. These households constitute 32 per cent of the total sample and 20 per cent are found in Damongo alone while the remaining 12 per cent are spread in all the rest of the settlements sampled. The households constituting an average of 7 members which also make up 32 per cent of the sample, consume an average of 14 litres per capita/annum. The third category of households with an average of 10 members consume an average of 14.7 litres per capita/annum. The larger households, that is, those with an average of 7 and those with 10 members, which together constitute 68 per cent of the sample, have a per capita annual consumption below the total sample average of 15.7 litres. On the other hand, the households with an average size of 3 consume more than one and a half times as much as those with more members. The difference in consumption levels between households with 7 and those with 10 members is very minimal.

Table 5.5 Kerosene Consumption

Categories of Households size 1		Number of Households 2	Household Population 3=(1x2)	Kerosene Consumption litres/mouth/ area 4	Total Qty Consumed l/mouth 5=(a+b)	Total Annual Consumption l. 6	Annual Consumption litres/capita 7=6/3
Damongo		20	60	103.5[a]			
	3				189	2268	23.6
Other areas		12	36 / 96*	85.5[b]			
Damongo		15	105	121.5[a]			
	7				261	3132	14.0
Other areas		17	119 / 224*	139.5[b]			
Damongo		17	170	193.5[a]			
	10				441	5292	14.7
Other areas		19	190 / 360*	247.5[b]			
Total/Average		100	680	891	891	10 692	15.7

*Household Category Population.

Source: Author's Household Survey.

In fact the households with 10 members consume slightly more than those with 7 members, that is 14.7 litres per capita/annum as compared with only 14.0 litres. The reasons for these variations are discussed in detail in Section 5.4.

5.2.2 Firewood

According to the survey the overall per capita firewood consumption of the sampled households amount to 0.71m^3 or 525.9 kg per annum. This is very close to Pluth's finding in his study of the energy sector in the Northern Region of Ghana[1]. He found that per capita firewood consumption for the region was 523.3kg per annum. The slight deviation from Siwatibau's[2] finding of 0.68m^3 or 506kg per capita/annum consumption for the rural areas of Fiji seems to be due to the fact that his values refer to oven dry weight which delivers more heat than air dry wood used in both this study and Pluth's. However, there is a significant deviation from the Tanzanian case which found a much higher consumption level of 2.2 m^3 or 1629.9 kg per capita per annum[3]. A total of 478.42 m^3 or 354415 kg of wood is consumed by the sample population as fuel per year. See Table 5.6.

There is some savings realised, as in the case of kerosene by larger households in the amount of firewood consumed. Households with an average of 3 members consume an average of 1.53 m^3 or 1133.3kg of firewood per capita per annum while the consumption of those with 7, amounts to only 0.57 m^3 or 422 kg per annum. Smaller household sizes consume as much as 2½ times more than larger households, However, like in the case of kerosene, the per capital consumption of households with 10 members is slightly higher than of those with 7 members on average, Table 5.6.

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[1] Pluth, "The Energy Sector in Northern Region Ghana", p. 30.
[2] Siwatibau, "Rural Energy in Fiji", p. 5
[3] Skutsch, Sadcc Energy", p. 19.

Table 5.6 Firewood Consumption

Category of H/holds size	Using Firewood Only: No. of H/holds	H/hold Population	Annual Consump/ Total m^3	Per Capita m^3	Kg	Using both Firewood and Charcoal: No. of H/holds	Population	Annual Consump/ Total m^3	Capita	Kg	Total Av. Consump/ m^3	Capita Kg
3	17	51	89.706	1.76	1303.7	15	45	57.092	1.27	940.7	1.53	1133.3
7	19	133	91.074	0.68	503.7	13	91	44.861	0.49	362.9	0.57	422
10	27	270	173.983	0.64	474.1	7	70	21.744	0.31	229.6	0.58	429
Total/Average	63	454	354.763	0.78	577.8	35	206	123.697	0.6	444.4	0.71	525.9

Total Annual Consumption = 478.46 m^3 354 415 kg

1000 kg = 1.35 m^3 wood (approx.), M. Raduor and A. Wad, E.D. Training.

Source: Author's Household Survey.

The 35 per cent of households which use both firewood and charcoal show a lower firewood consumption value as compared to those which solely depend on firewood. The average annual per capita consumption of people whose households use only firewood amounts to 0.78 m^3 or 577,8 kg while those using both consume an average of 0.6 m^3 (444.4kg). This obviously is due to the fact that charcoal consumption is not included in their consumption values of firewood, but treated separately in the next section.

5.2.3 Charcoal Consumption

Charcoal has been found to be used together with firewood in those households that use it. The average charcoal consumption per capita of the sample population amounts to 29.4 kg per annum. However, annual consumption for the 35 households which use charcoal amounts to 97.0 kg per capita. A total of 19,980 kg of charcoal is consumed annually by the respective households. In the case of charcoal consumption, economies of scale too are observable. Those households with an average of 3 members consume two and half times as much as those with an average household size of 7 and three times as much as those with 10 members. Table 5.7 summaries the situation.

Total Fuel Consumption

The total fuel consumption figures for the District are shown in Table 5.8. A total of about 1.3 million litres of kerosene are presently consumed annually in the District. The population of the District consumes firewood amounting to 58,749.7 m^3 which is equivalent to about 43.5 million kg. The total charcoal consumed is about 2.4 million kg, See Table 5.8. The consumption values for firewood and charcoal were combined by converting charcoal values into firewood to arrive at a single value for both firewood and charcoal.

Table 5.7 Charcoal Consumption

Category of Households size	No. of Households	Population	Total Annual Charcoal Consumption Kg	Annual Consumption/Capita: Charcoal users only Kg	Total Sample Annual Consumption/ Capita Kg.
3	15	45	8640	192	90
7	13	91	7020	77	31.3
10	7	70	4320	62	12.0
Total Average	35	206	19 980	97.7	29.4

Source: Author's Household Survey.

Table 5.8 Total Fuel Consumption - West Gonja District 1990.

Total Population	Type of Fuel	Annual Consumption/Capita	Total Fuel Consumption
82 746	Kerosene	15.7 Lt.	1 299 112
(Base Year 1989)	Firewood	0.71 m^3 (525.9 Kg)	58 749.7 m^3 (43517 777.8kg)
80 373	Charcoal	29.4 Kg	2 432 732.4
	Total Firewood and Charcoal[a]		71 885.6 m^3 (53 248 707.4kg)

[a]Charcoal is approximately 50% as dense as the wood and that the, Charcoal processing methods employed waste about 50% of the wood used. Therefore, 1Kg charcoal = 2kg of firewood = 4kg of wood cut. D. Pluth, "The Energy Sector" p. 29.

Source: Author's Household Survey.

5.3 Efficiency of Energy Usage

This study made use of the efficiency of the end-use devices, that is, the proportion of effective energy derived from an end-use device as a proxy indication for the overall energy usage efficiency in the District.

The most common lighting device in the surveyed households was found to be the hurricane lamp. It was found to be used by 78 per cent of the households. The traditional or 'home' made wick kerosene lamp was in use in 21 per cent of the households. Only one household reported using a kerosene tilley lamp for lighting purposes. Although the light intensity from a hurricane lamp is low, that is, only a mean 3 foot candle light intensity at 30cm distance[4], it seems that the popularity of the hurricane lamp is a question of affordability by the people. The hurricane lamp is much cheaper as compared to the tilley lamp for instance. Further evidence for this was indicated by the fact that, more people use the hurricane lamp in the urban area of Damongo than in other settlement. In Damongo, 46 out of the 52 households sampled or 89 per cent use the hurricane lamp and only 11 per cent use the traditional wick kerosene lamp. In other settlements however, 67 per cent use hurricane lamps and a fairly large proportion, 33 per cent use the traditional lamp.

The efficiency of firewood and charcoal utilisation in the District is very low. Energy losses are extremely high resulting from the use of highly inefficient end-use devices. The most common cooking, heating and brewing end-use device is the three stone fire place.

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[4]Siwatibau, "Rural Energy in Fiji", p. 7.

Table 5.9 End-Use Devices by Activity.

Activity	Area and Sample		Traditional Wick Kerosene Lamp H/holds	%	Hurricane Lamp H/holds	%	Tilley Lamp H/holds	%
Lighting	Damongo	52	6	11	46	89		
	Other Settlements	48	15	33	32	67	1	
		100	21	21%	78	78%	1	

Activity	Area and Sample		Open Fire H/holds	%	Mud Stove H/holds	%	Brazier H/holds	%	Wick Kerosene Stove H/holds	%	H/holds using more than 1 device
Cooking	Damongo	52	11	21.2	24	46.2	15	28.8	2	3.8	9
	Other	48	38	79.2	3	6.3	7	14.5	-	-	4
		100	49	49%	27	27%	22	22%	-	-	-
Heating	Damongo	52	10	19.2	19	36.5	22	42.3	-	-	-
	Other	48	36	75	3	6.3	9	18.7	-	-	-
		100	46	46%	22	22%	31	31%	-	-	-
Brewing	Damongo	52	3	5.8	2	3.8	-	-	-	-	-
	Other	48	11	22.9	2	4.2	1	2.0	-	-	-
		100	14	14%	4	4%	1	2%			

Source: Author's Household Survey.

Table 5.10 District Fuelwood Consumption Efficiency

FIREWOOD

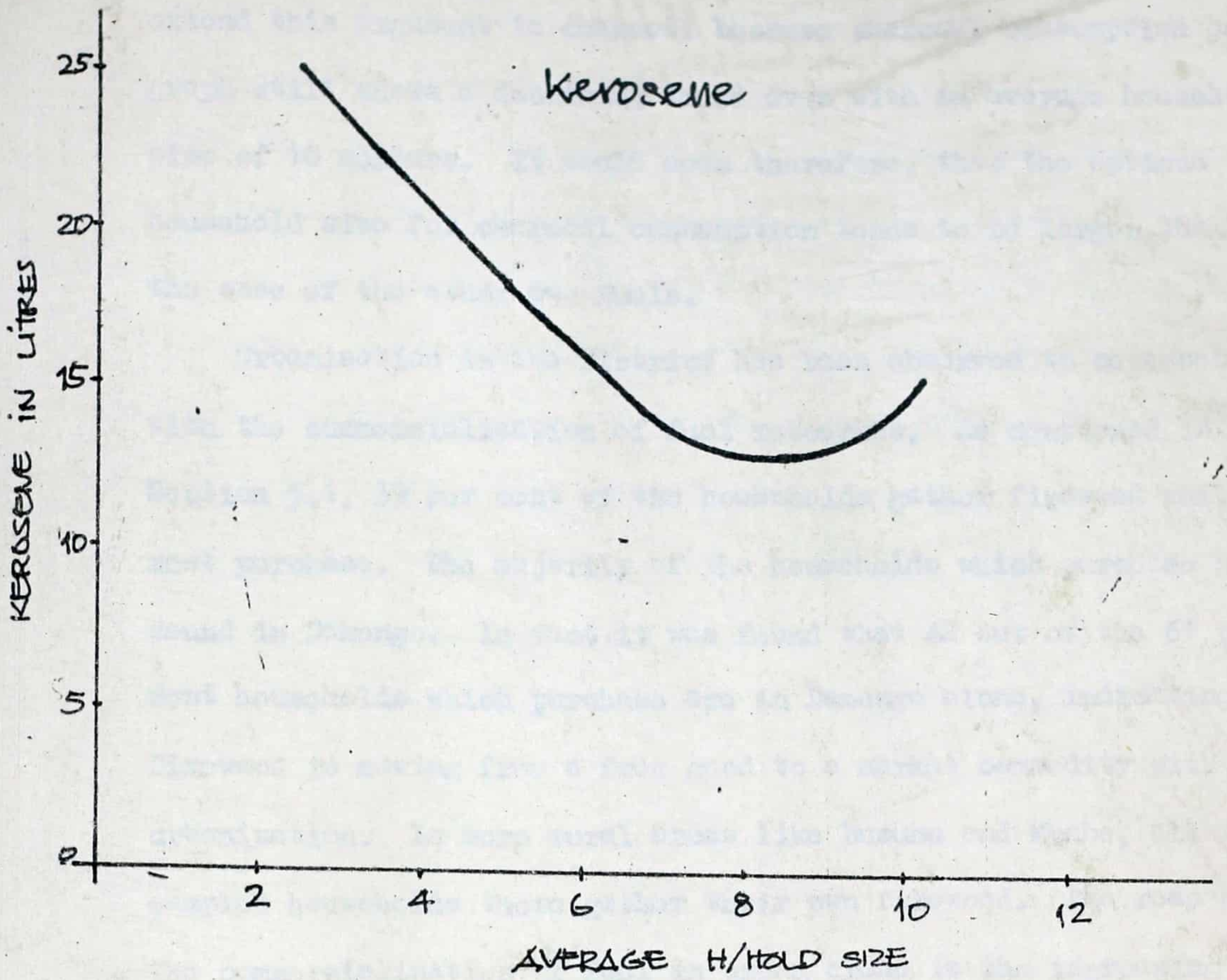
Type of Fuel	Colorific Value MJ/Kg	End-Use Device	Efficiency	Average Efficiency	Total Qty Consumed Kg	Total Energy Released Million MJ	Effective Energy Million MJ	Energy Lost Million MJ
Firewood	18	3 stone fire	10	15	42 268160.7	761	114	647
"	18	'Mud' stove	20					
Charcoal	30	Brazier	15		2 362 966.2	70.9	10.6	60.3
						831.9	124.6	707.3

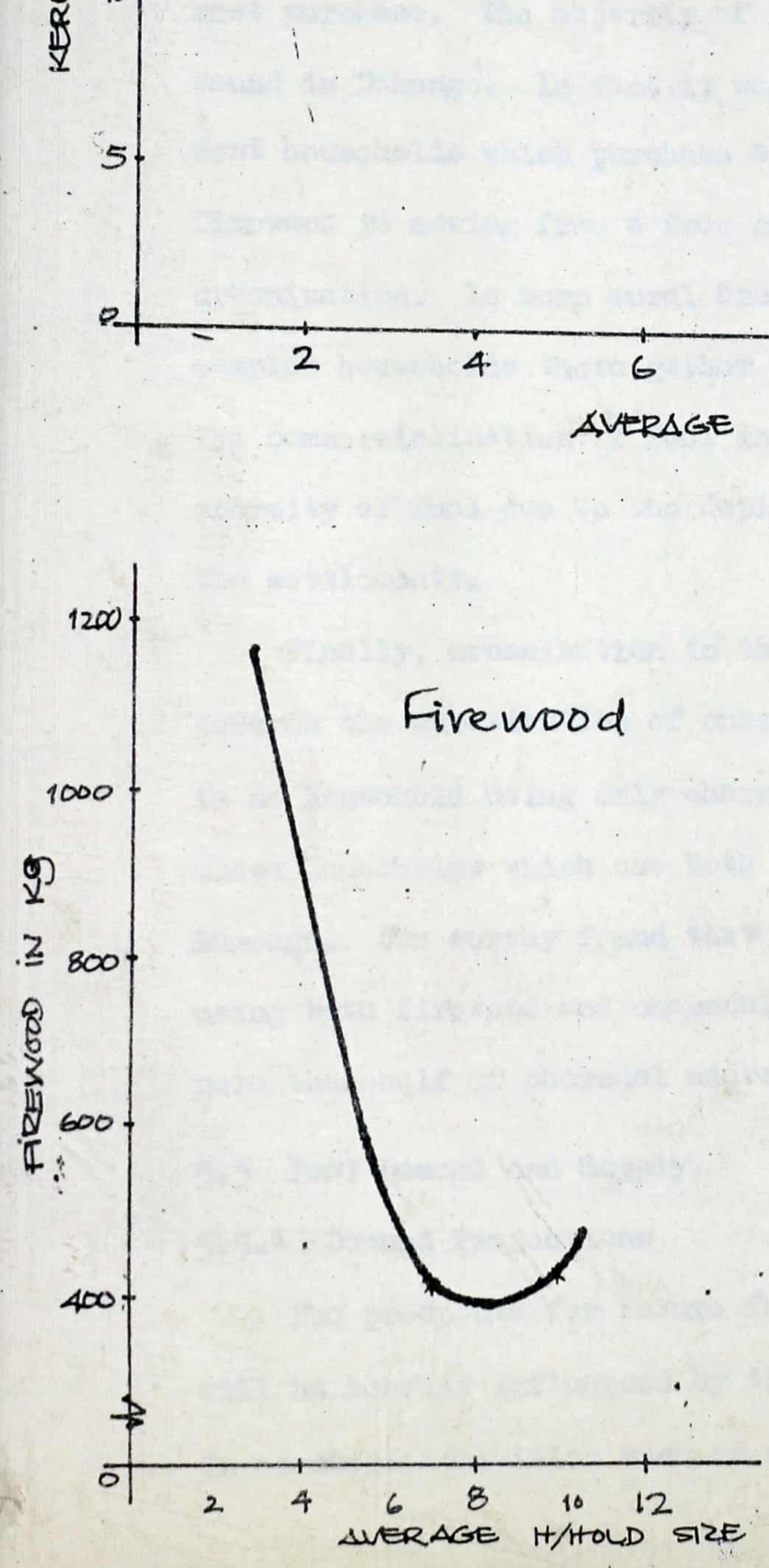
The total sample shows that 49 per cent of the households cook on the open fire place while 46 per cent do their heating activities on the open fire, Table 5.9. The open fire place makes available only a maximum of 10 per cent effective energy out of the total energy released by burning wood or charcoal, (Section 3.2). 27 per cent do their cooking on mud stoves while 22 per cent of the sample was found to be doing their cooking on a brazier. In general, both firewood and charcoal are consumed on the three devices namely open fire, mud stove and brazier with an average efficiency level of 15 per cent. This results in the loss, annually, of 707.3 million MJ as unavailable heat energy out of 831.9 million MJ released in the whole District, Table 5.10 elaborates.

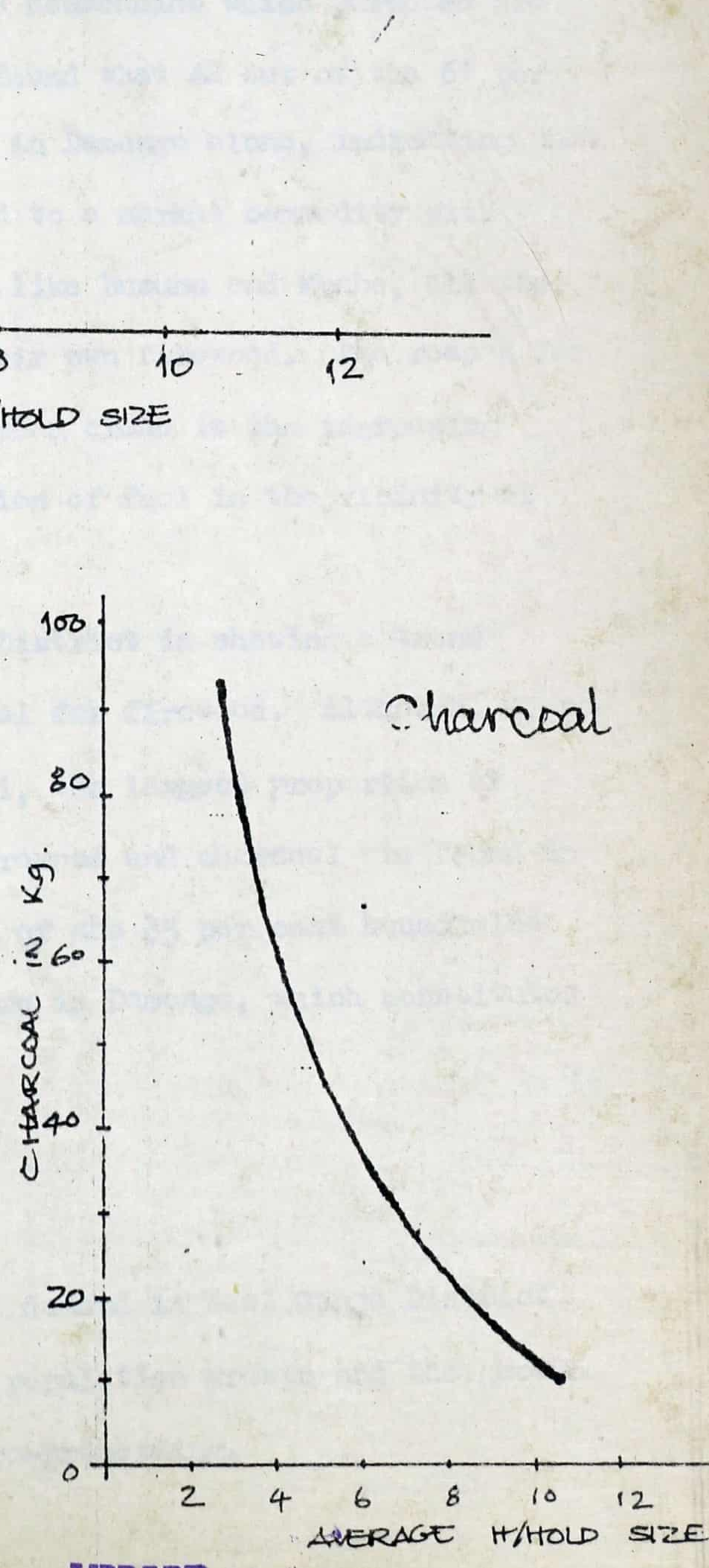
5.4 The Impact of Household Size and Urbanisation on Consumption

Urbanisation in the District is associated with smaller household sizes. It was observed that 20 out of the 32 households with an average size of 3 are found in Damongo, the urban area of the District. As has been observed from the consumption levels, smaller households tend to have higher per capita consumption levels of fuel than large households. The tendency of larger households to experience economies of scale has been observed through lower per capita consumption of fuel in these households. Figure 5.1 shows graphically, the fall in per capita consumption with increasing households size for the three most important fuels in the District: Kerosene, Firewood and Charcoal. However, the graphs also show that the economies of scale gained by larger households are not indefinite with increasing household size. In the case of kerosene and firewood, the optimum household size, that is, one experiencing the lowest per capita consumption is about 8.5. Beyond the optimum, per capita consumption increases with further increase in household size. The reason behind the economies of scale lie in the sizes of the end-use devices. Households larger and smaller than the optimum size, therefore, need larger and smaller end-use devices respectively.

Fig 5.1. Fuel Consumption by Household Size.







Source: Author's own survey.

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Available information on charcoal consumption does not suffice to extend this argument to charcoal because charcoal consumption on the graph still shows a declining trend even with an average household size of 10 members. It would seem therefore, that the optimum household size for charcoal consumption tends to be larger than in the case of the other two fuels.

Urbanisation in the District has been observed to be associated with the commercialisation of fuel resources. As mentioned in Section 5.1, 39 per cent of the households gather firewood while the rest purchase. The majority of the households which purchase are found in Damongo. In fact it was found that 42 out of the 61 per cent households which purchase are in Damongo alone, indicating that firewood is moving from a free good to a market commodity with urbanisation. In more rural areas like Busunu and Mpaha, all the sampled households there gather their own firewood. The reason for the commercialisation of fuel in urban areas is the increasing scarcity of fuel due to the depletion of fuel in the vicinity of the settlements.

Finally, urbanisation in the District is showing a trend towards the substitution of charcoal for firewood. Although, there is no household using only charcoal, the largest proportion of those households which use both firewood and charcoal are found in Damongo. The survey found that 19 of the 35 per cent households using both firewood and charcoal are in Damongo, which constitutes more than half of charcoal users.

5.5 Fuel Demand and Supply

5.5.1 Demand Projections

The prospects for future fuel demand in West Gonja District will be heavily influenced by the population growth and the growth in economic activities such as agro-processing.

The population of the District is growing very rapidly. The annual population growth rate presently stands at 4 per cent. The future estimates of fuelwood and kerosene demand in this study are based on a simple projection and an assumption of 4 per cent per annum growth rate. The high demand envisaged is expected to come not only from increasing domestic consumption due to rapid increase in population, but also from increasing economic activities, including brewing, food processing and non agricultural industrial ventures. Table 5.10 shows projected fuel demand up to the year 2005

Table 5.10

Fuel Demand Projections[a,b]

	1990	1995	2000	2005
Kerosene million litres	1.30	1.6	1.9	2.2
Fuel wood million kg	53.2	63.9	76.7	92.0
Thousand m^3	71.2	86.2	104.0	124.2

[a]Base year = 1989, population 80 373. [b]Population x 0.04 x 5 years.

From the Table it can be seen that the year 2005, over 2.2 million litres of kerosene and 92.0 million kg (124 thousand m^3) of wood will be demanded by the population.

5.5.2 Supply Projections

The most important sources of firewood and charcoal in the District will continue to be the unprotected forest rangeland which covers an area of 11 706 km^2. The forest Estates namely the Mole Games Park, the Konikeni forest estates south of the park and the Yakombo forest reserve will play a minor role due to the statutory restrictions.

The available information on estimates of growth increment of forests vary widely in range. This reflects the difficulty involved in making such estimates.

According to studies carried out in Tanzania, the mean forest growth increment of the 'Miombo' woodlands in the savanna is estimated at $2m^3$/hectare/year[5]. The Ghana Forestry Department estimated that forest estates have a growth increment ranging from 4 to 15 m^3/ha per annum, while the forest rangeland is estimated at between 3 and $7m^3$/ha[6]. Although international comparisons can be misleading as regards such estimates, an idea can be had concerning the complexity of the problem. This is because growth increments are influenced by many factors including soil fertility, moisture content of the soil, topography and human interventions.

This study assumes, for the supply projections an annual average growth increment of 4 m^3/ha for the forest rangeland. This is because it is anticipated that extensive human interventions through bush burning, grazing and other demands will tend to lower the growth increment of the rangeland forests. The expansions in agriculture is based on the current per capita hectarage of the District which is 1.1 ha[7]. This hectarage was assumed because existing agricultural productivity levels in the District are not anticipated to change significantly during the projection period. The results of the simple supply projections are shown in Table 5.12. From the table, it can be seen that the demand is by far less than the supply levels. In fact up to the end of the projection period, the demand will constitute about 3 per cent of the growth increment alone, not to mention the stock already there.

Although the results of the projections show a surplus of supply over demand, this does not mean that there is no perceived fuelwood scarcity in the District. Households interviewed perceive fuelwood scarcity in terms of increasing distances to sources of supply from settlements and longer collection time as compared to 15 years previously

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[5] Kutsch, "Sadcc Energy", p 23.

[6] Pluth, "The Energy Sector", p.33

[7] SPRING II Participants, "West Gonja Development Plan", p.12

Table 5.12 Forest Growth Increment and Fuelwood Demand

	Base Year 1989	1990	1995	2000	2005
Total Rangeland Area (ha) (1)	1170 600				
Total Population[a] (2)	80373	82 746	96 026	112 832	133 914
Fuelwood Demand at 4%/annum Growth(m^3) (3)	69800	71 200	86 200	104 000	124 200
Total Land Area Cultivated at 1.1 ha/capita (ha) (4)	88410	91 020	105 629	124 115	147 305
Forest Area Remaining (5 = 1 - 4)	10 82 190	1 079 580	1 064 971	1 046 485	1 023 295
Annual Forest Growth Increment ha x 4 m^3 m^3 (6 = 5 x 4 m^3)		4 318 320	4 259 884	4 185 940	4 093 180
% of Growth Increment Consumed for fuel (7 = 31[b])		1.6	2.0	2.4	3.0

a Population projection by Rapid Projection Model.

Morover, the tendency for more households to purchase firewood (61 per cent) as opposed to gathering (39 per cent) is an indication of increasing scarcity because where firewood is readily available, households tend to collect it themselves. The perceived fuel scarcity in the District, is therefore, a question of accessibility but not availability. The next section, environmental impacts and energy shortages, deals in more detail with the causes and effects of this perceived fuel scarcity.

5.6 Environmental Impacts and Energy Shortages.

5.6.1 Diminishing Land for Fuel Resources

There are competing uses of land apart from the provision of fuel. The high population growth rate experienced in the District means that more land will have to be converted from forestry into agriculture and other uses. The proportion of the population engaged in agriculture will continue to be the largest compared to other sectors. This can be seen from the labour force engaged in agriculture which currently stands at 59 per cent[8]. It is expected to decline to 55 per cent by the year 2000 and to 50 per cent by 2005.

This decline in the labour share of agriculture does not mean a decline in absolute terms. The absolute number of population engaged in agriculture will continue to expand as can be seen from the increasing land requirements, Table 5.12. Fuel scarcity, which is perceived through increasing distances to sources of supply and longer gathering time will be aggravated by further agricultural expansion resulting from increasing population in the District.

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[8] SPRING II Participants, "West Gonja Development Plan", P.17

The clearing of forest rangeland for agriculture proceeds progressively from settlement sites, meaning that average distances to farms will increase. Since firewood is collected mainly away from farms, expansion in agriculture will entail longer walking distances to fuel sources and therefore, increased scarcity. The prospects are that the increased scarcity, perceived through longer distances to sources of supply and longer collection time, may in turn lead to an increase in the proportion of households which purchase firewood. Moreover, more households may be induced to switch to the use of charcoal from firewood due to the advantages especially of easeness in storage and usage of charcoal over firewood. The longer distances to sources of fuel however, is likely to reflect itself in higher prices of fuels sold in the settlements. The perceived fuel scarcity is likely to increase with increasing population and the accompanying expansion of agriculture. The next section examines the impacts on the physical environment resulting from the energy and other demands on forestry.

5.6.2 Deforestation and Soil Erosion

The demand on forestry for firewood and charcoal are not the only causes of deforestation. Other demands are for housing purposes and various sorts of housing furniture contribute to deforestation and the accompanying soil erosion. Deforestation is perceived by the community through the ever increasing distance to the nearest forest. The survey found out that the forest is receding further away from settlements. In Busunu and Yapei, 100 per cent of the households interviewed indicated that presently a real forest could be found at distances of between 7 - 10 km from the settlement. It was the same in Buipe where the forest was said to be at a similar distance by 46 per cent of households interviewed. The only exception was Damongo where the majority indicated a distance of not more than 6 km.

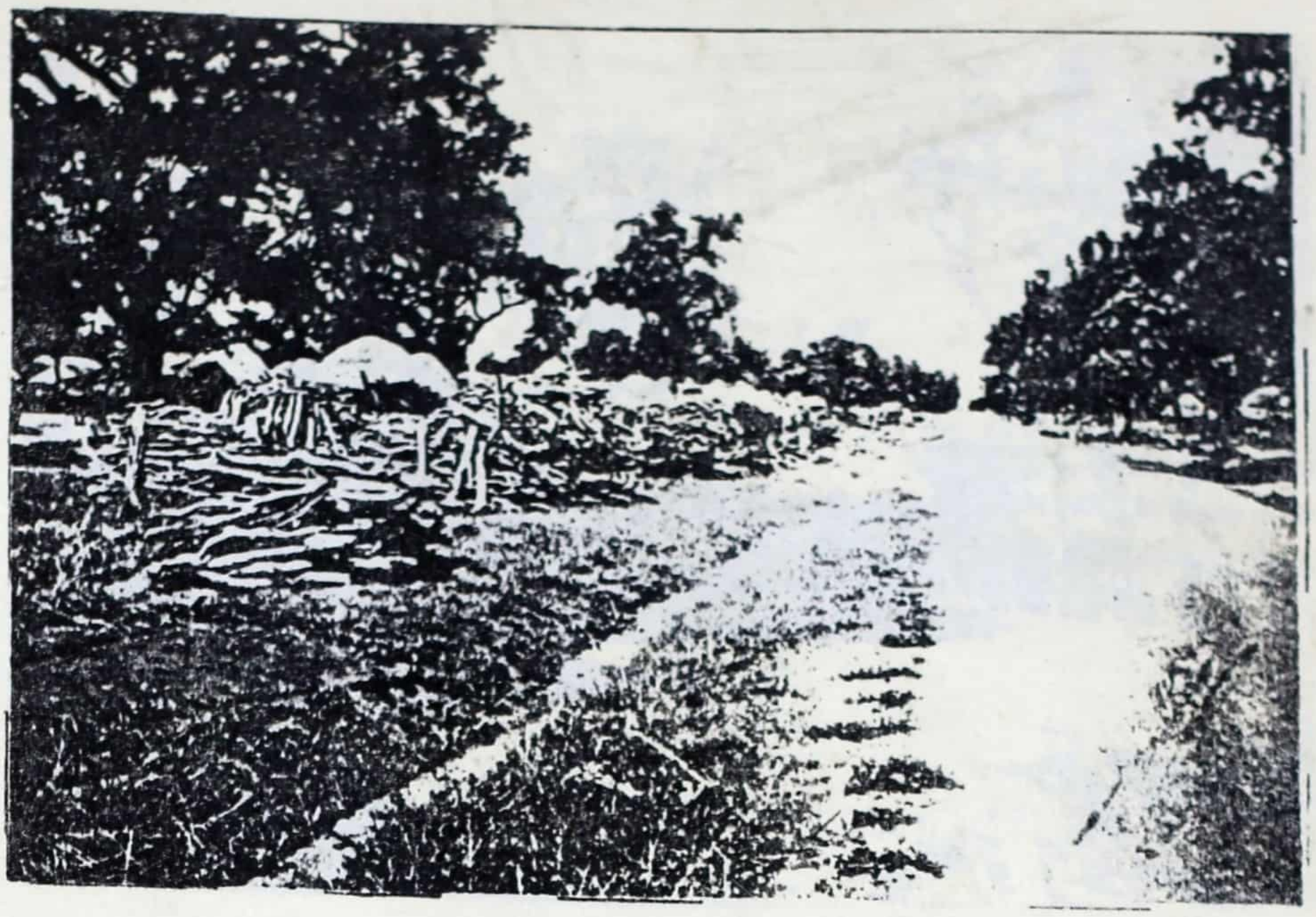
However, this is mainly due to the existence of protected forest areas namely the Konikoni forest and the Mole Game Park to the north of the town. This was found not to be the case some fifteen years previously. The forest then lay in close proximity to settlements surveyed, the average distance to the nearest forest fifteen years ago was 3 km. In Mpaha this was said to be the case by 71 per cent, in Buipe by 61 per cent, while in Busunu, it was true for all the respondents.

The effects of deforestation were observed by the respondents in the presence of gullies and exposed roots of plants resulting from soil erosion, in the lowering of the volume of water of some rivers and in the drying up of others. In all the settlements surveyed, there was evidence of serious soil erosion which was observed by both the respondents and the author. In the Damongo area, rivers like the Kpril, Sor, Wisiri, Bonya and Monori presently have lower water volumes than they used to. The Kolonkondo, Kodidiga, Zabaah, now experience seasonal drying while the Deboto has more or less dried up. In the Daboya area, the Charbose and other rivers experience seasonal drying up while in Busum, the Benyerg experiences the same situation.

The farming currently practised in the District was found to contribute to the state of environmental degradation in the area.

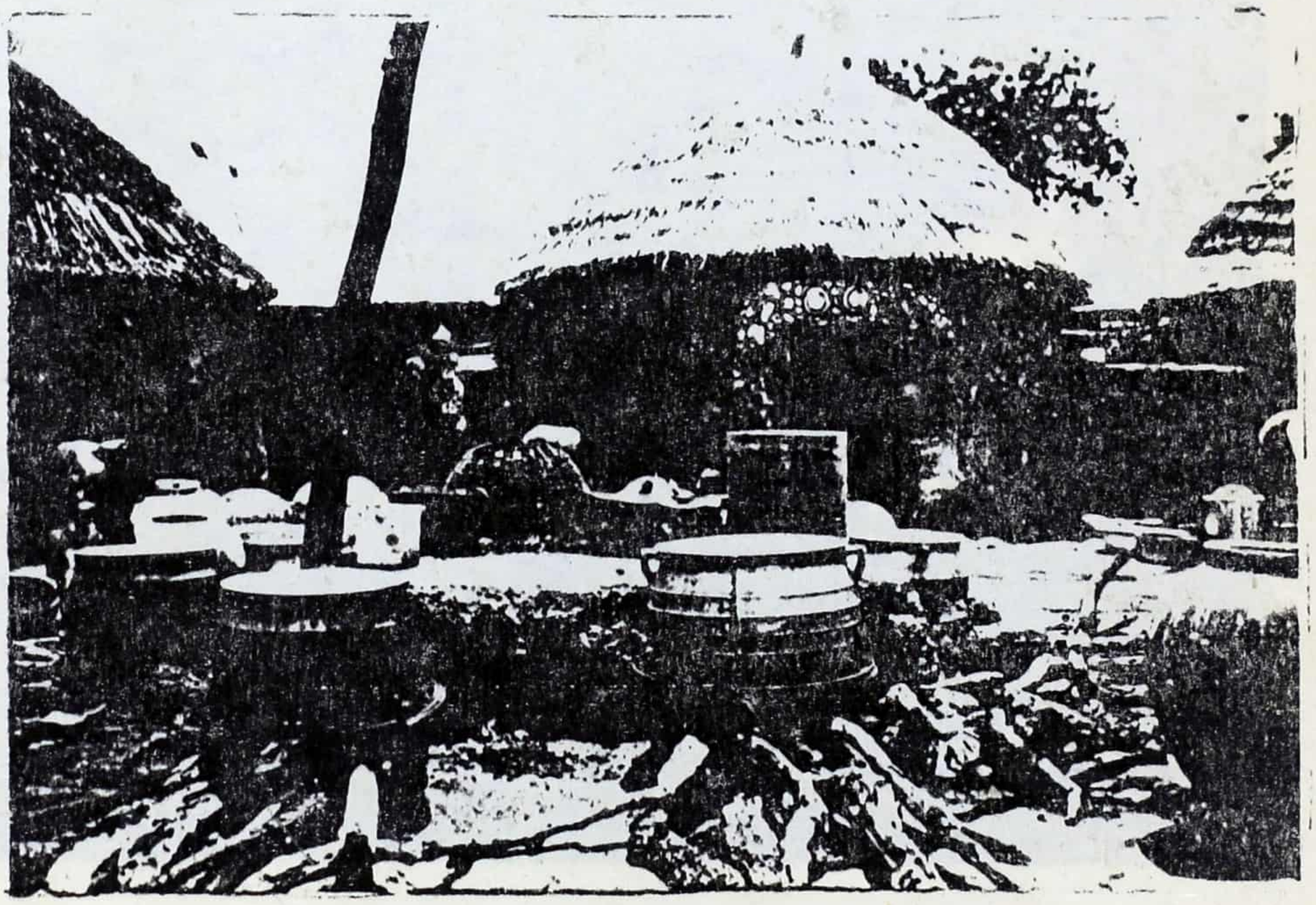
Many farmers, especially in the rest of the settlements outside Damongo apart from shifting cultivation used fire in the clearing of their fields. The reason for this seems to be partly in the nature of farm implements used which make it difficult to cultivate without first having to clear the land by burning away the plant growth, resulting in bushfires.

Plate 5.1



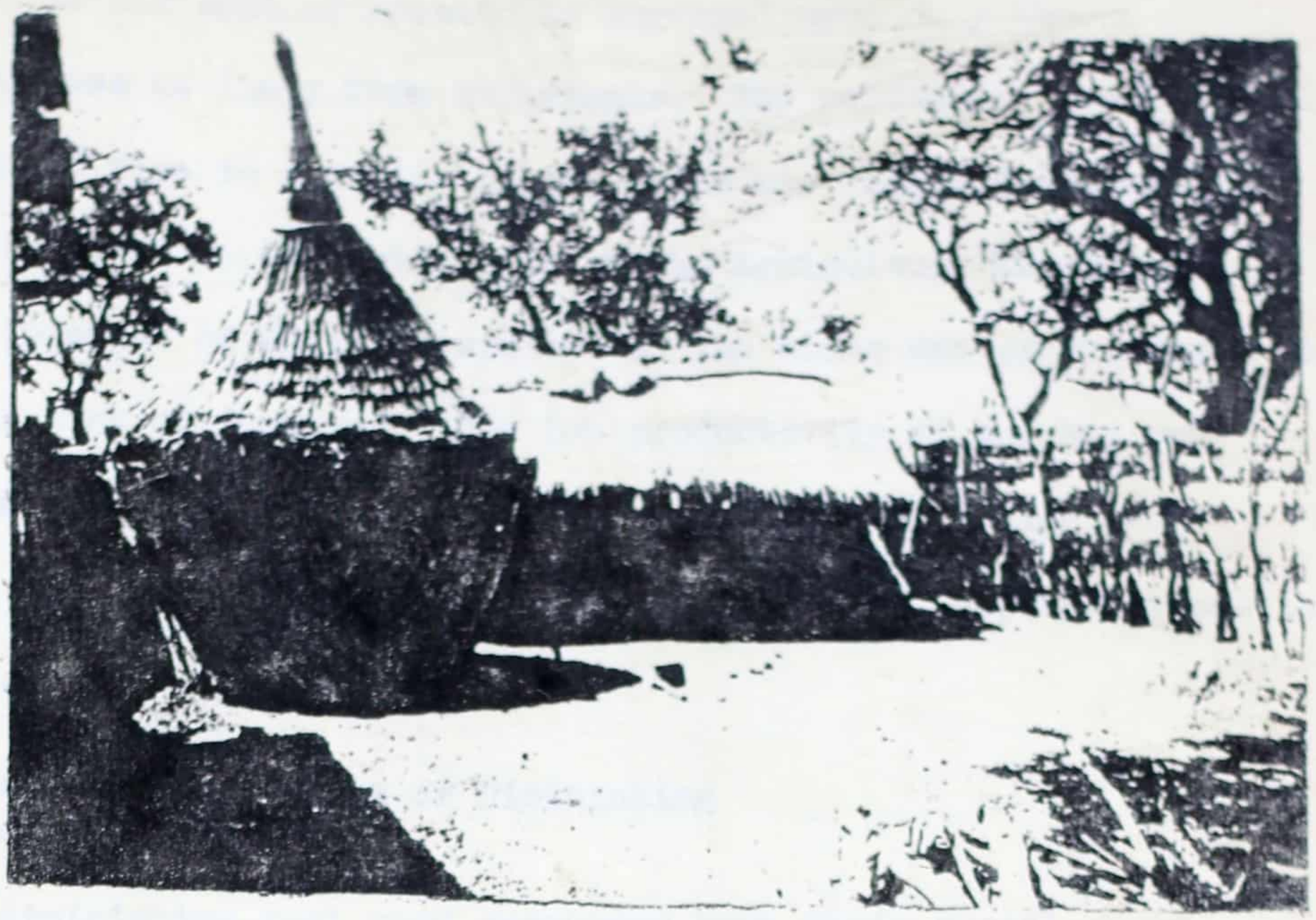
Bundles of collected firewood at Soleape, West Gonja. (Author)

Plate 5.2



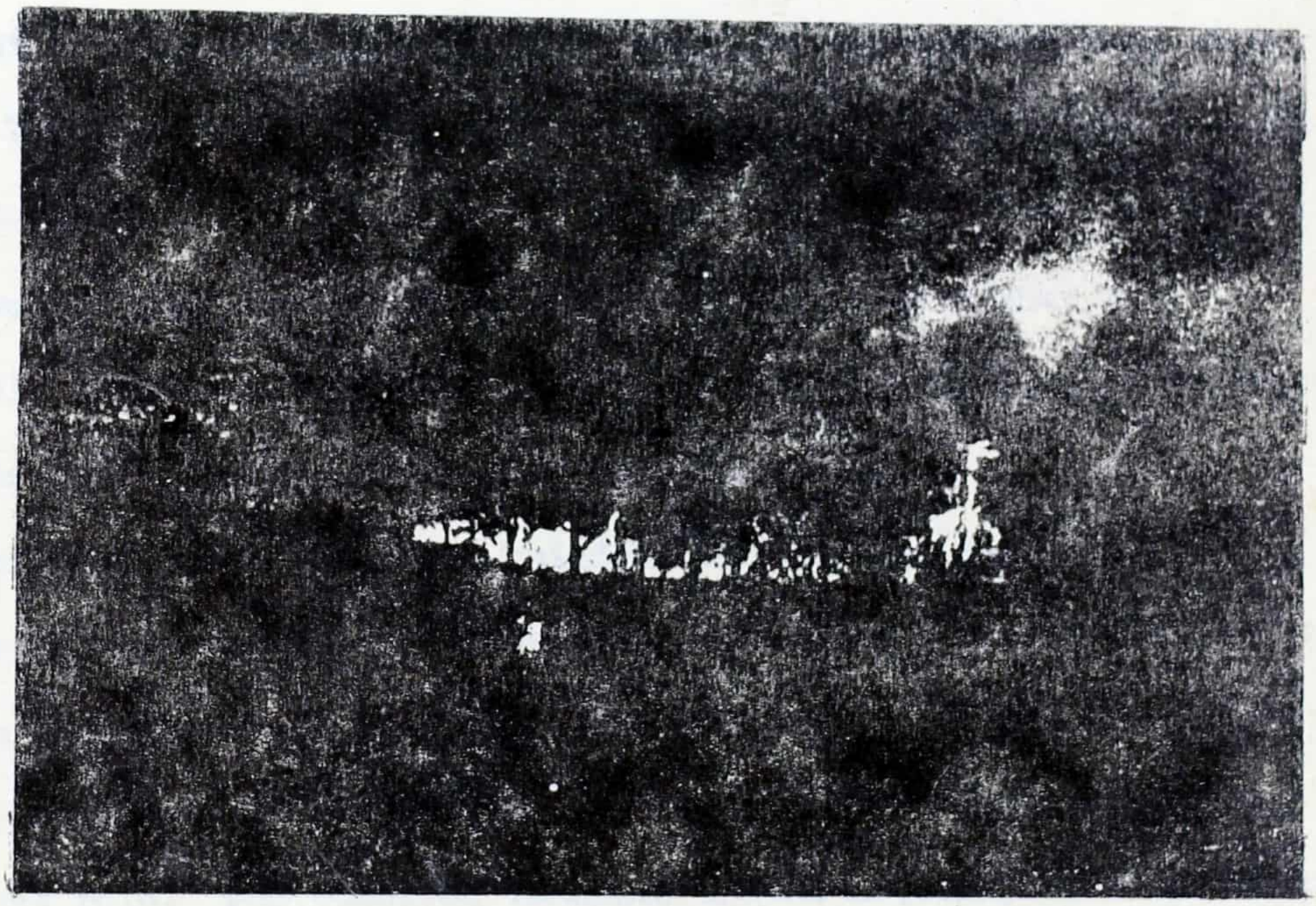
Pito Brewing in Damongo, West Gonja. Note the large quantities of firewood being consumed. (Sutomo, Spring)

Plate 5.3



A residential house and courtyard in Yapei,
West Gonja: Other uses of wood. (Sutomo, Spring)

Plate 5.4



Bush burning near Yapei, West Gonja.
Another major cause of deforestation.
(Author)

About 62 per cent of households surveyed used only the hoe and cutlass as their farm implements. The relatively low frequency of the use of fire in clearing fields which was observed in Damongo may be attributed to the activities of the Agriculture Extension Officers (because of their proximity and the wider use of tractors, that is, 29 per cent of farmers). The low productivity of the hoe and cutlass is compounded by the low usage of manure in farming even though 74 per cent of the respondents own livestock, especially cattle and goats.

5.6.3 Socio-Economic Costs of Diminishing Fuelwood Resources

The diminishing fuel wood resources have their social costs to the population of the District. In the households surveyed, increasing scarcity is reflecting itself in the increasing distances to sources of firewood for those households which mainly collect their own. It was found that 56 per cent of the households collect their firewood at a distance ranging from 1 - 5 km while ten years ago 64 per cent had their firewood sources within a distance of less than 1 km. The increasing distance is coupled with longer firewood gathering time.

Over 40 per cent of the respondents pointed out that it presently takes more than two hours to gather a head load of firewood while as ten years ago, it took less than one hour.

This means the women and children who are the people responsible for collecting firewood are devoting increasing amount of time in the collection of fuel. This takes place at the expense of other productive activities such as farming where women play a very important role. The observed tendency by the majority of households to purchase firewood instead of collecting is an indication of adjustment by households against the increasing distances to sources of supply and longer collection time.

This adjustment however, does not solve the fuel problem, but merely shifts the burden from women and children to the heads of households who have to provide the necessary finance. The diversion of increasing amounts of money into the energy requirements by households means lesser resources for food and other household requirements

5.6.4 Summary of Findings

The analysis of the data has shown that there are three most importants household fuels in West Gonja which are kerosene, firewood and charcoal. Kerosene is the major source of fuel for lighting used by almost all the households. It is normally used in hurricane lamps which were seen to be popular because of their lower costs as compared to better lighting devices such as tilley lamps. Firewood is the second most popular household fuel while charcoal is always used together with firewood in the households that use it mainly for cooking, heating and in a few cases brewing.

The popularity of these three fuels is based on their availability on the local market or as a free good in the forest for those who can collect. However, it was found that the tendency in the District is that the majority of households rather purchase household fuel. For those households which don't the common feature is for women and children to collect firewood.

The most common type of firewood used are branches, followed by trunks and then barks of trees. The use of solar power at household level is litorally for drying purposes only.

The seasonal variations in fuel usage is very small. However, there is a tendency for households that use charcoal to increase slightly during the rainy season. The very slight seasonal variation in fuel usage is due to the stock piling of firewood to last through the rainy season when people are busy and fuel scarcity tends to be higher.

Kerosene consumption averages 15.7 litres per person per year, firewood averages 0.71 m^2 (525.9 kg) and Charcoal 29.4 kg. Smaller households were found to consume comparatively bigger fuel quantities per capita than larger households. For instance, persons belonging to households with an average of 3 members consume 1½ times as much kerosene, 2½ times as much firewood and charcoal as those with 7 members. Households with 7 and 10 members have fuel consumption levels below the total average. However, it was also found in the case of kerosene and firewood that households with an average of 10 members consume slightly higher fuel levels than those with 7 members. This was explained as due to economies of scale with increasing household size up to an optimum size of about 8.5 members, and there after diseconomies of scale tend to increase the per capita consumption levels. Households using both firewood and charcoal tend to use less firewood per capita.

The efficiency of energy usage among households in the District is very low. This is the result of inefficient and-use devices commonly in use in the District.

The three stone fire place which is the most common device has an efficiency level not exceeding 10 per cent, the mud stove has about 20 per cent while the ordinary charcoal brazier has around 15 per cent. Only about 15 per cent of all the energy released by households in the District is used effectively.

Urbanization in the District tends to increase fuel consumption because of increasing smaller household sizes which have a higher per capita consumption. It has also been associated with the commercialisation of fuel resources and a tendency for more households to use more charcoal.

The demand projection anticipates a higher growth rate in the demand for the three fuel resources commonly in use in the District, that is a growth rate of 4 per cent per year up to the

year 2005 because of the fast growing population and an anticipated increase in economic activities.

The supply projections show that the forest growth increament caters adequately for the fuel wood demand of the District. It was noted therefore, that the issue of fuel scarcity in the District is a problem of accessibility to fuel sources by the people but not one of availability. This is because fuel scarcity is perceived by the people, as a result of increasing distances to sources and longer collection time for firewood. It was noted therefore, that, as more land is put into agriculture, distances to sources of firewood increase, which is reflected in increasing fuel scarcity and higher fuel prices.

The chapter showed that deforestation and soil erosion are perceived by the local community in increasing distances to the nearest forests, signs of exposed tree roots, the drying up of rivers and in the lowering of the volume of water in some rivers of the District.

CHAPTER SIX

PLANNING TOWARDS ENERGY CONSERVATION AND ENVIRONMENTAL PROTECTION

This chapter, which is divided into four parts, examines the planning implications of the energy and environmental situation analysed in the previous chapter. It also looks at the pertinent national policies and legislations regarding the energy sector and environmental management and the institutional set up. The last section examines the potential and prospects for community participation in energy conservation and environmental protection in the District.

6.1 Planning Implications of the Energy Situation in West Gonja.

The problems of the energy sector in the District can not be considered on their own. This section brings together the interrelationships of the energy sector with all other aspects of rural life and tries to show how changes in one can affect the others. The scarcity of energy sources causes and is also a reflection of several factors all acting together and reinforcing each other.

The population growth as indicated in section 5.5.1 needs to subsist and therefore the production levels will have to be expanded to cater for the increasing population. As indicated in the introductory section, the farming methods in the District are very extensive, therefore, production can only be increased by putting more land under cultivation at the expense of forestry or fuel resources. The growing population also exerts an increasing demand on fuel resources.

Furthermore, the increasing urbanisation of the District increases the per capita fuel consumption due to smaller household sizes (Section 5.4).

The growing population also demands more land for non agricultural activities such as settlements, roads and social facilities. The rate of deforestation therefore will increase and reflect itself in declining production and a lower living standard of the population. Fig 6.1 shows these interelationships in the form of a problem tree.

The foregoing discussion goes to show that the fuel problem can undermine any development activities that are narrowly conceived and directed at a single sector.

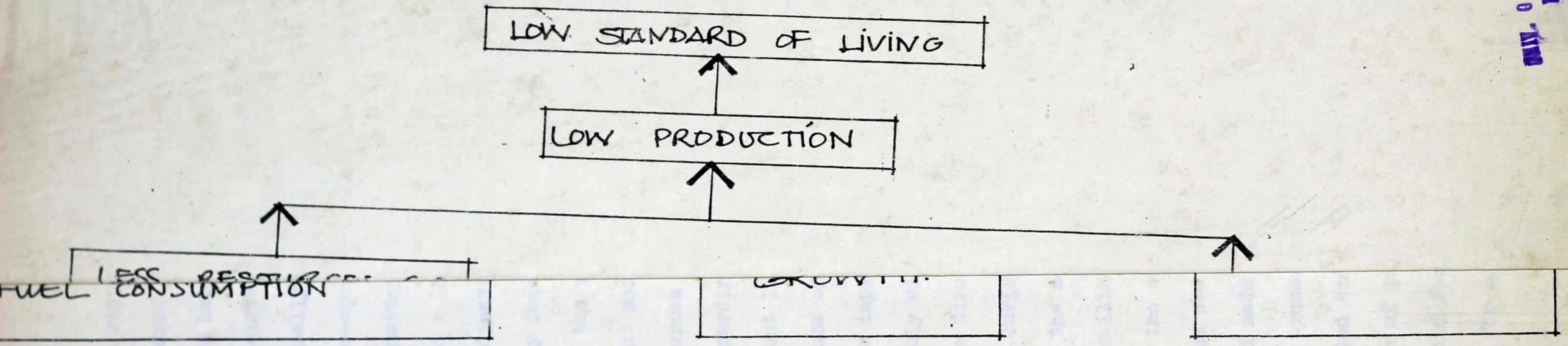
In seeking solutions to it, a holistic approach must be taken that addresses itself to all the major sectors. This approach, of necessity involves intersectoral coordination in project planning and implementation.

Institutions like the National Energy Board, the Environmental Protection Council, the Ministry of Agriculture - Extension Department, the Lands Commission and all others involved in rural development and resource management need consultations and information exchange for the success of their activities. The policies and legislative framework relating to the powers and responsibilities of the aforementioned institutions is the subject of the next section.

6.2 National Policies and Legislations

The National Energy Board (NEB) of Ghana was established by Government legislation with a view to develop and advice the government on energy issues and policies. It also acts as a channel of information of the various institutions undertaking researches in the energy sector.

Fig 6.1 Rural Energy and Intersectoral linkages.



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In this respect, the Energy Research Group (ERG), which is an independent Non-Governmental Organisation has played an important role and has regularly made known its activities through the ERG newsletter.

Finally, the NEB is the overall official body through which co-operation with other national and international bodies on energy matters is undertaken. Since its establishment, the NEB has done a lot to raise public awareness about energy saving and in coordinating and promoting research on energy as evidenced by the many fora it provided in the form of workshops and symposia.

In the renewable energy sector, the policy is to promote efficient means of resource utilisation in order to have sustainable sources of supply.

Regarding natural resource management, there are several Government Legislations under various responsible bodies. It is the nature of these policies and legislations and the efficiency of their implementation by the responsible Agencies which invariably will determine the state of the environment.

The direct relationship that exists between rural energy and the environment means that the rural energy policy becomes part of the national environmental policy. The concern for proper utilization of natural resources in Ghana can be traced back to the colonial period when for example in 1927, the Forest Ordinance was passed for the establishment of the Forestry Department and made provision for the acquisition of land for forest reserve areas. In 1948, the National Forest Policy statement was formulated and adopted. The clauses of the statement included the creation of permanent forest reserves by reservation of sufficient forest and forest lands, efficient management of the reserved forests for maximum productivity and value on a sustained yield

basis; regulation of the exploitation of the resources of the unreserved forests to ensure that they are fully utilised before the land is converted to other uses; public education to raise awareness of the value of forests and the need for conservation and to ensure co-operation with related forms of land use and land agencies.

The policy statement was accompanied by broad guidelines as to measures to be taken to achieve the policy objectives. Over the years, emphasis has been put in the utilisation and management of the forests. Further reservations of forest areas have almost ceased. The Forest Offences Act 83 of 1959, Forest Improvement Act 1962, The Timber Protection Decree of 1974, the Trees and Timber Decree of 1974 and the Forest Fees Regulation of 1976 all go to show the stress being put on utilisation and management of forest resources. These Policies and Legislations have been more effective in forest reserves and areas with timber exploitation potential, but not on forest range land areas, that is, areas outside the forest reserves.

The forest range land areas are where the competition for land between agriculture and forestry is most intense. Moreover, the incidence of bush fires on forest range land is very high. Frequent bush burning has been instrumental in destroying the regeneration capacity of the natural vegetation. The ineffectiveness of the Control of Bush fires Law of 1983 has been due to the vastness of forest range land and the lack of a directly responsible agency. Amendment of this law has been proposed with a view to establishing anti-bushfire committees and fire volunteer squads for towns and villages.

Indeed, this has been noted by the National Plan of Action to combat desertification which proposes among other things; a review of the Land Planning and Soil Conservation (Amendment) Act with a view to bringing it in line with present realities; a review of the land tenure system as a step towards the introduction of land reform legislation and the establishment of a Land Use Planning body; a centralised national institution to be charged with land use planning with branches in all the regions[1].

The lack of a national policy pertaining to range lands was noted by the United Nations Sudano-Sehelian Office Planning and Programming Mission to Ghana. The mission noted that, rangeland must be recognised as vital natural resource through legislative action. It was also proposed that the policy should be a Renewable Natural Resources Act covering all types of land and land uses[2].

Logislations relating to land management is embedded in the planning and soil conservation (Amendment) Act of 1957 read as one with the land planning and soil conservation ordinance 1953 and the Town and Country Planning ordinance, Cap 84 of 1945. The purpose of the Act is for better utilisation of land in the designated areas through preserving and reclaiming lands and protecting water resources. The Act is implemented through the establishment of work and coordinating committees for land planning and soil conservation by the Minister for Agriculture. The Act also empowers the Minister to prohibit, regulate and control breaking up or cleaning of land for cultivation or for any other purposes; and to require, regulate and control afforestation of land, protection of slopes, banks of streams, rivers and dams. There is no doubt that the act is very comprehensive.

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[1] EPC Draft National Environmental Policy (Accra: EPC, 1989) p. 2-5

[2] EPC, "Draft National Environmental Policy" p 2-5.

However, there is no responsible body directly charged with its implementation. Moreover, as noted earlier, the Act itself needs to be reviewed to bring it in line with current trends. The limitation of the implementation of the Town and Country Planning Ordinance by the Department of Town and Country Planning lies with the tendency by the Department to dwell more on the town aspects of the ordinance to the neglect of the country aspects.

The Ghana Government realising the complexity of implementing the various policies and legislations bydifferent sector agencies, established the Environmental Protection Council (EPC) by Government decree 239 of 1974. The Environmental Protection Council was established to coordinate the activities of all bodies concerned with environmental matters and to serve as a channel of communication between those bodies and the Government, and as the official national body for co-operating and liaising with other national bodies and international organisation on environmental matters.

Despite the laudable responsibilities the EPC has, it plays mainly an advisory role and has no power to enforce coordination. As such, coordination among the various bodies concerned with environmental matters remains on voluntary basis. Other bodies whose activities have a bearing on Natural resources include among others: the Lands Commission, the Department of Games and Wildlife, the Fisheries Department, the Institute of Renewable Natural Resources, the Forest Products Institute and the Department of Agricultural extension.

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As indicated earlier, a guarantood supply of onorgy namoly firowood and charcoal will dopond on tho succossful implomontation of tho various Policios and Acts togothor with tho accompanying programmos portaining to onvironmental consorvation and managomont. Coordination botwoon tho activitios of tho NEB and thoso of the E.P.C. will bo crucial in tho succoss of tho onorgy and ovironmontal policy.

6.3 Tho Forostry Dopartmont

Tho main activitios of the Forostry Dopartmont in tho Distriot is mainly tho Managomont of tho Yakombo and Konikoni forost rosorvos and tho Molo Gamo Park which is also undor tho Dopartmont of Wildlifo. Tho forost rosorvo aroas as notod oarlior covor a total aroa of 5000 km^2 undor indogonoous troos adaptod to tho Guinoa Savannah Climatic Conditions.

At prosont, a National Afforostation Programmo is boing undortakon. Tho programmo, which involvos roafforostation and tho ostablishmont of community woodlots is undor tho Forostry Dopartmont at Distriot lovol. Tho Dopartmont oducatos tho pooplo on tho bonofits of troo planting and supplios thom with soodlings. In tho Northorn Rogion, tho Dopartmont runs nursorios at rogional lovol with tho holp of intornational agoncios such as tho Unitod Nations Dovolopmont Programmo which aro thon suppliod to tho distriot lovol for distribution to farmors.

Tho nursorios in oporation includo tho Bontanga, Tamalo, Kolongo, Tugu, Bimbila, Gambaga and Naroligu. Tho Agro forostry programmo which aims at toaching farmors how to intograto poronial woody plants with ordinary crops or animals on tho samo farm is also underway.

Three institutions are involved. They are the Forestry Department, the Agricultural Extension Department and the Institute of Renewable Natural Resources. The institute is to provide the necessary man-power training services; the Agricultural Extension Department is to provide practical training and demonstrations to the farmers while the Forestry Department is to supply the seedlings. However, since institutional coordination is not mandatory, the success of this programme will depend on how far the three institutions forge links with each other and work as one.

The District Forestry Department Office in Damongo has responded to those national challenges of establishing forest plantations to augment the natural forests. Some forest plantations were therefore established in the District whose purposes were to provide firewood and wood for charcoal to the community; to serve as wind breakers; to protect water catchment areas; to check desertification, soil erosion and to provide building materials. However, only 0.5 km^2 and 1.1 km^2 of forest plantations has so far been established in the Districts in Damongo and Bombi respectively[3]. The two plantations were established by the Forestry Department Staff. There are no community or individual woodlots so far established in the District. The lack of sufficient educational campaigns and ineffective implementation strategy due to lack of cooperation among the various departments at district level are factors contributing to the lack of community enthusiasm.

The next section looks at how public participation can be a pre-condition for the success of energy and environmental conservation programmes.

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[3](District Forest Officer, S. Mukalabai Mubita, Damongo, 14th May, 1990).

6.4 The Need for Community Participation in Energy Conservation and Environmental Protection

Community participation must be integrated in energy programmes especially in the case of the two locally obtained fuels: firewood and charcoal. Moreover, these are the fuels which are likely to have the most significant impact on the environment in the District. The human factor is critical in any programme or project aimed at easing the energy problem. It is only when the local perspective is understood very well regarding the constraints that people face, that a programme can succeed and avoid promoting strategies which are completely out of local context in practice, though they may sound simple and straight forward in theory.

The rural population is very rational in whatever activity it is involved in. For any programme to succeed, benefits to be derived from it must be apparent to the community or individual. Waine[4] points out that new stoves for example, are accepted most readily when they combine several advantages such as improved energy efficiency with cleanliness and convenience. He further argues that the trees most popular with villagers are usually those which provide multiple benefits such as fruits, poles and fodder as well as fire-wood. Another important consideration is that programmes must not be too demanding in terms of time because the energy problem is one among many problems people face. This is why the socio-cultural context must be studied and understood clearly before undertaking a programme.

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[4] C. Waine; "The Woodfuel Challenge: looking to the future". The Courier, No. 95 (Jan - Feb, 1986) p. 86.

The target group oriented approach means consulting the people: farmers, industrialists and the urban wood users and learning from them what they see as their priority problems. It means encouraging them to participate in selecting, designing and implementing appropriate solutions. Morever, the approach allows for the tapping of local knowledge on forest management and makes use of the local labour.

The current decentralisation system of administration[4] undergoing implementation in Ghana opens up opportunities for target group or local level based planning and project implementation with prospects for massive public participation. Under the new district administration machinery, four administrative levels exist, namely, District level, Administrative Zones, Town and Area Councils. Representatives are elected to the District Assemblies and to the other units. The objectives of the District Assemblies are:

(1) to provide a democratic and effective administration of the district as a whole in a way which involved the maximum participation of communities in decisions.

(2) to promote political, economic, social and spatial development of the District as a whole through better planning and management of human, natural and financial resources.

The highest political policy making body at District level is the District Council which comprises the District Administration and the District Assembly. The District Assembly comprises two-thirds elected representatives and one-third government appointees and is charged with powers to formulate and implement plans under the various committees.

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[4] P.N.D.C. Law 207. (Accra, 1988).

The District Administration organogram under the decentralisation system is shown in Appendix 1.

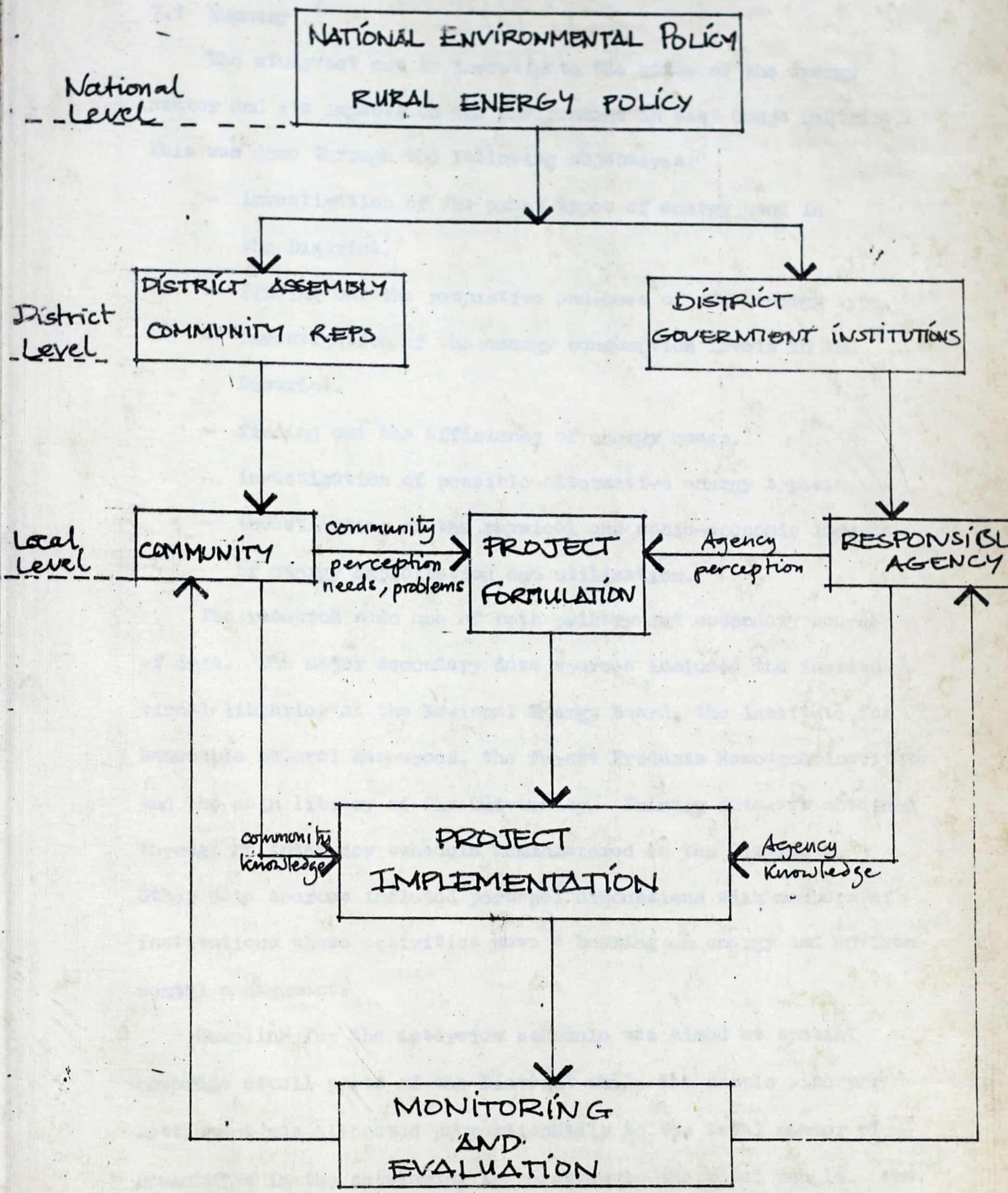
Under the decentralised system, all Government departments are accountable to the district administration which allows for the coordination of their activities at district level. There is also a link from the District Assembly to Zonal, Town and down to the Area Councils and the community through the elected representatives.

The important point is that project planners can now take advantage of this new administrative structure and involve the people in designing, imlementing and monitoring of programmes and projects. The diagram Fig 6.1 illustrates how this can be done.

The diagram shows that the formulation of a project must be the result of two points of view namely; community perception of their needs and the obstacles to the successful achievement of these needs on one hand, and on the other, the responsible agency's perception at district level, with national policies in consideration. In the implementation of projects, the community knowledge and the Agency's should support each other.

The results of the monitoring and evaluation must be fed back to the community so that any modifications to the project are not imposed on the community.

fig 6.2 Schematic Diagram of Planning and Implementation with community Participation



SOURCE: AUTHOR'S CONSTRUCT

CHAPTER SEVEN

SUMMARY, RECOMMENDATION AND CONCLUSION

7.1 Summary

The study set out to investigate the state of the energy sector and its impacts on the environment in West Gonja District. This was done through the following objectives:

- investigation of the exact types of energy used in the District.
- finding out the respective end-uses of each energy type.
- investigation of the energy consumption levels in the District.
- finding out the efficiency of energy usage.
- investigation of possible alternative energy types.
- investigation of the physical and socio-economic impacts of energy exploitation and utilisation.

The research made use of both primary and secondary sources of data. The major secondary data sources included the institutional libraries at the National Energy Board, the Institute for Renewable Natural Resources, the Forest Products Research Institute and the main library of the University. Primary data was obtained through an interview schedule administered in the District. Other data sources included personal discussions with members of institutions whose activities have a bearing on energy and environmental management.

Sampling for the interview schedule was aimed at spatial coverage of all parts of the District while the sample size per settlement was allocated proportionately to the total number of households in the settlement in relation to the total sample. The selection of respondents made use of systematic random sampling.

A review of literature on recent findings formed a basis for the study and the development of the conceptual framework.

The conceptual framework of the study is as follows. The behaviour of energy is explained by the first and second laws of thermodynamics which deal with the conservation and degradation of energy respectively. The same laws apply to the movement of energy in the ecosystems. Ecosystems themselves are in a delicate state of dynamic balance which is self-regulatory. The self regulation of the exosystems is due to the flow of energy, the cycling of materials and the adaptation of species within the ecosystem. However, because of great intellectual development, above all other animals, man exerts the greatest influence on the environment, and his activities even pose a threat to the stability of ecosystems in which he lives.

The analysis and interpretation of data resulted in the following findings:

- The most widely used domestic fuels in West Gonja district are: kerosene for lighting, and firewood and charcoal for cooking, heating and brewing.
- The annual per capita consumption for kerosene is 15.7 l, firewood is 0.71 m^3(525.9 kg) while charcoal is 29.4 kg.
- Per capita consumption of fuel varies with household size and is highest with smaller households (3 members), lowest with medium households (about 8 members) and slightly higher with larger households (10 members).
- Common end-use devices in the District are very inefficient.
- The perceived fuelwood scarcity in the District is a result of problems of accessibility to fuelwood sources but not availability because existing and projected total supply from rangeland surpasses demand.

- There are serious environmental problems around population centres expressing themselves in deforestation, soil erosion and increasing fuelwood scarcity due to increasing competition among various land uses.
- Alternative sources of energy may be difficult to introduce especially at household level due to high initial investments which this may entail.
- There is need for more coordination among the institutions involved in energy and environmental management.
- The existing political structure at District and local level is suited towards increasing public participation.

Recommendations were based on those findings which briefly include (i) Energy Conservation through encouraging the use of more efficient end-use devices; (ii) augmentation fuel resources by encouraging tree planting near settlements, (iii) improvement of fuel exploitation methods especially charcoal making, (iv) increasing agricultural productivity, (v) control of bush fires, (vi) family planning to lower the population growth rate and (vii) increasing environmental awareness among the local population.

7.2 Recommendations and Conclusion.

Consequent on the analysis of the environmental problems resulting from the needs of the energy sector in West Gonja District, the following recommendations are proposed to address the problem.

1. Energy Conservation:

The main area to be addressed here is the efficiency of energy utilisation. Energy end-use devices with higher efficiency levels should be encouraged, as most of those in current use are very wasteful of energy (Section 5.3).

A number of institutions, for instance the Forest Product Research Institute, the Institute for Renewable Natural Resources and the Department of Mechanical Engineering, all of the University of Science and Technology, Kumasi, and the Department of Housing and Cottage Industries are developing higher efficiency charcoal and firewood stoves which if adopted widely, would drastically cut down on the amount of fuel consumed.

2. Augmentation of Energy Sources

The existing fuel resources should be augmented by encouraging the planting of community and individual woodlots close to villages. Agro-forestry too should be encouraged in all farming activities. The objective of this augmentation is to cut down on the increasing amount of resources namely, time, labour and finance devoted to fuel acquisition.

3. Improvement of Fuel Exploitation Methods.

This recommendation mainly addresses the charcoal production methods. The methods of charcoal production are very inefficient and waste a lot of wood employed (Section 3.2). Higher charcoal yielding methods should be introduced to the charcoaters. This problem has been noted by the National Energy Board which has began a programme to improve charcoal production methods in the country.

4. Increasing Agricultural Productivity.

The existing farming methods in the District are ill suited to the physical environmental conditions obtainable in the District, as they tend to be extensive and unnecessarily exposes too much land to deforestation and soil erosion. Agricultural productivity per hectarage should be increased by adopting better farming practices such as crop rotation, establishment of windbreaks, encouraging mixed farming and use of organic types of fertilisers. Increasing productivity in the District would reduce the pace of agricultural encroachment on forest rangeland.

5. Control of Bushfires.

Bush fires, resulting from the inappropriate farming methods and other causes, annually destroy large tracts of forest. The control of bush fires through the establishment of community fire fighting squads needs immediate attention. Political organs at local level such as the CDRs (Committee for the Defence of the Revolution) should be made responsible for mobilising and organising people to join these squads. These squads can be able to protect the environs of their individual settlements.

6. Family Planning.

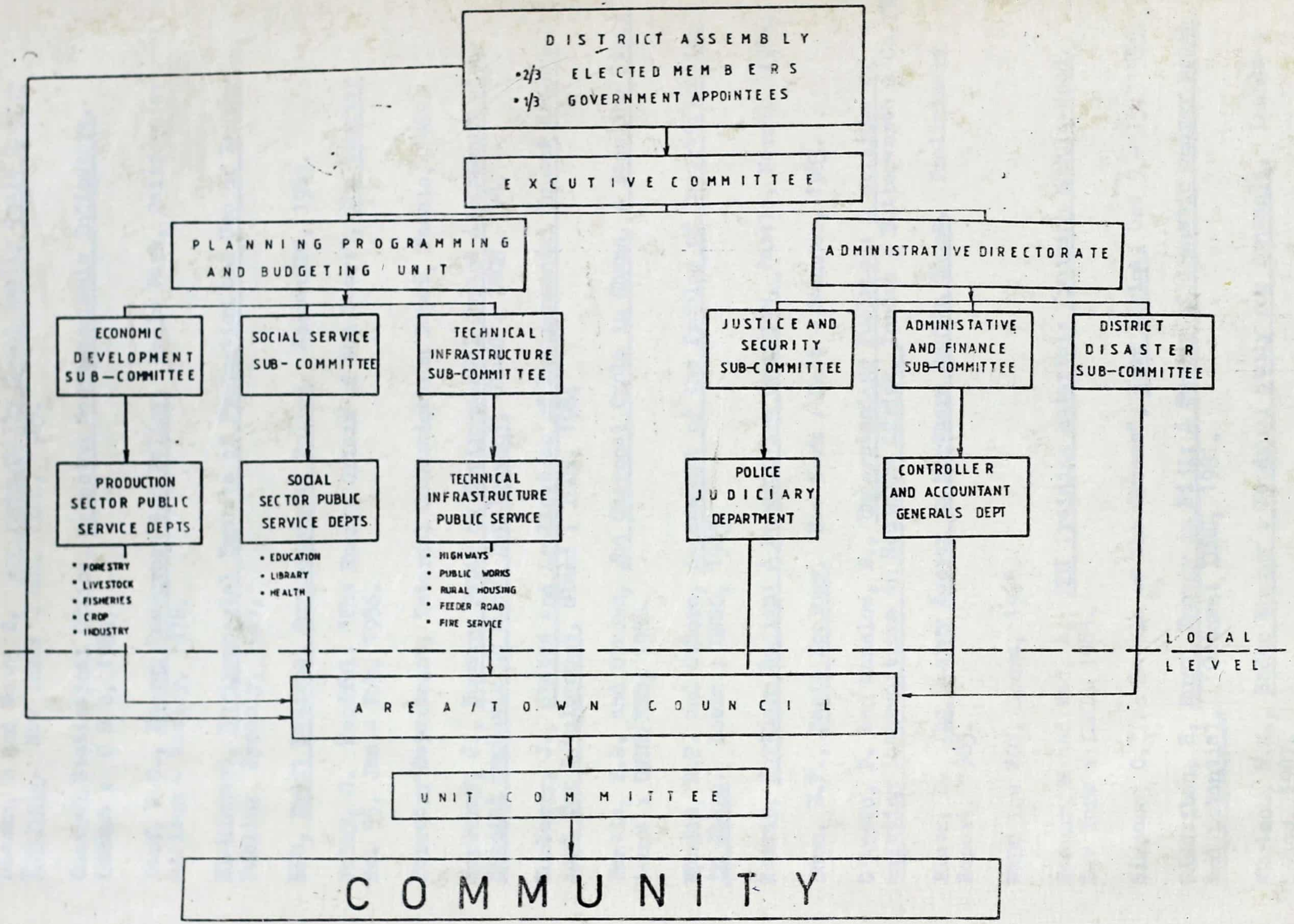
It has been noted that the high population growth rate of the District requires an over-increasing amounts of fuel resources from the forests and the conversion of land from forestry to agriculture and other uses. A reduction of the population growth rate will slow down the growth in energy demand and competing land uses. The Ministry of Health and the Planned Parenthood Association of Ghana, by undertaking educational campaigns in the District on the importance and methods of family planning, would play an important role. The Ministry of Health and the Planned Parenthood Association of Ghana supported by Assembly and Area Council members should organise educational campaigns on the importance and methods of family planning. The meetings can be held at the hospital, health centres and health posts throughout the District.

7. Environmental Education.

The success of these recommendations depends on active community involvement. Community involvement in turn depends on awareness on the part of the community regarding energy and environmental conservation issues. Environmental awareness at District level should therefore be seriously promoted. The responsible institutions, which include the Forestry Department, the Department of Agricultural Extension, the Environmental Protection Council and the National Energy Board should coordinate their activities and make use of the existing political structure at district and local level (District Assembly, Town and Area Councils) both as channels of information and to ensure community participation.

In conclusion, it can be said that in the foreseable future, the three fuels presently in common use in the District, namely kerosene, firewood and charcoal will continue to be a very important in catering for the energy requirements of the District. A sustained, easily accessible and cheap supply of fuel wood for District however, requires deliberate steps to be taken in the areas of energy conservation, forest and land resource management which should be the responsibility of both the community and the responsible institutions. Augmentation of fuel resources by establishing fuel woodlots around settlement areas and conservation of energy will go a long way in ensuring easy access to a cheap source of fuel.

APPENDIX 1: DISTRICT ADMINISTRATIVE MACHINERY



SOURCE P.N.D.C. LAW 207 1988

LIBRARY
UNIV. OF SCIENCE & TECH.
KUMASI - GHANA

B I B L I O G R A P H Y

Bassan, E and Wood, T. Environmentally Sound Smally Scale Energy Projects. New York: CODEL. VITA, 1985.

Contral Statistical Office, Selected Socio-economic Indicators. Lusaka : C S O, 1984.

Dorf, R.C., Energy Resources and Policy. Menlo Park, California: Addison - Wesley, 1978.

El-Hinnawi, Environmental Impacts of Production and Use of Energy. Dublin: Tycooly, 1981,

EPC, Draft National Environmental Policy. Accra:EPC, 1989.

Foley, G. Woodful: "The Energy Crisis of the Poor:", The Courier No. 95, Jan - Feb. 1986.

Forestry Department, Internal Communication Paper, Tamale, 1989.

Horberry, J., Summary Paper on Environmental Impact Assessment with Special Emphasis on Rural Development, Gland : IUCN, 1984

Horberry, J., Status and Application of Environmental Impact Assessment for Development, Gland : IUCN, 1984

Kontia, K.S. and Others, The Charcoal Cycle in Ghana, A Baseline Study Accra : UNDP/NEB, 1988.

Mendez, R.P. and Others, Assessment of the Problem of Desertification in Ghana. Accra : UNSO, 1985.

Norrip, Northern Region: A Descriptive Overview, Tamale, Norrip, 1983.

Odum, E.P., Basic Ecology. New York : Holt - Saunder, 1983.

O'koefo, P. and Munslow, B., Understanding Fuelwood: A critique of existing interventions in Southern Africa, London : Butterworth & Co,1989

Pluth, D. The Energy Sector in Northern Region Ghana. Preliminary Report, 1985.

PNDC Law 207, Accra, 1988.

Raduor, M and Wad, A, EDI Training Material: Training Module-Wood. New York : IBRD, 1985.

Simpson, C,"The Battle of the Greens", West Africa, Oct 9 - 15, 1989.

Siwatibau, S, Rural Energy in Fiji: A Survey of domestic energy usage and potential. Ottawa: IDRC, 1981.

Skutsch, M.M., Sadcc Energy : Woodfuel Study for Tanzania. Luanda : Sadcc, 1987.

Statistical Board Services, National Census Reports - Accra: SBS, 1960, 1970 and 1984.

SPRING II Participants, West Gonja District Study", (Workshop Proliminary Report), Kumasi, U.S.T., 1990

Waino, C, "The Woodfuel Challenge: looking to the future". , The Courier, No. 95, Jan - Feb. 1986.

Woroko-Brobby, C, Energy Research in Ghana: Review and Future Directions. Accra : CWED, 1988.