

**RURAL ENERGY RESOURCES UTILIZATION
AND DISTRICT DEVELOPMENT:
A CASE STUDY OF NKORANZA DISTRICT**

A Thesis submitted to the Board of Post-Graduate Studies,
University of Science and Technology, Kumasi,
in Partial fulfillment of the requirements for the
degree of Master of Science in
Development Planning and Management

**LIBRARY
UNIVERSITY OF SCIENCE AND TECHNOLOGY**

By

Kingsley H. Hugo-Krieger

July, 1994

Supervisors:

Dr. Kwasi Nsiah-Gyabaah

Mr. E. A. Turkson

Signature: Kwasi Nsiah-Gyabaah

Signature: E. A. Turkson

Signature: E. K. A. Tamakloe

Name: Prof. E.K.A. Tamakloe
HEAD, DEPARTMENT OF PLANNING

VITA

Kingsley was born on 29th January, 1957 at Keta, Volta Region, Ghana. He received his elementary education at the A.M.E. Zion Mission School, Keta, from where he proceeded to Zion Secondary School and finishing at Labone Secondary School, Accra. From there he gained admission to the University of Ghana, Legon in 1979. He graduated in 1981 with a Bachelor's Degree in Sociology.

From late 1981 to mid 1987, he served as a tutor at Tema Secondary School. In February 1990 he became the Development Planning Officer, Asuogyaman District Assembly, Akosombo.

In September, 1992, he gained admission to the University of Dortmund, Germany for the first phase of the SPRING Programme. He obtained a Postgraduate Diploma in Regional Development Planning and Management in July 1993 which fulfilled the requirement for the second phase of the Programme at the University of Science and Technology, Kumasi, the same year. This thesis was presented in partial fulfillment of the requirements for the degree of Master of Science in Development Planning and Management.

LIBRARY
UNIVERSITY OF SCIENCE AND TECHNOLOGY

ACKNOWLEDGEMENTS

Many personalities have contributed in diverse ways towards the writing of this Thesis, to all of them I am greatly indebted. The contributions of a few, however, cannot go without mention.

The efforts of my supervisors, Dr. Kwasi Nsiah-Gyabaah and Mr. E. A. Turkson, in patiently and carefully guiding me through the stages of its preparation are very much appreciated. To them, I render my profound gratitude.

I am also grateful to all the members of staff, Department of Planning, U.S.T.

I thank all my colleagues, SPRING II 1993/94 participants without whose encouragement and support I would hardly have managed to complete my studies.

I appreciate the efforts of Ms. Anita Boateng who sacrificed her private time on most occasions to type this Thesis. To her, I render an unqualified gratitude.

I thank the German Academic Exchange Service (DAAD) for sponsoring my studies.

Above all, however, I am indeed grateful to the Almighty Lord whose guidance and protection led me to bring this Thesis to this form. To Him be the Glory.

LIBRARY
UNIVERSITY OF SCIENCE AND TECHNOLOGY

ABSTRACT

Energy plays a vital role in the domestic and economic activity of man. Energy, in any form, influences the pattern of development in every society. For the energy sector to contribute its quota and enhance development, it is important that information is gathered on energy sources, levels of consumption, the types of fuels commonly used for domestic and non-domestic activities and the various end-use devices commonly used. The recognition of the need to gather such information to direct development of a sound energy base to promote overall development in Nkoranza District influenced the present study.

This study through a sample survey of 40 households in 4 settlements and 10 small-scale enterprises highlights the high dependence of the district on biomass fuel, notably firewood and charcoal to satisfy both domestic and industrial needs. Kerosene is found to be the major source of fuel for lighting, using hurricane lamps.

The local brazier (coalpot) and the 3-stone fireplace were the common end-use devices used for cooking and brewing. Levels of consumption, it was observed from the survey, vary with household size - smaller households consume higher amounts of the three basic fuel types especially firewood and kerosene.

LIBRARY
UNIVERSITY OF SCIENCE AND TECHNOLOGY

TABLE OF CONTENTS

	<u>Page</u>
Vita	ii
Acknowledgements	iii
Abstract	iv
List of Tables	ix
List of Figures	x
List of Maps	
CHAPTER ONE: INTRODUCTION	
1.1 General Introduction	1
1.2 The Problem	4
1.3 Objectives of the Study	5
1.4.1 Research Approach and Methodology	6
1.4.2 Design and Administration of Interview Schedule	8
1.4.3 Analytical Techniques	10
1.5 Scope and Limitation of the Study	12
1.6 Organization of the Thesis	12
CHAPTER TWO: THEORETICAL FRAMEWORK	
2.0 Introduction	14
2.1 The Laws of Thermodynamics	14
2.2 Ecosystems and Energy Flows	19
2.3 Energy and Development	24
CHAPTER THREE: NKORANZA DISTRICT PROFILE	
3.1 Location and Size	34

	<u>Page</u>
3.2 Relief and Drainage	34
3.3 Soils and Vegetation	35
3.4 Demographic Characteristics	36
3.5 Economic Activities	38
CHAPTER FOUR: ENERGY USE IN NKORANZA DISTRICT	
4.0 Introduction	40
4.1 Fuel Preferences	40
4.2 Fuel Consumption Levels	44
4.2.1 Firewood Consumption	44
4.2.2 Charcoal Consumption	45
4.2.3 Kerosene Consumption	46
4.2.4 Non-Domestic Fuel Consumption	47
4.2.5 Total Fuel Consumption	47
4.3 Efficiency of Energy Use	48
CHAPTER FIVE: PLANNING RURAL ENERGY FOR DEVELOPMENT	
5.0 Introduction	52
5.1 Development Issues Relating to the Sector	52
CHAPTER SIX: SUMMARY AND CONCLUSIONS	
6.1 Summary	57
6.2 Conclusions	60
APPENDICES	
Appendix I - Scalogram of Nkoranza District	63
Appendix II - Interview Schedule	64
BIBLIOGRAPHY	69

LIST OF TABLES

Table 1	-	Selected Settlements and Sample Distribution	1
2	-	Efficiency of Common End-Use Devices	1
3	-	Fuelwood Productivity of Natural Vegetation in the Tropics	2
4	-	Structure of Rural Energy Needs in West Africa	2
5	-	Crude Densities of Brong Ahafo Region and Nkoranza District From 1960 - 1994	3
6	-	Distribution of Sample Population Aged 15 Years and Above by Major and Minor Occupations	39
7	-	Fuel Use for Domestic Activities	41
8	-	Responsibility for Firewood Collection	43
9	-	Type of Firewood Used	43
10	-	Firewood consumption Levels in Relation to Household Size	46
11	-	Charcoal Consumption Levels	46
12	-	Kerosene Consumption Levels	46
13	-	Total Fuel Consumption in Nkoranza District	48

LIBRARY

UNIVERSITY OF SCIENCE AND TECHNOLOGY

LIST OF FIGURES

Figure 1.1	-	Energy Changes Through an Ecosystem	21b
2.2	-	Cycle of Destruction in Forest Lands Due to Fuel Shortage	21c

LIST OF MAPS

1.1	-	Nkoranza District in National and Regional Context	34b
2.2	-	Hierarchy of Settlements Based on Population	34c

CHAPTER ONE

INTRODUCTION

1.1 General Introduction

Energy is a basic input in every society. It provides heat for cooking and manufacturing, or power for transport and mechanical activity. Energy is, therefore, important for human survival and has a significant bearing on every society's development.

The energy crisis of 1973 urged nations - particularly the non-oil producing third world countries - to reassess their energy requirements and search for alternative sources of energy. This search was given further impetus by the realization that for the vast majority in developing countries dependence on fuelwood for heating and cooking would continue for many years to come. Studies have shown that deforestation and destruction of the vegetative cover in recent decades to feed growing population could have devastating social, environmental, and economic consequences. It has been further observed that if tropical forests continue to shrink at their present rate, by the year 2000 the area covered by them would have decreased by 12 per cent (12%) and most of this decrease will be in the developing countries¹.

The aftermath of the energy crises was the proliferation

¹ John S. Spears, "Can the Wet Tropical Forest Survive?" Commonwealth Forestry Review, Vol. 58, No. 3 (1979).

of various institutions to deal with energy planning in many countries. In several cases, however, these bodies were more concerned with fossil fuel and electricity, which basically serve the energy needs of urban areas, to the neglect of renewable energy sources on which most rural dwellers and the urban poor, who form the bulk of the world's population, depend. In recent years, however, many countries and non-governmental organizations have tended to focus attention on alternative (often locally obtainable) sources of energy. Researches into these alternatives have become issues of prime concern in many developing countries.

A survey initiated by the World Bank, conducted among some African countries, revealed that in rural areas especially, costs associated with the distribution of commercial fuels - notably kerosene and Liquefied Petroleum Gas (LPG) - are very high, given the distances covered and poor accessibility. Furthermore, efforts aimed at making a transition from reliance on biomass to these fuels are most often hampered by poor infrastructure, dispersed settlements and poor delivery services in these areas. Anderson and Fishwick² observed that the (private) cost differences between fuelwood and its commercial alternatives continue to favour the consumption of fuelwood or, once this runs out, crop residues and animal dung.

In recent times, analysis of these constraints have led to considerations being given to the development and use of

² Anderson, D. & Fishwick, R.: Fuelwood Consumption and Deforestation in African Countries. World Bank Staff Working Paper, No. 704 (Washington, 1984)

biogas, especially within rural communities. However, the main problem encountered in popularizing biogas among the low-income rural poor will be the high capital outlay involved in setting up a digester despite the low marginal cost of the fuel and fertilizer which are produced, since the major problems facing biogas development are not purely technical, but involve social and economic factors³ as well.

Wood is especially important as a source of energy in rural areas. Fuelwood has been considered a free commodity, supplied by nature. However, as its sources move further away, it becomes harder to find. It consumes more time and money, and becomes "a commercial asset". More people get involved in supplying and marketing it. Rural people are thus reduced to cutting whatever wood is available on community lands, either to use it themselves or to sell it.

The World Bank estimates that:

"across the third world, daily woodfuel consumption is equal to 21 million barrels of oil, or the equivalent of the total pumped by OPEC countries daily".⁴

At this alarming rate, the fear of an environmental disaster has been heightened in many countries.

In Ghana, the most important source of energy in rural communities is biomass. Most of the energy needs of the majority of people in these communities are still being met by the use of, and reliance on, traditional fuels, notably

³ Commonwealth Science Council: Biogas Systems for Rural Development, Report of the Training Workshop on Monitoring and Evaluation of Biogas Systems. Commonwealth Secretariat, 1983.

⁴ The Urban Edge: Fuelwood - A Burning Issue in the Third World. Vol.14, May, 1990.

firewood and charcoal. These are the primary energy sources for the majority in rural households and those engaged in small-scale industrial operations.

Available information on the energy situation in Ghana indicates that:

"a breakdown 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."⁵

Notwithstanding the importance of biomass fuel, data on its supply and consumption patterns in the district remain very sketchy. In fact, available figures are usually based on national averages and projections which are hardly adequate in addressing issues of regional importance.

1.2 The Problem

In most developing countries, it is imperative that, for a reliable and sustainable source of energy supply to be maintained, a good data base is a sine qua non. Moreover, since energy and development have both complementary and competing interactions, it is important to examine their relationship in the socio-economic development process. With this in mind, this case study was conducted into various aspects of rural energy resource utilization and consumption levels, alongside considering impacts of these on the overall development process of rural regions.

⁵ C. Wereko-Brobby: Energy Research in Ghana: Review of Future Directions, (Accra: (EED), 1988).

The energy sector in Nkoranza district is virtually dominated by the exploitation of wood-based energy resources. In most rural communities, levels of production and forest generation are to a large extent unknown. This is even more acute with regard to energy consumption levels in households and small-scale industries. Information on rural energy resources and their levels of utilization is vital for planning the energy sector as part of the overall development process in the district. Moreover, it is also of much importance to know the sustainability of present rural energy bases, viewed against future energy requirements and expected supply levels. With this done, the rural energy sector would then be well integrated into the development processes going on in the district.

Furthermore, since methods of energy utilization differ according to spatial differences, levels of development and social status, it is important to identify different target groups and their peculiar energy problems if we are to make any meaningful proposals that could help arrest the alarming rate of depletion of tree stocks currently being experienced in most rural regions of the developing world.

1.3 Objectives of the Study

The study aims at satisfying the following objectives:

- (i) to identify the major rural energy sources in the district;
- (ii) to determine the extent of the district's reliance on each energy source;

- (iii) to examine the types of end use devices used by households and small-scale enterprises;
- (iv) to determine the current and future implications of overdependence on wood-based energy sources;
- (v) to find out what the results of the pressure exerted on wood-based energy sources are; and
- (vi) make recommendations which when implemented, would ensure the development of sustainable rural energy resource bases in the Nkoranza District.

Justification for the above objectives lies in the fact that for as long as wood remains the primary energy source for the majority in rural households and small-scale enterprises, efficiency in its utilization might be one appropriate way of supporting development interventions recommended for these communities.

1.4.1 Research Methodology

Nkoranza District formed the study area of the 1993/94 SPRING II Participants (of which I was a member) for a Development Workshop Report. The group made several visits to the district for reconnaissance, baseline surveys and community/technical interaction activities. Personal observations made during these visits were instrumental in developing my research interest.

Primary data was obtained from a household survey of energy types and aspects of utilization in selected settlements. This was to supplement earlier findings made by

the SPRING group in the survey of energy use in small-scale industries in 32 sampled settlements of the district and constituted the basis for this study.

Moreover, the review of relevant literature obtained from specialized research institutions like the Forest Products Research Institute and the Institute of Renewable Natural Resources (IRNR) at the UST, and a previous study on the energy sector in the Northern Region of Ghana,⁶ provided basic guiding information from which the study emanates.

Furthermore, discussions were held with various heads of decentralized departments and small-scale industrialists whose activities impinge on the energy sector in the district.

Special studies conducted by former undergraduates and SPRING participants were also sources of valuable secondary data. Data on the direct dependence of the people on the forest as a primary source of energy, kinds of trees used for fuel, preferred charcoal-burning tree species, cooking patterns and energy end-use devices, were also obtained from the field and analyzed. Other uses of forest products and signs of environmental degradation and deforestation were all studied during field visits to the district from December, 1993 to May, 1994, when the study period ended with a detailed survey of energy use in households and small-scale enterprises in selected settlements of the district.

⁶ D. Pluth, The Energy Sector in Northern Region, Ghana Preliminary Report, 1985).

1.4.2 Design and Administration of Interview Schedule

(a) Questionnaire Design

Questions in the Interview Schedule were framed under four main areas:

1. Respondents' Background.
2. Energy-oriented Activities
3. Energy End-use Devices, and
4. Respondents' General Opinion on energy-related developmental issues.

(b) Determination of Sample size

In arriving at the sample size, the household was considered the primary unit of socio-economic activity and since the responsibility of women in the household is basically more of cooking, one woman in each of the forty households covered in the survey was selected for interview. As much as possible efforts were made to interview only married women in the randomly selected households.

The forty households interviewed were further complemented by ten randomly selected small-scale enterprises in Nkoranza which depend on energy.

The total sample size of fifty was considered the maximum which could effectively be handled, given the time constraints, to provide the detailed information required, since data had already been compiled on household energy consumption pattern in the district by the SPRING 1993/1994 participants. From this earlier survey, it was further

estimated that over ninety per cent and twenty-five per cent of households in the district depend on firewood and charcoal respectively for heating.⁷ The homogenous nature of the district is further emphasized by the fact that ninety-five per cent of her economically active labour force is engaged in agriculture.

A further justification why the sample size was kept within manageable limit lies in the fact that information was also obtained from personnel of institutions related to the energy sector in the district. Information was sought from the Forestry Department and the Leaf Development Company, among other institutions, as a means of corroborating data obtained from the earlier household survey carried out by the team. Thus, it was deemed imperative that for detailed information to be obtained on wood-based energy resources utilization to give results which could be applied to the whole district the sample size be kept within manageable limit.

(c) Selection of Settlements

Based upon the 1984 Population Census, five settlements from different population cohorts were selected for interview.

The settlements selected for the survey are shown in Table 1 below.

⁷ SPRING 1993/1994, Nkoranza District Development Workshop report, U.S.T., Kumasi, July, 1994.

Table 1: Selected Settlements and Sample Distribution

Level	Cohort	Name of Settlement	Popn. 1984	No. of Households	Vegetation and land-use feature
1.	>15,000	Nkoranza	15,001	10	Areas of Forest Regrowth and food farms
2.	3,000-15,000	a. Nkwabeng	3,994	8	Areas of open-tree savanna and food farms
		b. Busunya	3,168	8	Areas of food and teak farming
3.	2,000-2,999	Dromankese	2,736	8	Savanna woodlands
4.	<2000	Yefri	1,534	6	Food and teak farms
Total	-	5	26,433	40	

(d) Questionnaire Administration

Five National Service Personnel on assignment in the district, were engaged to conduct the interviews in the selected settlements. The interviews were held from the 27th of April to the 4th of May, 1994.

1.4.3 Analytical Techniques

Each of the settlements surveyed has particular vegetative and land-use features which influence wood-based energy resource procurement and utilization. However, in order to obtain an overview of the whole district, data from the various settlements were analyzed together.

In order to measure firewood consumption in the district, the "Headload" was used as the unit of measurement in which firewood pieces were bundled after collection for sale. This unit has a

lot of limitations, as the size (encompassing volume and weight dimensions) of a "headload" differs according to the age and physical strength of the carrier and the distance over which the bundle is to be carried. However, despite this limitation, the "headload" was considered the most convenient and appropriate unit of measurement, since most people in the district either gather or buy firewood pieces in "headloads". A "headload" of firewood in the district was found to weigh on average between 20 to 25kg.⁸

Charcoal was measured and collected into standardized bags with average weight assumed to be equivalent to the average weight of a bag of charcoal in Northern Ghana, which is 45kg⁹. Thus, for each kilogram of charcoal produced, approximately 4kg of wood is cut for burning.

Kerosene is bought from table-top retailers in 0.65 or 32.5 litre-sized bottles. Since most households bought it in either of these two units of measurement, this was used as the unit of measurement in the survey. Results obtained were then converted into litres during the analysis of data stage.

The energy input of an average person in agriculture in the district was considered as 0.8×10^9 joules/ha.¹⁰ Analysis of efficiency of energy utilization in the district was based on the efficiency of the various end-use devices commonly used in households. This analysis is dealt with in

⁸ Author's Field Survey using a weighing scale.

⁹ D. Pluth, The Energy Sector in Northern Region, Ghana.

¹⁰ FAO: State of Food and Agriculture, 1976. Agricultural Series No.4 (Rome, 1977).

detail in Chapter 4.

1.5 Scope and Limitations of the Study

The study focussed on the energy situation in Nkoranza District. To a large extent, however, the findings could be applied to other areas in the region, which have similar bio-physical and socio-economic features.

Household energy consumption formed the major basis of the survey. This was studied alongside other socio-economic activities which impinge on energy. The implications of these variables in the development of the district were also analyzed. Resource constraints, especially the brief period available for data collection and analysis, together with the organization and write-up of the thesis document, have had some impacts on the survey, notably limiting the sample and settlement sizes to manageable levels. Perhaps, more desirable in a study of this kind would have been the collection of data over a longer period.

1.6 Organization of the Thesis

The underlying theoretical framework within which the survey was conducted is presented in Chapter 2.

Chapter Three introduces the study district by way of describing its bio-physical, demographic and socio-economic features. Analysis of data and discussion of findings are dealt with in Chapter Four. In Chapter Five, development issues relating to the energy sector in the district, institutions implementing national policies on energy issues

and recommended solutions and suggestions for ensuring a sustainable rural-energy resource base are discussed with the view of planning energy to enhance development in the district.

A summary of conclusions and recommendations drawn from the survey are set out in Chapter Six.

CHAPTER TWO

THEORETICAL FRAMEWORK

SECTION ONE

2.0 INTRODUCTION

This chapter discusses the theoretical framework within which the survey is conducted. Discussed under the first section of the chapter are the fundamental laws underlying the behaviour of energy. The various applications to which these laws are subjected are also discussed. Furthermore, ecosystems and the role energy plays within these systems are reviewed in its concluding part.

The relationship between energy and development issues are discussed in the second section of the chapter. In its concluding parts, various development theories that relate to energy and its role in rural systems are also discussed. Basically, wood fuels, notable among which are firewood and charcoal are the predominant rural energy types.

2.1 The Laws of Thermodynamics

Energy is defined as the ability to do work. In the main, two laws describe the fundamental behaviour of energy. These are the first and second laws of thermodynamics. According to the first law of thermodynamics:

"energy may be converted from one form to another, (solar energy to chemical energy in green plants; chemical energy to heat energy by herbivores etc.), but is neither destroyed nor created."²

Thus, the first law recognizes that energy exists in various forms, many of which are not able to be reached or used by man, and therefore must be transformed into useful forms. However, during this process of conversion or transformation, energy is in its totality conserved; with the total quantity of energy involved in the transformation process being the same.

Unlike the first law, the second law, however, deals with the non-conservational nature of energy. It states that,

"every process involving energy transformation is accompanied by a degradation of energy from a concentrated form into a dispersed form."³

Thus, while the first law deals with the conservational nature of energy, the second law deals with it essentially in its non-preservational form, as for instance, when a hot object will tend to gradually lose heat and finally get cold as heat is dispersed from it on exposure to low temperature. The second law has been at the fore of many studies and trials of many cookstoves in efforts to forestall imminent shortages.

The seeming contradiction between the two laws must well be perceived, since the first law states that there is no energy loss (or gain) in the process of transformation from

² Odum, E.P. Basic Ecology, 1983.

³ Odum, E.P. Basic Ecology, pg. 86.

one form to another while the second indicates that the process of transformation is not 100 per cent efficient because some amount of energy may be retained in its original form, others converted into different forms other than is expected, and the rest into the form that is expected. When, in the final analysis, all these energy forms available during the process of conversion are added together, the total amount of energy would be the same. For instance, the conversion of solar energy (sunlight) to useful energy in stored carbohydrates is never 100 per cent efficient because some amount of energy is always lost as unavailable heat energy and excretory products in a more dispersed form. In general terms, the second law of thermodynamics points out the concept of optimization of energy usage. Implications of this concept are that there are better and worse ways of using energy. Thus, in any energy transformation process, energy degradation can be measured in terms of the efficiency of energy usage.

Furthermore, as will be discussed in the next chapter, some devices, that is, end-use or conversion devices, are more co-efficient at energy usage or conversion respectively than others. Thus, in terms of practical energy usage, the second law of thermodynamics plays an increasingly vital role in the analysis of new energy transformation processes and devices, and in the improvement of old ones. Various conversion technologies have been developed with various end-use or conversion devices in use in efforts to optimize energy conversion. In line with this, we describe the efficiency of a conversion technology, system or device as the proportion

of energy converted from one form to another as against that which is lost in the process. It is important to keep in mind that the ratio of loss is always less than 1 as no perfectly efficient system, device or technology has as yet been developed.

In traditional rural societies, direct combustion of biomass fuels provides energy for use in most household and industrial operations. Thus, the efficiency of common end-use devices in these and other societies has for long been a subject of study in many countries. A survey in Indonesia, conducted in 1981, found that:

"on the usual type of firewood stove, 94 per cent of the heat value of wood is wasted. Simple improvements to the stove cut this loss by about 20 per cent."

El-Hinnawi⁵ further mentions that:

"cooking on an open, slow burning fire requires about five times as much energy as cooking on a kerosene stove."

Furthermore, the efficiencies of various end-use devices in developing countries have been compared in different studies conducted by Wood and Baldwin. Results of these studies, summarized in Table 2 below, indicates the vast amounts of energy lost by the use of various end-use devices with the 3-stone open fire being the worst in terms of efficiency.

⁴ El-Hinnawi, E.E. "The Environmental Impact of Production and Use of Energy." (UNEP, 1981) pg. 278.

⁵ El-Hinnawi, E.E. (U.N.E.P., 1981) pg. 278.

Table 2 - Efficiency of Common End-Use Devices

Device Used	Fuel Used	Efficiency Percent	Heat/Calorific Value of Fuel mJ/kg
3-stone Fireplace	Firewood	5 - 10	18
Improved mud/brick stove	Firewood	20	18
Local Brazier	Charcoal	15	30
Improved Stove	Charcoal	22	30
Wick Stove	Kerosene	37	42
Pressure Stove	Kerosene	50	42

Source: Wood, Baldwin, 1985.

The traditional earth-mound used in producing charcoal fritters away vast quantities of wood. By the burning process, wood is transformed into charcoal. The process of conversion or transformation of the original material - wood - into the charcoal depicts the non-conservational nature of energy, since in the process energy is lost out as unavailable heat energy in a more dispersed form.

In recent times, the idea that has won most attention has been the introduction of wood-burning stoves, and inculcating in people changes and methods of cooking in ways that would achieve improvements and ensure efficiency in their energy usage in terms of what is accomplished as compared to what it costs. Indeed, popularising the use of high energy efficient domestic appliances like the Pressure and Wick Stoves using kerosene, or even the improved mud/brick stove using firewood, would mean less energy costs to be borne by the people and an

alleviation of the level of deforestation.⁶

19

2.2 Ecosystems and Energy Flows

The basic functional unit considered in the scientific study of living things in relation to each other and to their environment is the ecosystem. This is any unit that included 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.⁷ Inherent in this definition is the fact that an ecosystem is made up of two parts - the biotic and abiotic or non-living communities. The interaction between these two parts and the influence each has on the properties of the other are necessary for the maintenance of life. Ecosystems can range in size from large tropical forests or oceans to as small as a pond of water.

In general, there are three basic components and processes that make an ecosystem function. These basic components and processes involve the interaction of:

1. the biological community or organisms;
2. the cycling of materials including basic nutrients such as carbon, nitrogen and phosphorus; and

⁶ World Bank: "Fuelwood - A Burning Issue in the Third World. Vol.14, No. 4; (The World Bank, May, 1990) pg.4.

⁷ Odum, E.P. Basic Ecology, 1983

3. the flow of energy through the system.

Components of the ecosystem are continuously recycled between the living and the non-living parts. The efficiency of this process, and the magnitude of materials brought into and out of the ecosystem vary widely with the type of ecosystem.⁸ Thus, ecological processes in the warm and wet tropics tend to occur at a faster rate than in other areas. Each ecosystem is said to have a unique structure characterized by its species composition, its biomass - the total weight of its constituent organisms - and the special organization of its abiotic components. In this way, an ecosystem structure refers not only to the physiognomy of the system, but also to the way that nutrients and energy flow through it.

Energy flow in the ecosystem has a direct impact on the populations of the various organisms in an environment - producer plants, herbivores and the various carnivores are all limited and controlled by the flow of energy in the ecosystem. By this role, they form the basis for the functioning of the ecosystem. The various organisms in the ecosystem are specialized in various ways and perform functions delicately balanced and intricately vital to maintain the flow of energy.

The ultimate source of energy for almost all activity carried on in the ecosystem is the sun. The amount of solar energy that reaches the outer surface of the earth's atmosphere is relatively constant at about 2 calories per

⁸ Odum, E.P., Basic Ecology, 1983

square centimeter per minute ($2\text{cal}/\text{cm}^2/\text{min}$),⁹ but not all of this energy reaches the ground. In the process, thirty percent of this amount is lost and does not reach the earth's surface. Due to reflection, absorption by land or water, re-radiation, only a very small portion of the sun's energy is available to sustain life, the essence of which is "the progression of such changes as growth, self-duplication and synthesis of complex relationships of matter."¹⁰

Figure 1 illustrates the sequence of energy change through an ecosystem. The figure shows that, in a herbivores food chain, the decline in energy level is from about 1 million kcal/m^2 sun input down to only 100 kcal/m^2 available at the predator level. However, the concentration of energy in a given mass of predators is 100 times more than in a similar mass of herbivores. The same principle is at work in the process of fossilization up to the production of electricity. Indeed, fossil fuel has a work potential 200 times higher than energy in autotrophs, and electricity about 8 times higher than fossil fuels¹¹.

Ecosystems, like the organisms that are members of them, change with time; they originate, develop and mature (and sometimes decline and disappear). Ecological succession, as this change is called, is the result of the dynamic interaction that takes place between the biotic and abiotic

⁹ Ziegler, C.: Fundamentals of Ecology, SPRING, Universitaet Dortmund, Nov., 1992

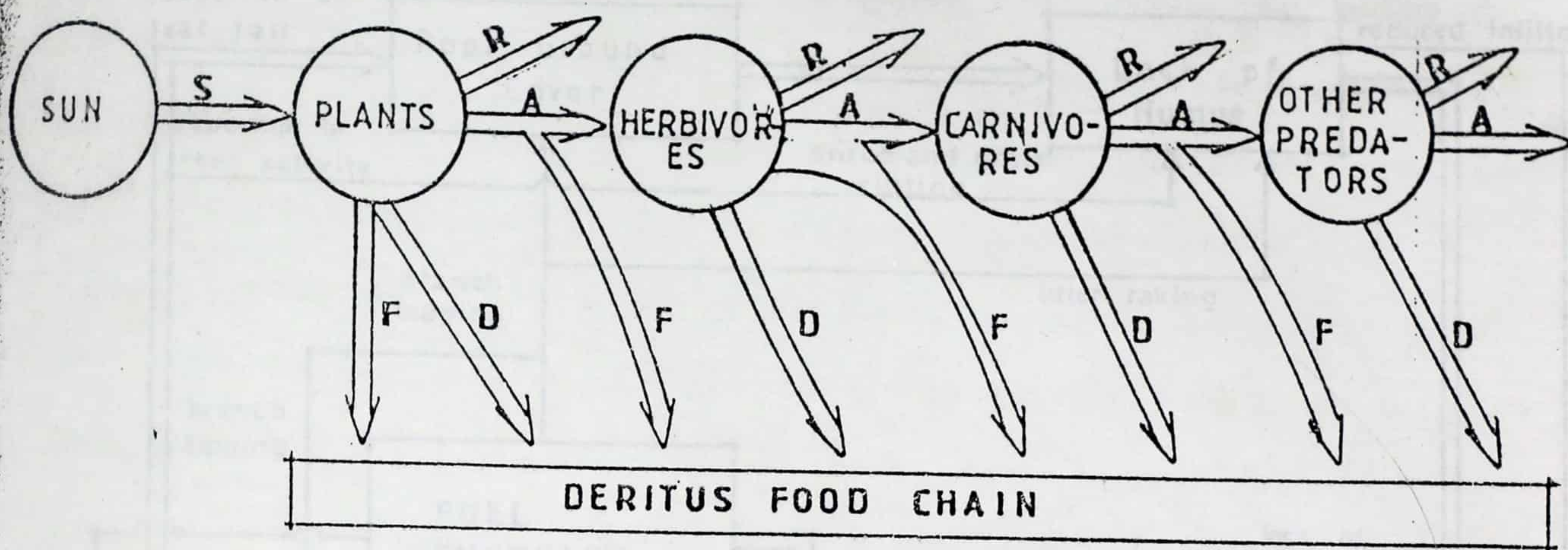
¹⁰ Odum, E.P. Basic Ecology, 1983

¹¹ Odum, E.P.: Basic Ecology, New York; Holt-Saunders, (1983) pg.86

FIGURE 1 - ENERGY CHANGES THROUGH AN ECOSYSTEM

Decreasing
Quantity

$1 \times 10^6 \longrightarrow 1 \times 10^4 \longrightarrow 1 \times 10^3 \longrightarrow 1 \times 10^2$



Increasing
Quantity

$10 \longrightarrow 1 \times 10^2 \longrightarrow 1 \times 10^3 \longrightarrow 1 \times 10^4$

S — Solar energy entering the system

A — Energy available for the next trophic level

D — Energy lost through death and decomposition

F — Energy lost in the form of faeces and other waste product

R — Energy lost through respiration

Sources : Adaptation of Odum, Basic Ecology and Cox and Atkins, Agricultural Ecology



components of each community that develops. These interactions form a series of feedback mechanisms that drive the succession towards a steady state called a climax. Under climax conditions, primary production and accumulated biomass are at their highest. The removal of biomass from the ecosystem has, therefore a destabilizing effect on the ecology. Effects of this practice are more visible in rural communities where majority of dwellers depend mainly on plants, the autotrophs, in fulfilling their energy requirements and these, apart from being low in energy quality, also threaten the existence of organisms at the higher trophic levels.

The level of ecosystem stability and biomass production depends on the climatic and edaptive conditions. The total biomass of mature tropical forests ranges from 200 to 400 tonnes per hectare of dry matter in a proportion of 75 percent branches and trunks, 15 to 20 percent roots, 4 to 6 percent leaves and 1 to 2 percent litter.¹²

Findings from a study carried out by the Food and Agriculture Organisation (FAO) in 1983 give the average amount of fuelwood that is available for exploitation after the removal of industrial and agriculturally useful wood from various ecosystems. Results from their survey are outlined in Table 3 below.

¹² Ziegler, C.: Fundamentals of Ecology, Nov. 1992

Table 3 - Fuelwood Productivity of Natural Vegetation in the Tropics

Vegetation Type	Productivity (m ³ /ha/year)
1. Closed broad-leaved Forests	3
2. Formations with predominance of trees of coniferous species	2
3. Wooded Savanna	1
4. Savanna with trees	0.5
5. Shrub formations	0.1
6. Forest Fallow (after shifting cultivation and bush fallow)	1

Source: de Montalambert, M.R. and J. Clement: Fuelwood Suppliers in the developing countries. FAO, (Rome, 1983).

As could be observed in Table 3 above, different ecosystems have different productivity levels. This being the case, it is important that different cultural practices are maintained with each system in order to maintain balance within the system. However, everywhere in the developing world, "problems..... unrestrained settlement, erosion of mountain lands, the fuelwood crisis, desertification, and uncontrolled industrial exploitation of the forests"¹³ continue to threaten the environment. In mountain regions, deforestation has triggered serious erosion and flooding.

Tropical forests are the most varied ecosystems on the earth. They contain almost half of all the animal and vegetable life identified to date. About two billion people, most of them rural but some urban dwellers, depend on fuelwood as their main source of cooking and heating. Majority of these people can

¹³ FAO: Tropical Forest Plan of Action. Rome, 1985

meet their energy needs only by overworking the biomass available in their environment - lacking wood, they burn agricultural waste and even dried manure.¹⁴

For many people in the developing world, access to forests and trees is essential to daily survival: from this precious resource they obtain fuel, food, fodder, medicines, building materials and land for farming and grazing. Moreover, the growing shortage of fuelwood has been a disaster for the rural poor.

2.3 ENERGY AND DEVELOPMENT

Energy is a vital input in development. It comes in as an intermediate commodity essential for various domestic and economic activities. Energy, in various forms, is usually valued as an input necessary to initiate a process of production or utilization which results in a final product. Thus, energy in all its forms is generally valued as a critical input. In itself, energy has no intrinsic value; it is a means for attaining society's material goals - a means to an end. In the home, energy is essential for lighting, cooking, heating and drying. Outside the home, in the economic sphere, energy in its kinetic form is used to generate productive activities such as in agriculture and industry. Energy is, therefore, important in all activities which generate income and create employment opportunities for vast majority of people.

In today's world, economic growth and development is

¹⁴ WRI: Tropical Forests: A Call for Action. Washington, 1985

related in large part to the substitution of muscle energy for fossil energy and other types of fuels in the performance of agricultural and industrial tasks and services. Moreover, many of the inputs required in crop and livestock production are also produced through high energy application and consumption. Production and application of fertilizers, herbicides, insecticides, farm machinery and implements, among other agricultural products, are produced through high energy consumption activities, especially in terms of production and transportation.

According to Poostschi¹⁵ (1986), a kilogram of Urea (nitrogenous fertilizer) requires 2.3×10^3 KJ of energy to produce it. This aside, extra energy is required, as for instance, when a tractor, a combine harvester or a crop sprayer is used.

The sources of energy available to man are varied. They include petroleum, hydro-power, nuclear, solar, wind and wood fuels. In developing countries, however, traditional sources of energy include animal excrement, crop residues, firewood and charcoal. These are by far the most relied upon sources of energy. Agriculture is mostly dominated by muscle power, and domestic requirements are met by firewood and charcoal (which are by far, the most important). According to Bassan, traditional sources account for about 85 percent of total energy use in Africa, 65 percent in Asia, and 20 percent in Latin

¹⁵ Poostschi, I.: Rural Development and Developing Countries. Approach. An Inter-Disciplinary Introductory (Ontario, 1986) pg. 596.

America.¹⁶ It is, however, worth mentioning that regional and local differences characterize proportions of traditional energy sources relied upon even within a country. Combining the rural sectors of households, agricultural production and processing rural craftsmanship and transport, traditional energy sources can form up to 98 percent of all energy-use in many rural communities in developing countries.¹⁷

The degree of dependence of a society on traditional sources of energy, at any given point provides a "snapshot" of the mode and level of development. The higher the level of a society's economic development, the higher the proportion of commercial energy usage and per capita energy consumption. Measuring development on the basis of the Physical Quality of Life Index (PQLI), Zeitinge *et al* indicate that most African countries have an index of less than or around 40. (The PQLI is an index outlined by the Overseas Development Council, based on a weighted average of life expectancy, child mortality and illiteracy rate. Internationally, it is considered an important supplement to the GNP per capita, measuring the degree of satisfaction of a country's basic needs. The highest value on the theoretical scale is 100. Germany, for instance has a value of 96, Niger 14 and the average for developing countries is 56). Plotting the graph of the PQLI against per capita energy consumption, Zeitinge *et al* comment that most rural populations

¹⁶ Bassan, E. and Wood, T.: Environmentally Sound Small-Scale Energy Projects. (New York: CODEL, CITA, 1985) pg.1

¹⁷ Zeitinge, C.P. *et al*: "Utilization of Renewal Energy Resources: A Programme of Germany for the Third World." S.E.P. Programme (GATE, 1982) pg.33

are living near or below the subsistence minimum of between 8 to $11.7 \times 10^9 \text{ J}$ per annum.

Some authors hold the view that the setting of minimum energy requirements is quite questionable. Pryor¹⁸ is particularly critical of it. He comments:

"the crucial gap in our understanding lies in the question (what is the purpose of energy in development?) about energy policy. Do energy sources have intrinsic value in themselves, outside the context of development goals? It is questionable that Indian Peasants "need" a certain quantity of energy simply because Americans consume a certain multiple of that amount. The decision rests, not on some definition of basic minimum energy requirements, but rather on the type of life one wants that population to have. Particularly when such basic minimum "needs" as health and literacy are discussed, it is extremely misleading to imply that certain amount of energy consumption is required to achieve a certain level of service. Energy can only be a component of development, not a goal in itself."

Notwithstanding such comments however, Pryor, paradoxically, goes on to suggest the adoption of small-scale rural electrification and biogas projects to solve some of the developmental problems besetting rural communities; underlying the fact that there is general consensus on the fact of energy being a catalyst for development and that the more traditional source of energy used, the slower the rate of development.

Invariably, the most important sector in rural communities with respect to energy usage is the household, with its activities of cooking, water heating and lighting being the

¹⁸ Pryor, C.A.: "Environmental Impacts of Renewable Energy and Alternative Development Strategies in Energy and Environment in Developing Countries" ed. M. Chatterji (Wiley and Sons, 1986) p.126 - 127

final consumer of most energy in the house. The structure of rural energy needs in most West African countries is illustrated in Table 4 below:

Table 4 - Structure of Rural Energy Needs in West Africa

Household Consumption	87%
Local Artisans	4%
Small Engines	2%
Small Irrigation	1%
Lighting	2%
Private Transport	1%
Others	3%

Source: Zeitinge et al

In most cases, fuelwood is the only source of energy for both household and local artisans. Thus, discussion of rural energy, inevitably tends to zoom in on fuelwood. Wood is the fuel customarily preferred by rural people because its centralized method of production is suited to the scattered nature of rural habitation and usually makes it possible to obtain without added cost. It is a renewable source of energy which is integrated into the complex rural structure of relationship between resources and activities. Montalambert and Clement,¹⁹ outlining the main characteristics of fuelwood in rural energy systems, comment that:

1. fuelwood is preferred by rural people, who have little access to other forms of energy, because apart from its

¹⁹ Montalambert, M.R. & Clement, J.: "Fuel Supplies in Developing Countries," FAO (Rome, 1983)

renewable and decentralized nature, it can be gathered and used by simple techniques, without recourse to expensive equipment;

2. apart from the domestic uses of fuelwood, it also serves as the fuel for many rural industries like fish smoking, pottery and smithing which are interwoven into rural economies;
3. gathering and use of fuelwood is part of the subsistence economy system of rural communities, with its role casting. Women and children are usually responsible for the collection of the wood;
4. in times of scarcity, fuelwood serves as a source of employment for many rural people who gather and sell firewood or charcoal.

The most obvious effect of the dependence of rural communities on fuelwood is its influence on the environment. The role fuelwood gathering plays in deforestation differs from one ecoregion to the other, but generally it is now recognized that the extent to which the satisfaction of rural energy needs causes deforestation had been overemphasized in the past.²⁰ Commenting further, Foley maintains that if all fuelwood cutting was stopped, deforestation would not reduce significantly. However, fuelwood gathering seems to aggravate deforestation in situations where wood become scarce. As the FAO reports,²¹

"the search for domestic fuel supplies

²⁰ Foley, G.: Wood in World Energy Commission Survey of Energy Resources. (1989) pg.123

²¹ FAO Forestry Department: "Forestry for Rural Communities" (Rome, 1985) pg.14

follows a predictable path in many communities. From collecting deadwood, people go on to lop branches from living trees. Later, trees are felled. Eventually, even stumps are uprooted. Thorns, scrub and bush suffer a similar fate. Once fuelwood becomes scarce or expensive, people start turning to animal dung or crop residues. Returned to the soil, the organic waste would help to improve its nutrient level, structure and capacity to retain moisture. As it is, the soil is denied a vital fertilizer and conditioner."

A cycle of destruction in forest lands due to fuel shortage leading to poor forest cover, and rural poverty in the end, is illustrated in Figure 2.

In the 1950s and 1960s, when economic growth dominated development theories, little attention was paid not only to rural energy but to the rural sector as a whole. The sector mattered in as much as it contributed to accelerated growth of the macroeconomy. Material and human resources were siphoned from the periphery into the core without thought of their depletion.²²

In recent development thinking, however, a positive attitude to the rural sector has emerged, with theories like basic development and ecodevelopment in vogue. All these approaches to development are postulated with the future generation in mind. According to Sachs²³,

"the finite nature of the spaceship - earth and the present dimensions of misdevelopment make it imperative for us to

²² Lee, E.: Basic Needs Strategies: A Frustrated Response to Development from Below? in Development from Above or Below? ed. Stohr, W. and Taylor, D.R. (Chichester, 1981) pg.108

²³ Sachs, J.: Development and Planning, (Cambridge, 1987)

apply this new rationality (of synchronic solidarity with future generations) to the management of our resources of energy, space and the environment."

Thus, it is this need for sustainable development strategy that makes it necessary that needs of the present are met without compromising the ability of future generations to meet their own needs.

As Nsiah-Gyabaah²⁴ rightly pointed out:

"While lower household incomes restrict access, the cost, non-availability and erratic supply of petroleum products make the consumption of fuelwood and agricultural residues the only viable alternatives."

It is now generally accepted that the objective of rural development is the improvement of the standard of living of rural population as a whole, not only through increased agricultural production and the resulting rise in incomes but also through improvement in the "quality of life" as in areas of employment generation, basic health care, education, culture and the people's active participation in the development process. Basic to this approach is the concept of social equity, whereby the low-income rural population shares equitably in the benefit of development.

This new approach was formalized at the 1979 World Conference on Agrarian Reform and Rural Development, when the international community adopted a programme of action in which

"national objectives and strategies would be governed by policies for attaining growth with equity, people's participation,

²⁴ Nsiah-Gyabaah, K.: Environmental Degradation and Desertification in Ghana: A Study of the Upper West Region. (Avebury Studies in Green Research, 1994) pg.165

and redistribution of economic and political power.²⁵

Generally, the main objectives associated with contemporary rural development thinking can be summarized as follows:

- i. increasing agricultural productivity;
- ii. ensuring fair distribution of benefits of development between sectors of the population;
- iii. providing employment avenues to absorb an increasing labour force;
- iv. improving the standard of living of the under-privileged sectors of the economy; and
- v. ensuring greater participation of the population in policy formulation and implementation.

It is important to understand that the role energy plays in the achievement (or non-achievement) of these laudable objectives is a complex interlace stemming from the nature of energy as a vital input required for their achievement, while at the same time being a consumer of resources necessary for achieving these objectives. Thus, the heavy dependence of rural societies on fuelwood has detrimental effects on the environment, upon which also increased agricultural production depends.

The question then remains, how do we meet the energy demands of rural people without compromising the objectives of increased agricultural production? What kind of development interventions do we propose for these communities? Or, one

²⁵ Ghonemy, El, M.R.: Development Strategies for the Rural Poor. FAO Economic and Social Development Paper No.44 (FAO, Rome: 1984) pg. 103

could further ask, how is the efficiency of energy utilization ensured in boosting (or hampering) agro-industrial development needed to absorb the growing work force? These and many other developmental issues bring to the fore the necessity of investigating the different aspects of energy use in the district, and how these relate to the overall development of the district.

The process of environmental degradation and desertification visible in most rural communities could be held in check if adequate measures are taken to control it. Laws should be passed to control bush-burning. Inevitably, we can reasonably foresee that population growth will continue to push farmers out of the valleys and plains, onto the hillsides and marginal lands, and into what is left of the forest.

The district, covering a total land area of 2,300 km², consisting about 5.8% of the total landmass of the Brong Ahafo Region, has about 120 settlements most of which are rural. Nkoranza town is the capital of the district.

Map 1 illustrates Nkoranza District in National and Regional contexts and Map 2 shows the hierarchy of settlements based on population sizes.

1.2 Relief and Drainage

Nkoranza District lies in the semi-equatorial region having an average annual rainfall of between 80 to 100mm. The district, which is generally low-lying and rising gradually from 500 feet to 1,000 feet above sea level, is fairly drained by several rivers and streams, notable among which are the Fla.

CHAPTER THREENKORANZA DISTRICT PROFILE3.1 Location and Size

Nkoranza District is one of the 13 administrative units in the Brong Ahafo Region of Ghana. Lying within longitudes $2^{\circ} 30'W$ and $1^{\circ} 00'E$, and latitudes $8^{\circ} 0'N$ and $7^{\circ} 35'S$, other districts with which Nkoranza District shares boundaries are Atebubu to the East - in the same region with it - and the Ejura-Sekyeredumasi District in neighbouring Ashanti Region to the South.

Nkoranza District was formerly demarcated within the confines of a larger administrative unit - the Nkoranza-Kintampo District, prior to the 1989 National Districts Re-demarcation Exercise. The district, covering a total land area of $2,300\text{km}^2$, consisting about 5.8% of the total landmass of the Brong Ahafo Region, has about 120 settlements most of which are rural. Nkoranza town is the capital of the district.

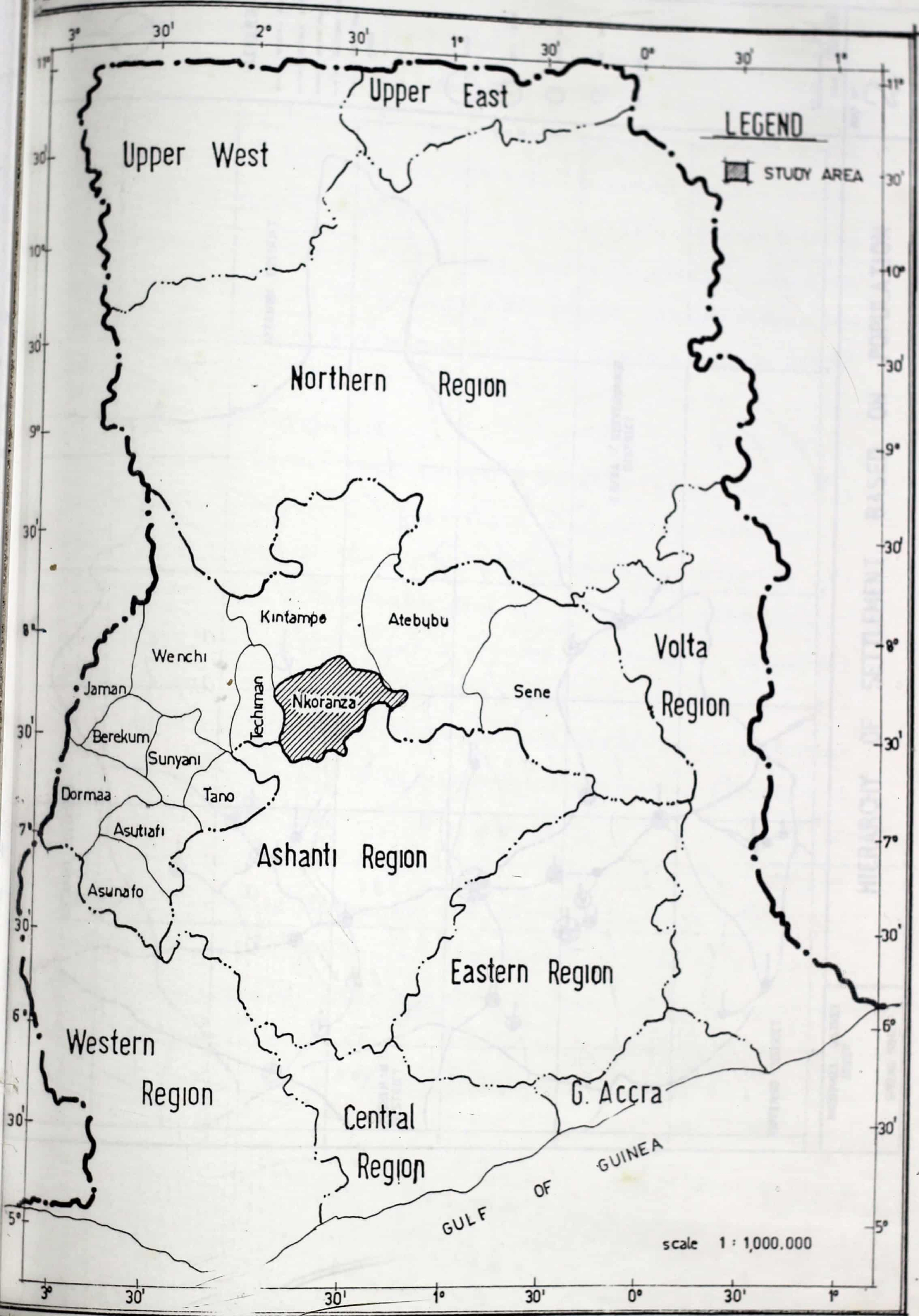
Map 1 illustrates Nkoranza District in National and Regional contexts and Map 2 shows the hierarchy of settlements based on population sizes.

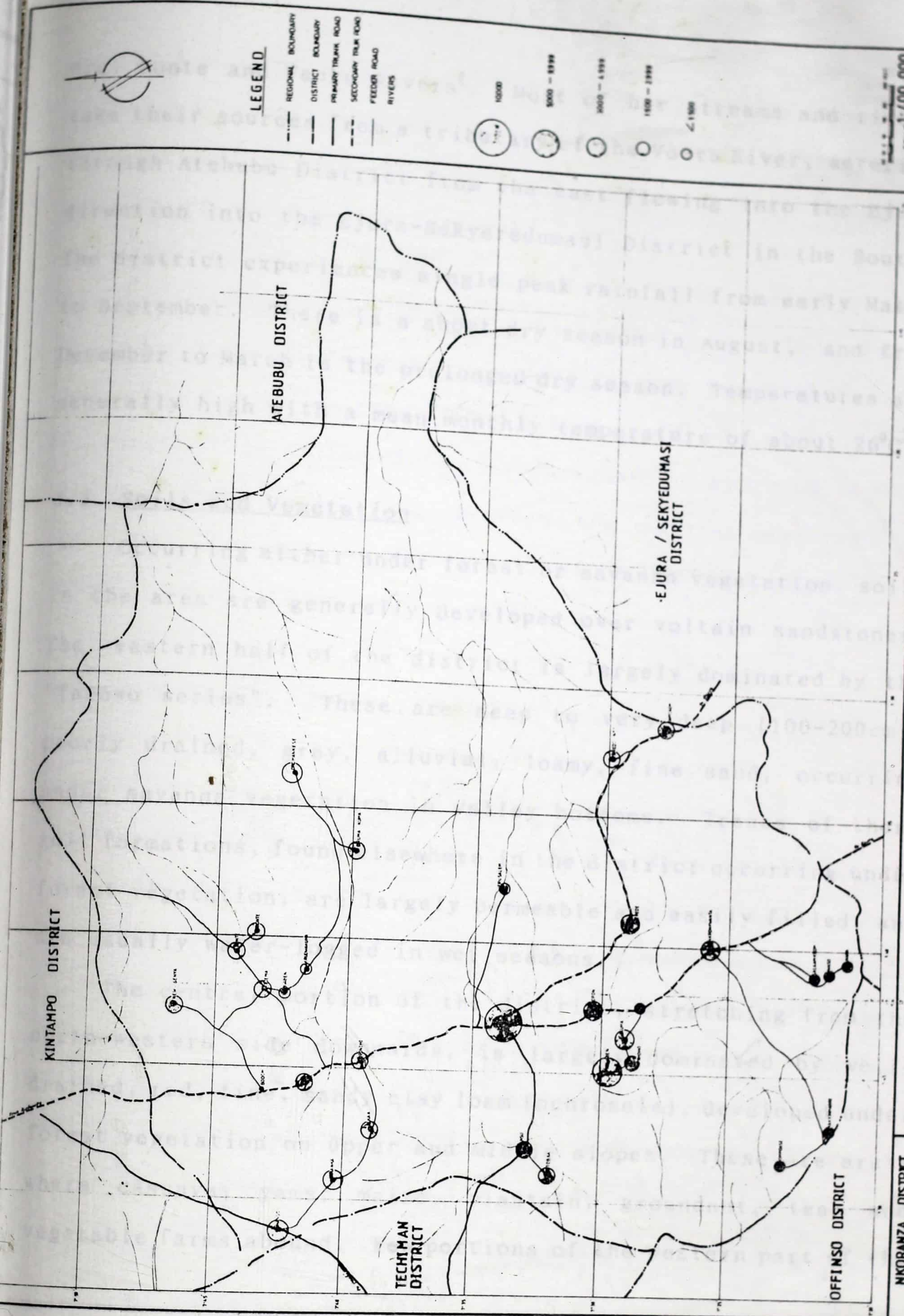
LIBRARY
UNIVERSITY OF SCIENCE AND TECHNOLOGY3.2 Relief and Drainage

Nkoranza District lies in the semi-equatorial region having an average annual rainfall of between 80 to 100mm. The district, which is generally low-lying and rising gradually from 500 feet to 1,000 feet above sea level, is fairly drained by several rivers and streams, notable among which are the Fia,

NKORANZA DISTRICT IN NATIONAL AND REGIONAL CONTEXT

MAP 1





HIERARCHY OF SETTLEMENT BASED ON POPULATION

NKORANZA DISTRICT STUDY

SPRING 1994

MAP NO

2

BIRD: "Nkoranza District Assembly Project Proposal", November, 1994.

BIRD: (op.cit)

Pru, Bonte and Fanku Rivers¹. Most of her streams and rivers take their sources from a tributary of the Volta River, entering through Atebubu District from the east flowing into the Ejura direction into the Ejura-Sekyeredumasi District in the South. The district experiences single peak rainfall from early March to September. There is a short dry season in August, and from December to March is the prolonged dry season. Temperatures are generally high with a mean monthly temperature of about 26°C².

3.3 Soils and Vegetation

Occurring either under forest or savanna vegetation, soils in the area are generally developed over voltain sandstones. The eastern half of the district is largely dominated by the "Tanoso series". These are deep to very deep (100-200cm), poorly drained, grey, alluvial, loamy, fine sand, occurring under savanna vegetation in valley bottoms. Traces of these soil formations, found elsewhere in the district occurring under forest vegetation, are largely permeable and easily filled, and are usually water-logged in wet seasons.

The central portion of the district, stretching from the north-western side downwards, is largely dominated by well-drained, red, fine, sandy clay loam (ochrosols), developed under forest vegetation on upper and middle slopes. These are areas where cassava, yams, maize, plantain, groundnut, teak and vegetable farms abound. Few portions of the western part of the

¹ BIRD: "Nkoranza District Assembly Project Proposals," Kumasi. November, 1991.

² BIRD: (op.cit)

regional growth rate of 7.1⁶, which are both above the national rate of 6.2 (Ghana Statistics, 1988).

Furthermore, it was realized from the SPRING team's Nkoranza District Household Survey that the Infant Mortality Rate (IMR) of 58/1,000 was far lower than the regional and national rates of 65/1,000 and 81/1,000⁶.

The district is basically a rural one, with only 28.5% of her entire population living in settlements with population sizes ranging above 5,000. In fact, there are only 3 settlements with population sizes above 5,000. Of these settlements - Nkoranza, Nkwabeng and Busunya - Nkoranza is the dominant one having about 19.3% of the total district population. Population in the district is concentrated along the major trunk roads linking these major settlements with other areas and the largely uninhabited eastern portion of the district. Map 2 shows the distribution of population by settlements in the district.

Average household size was found to be 7.2, compared with the national average of 5.24 persons for rural areas.⁷

From Table 5 below, it could be observed that the crude densities of both Nkoranza District and the Brong Ahafo Region are relatively low compared with the national densities. The relatively low densities in her communities, together with the

⁶ Statistical Services, 1988 Ghana Statistics, Accra, Ghana.

⁶ Statistical Services, 1988 Ghana Statistics, Accra, Ghana.

⁷ Statistical Services, 1988 Ghana Statistics, Accra, Ghana.

fairly good soils and favourable rainfall patterns have been major attractions for in-migrant farmers who come in from the northern parts of the country.

38

Table 5: Crude Densities of Brong Ahafo Region and Nkoranza District From 1960 - 1994

AREA	Y E A R			
	1960 ^a	1970 ^a	1984 ^a	1994 ^b
National (persons/km ²)	28	36	52	60
Brong Ahafo Region (persons/km ²)	14.9	19.4	29.8	40.7
Nkoranza (persons/km ²)	16.8	17.9	40.8	55.6

Sources:

(a) Ghana, Population Census Reports, 1960, 1970 and 1984.

(b) SPRING, 1993/1994. Projected Population based on Household Survey.

3.5 Economic Activities

Nkoranza District's economy is largely rural. It is dominated by agriculture, with crop farming being the major activity. According to the SPRING team's baseline survey, crop farming employs about 95% of the entire district labour force. The most important crops cultivated are maize, yam, cassava and vegetables. Crop cultivation in the district is largely rain-fed and practised under a system of shifting cultivation.

Aside agriculture, 32% of those engaged in other occupations still take up agriculture as a minor activity as

depicted in Table 6 below.

Table 6: Distribution of Sample Population Aged 15 Years and Above by Major and Minor Occupations

OCCUPATION	MAJOR		MINOR	
	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE
Farming	1514	95.0	95	32.0
Small-Scale Industries	27	1.7	108	36.0
Trading	22	1.4	51	17.0
Government Employment	12	0.8	5	2.0
Others	17	1.1	39	13.0
TOTAL	1594	100.0	298	100.0

Source: SPRING 1993/1994 Household Survey, Nkoranza District.

From the Table, it could be observed that the next occupation after agriculture, the industrial sector dominated by small-scale industrial operations, employs only 1.7 per cent of the sampled population. Major small-scale industrial operations are agro-based involving food processing activities and farm implements' manufacture. To a large extent, these operations depend on biomass energy for their production processes.

CHAPTER FOUR

ENERGY USE IN NKORANZA DISTRICT

INTRODUCTION

This chapter is devoted to the analysis of data obtained from the survey. Fuel preferences and consumption levels obtained from the field are discussed. In addition, the efficiency of energy utilization is examined. Finally, the impact of the energy situation on development in the district is discussed. As could be expected, the major focus of the analysis in the chapter is on household energy consumption since this constitutes the bulk of energy consumption in the district.

4.1 Fuel Preference

Fuels commonly used in the settlements surveyed in the district are firewood, charcoal and kerosene. Firewood and charcoal are used for cooking and heating, whereas kerosene is mostly used for lighting. Table 7 depicts the types of fuels used for domestic activities.

Table 7 - Fuel Preference for Domestic Activities

Activity	Using Firewood only		Using Charcoal only		Using Charcoal & Firewood		Using Kerosene only		Using Kerosene & Electricity		Solar	
	H'hold	%	H'hold	%	H'hold	%	H'hold	%	H'hold	%	H'hold	%
Cooking	15	37.5	6	15	13	32.5	2	5	4	10	-	-
Heating	17	42.5	2	5	15	37.5	-	-	6	15	-	-
Lighting	-	-	-	-	-	-	34	85	6	15	-	-
Drying	-	-	-	-	-	-	-	-	-	-	-	-
Smoking	40	100	-	-	-	-	-	-	-	-	40	100

H'hold = Household

Author's Household Survey, April/May, 1994

The total dependence of the district on fuelwood for cooking and heating is evident as in both case eighty-five (85) percent of the forty (40) surveyed households use either firewood and charcoal. Further analysis revealed that for heating and cooking together, eighty (80) per cent of households covered in the survey depend on only firewood. Only eight (8) households, constituting twenty (20) per cent, use only charcoal for these two household activities. In the case of kerosene usage, two (2) households were found to be using it in addition to electricity. These six (6) households were found in the district capital which comparatively is considered to be at a higher level of economic development. Furthermore, only six (6) households were found to be using kerosene together with electricity for heating. For lighting, eighty-five (85) per cent, who have no access to electricity, depend on kerosene whereas fifteen (15) per cent, who are in the district capital where electricity is available, use it

in addition to electricity. In these areas, it was realized that no household depends entirely on electricity for lighting. Firewood is used for all fish-smoking in the district, just as solar energy is used for all the drying in the settlements surveyed.

For non-domestic activities, pito-brewing, gari processing, kenkey-making and tobacco-burning, were the dominant activities observed. Other activities observed are bread-baking, pottery, and black-smithing.

There is a high degree of commercialization of firewood and charcoal in the district. Seventy (70) per cent of households which depend on firewood indicated that they purchase wood, whilst ten (10) per cent collect them from their own farms and twenty (20) per cent obtain theirs from surrounding bushes. In the case of charcoal ninety-eight (98) per cent of users purchase whilst two (2) per cent make their own charcoal. The average price for a headload of firewood in the district was found to be ₵200.00. A bag of charcoal costs between ₵600.00 to ₵800.00 on the average. Most purchased firewood is obtained from the district.

Distances covered to the sources of firewood indicate that sixty-eight (68) per cent of respondents who collect their own firewood, cover less than a kilometer to obtain their supply.

To a large extent, responsibility for collection of firewood falls on women and children. The Table below shows the responsibility for collection of firewood.

Table 8 - Responsibility for Firewood Collection

<u>Household Member</u>	<u>No. of Households</u>
Women alone	20
Children alone	5
Women and Children	10
All members of household	5
Total	<u>40</u>

Source: Author's Household survey.

In terms of 'who pays for the purchased firewood', in eighteen (18) out of twenty-five (25) households which purchase firewood, women are responsible for the payment, whereas men pay for it in twenty-eight (28) per cent of households.

In the district seventy (70) per cent of all firewood users make use of branches. Table 9 shows the types of firewood used by different households.

Table 9 - Type of Firewood Used

Type	No. of Households	Percent of Respondents
Branches	28	70
Trunk	5	12.5
Branches/Trunk	5	12.5
Barks/Agricultural residues	2	5
Total	40	100

Source: Author's Household Survey

With regard to the use of charcoal, most users obtain it

within their settlements whilst the rest obtain it outside their settlements but mostly within the district. There is a similar trend in kerosene usage, where ninety-eight (98) per cent of households obtain their supply within their settlements, buying them from retailers who sell kerosene in bottles in almost all the settlements. Kerosene is virtually the only fuel used for lighting and except for the two (2) households which used it for cooking, lighting seems to be the only role kerosene plays in the energy sector of the District.

4.2 Fuel Consumption Levels

From the survey, it was observed that per capita energy consumption levels vary according to household size and the activity for which the fuel is used.

4.2.1 Firewood Consumption

From the survey, it was observed that per capita energy consumption levels vary according to household size and the activity for which the fuel is used. This result is comparable to what Ardayfio obtained from her study of three areas in the Accra Plains.¹ She obtained the lowest per capita consumption of 0.730 tonnes per year and the highest value of 1 tonne. The district's average is also above the annual average of 700 kilogram estimated by the World

¹ Ardayfio, E: The Rural Energy Crisis in Ghana: Its Implications for Women's Work and Household Survival (ILO, 1986)

Commission on Environment and Development.² Pluth also obtained a far lower level of consumption in the Northern Region of Ghana (523.3kg per annum)³.

The size and social organization of households were found to have some influence on per capita firewood consumption rates. Households of average size of four (4) consumed 1835.6 kg. while households of between five (5) and seven (7) members consumed 1406.2kg. The lowest per capita consumption rate was found in households of size above ten (10). They consume 632.5kg. per capita - about three (3) times less than what is consumed in small-sized households. Table 10 shows the relation between household size and annual per capita firewood consumption.

4.2.2 Charcoal Consumption

The level of charcoal consumption and its relation to household size is summarized in Table 11 below. The total amount of charcoal consumed per annum by the eight (8) households who use charcoal is 9,940kg and the average per capita consumption is 180.7kg. As with firewood consumption, large households enjoy economies of scale, with small households (1 - 4 persons) consuming twice as much as those in the 5 - 7 household cohort, and almost four times higher than those in households of above ten (10) persons.

² The World Commission on Environment and Development: Our Common Future (Oxford: Oxford University Press, 1987) p. 189

³ Pluth: "The Energy Sector in Northern Region of Ghana".

Table 10 - Firewood Consumption Levels

Household Size	No. of Households	Total Household Population	Total Amount Consumed in Kg	Annual Per Capita Consumption in Kg
1 - 4	4	15	27,534	1835.6
5 - 7	6	38	53,434	1406.2
8 - 10	8	76	75,264	990.3
Above 10	10	126	79,694	632.5
Total/Average	28	255	235,926	925.2

Source: Author's Household Survey.

Table 11 - Charcoal Consumption Levels

Size	Households	Population	Total Consumption in Kg	Annual Per Capita in Kg
1 - 4	3	11	2,690	244.5
5 - 7	2	13	1,586	122
8 - 10	1	9	4,336	482
Above 10	2	22	1,328	60.3
Total/Av.	8	55	9,940	180.7

Source: Author's Household Survey

LIBRARY
UNIVERSITY OF SCIENCE AND TECHNOLOGY

4.2.3 Kerosene Consumption

From the survey, the total amount of kerosene used is 6,842.4 litres (1807.7 gallons) per annum, with each person using 21.2 litres per annum. The Table below depicts the consumption pattern in the various household-size categories.

Table 12 - Kerosene Consumption Levels

Household size category	No. of households	Total Population	Total Consumed	Annual Per Capita Consumption in litres
1 - 4	9	30	1,230	41
5 - 7	8	43	1,250	29
8 - 10	12	110	1,890	17.2
Above 10	11	140	2,472	17.6
Total/Average	40	323	6,842	21.2

Source: Author's Household Survey

4.2.4 Non-Domestic Fuel Consumption

The survey of the two business enterprises in Nkoranza revealed that firewood is the dominant energy source. The two pito brewers, the two restaurant operators, the two tobacco burners, the one baker and the one akpeteshie distiller covered in the survey indicated their reliance on firewood. It was only the two black-smiths who use hard charcoal and at times palm-nut shells.

Furthermore, in the field of agriculture, the major fuel relied upon is diesel. This is used by tractors in ploughing farm lands. total cultivable land area is approximately 184,000 hectares and the average farm size is 1.8 hectares.⁴ About sixty-eight (68) per cent of farmers in the district depend on tractors to plough their fields, and between six to seven litres of diesel is required to plough a hectare of farm land. Diesel is procured from about six filling stations in the district.

In terms of electricity utilization, it was found that electricity is becoming more widely used in households and business enterprises as at now. All the mechanics at the industrial area depend on electricity. Sawmillers and few tailors and seamstresses depend on electricity.

4.2.5 Total Fuel Consumption

Extending the figures obtained from the sample to cover

⁴ SPRING 1993/1994: Nkoranza District Development Workshop Report, U.S.T., Kumasi. July, 1994.

the whole district, the total fuel consumed on the basis of the 1984 population of 93,791 persons were estimated and presented in Table 13 below.

Table 13 - Total Fuel Consumption in Nkoranza District

Fuel Type	Annual Per Capita Consumption	Total Annual Consumption
Kerosene	21.2 litres	1,988,369.2 litres
Charcoal	180.7 kg	16,948,033 kg (16,948.03) tonnes
Firewood	925.2 kg	86,775,433 kg (86,775.43) tonnes

4.3 Efficiency of Energy Usage

The study made use of the efficiency of various end-use devices to determine the proportion of effective energy derived from an end-use device as a proxy indicator 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 90 per cent of the households. The remaining 10 per cent representing 4 households, all in the district capital use it in addition to electricity. The traditional or "home" made wick kerosene lamp was in use in the 36 households where the hurricane lamp was also used. Out of these same number, 6 households representing 15 per cent reported using a kerosene tilley lamp alongside the hurricane lamp for lighting. Although the light intensity from a hurricane lamp is low, a mere 3-foot candle light intensity at 30cm distance⁵, it

⁵ Mubita, S.M. : The Rural Energy Sector and the Environment: A Case Study of West Gonja District, Ghana.

seems that the popularity of the hurricane lamp is a question of affordability by the people.

The common end-use devices reported among firewood users is the traditional mud stove and the 3-stone fire place. These end-use devices were used by 92.5 per cent representing 37 households in the sampled settlements. The rest use open-fire with an average efficiency of 10 per cent (See section 3.1). For charcoal users, all respondents use the traditional brazier or coal pot which has an efficiency of 15 per cent.

Informal interviews conducted among 2 pito brewers, 3 chop-bar operators, 2 blacksmiths, 2 tobacco burners and 1 kenkey maker in Nkoranza town itself showed large variations in quantities of firewood used depending on the season, but on the average each pito brewer uses almost a tractor full of firewood per month, each chop-bar operator uses the same quantity per month and the black-smith used 1 headload of firewood per week, with the kenkey maker using 4 headloads of firewood per day operating on the average of 6 days in a week.

Dromankese and Busunya are major settlements noted for charcoal production in the district. Asuano, Akonkonti, Dumase and Asekye are settlements from where large quantities of firewood are brought to Nkoranza. 64% of firewood users reported that in recent times they have to go deep into the woodland before getting their preferred firewood species. Tree species preferred for firewood and charcoal-burning include Phyllanthus discoideus ("Pepia"), Anogeisus leiocarpus ("Kane"), Tetrapleura tetraptera ("Prekese"), Vitex

fosteri ("Otwentorowaa"), Ficus capensis ("Doma"), Celtis spp ("Sa"), Crossopteryx febrifuga ("Yiyefantorowa") and Cassia spp ("Mmofraborode"). When timber merchants fell Chrorophora excelsia ("Odum), most households also go in for the pieces that are left over.

The two blacksmiths covered in the survey indicated that they preferred charcoal burnt from Erythrophleum ivorensis ("Potro dum").

However, charcoal burnt from this tree is very scarce to come by since charcoal burners do not burn this specie very often because of the low demand from household users. This is so because most households do not prefer using charcoal burnt from this specie because it is hard and does not burn efficiently.

The price per bag of charcoal vary according to the time of year. Prices are highest in the rainy season when it is difficult to burn and the roads leading to the production centers are muddy and accessibility to them becomes problematic.

Marketing of fuelwood and charcoal is done by retailers in the various settlements in the district. Wholesalers buy charcoal, especially, in large quantities and transport them outside the district to retail. On average, it is estimated that about one thousand four hundred bags of charcoal leave Dromankese every week.⁶ In the case of Busunya, information obtained from the boys who assist in the charcoal-burning

⁶ S.F. Poku-Kodom: District Assembly Representative, Dromankese.

process estimated that about one thousand bags are transported out of the settlement every week.

There is a high degree of commercialization of firewood and charcoal in the district. Thirty-eight (38) per cent of households which use firewood indicated that they purchase it, while sixty-two (62) per cent indicated that they gather them from and around their own farms and surrounding bushes. In the case of charcoal, ninety-one (91) per cent of users purchase it whilst nine (9) per cent make their own. Most purchased firewood and charcoal is obtained from the district.

Distances covered to the sources of firewood indicated that 78 per cent of respondents who collect their own firewood, cover under one (1) kilometre to obtain their supply, with the remaining 22 per cent covering just a little above a kilometre. The survey further revealed that on the average, the number of days spent per week in collecting firewood was found to be 4.6.

LIBRARY
UNIVERSITY OF SCIENCE AND TECHNOLOGY

CHAPTER FIVE

PLANNING RURAL ENERGY FOR DEVELOPMENT

5.0 INTRODUCTION

This chapter considers development issues relevant to the sector. It looks further at national policies and legislations on rural energy as implemented through various related agencies. In its concluding section it recommends interventions needed to develop the sector in the district.

5.1 Development Issues Relating to the Sector

The problems of the rural energy sector in the District cannot be considered in isolation because it brings together the inter-relationships which it has with all other aspects of rural life and tries to show how changes in one can affect the other since the exploitation and utilization of energy sources is a reflection of several factors which all go together reinforcing each other. Moreover, the population of the District is projected to increase to 229,257 by the year 2009. This being so, agricultural production levels will have to be increased to feed the growing population by putting more land under cultivation at the expense of forestry or wood-based fuel resources. The growing population will also exert an increasing demand on fuel resources since non-commercial fuels remain the primary energy sources for her rural households. Thus the questions that come to mind will be: how are the energy needs going to be met?; if the present

situation continues, what would be the consequences on the District's development? Without doubt, the growing population's demand for more land for non-agricultural purposes will increase the rate of deforestation. Moreover, if efforts are intensified during the period to reduce the population growth rate, this might result in smaller household sizes, which would, as seen from the analysis in Chapter 4, increase the per capita energy demand. The dilemma then becomes: is the district ready to decrease the population and pay for it in energy? How can the population growth rate be slowed down and at the same time per capita energy demand reduced or even maintained?

The foregoing discussion goes to show that the fuel problem can undermine any development activity that is narrowly conceived and directed at a single sector. In seeking solutions to it, therefore, a holistic approach addresses its solution to all the major sectors. Being so, it is necessary to involve inter-sectoral co-ordination in project planning and implementation. Institutions involved in rural development and resource management must be contacted for expert consultations and information exchange. Policies and legislative framework relating to the powers and functions of organizations to be involved are covered in the next section.

5.2 National Policies and Legislations

National Policies and Legislations on energy issues emanate from the Ministry of Energy. The Ministry of Energy

has the responsibility to advise the Ghana Government on all issues pertaining to energy in the country. It acts as the overall official body for co-operation with other national and international bodies on energy matters. The National Energy Board (NEB) executes all national policies pertaining to energy and renewable energy resources emanating from it.

The Public Investment Programme spells out the NEB's renewable energy programme as being to;

- i. assess the availability of renewable energy resources in Ghana;
- ii. implement pilot demonstration projects with the view to setting up the technical and economic viability of most promising renewable energy technologies;
- iii. establish mechanisms for securing comprehensive and systematic energy resources management on a sustainable basis;
- iv. ensure efficient and cost effective production and use of the country's renewable resources; and
- v. develop the relevant information base that will facilitate the framework for national development and use of the country's renewable energy resources.¹

In pursuance of these objectives, specific sub-projects have been designed under two broad headlines of "Biomass" and "Solar" Energy.

The "Biomass" activities of the NEB are aimed at:

- a. conserving forest resources through improved production

¹Ghana, Republic of,: Public Investment Programme 1990-1992. Vol.2.6 p.33

- methods. One area under this where attention has been focussed is the improved charcoal production strategy, in which demonstration and evaluation of improved charcoal production methods have been and are being made to Ghanaian charcoal producers;
- b. decreasing the demand for wood-based fuels through the use of more efficient cooking devices. In this sub-project, selected models of improved charcoal stoves are being promoted among urban domestic users. Four models of these have been tested in 800 households in Accra;
 - c. expanding the use of other biomass energy sources, especially generation of biogas from organic and agricultural wastes for use as an alternative source of fuel to meet the cooking and lighting requirements of rural dwellers. Already one biogas project has been commissioned at Shai Hills with Chinese Government technical assistance. Two are at Appolonia and Okponglo. All three are in the Greater Accra Region.
 - d. Planning for the future security of biomass supply. The objective is to be achieved through a sustained programme of forest regeneration and afforestation. In this regard, the NEB has been sponsoring the development of afforestation projects in collaboration with relevant public agencies.
 - e. Substituting other fuels for fuelwood. To achieve this aim, NEB on 1st March, 1990 put into action its programme to encourage more urban households and institutions to switch to Liquified Petroleum Gas (LPG) as a major

alternative for charcoal and firewood.

The direct relationship that exists between rural energy and the environment means that rural energy policy be well integrated into any national environment policy. This being the case, an Environmental Protection Council (EPC) was established in 1974 and given the responsibility to co-ordinate the activities of all agencies concerned with environmental matters. It was also to serve as a channel of communication between those bodies and the Government. It serves also as the official body for co-operation and liaising with other national bodies and international organizations on environment.

The activities being undertaken by the EPC in rural Ghana include promotion of agro-forestry, energy-saving, anti-bush fire campaigns and general education on environmental issues.

Furthermore, EPC is also involved in an integrated programme in which villages are assisted with funding from the United Nations to plant trees for fuelwood.

² Ghana, Government of, : National Redemption Council Decree (NRCD) 239, 97

CHAPTER SIX

SUMMARY AND CONCLUSIONS

6.1 SUMMARY

The study was undertaken to assess the state of the energy sector in Nkoranza District and its effects on her development. Objectives set for the study were:

- a. to identify the major rural energy sources in the district;
- b. to determine the extent of the district's reliance on each energy source;
- c. to examine the types of end-use devices used by households and small-scale enterprises;
- d. to determine the current and future implications of over-dependence on wood-based energy sources;
- e. to find out what the results of the pressure exerted on wood-based energy sources are; and
- f. make recommendations which when implemented, would ensure the development of sustainable rural-energy resource bases in the Nkoranza District.

The research made use of both primary and secondary data sources. The major secondary data sources included the National Energy Board, the Institute of Renewable Natural Resources, the Forest Products Research Institute and the Main Library of the University of Science and Technology, Kumasi. Primary data was obtained through an interview schedule administered in the District. Other data sources included

personal discussions held with members of institutions whose activities relate to energy and environmental management, as well as with small-scale industrial operators.

Sampling for the interview schedule was aimed at achieving fair representation in terms of population sizes and vegetation and land use features. The sample size per settlement was allocated in terms of population sizes with the district capital having the highest number of households to be interviewed, followed by the next two population cohorts having equal number of households selected and the last population cohort having the least. The selection of respondents was by systematic random sampling.

A review of literature on past findings formed a basis for the study. This was guided by the conceptual framework. 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 deal with the movement of energy in the ecosystem. Ecosystems are in a state of delicate balance and is regulated by energy movement through it and the removal or interference with the system destabilizes their self-regulatory abilities. Furthermore, that development and energy are intricately related, makes it imperative that judicious exploitation and utilization of energy be ensured for sustainable development.

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

1. Three basic fuels are in use in the district; firewood and charcoal for brewing, cooking and heating; and

kerosene for lighting. These also form the major source of energy for non-domestic operations.

2. The 3-stone fireplace and the coalpot are used in majority of households covered in the survey.
3. Annual per capita energy consumption is higher in smaller households (1-4 members) and lower in households of more than 10 members.
4. The most preferred end-use device for lighting was found to be the hurricane.

These characteristics of energy usage in the district have adversely affected the district's development. The visible signs of deforestation, soil erosion and degradation in the district have contributed to lowering yields in the agricultural sector.

On the basis of the above findings, proposals are made as a means of combating fuelwood shortage. The proposals made include:

- the creation of new fuelwood bases in the form of community woodlots;
- the promotion of agro-forestry practices, especially alley cropping;
- the introduction of more efficient end-use devices like cooking stoves to use either firewood or charcoal (See Table 2);
- improvement of agricultural productivity through improved farming practices like crop rotation and mixed farming;
- intensification of family planning education to keep population growth in check;

- biogas development from human and livestock excreta.

The benefits of the above proposals can only be realized through:

- the education of the people on the need to safeguard the environment;
- the District Assembly involving officials from the National Energy Board and the Environmental Protection Council in programmes to educate people in the district on energy conservation and environmental protection;
- intensification of the activities of Non-Governmental Organisations like the Adventist Relief Agency (ADRA) and business concerns like the Pioneer Tobacco Company (PTC) in assisting communities and individual farmers to engage in reafforestation projects.

6.2 Conclusions

The study has to a large extent met its set objectives. Notwithstanding this, however, further study may be necessary, especially in sectors which although use energy are not covered in this study, as for instance the role of tobacco burners. The tobacco industry is a major user of fuelwood, hence it is imperative that their role in environmental and land degradation in the district be further investigated. The issue of using solar energy for tobacco curing must equally be further looked at.

Furthermore, considering the fact that the net effect of increasing woodfuel consumption extends beyond problems such as rainfall reduction and lower crop yields, there is the need

energy consumption pattern in the district.

SCALOGRAM FOR NKORANZA DISTRICT 1993 - 1994

[illegible]

DEPARTMENT OF PLANNING
FACULTY OF ENVIRONMENTAL AND DEVELOPMENT STUDIES
University of Science and Technology, Kumasi
SPRING II 1993/94 PARTICIPANT

DATA REQUIRED FOR A THESIS ON
"RURAL ENERGY RESOURCES UTILIZATION AND DISTRICT
DEVELOPMENT: THE CASE STUDY OF NKORANZA DISTRICT, GHANA"

Name of Interviewer: _____

Date of interview: _____

Name of Town/Village: _____

A. BACKGROUND OF RESPONDENT

1. Sex ☐ male ☐ female 2. ☐ Age (to the nearest year)

3. Occupation (a) Major _____

(b) Minor _____

4. Educational Level:

☐ Never been to school

☐ Attended Adult Literacy classes

☐ Attended Primary School

☐ Completed Middle School

☐ Completed Secondary School

☐ Tertiary School

☐ University

☐ Dropped out of school (Specify) _____

5. What is your household status? Please, put a cross (X)

☐ Household Head

Indicate ☐ Male ☐ Female ☐ Married Woman

☐ Any other: (Please specify) _____

B. ENERGY-ORIENTED ACTIVITIES

6. What types of energy do you use for the following domestic activities?

<u>ACTIVITY</u>	<u>TYPE OF ENERGY USED</u>
Cooking	
Heating	
Lighting	
Drying	
Smoking	

7. Which of the following activities do you or any member of your household engage in? Indicate the type of energy used, (eg. Firewood, Charcoal, Kerosene, Diesel, Electricity, Solar), in each case:

<u>ACTIVITY</u>	<u>TYPE OF ENERGY</u>
☐ Gari processing	
☐ Kenkey making	
☐ Baking	
☐ Fish Smoking	
☐ Palm-Wine tapping	
☐ Gin. (Akpeteshie) Distilling	
☐ Pottery	
☐ Blacksmithing	
☐ Others (specify) _____	

8. How many times do you cook in your household in a day?

9. Where do you obtain the fuel you use in the house?

Firewood ☐ on farm ☐ from bush ☐ purchased

Charcoal ☐ on farm ☐ purchased ☐ home made

Kerosene ☐ within settlement ☐ outside settlement

10. How much do you pay for the fuel you buy per unit?

Firewood £ per headload bundle
 Charcoal £ per bag (full)
 Kerosene £ per bottle (Beer Size)
 Gas £ per cylinder. (Indicate: Small ☐ Big ☐)

11. Indicate the amount of fuel you use per week in your household (during the dry season and the wet season):

Dry Season Wet Season

TYPE OF ENERGY	QUANTITY DRY SEASON	QUANTITY WET SEASON
Firewood		
Charcoal		
Kerosene		
Gas		
Others (Specify).....		

12. How far do you normally go to collect firewood?

- ☐ Less than 1Km
☐ 1-5 km
☐ more than 5 km

LIBRARY
 UNIVERSITY OF SCIENCE AND TECHNOLOGY

13(a) How far did you previously (10-15) years ago) have to go to collect firewood?

- ☐ less than 1 km
☐ 1-5 km
☐ more than 5 km.

(b) Indicate whether the present source of Firewood is getting diminished and further away from your place of residence.

14. Which members of your household are responsible for firewood collection?

.....

15. Who pays for the firewood in case it is purchased?
.....

16. What type(s) of firewood do you normally use?

- ☒ Branches ☐ Trunks/Split log ☐ Barks/Agricultural Residue

17. Did you use the same type(s) previously (10-15 years ago)?

- ☐ Yes ☐ No

18. State reasons why you use them now

.....
.....
.....

19. What species of wood do you use as firewood? (Give their names)
.....

20. What species did you use 10-15 years ago?

.....

21. Why do you use different species now?

.....

22. From where do you obtain your charcoal?

- ☐ within Settlement
☐ outside the district
☐ outside the settlement but within the district

23. From where do you obtain your Kerosene?

- ☐ within the settlement
☐ outside the settlement but within the district
☐ Outside the district.

(c) END-USE DEVICES

24. What types of devices do you use for your cooking?

- ☐ open fire ☐ mud stove ☐ brazier
☐ Kerosene Stove
☐ Others (Specify)

25. Do you know any other type of device you could use for cooking?

- ☐ Yes ☐ No

If yes specify which type(s)

- If Yes, briefly describe the form in which this is practised:

BIBLIOGRAPHY

- Anderson, D. and Fishwick, R. : Fuelwood Consumption and Deforestation in African Countries; World Bank Staff Working Paper, No. 704, Washington, 1984.
- Ardayfio, E. : The Rural Energy in Ghana; Its Implication for Women's Work and Household Survival; ILO, 1986.
- Bassan, E. and Wood, T. : Environmentally Sound Small-Scale Energy Projects. New York. CODEL. VITA. 1985.
- El-Hinnawi, E. E. : Environmental Impacts of Production and Use of Energy. Dublin: Tycooli, 1981.
- E.P.C. : National Environmental Policy, Accra: EPC, 1992.
- FAO : African Agriculture, the Next 25 Years, Annex II. The Land Resource Base, Rome, 1985.
- FAO : State of Food and Agriculture, 1976. Agricultural Series; No.4, Rome, 1977.
- FAO : Forestry Department; Forestry for Rural Communities; Rome, 1985.
- FAO : Forestry Department, Potential for Fuelwood and Charcoal in Energy Systems of Developing Countries. Rome, 1980.
- Foley, G. : "Wood": World Energy Commission Survey of Energy Resources; 1989.
- Gajo, M. : "How Much Can Improved Stoves Save?" GATE Questions, Answers, Information. No.1/91 March 1991.
- Ghana, Republic of, : Public Investment Programme 1990-1992 Vol. 2.6.
- Ghanemy, El-M.R., : Development Strategies for Rural Poor. FAO Economic and Social Development Paper. No.44, Rome, 1984

- Lee, E.
- Mann, R.D.
- Montalambert, M.R. and
- Mubita, S.M.
- National Energy Board (NEB)
- Nsiah-Gyabaah, K.
- Odum, E.P.
- Pluth, D.
- Poostchi, I.
- Pryor, C. A.
- Raudor, M. and Wad, A.
- Sachs, J.
- Spears, J. S.
- : "Basic Needs Strategies: A Frustrated Response to Development from Below?" Development From Above or Below? (eds) W. Stohr and D.R. Taylor, Chichester, 1981.
- : "Time Running Out". The Ecologist Vol.20 No.2, March/April 1990.
- : Fuelwood Supplies in Developing Countries. FAO, Rome, 1983.
- : "The Rural Energy Sector and the Environment: A Case Study of West Gonja District, Ghana." Unpublished M.Sc. Thesis, U.S.T. Kumasi, 1990.
- : Rural Energy Studies, Preliminary Report, Accra, 1990
- : Environmental Degradation and Desertification in Ghana: A Study of the Upper West Region. Avebury Studies, England, 1994.
- : Basic Ecology, New York, Holt-Saunders, 1983.
- : The Energy Sector in Northern Region, Ghana; Preliminary Report, 1985.
- : Rural Development and the Developing Countries. An Interdisciplinary Introductory Approach, Ontario, 1986.
- : "Environmental Impacts of Renewable Energy and Alternative Development Strategies." Energy and Environment in Developing Countries; ed. M. Chateerji, Wiley and Sons, 1986.
- : EDI Training Material: Training Module - Wood; New York, IBRD, 1985.
- : Development and Planning. Cambridge, 1987.
- : "Can the Wet Tropical Forest Survive?" Commonwealth Forestry Review, Vol.58. No.3, 1979.

- SPRING 1993/1994 Participants:
- Nkoranza District Study,
Development Workshop Report,
U.S.T., Kumasi, July, 1994.
 - Statistical Services : National Census Reports, Accra, SBS
1960, 1970 and 1984.
 - United Nations Population
Fund (UNFPA) : The State of World Population 1989,
New York: UNFPA, 1989.
 - World Bank : "Fuelwood - A Burning Issue in the
Third World". Urban Edge, Vol.14,
No.4; May, 1990.
 - Wereko Brobbly, C. : Energy Research in Ghana: Review
and Future Directions. Accra,
CEED, 1988
 - Wood, T. S. and Baldwin, S. : "Fuelwood and Charcoal Use in
Developing Countries," Annual
Reviews, 1985.
 - World Commission on
Environment and Development : Our Common Future. Oxford:
Oxford University Press, 1987
 - Zeitinge, C.P., Zieroth, G.
and Biermann, E. R. : Utilization of Renewable Energy
Resources. A Programme for Germany
for the Third World. (S.E.P.
Programme) GATE, 1982.
 - Ziegler, C. : "Fundamentals of Ecology". Lecture
Notes for SPRING I, Universitaet
Dortmund, Nov. 1992.