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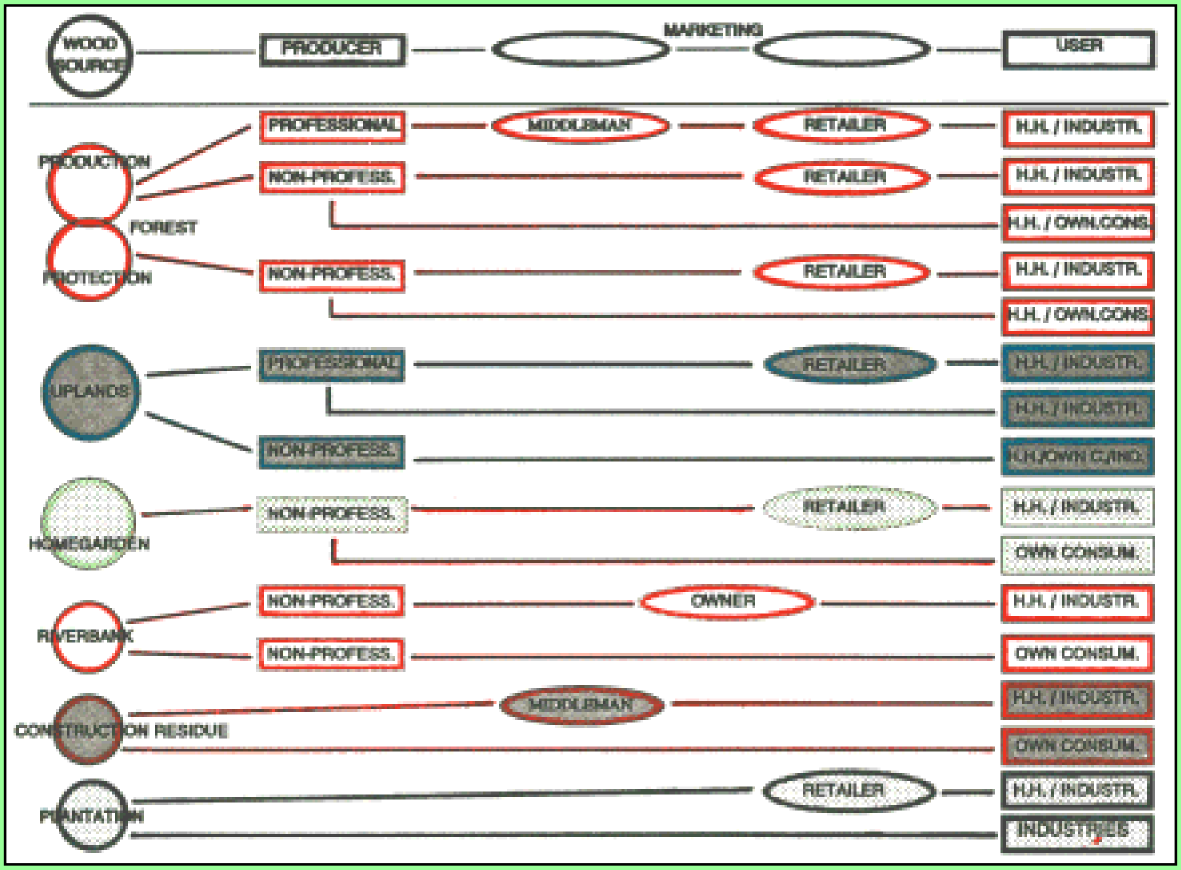
REGIONAL WOOD ENERGY DEVELOPMENT PROGRAMME IN ASIA
GCP/RAS/154/NET

WOOD ENERGY DEVELOPMENT:

PLANNING, POLICIES AND STRATEGIES

VOLUME II
Papers Presented at the "Expert Consultation on Data Assessment and Analysis for Wood Energy Planning"



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
Bangkok, May 1993

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Volume I: Report on the RWEDP Regional Meetings on Wood Energy Planning and Policies
Volume II: Papers Presented at the "Expert Consultation on Data Assessment and Analysis for Wood Energy Planning
Volume III: Papers Presented at the "Seminar on Policy Instruments for Implementation of Wood Energy Development Programmes"

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FOREWORD

Development of appropriate wood energy strategies and improvement of the capabilities of member countries in planning wood energy development programmes are two important objectives of the Regional Wood Energy Development Programme in Asia (RWEDP). Since its inception in 1985 RWEDP has supported a large number of case studies, workshops and training courses on various specific subjects related to these two objectives. The list of RWEDP publications on the back of this document reflect the project's past activities in this field. Other national and international institutions and organizations have also contributed to an improved information base on wood energy.

The actors in wood energy systems, from the supply and demand sides, are clearly identified and their roles are now better defined than in the past. In addition forest resources are beginning to be assessed and evaluated in a more systematic way.

For example, while earlier the use of fuelwood by poor people was seen as the cause of deforestation it is now recognized that other factors such as conversion to farmlands, industrial use of forests and forest fires - for which not always the poor people are responsible - are also important causes.

It has also become clear that wood energy provides opportunities for income generation and rural development and deserve attention of policy makers from a broad range of sectors.

While considerable progress has been achieved in improving national capabilities in research, training, education and wood fuel surveying additional efforts are required to create multidisciplinary teams capable of mastering the subject and involving relevant groups (local governments, villagers, NGOs, university research and extension programmes, and others) in the planning and implementation of wood energy projects.

Unfortunately, the quality of wood energy data available is still inadequate for conducting detailed sectoral reviews and wood energy planning activities. In many countries, this lack of accurate information leads to controversial interpretation of the energy situation and hampers the correct identification of solutions to be undertaken.

The end of the second phase of RWEDP was considered to be an opportune time to reflect on the progress made in our understanding of wood energy issues in RWEDP’s II member countries and on possible issues to be addressed in a follow-up project.

Thus, from 22 February to 3 March 1993, two consecutive regional meetings were conducted in Chiang Mai, Thailand. The first one, aimed at planners from RWEDP member countries, was an “*expert consultation on data analysis and assessment for wood energy planning*” while the second one, aimed at policy makers, was a “*seminar on policy instruments for the implementation of wood energy development programmes*”. 36 participants came from the member countries to the two meetings, and a total of 29 papers by 23 resource persons were presented.

A wealth of information became available during these meetings and RWEDP is grateful to all the participants and resource persons who contributed to lively discussions and/or acted as rapporteurs of the various sessions and workshops. Particular thanks go to C. Heruela, who as a consultant to the project was primarily responsible, from the initial conceptual framework to the final editing of the three volumes of this report. I also wish to thank Aroon Chomcharn and Cor Veer for their valuable inputs in preparing the agenda's and Tina Sriratana, Pimpa Molkul, Panpicha Issawasopon and Navaporn Liangcheevasoontorn for their assistance in the organization of the meeting and Panpicha for the typing and design of the documents.

It is hoped that the two meetings and this report will generate appropriate attention to wood energy from planners and policy makers in the field of energy, natural resources and rural development. Hundreds of millions of poor people in our member countries, depending on this important source of energy and income, deserve it.

Egbert Pelinck
Chief Technical Adviser

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Expert Consultation on Data Assessment and Analysis for Wood Energy Planning (23-27 February, 1993), Chiang Mai, Thailand

STATEMENT

by

MR. MIGUEL TROSSER0[1]
on behalf of Assistant Director General,
Forestry Department, FAO/Rome

Honourable Mr. Pongpayom Vasaputi, Vice Governor of Chiang Mai,

Mr. Sompongse Chantavorapap, Deputy Director General, Dept. of Energy Promotion and Development, Royal Thai Government

Mr. E. Pelinck, Chief Technical Adviser, Regional Wood Energy Development Programme in Asia,

Distinguished experts and guests, ladies and gentlemen.

It is indeed my great pleasure and privilege to have this opportunity to be with you to inaugurate this Regional Expert Consultation on Data Assessment and Analysis for Wood Energy Planning.

On behalf of the ADG, Forestry Department, I wish to express my gratitude to the Royal Thai Government for its hospitality, to the Government of the Netherlands for this continuous financial support and, particularly, to the project staff for all the dedication provided for the preparation of this meeting.

I wish also to give a warm welcome to all the international experts, Heads and Senior staff of energy and forestry planning, our guests and observers taking part in this consultation.

As senior planners of the energy and forestry sector you are well aware of the inconveniences caused by the insufficient availability of information and data about wood energy sector. Part of the main concern to be tackled in the future and for which I expect we can find a clear way of action through this consultation. Weak, and in many cases, lack of data on forestry resources availability for fuelwood production, preparation, transportation, utilization, trade and marketing, has led to the absence of wood energy policies and strategies, which have caused that many projects and activities have not been able to achieve the results expected.

[1] Acting Chief, Non-Wood Products and Energy Branch (FOPN), FAO/Rome

Most of problems to be tackled by wood energy projects were identified under the perceptions and approaches developed before and after the Nairobi Conference on NRSE (1981). In this period the international situation was characterized by the “cold war”, high international oil prices, high concentration of oil resources and fuelwood and charcoal were considered the main causes of deforestation.

Now, the international situation looks quite different and the main concerns for the decade to come are: sustainable development and environment protection.

Once again, energy aspects are one of the main concerns of our society. Unbalanced emission of $C0_2$ and other pollutants resulting from the combustion of fossil fuels have led to seek new environmentally-friendly sources of energy. Wood energy systems, rationally planned and organized can contribute to mitigate part of this present environment concern in three different manners:

The first one, better organized and economically feasible wood energy systems will lead to protect our forests; in the meantime can contribute to increase their value through an increased utilization of the biomass available.

The second one, the protection and higher value of products derived from existing forests and wood lands, as well as new tree plantations for energy and other purposes will help to improve the environment at local level through soil conservation, water management and scenery.

The third one, if wood fuels are sustainable supplied, they constitute a source of energy with a balanced emission of C02 which can also contribute to absorb part of the excess of C02 produced by the combustion of fossil fuels.

With respect to sustainable development, again wood energy can provide a great contribution, particularly through the generation of new jobs and higher incomes. Considering that wood energy is always locally available source of energy, it can also contribute to the substitution of imported fossil fuels with all the derived socioeconomic implications.

In the past, the implementation of many wood energy projects and activities have left, among other things, a better understanding of the wood energy situations and have contributed to develop a critical mass of human resources, properly trained who have an important role to play in the years to come.

I would like to draw the attention of energy experts that, fuelwood and charcoal constitute the major source of energy of the national energy balances and for the forest experts I would like to remind that fuelwood and charcoal constitute the main forest product derived from forests and wood lands. Aspect which is particularly important when and and semi and lands are considered.

However, despite of these important factors above mentioned, we have hot been able to tackle most of the problems with fuelwood and charcoal, and the wood energy sector has not yet received the attention that it deserve.

On the other hand, it must be recognised that, wood energy sector is composed of millions of fuelwood suppliers and charcoal makers scattered in rural areas, that most of the fuelwood and charcoal is traded through informal markets, that fuelwood and charcoal even where is a commodity very often is freely appropriated or illegally cut.

These aspects make particularly difficult the collection of data and information and these are one of the problems to be overcome in future wood energy planning exercises. Aspects that also must be properly addressed and considered at the moment of formulating policies and intervention.

The experience of energy and forestry planners will be excellent but not enough. Ad hoc teams for data collection, analysis, processing and interpretation, must be trained and established as well as appropriate planning methodologies, should be adopted.

These groups composed by professional and technicians of different areas of specialization should be provided by institutions from the energy, forestry and other related organizations, including NGO's, in order to ensure the necessary participation of all the interested actors of the sector.

Participative wood energy planning exercises will constitute a key factor for the formulation of well integrated wood energy scenarios; scenarios which should be permanently reviewed and improved with updated and upgraded information in order to adjust the policies and actions to:

- the dynamic of different economic sectors,
- the needs of the different actors of the wood energy systems,
- the interrelation with socioeconomic and environmental aspects.

Furthermore, I'd like to remind that new and more advanced technologies for the utilization of other renewable and non-renewable sources of energy are upcoming in the horizon and some of these technologies can help to tackle part of the problems faced by the wood energy sector. Therefore, multi-disciplinary and interinstitutional teams for wood energy planning should be kept informed of the technological developments not only for the introduction of improved technologies on wood energy, but also for the utilization of other sources of energy such as new bio-fuels, solar energy, and of course, fossil fuels.

Last but not least, please be reminded that this consultation will be important for you, because you will have the opportunity to exchange views and experiences with colleagues of other countries and different sectors, but also will be important for us to know your problems, your needs and' so that identify the assistance to be provided by the project in the years to come.

I hope you enjoy your stay in Chiang Mai and you benefit from the fruitful discussions to be held in the different sessions of the consultation and I wish that this meeting constitutes a permanent guidance for our future work.

WHY A WOOD ENERGY WORKSHOP

EGBERT PELINCK
Chief Technical Adviser
Regional Wood Energy Development Programme in Asia

Let me start by welcoming you all to this first working session of the expert consultation. The Regional Wood Energy Development Programme feels privileged and fortunate that you have made the effort to come to Chiang Mai and share your views and experiences in wood energy development activities. Your presence and the quality of the contributions that we have received already, provide the main part of the answer to the question raised in the agenda of this meeting "why a wood energy planning workshop?". The papers we have received and had a chance to glance through do confirm the expectations we had when starting the organization of this meeting: New information has been gathered and analyzed in many Asian countries. This forms the basis for new perspectives on wood energy development programmes and policies that are emerging. The information is not just new, it is also much more accurate than the wild guesses on the basis of which we have often been forced in the past to draw our conclusions and formulate our recommendations. The information presented and to be discussed this week is expected to lead to the identification of new policy issues that need to be addressed and which will discuss in more detail, next week. This week we hope, not only to learn from the results of the various types of analysis of the wood energy situation in Asia, but also to learn how such more accurate information was obtained, managed and presented in a format that decision makers could make use of it. And how we can institutionalize and disseminate such approaches.

We take the liberty of interpreting your presence here, as an agreement that wood energy matters, and that it matters now and will continue to matter a lot in the foreseeable future... but I hasten to add that we would be most interested in views to the contrary. We hope and beg for debate, we urge you to frankly express your views and the reasons for them, as we subscribe to the belief that rational debate and discussion must form the basis for public policies and programmes. Now, with the global movement towards more open societies, more than ever.

Though the list of participants that has been distributed, seems to suggest that there are different categories of participants in this meeting (participants, resource persons, FA0 staff, etc.) with different responsibilities, we wish to emphasize that such differences are only of an organizational nature. It is understood that for the purpose of this meeting, we are all participating on an equal basis in the discussion, in our capacities as knowledgeable and interested individuals, rather than as representatives and advocates of any predetermined organizational perspective.

In addition to the emergence of new information and new methods to gather and analyze this, another reason for organizing this meeting at this point in time is more directly related to the planning and implementation of Regional Wood Energy Development support activities. The present phase of RWEDP ends by the middle of this year. Follow on activities are under the consideration of the institutions in the 11 countries presently participating in RWEDP, FA0 and the Netherlands' Government. Review of past activities and the current status of wood energy development is expected to contribute to better identification and planning of future priorities.

But most important of all I hope that the outcome of this meeting will underscore with solid data the importance of woodfuels for the livelihoods of the hundreds of millions of poor people in Asia, rural and urban, male and female, young and old. People whose concerns have been too often ignored or misunderstood in the quest for rapid modernization. And that they need more attention from the policy makers (and donor organizations) when they consider energy options for Asia for the next 30 to 40 years. Next week's meeting of energy and forestry policy makers from all the eleven member countries of RWEDP will be the first opportunity to get that attention. Your contribution will be crucial for that.

We thank you once again for your participation and wish you fruitful discussions and a pleasant stay here in Chiang Mai.

Wood Energy Development in Asia Assessment of Critical is Use, Constraints and Prospects

by

Auke Koopmans[1]

1. INTRODUCTION AND BACKGROUND INFORMATION

1.1 Introduction

In many countries, not only in Asia but also in other parts of the world like Africa, Latin America, Oceania, etc. fuelwood is an important source of energy. Unfortunately, although some scattered information is available on a few countries from a variety of documents like national statistics, energy balances, World Bank and United Nation organizations reports, etc. it is difficult to find a document which provides, by using detailed information on a country by country basis, a regional overview of the wood or biomass energy situation. This lack may result in weaknesses in the energy planning process for individual countries as well as for the region as a whole.

For this reason FAO Regional Wood Energy Development Programme in Asia (RWEDP) with support from FAO/Forest Industries Regular Programme decided to commission a desk study on the importance of biomass energy within South East Asia with emphasis on the 11 countries

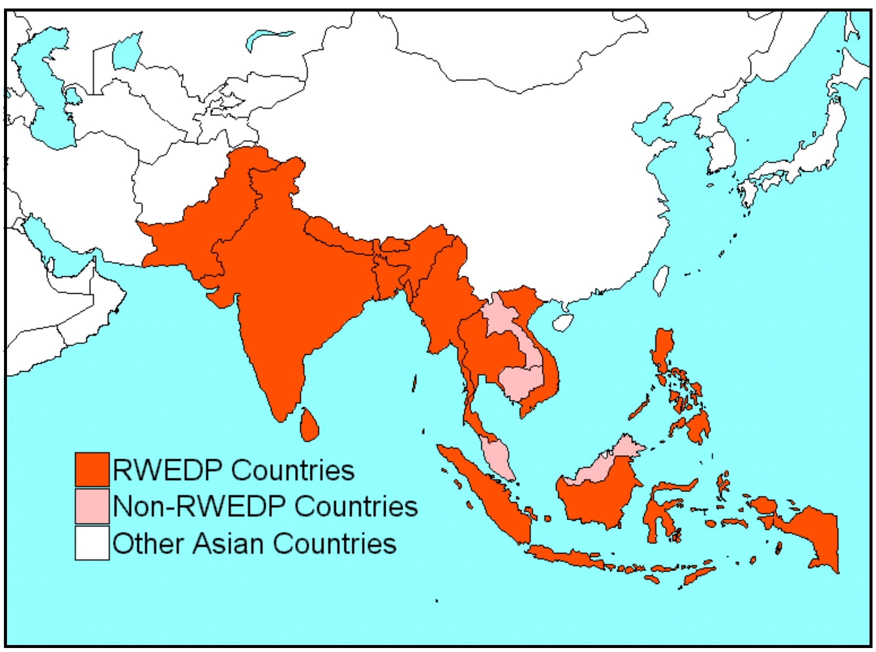

Figure 1.1: The RWEDP and Non-RWEDP Countries

[1] Managing Director, HSE - Green fields, P.O. Box 167, Chiang Mai, Thailand.

which are covered by RWEDP Asia. In addition to the 11 member countries e.g. Bangladesh, Bhutan, India, Indonesia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam, three other countries have been covered also. These countries, further mentioned as the Non-RWEDP countries consist of Cambodia, Laos and Malaysia. The reason to cover these three countries as well is as these countries form an integral part of the region and may become members of RWEDP in a future phase. Figure 1.1 shows the 11 member countries as well as the 3 non-member countries within Asia.

Besides fuelwood, other biomass sources such as agricultural residues in the form of straw, stalks, husks, cobs, etc., leaves, grass as well as animal dung also play an important role as a source of energy, not only for industrial use but also for domestic use. In fact fuelwood and other biomass energy sources are often inter-substituted, depending on availability, price, etc. It is therefore almost impossible to cover fuelwood alone. Within the present report, which attempts to give a regional overview of the importance of fuelwood, other biomass energy sources, collectively called the "traditional energy sources", are also covered for as far as a separation could be made. The term "Commercial sources of energy" within this report represent the other, mainly non-renewable energy sources like kerosene, natural gas, LPG, coal, electricity, etc. Although wood, charcoal and in some cases agro-residues are also commercially traded, these are considered as traditional sources of energy.

1.2 Background Information on the Countries

The 14 countries covered show large variations in terms of size, population, population density, forest cover, per capita Gross Domestic product, etc. Table 1.1 gives an overview of the size and the rate of growth of the population.

Table 1.1: Population and Population Density of RWEDP and Other Countries

Country/Region	Population in millions in 1990	Average population growth rate in % 1985-1990	Population density per sq/km 1990	Rural Population as % of total 1990
RWEDP Countries				
Banglades	115.59	2.67	888	83.6
Bhutan	1.52	2.15	32	94.7
India	853.09	2.07	287	73.0
Indonesia	184.28	1.93	102	69.5
Myanmar	41.68	2.09	63	75.2
Nepal	19.14	2.48	140	90.4
Pakistan	122.63	3.44	159	68.0
Philippines	62.41	2.49	209	57.4
Sri Lanka	17.22	1.33	266	78.6
Thailand	56.70	1.53	109	77.4
Vietnam	66.69	2.15	205	78.1
Non-RWEDP Countries				
Cambodia	8.25	2.48	47	88.4
Laos	4.14	2.82	18	81.4
Malaysia	17.89	2.64	55	57.0
RWEDP Countries	1,540.95	----------	----------	72.9
Non-RWEDP Countries	30.28	----------	----------	----------
ASIA	3,112.70	1.87	114	65.6
WORLD	5,292.20	1.74	40	54.8

Source: World Resources 1992-1993 (WRI, 1992)

Asia as well as the RWEDP region is heavily populated with Asia accounting for 58.8% of the worlds population while the RWEDP region accounts for 29.1%. Figure 1.2 shows the population distribution of continents as well as distinct regions of the world.

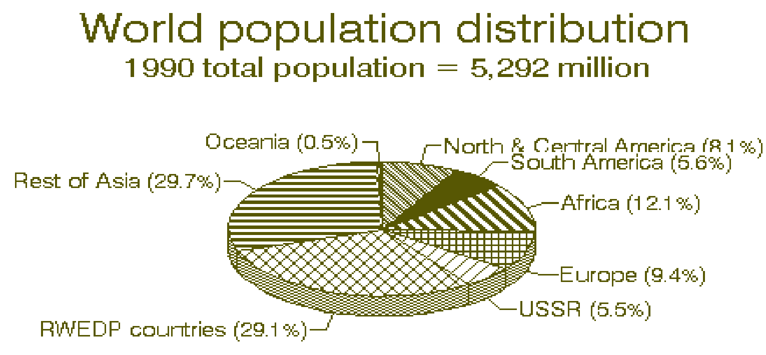

Figure 1.2 Population Distribution

From the table it is clear that all countries have quite a large rural population. However, it is expected that the urban-rural ratio will change dramatically in the RWEDP countries in the next 20-25 years from an average of 73% rural based population to an estimated 67% in the year 2000 and further falling to 60% in 2010. The accelerated urbanization trend has multiple reasons: A lack of job opportunities in rural areas and coupled with it a disparity of income, new agricultural land becoming scarce resulting in that existing plots have to be divided and subdivided, a lack of facilities in rural areas, etc. The figures 1.3, 1.4 and 1.5 show the population increase as a percentage of the size of the population in 1960 (WRI, 1992).

However, when population growth will stabilize is a matter of speculation. Demographic projections published by the World Bank in 1984 suggest a hypothetical stabilized population of around 11 billion by the year 2150. The most alarming feature of the population projections concerns the anticipated rates of growth in the poorest countries and regions. The Bank's projections show that for instance India's population will not stabilize until it reaches 1.7 billion while Bangladesh might have a stable population of 450 million (HABITAT, 1986).

The data as presented in table 1.1 should be treated with caution as there are large variations in population density. For example, Indonesia which shows an average population density of 102 people per sq. kilometer has a disproportionate population density. The island of Java covers about 7% of the total land area but at the same time is home to about 67% of the population, resulting in a population density of close to 1,000 people per square kilometer. This disproportional population density will influence the urbanization rate also and it is expected that by the year 2010 only 52% of the population will be living in rural areas, mainly outside the island of Java.

Table 1.2 shows data related to the Gross National Product (GNP) of the different countries which shows that most of the countries are poor to very poor with 6-7 of them (Bangladesh, Bhutan, Myanmar, Nepal, Vietnam, Laos and presumably Cambodia) belonging to the group of 25 poorest countries in the world. The same table also shows that the agricultural sector, including forestry, fisheries and hunting, is very important for most countries, not only in terms of providing food to the population but also in terms of providing employment.

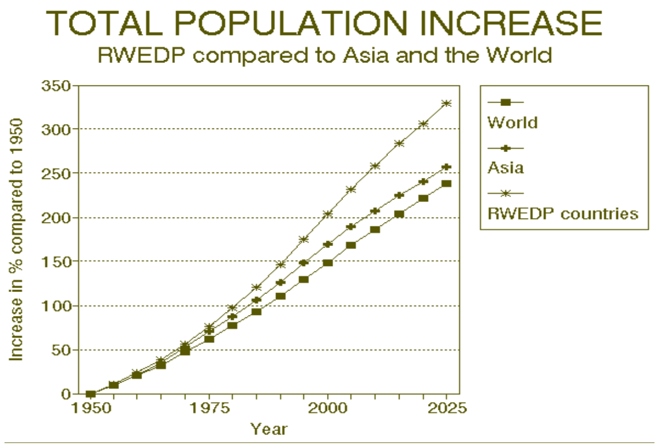

Figure 1.3 Total population increase

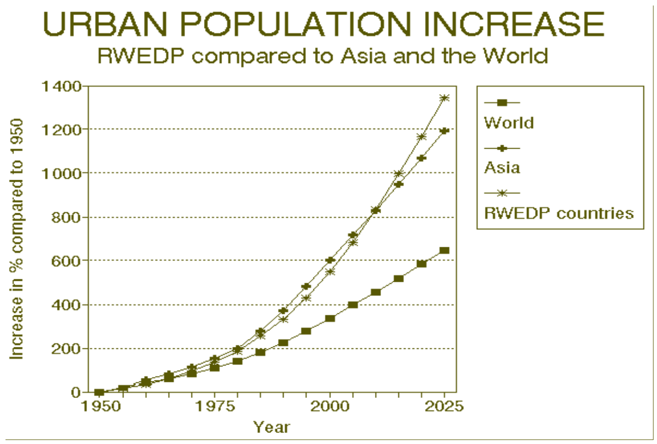

Figure 1.4 Urban Population Increase

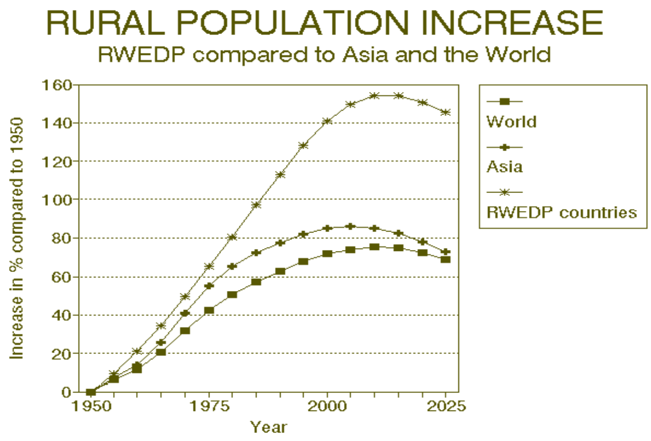

Figure 1.5 Rural Population Increase

Table 1.2: National account data and labour occupation

Country/ Region	GNP per Capita in US$ in 1991-92 [1]	Average annual change in real GNP 1979-1989	Distrib. of GDP 1989 % [2]			% of 1980 Labour Force in		
			Agric	Indust	Service	Agric	Indus	Service
RWEDP Countries								
Bangladesh	208	3.5	44.3	14.4	41.3	75	6	19
Bhutan	415	-----	46.1	29.3	24.6	---	----	----
India	310	5.6	31.7	28.5	39.8	70	13	17
Indonesia	605	6.5	24.1	35.7	40.2	57	13	30
Myanmar	250	2.3	----	----	----	53	19	28
Nepal	160	4.0	58.7	15.0	26.4	93	1	7
Pakistan	430	6.8	26.6	23.9	49.5	55	16	30
Philippines	725	1.8	23.5	33.3	43.3	52	16	33
Sri Lanka	510	4.0	26.0	26.8	47.2	53	14	33
Thailand	1,605	7.3	16.9	35.1	48.0	71	10	19
Vietnam	200	-----	----	----	----	68	12	21
Non-RWEDP Countries								
Cambodia	150	-----	----	----	----	---	---	----
Laos	180	-----	----	----	----	76	7	17
Malaysia	2,475	5.7	----	----	----	42	19	39

Source: World Resources 1992-1993 (WRI, 1992) and Asia Week Nov. 27, 1992
Note : (1) Data from Asia Week, (2) Numbers in italic are from earlier years. --- Data not available

However, the contribution of the agricultural sector to GDP, although considerable, appears to be low on a per capita basis when judged on the size of the labour force employed within the sector. This possible can be considered as an indication or measure of the amount of under-employment within the agricultural sector.

1.3 Land Area and Land Use

As is the case with population, the same is true for land areas and land use with individual countries showing large variations. Table 1.3 gives an overview of the land area covered, the amount of cropland, permanent pasture land, forest and woodland and other land as well as the percentual changes which have occurred since 1977-1979. Contrary to the population size, with Asia and the RWEDP countries accounting for a very large share of the total population of the world, the land area covered, as shown in figure 1.6, is relatively small. The large population size occupying a relatively small land area indicates that conditions with regard to land availability for agriculture, etc. is a large constraint, and will increasingly become so, in particular in comparison to other parts of the world. Besides the problems with agricultural land, the pressure on the forests and woodlands will increasingly become more severe, not only from fuelwood harvesting and as a source of timber for construction purposes but probably even more important as a source of land to grow food. With regard to the amount of forest and woodland as shown in table 1.3, not much is known. The RWEDP countries still have a forest cover of about 33% which, when compared to the Asia average of about 20% appears to be good. However, most of the forest is located in Indonesia and, in case Indonesia is taken out, the average forest cover of the RWEDP countries (minus Indonesia) drops to about 25%. In most cases the ratio of closed to open forest is known, but apparently only little information exists on crown cover, stocking, mean annual increment, etc. Deforestation rates are an equally uncertain factor and although again some information is available, much appears to be based on estimates. The World Resources Institute (WRI, 1992) estimates that within the Asian region annually 3.6 million ha. of forest has disappeared during the period 1981-1990. Insular South east Asia (Indonesia, Malaysia and the Philippines) account for 1,8 million ha with Indonesia alone accounting for about 1 million ha. Continental South East Asia (Cambodia, Laos, Myanmar, Thailand and Vietnam) account for 1,4 million ha. while the remaining Asian countries account for 0.4 million ha.

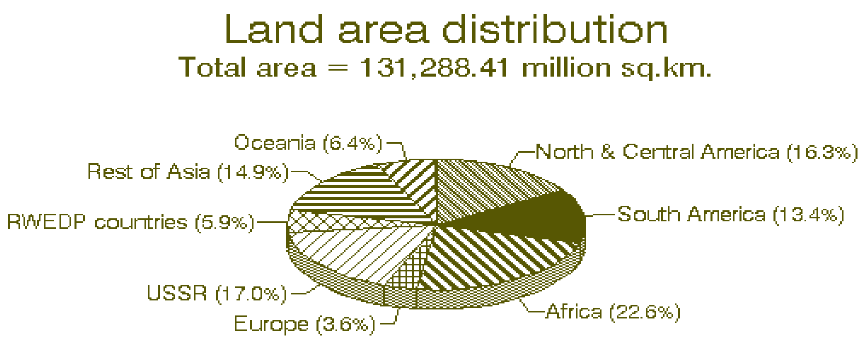

Figure 1.6 Area Distribution

Table 1.3: Land Area and Land Use in Sq Km. (1987-1989)

Country/Region	Total Area sq km	Total Area % of total	Cropland Area sq km	Permanent pasture area sq km	Forest/ woodland area in sq km	Other land area sq km
RWEDP Countries						
Bangladesh	130,170	0.10	92,710	6,000	19,660	11,810
Bhutan	47,000	0.04	1,300	2,700	26,000	17,000
India	2,973,190	2.26	1,693,570	119,230	667,820	492,580
Indonesia	1,811,570	1.38	212,330	118,000	1,134,330	346,910
Myanmar	657,540	0.50	100,350	3,620	323,960	229,620
Nepal	136,800	0.10	26,000	19,970	24,800	66,030
Pakistan	770,880	0.59	207,700	50,000	32,930	480,250
Philippines	298,170	0.22	79,570	12,200	107,500	98,900
Sri Lanka	64,630	0.05	18,980	4,390	17,470	23,790
Thailand	510,890	0.39	216,240	7,610	143,730	143,310
Vietnam	325,490	0.25	65,920	3,300	93,560	162,710
Non-RWEDP Countries						
Cambodia	176,520	0.13	30,560		133,720	6,440,580
Laos	230,800	0.18	9,010	8,000	129,000	84,790
Malaysia	328,550	0.25	48,800	270	193,400	86,980
RWEDP Countries	7,726,330	5.88	2,714,670	347,020	2,591,760	2,072,910
Non-RWEDP Countries	735,870	0.56	88,370	14,070	456,120	178,210
ASIA	27,312,280	20.80	4,544,560	6,942,510	5,388,550	10,436,660
WORDLD	131,228,410	100.00	14,778,770	33,229,430	40,953,170	42,327,370

Source: World Resources 1992-1993 (WRI, 1992)

1.4 The Energy Sector

The average per capita energy requirements (commercial as well as traditional energy sources such as fuelwood, residues, dung, leaves, etc.) in 1989 in the Asia region is estimated as 28 Giga Joule (GJ). From 1979 to 1989 the per capita energy consumption increased 26%. Even though the per capita energy consumption has increased considerable, it is still low when compared to the World's average of 67 GJ which, since 1979, only increased 2%. The RWEDP countries, however, show only a per capita total energy requirement of about 12 GJ, even lower then the Asian average.

Even though since 1979 the per capita energy use in North and Central America declined with 6%, the 1989 average of 233 GJ is still about 8-9 times as high as in Asia. Out of the individual RWEDP countries only Thailand has an average per capita energy consumption which is higher then the Asian average and out of the Non-RWEDP countries only Malaysia shows an above average consumption. Figure 1.7 presents an overview of the per capita energy consumption figures for the RWEDP and Non-RWEDP countries in comparison to other areas (WRI, 1992). However, with the area being densely populated, the total amount of energy consumed is considerable.

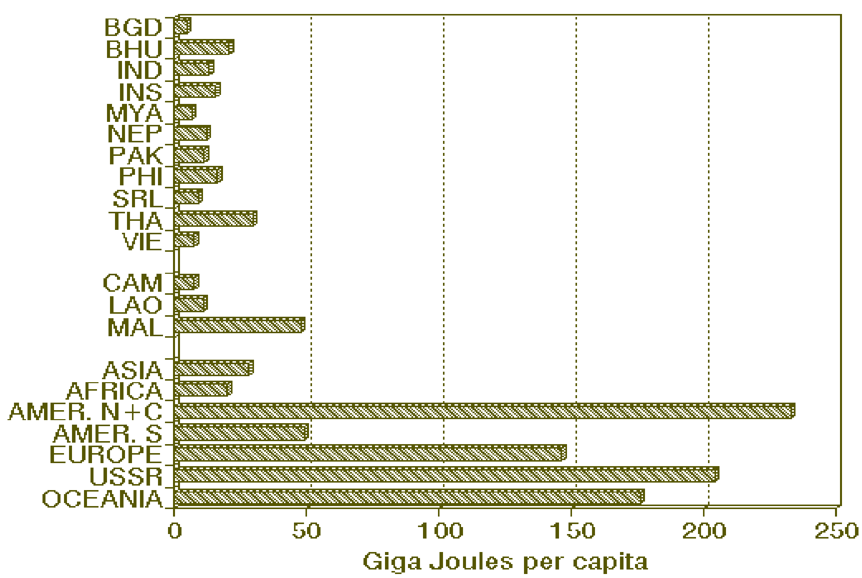

Figure 1.7 Per Capita Energy Use (commercial and traditional energy sources)

Even though the per capita energy use in the RWEDP countries can be considered low, it is estimated that the amount needed for cooking does not show large differences when compared to many western countries. The main difference is that in western countries cooking energy requirements are met by commercial sources of energy while, in most of the countries covered, traditional sources of energy play a much more dominant role. The apparent scarcity of the latter poses problems to many people, in particular for the urban and rural poor. However this problem of scarcity has many faces: Even in places, where traditional sources of energy are in abundant supply, people complain about problems with supplies. Part of these complaints are based on that people, in particular the poor and landless, do not have access to these supplies and therefore are facing scarcities. In other cases the workload of the people, often the women who are responsible for agricultural tasks, household chores, collecting water and fuel, etc. can be so high that, even though the fuels can be collected easily and freely, the time to do this is not available. In other cases fuels may be abundantly available but the means to transport it do not exist or are costly. This shows, albeit very briefly, that many issues are involved and that simply looking purely at the demand and supply of traditional fuels is not sufficient because their are many underlying factors, partly known but in other cases unknown, involved in understanding the traditional energy sector. This paper, which deals with a regional review of available information can only scratch on the surface of the demand and supply situation. It is therefore clear that no all encompassing solutions to the apparent problem can be advanced here.

2. THE ROLE OF TRADITIONAL SOURCES OF ENERGY IN THE RWEDP COUNTRIES

As shown in the previous chapter, the overall energy consumption (commercial as well as traditional energy sources) in the RWEDP countries can be considered, when compared to most developed countries, to be low to very low. The per capita energy consumption figures as presented in figure 1.7 cover all energy sources, including the traditional sources of energy e.g. fuelwood, charcoal, residues, dung, etc. Traditional energy sources play a very important role in most of the RWEDP countries and may in some cases account for close to 100% of the total amount of energy consumed.

2.1 Total Consumption of Traditional Sources of Energy

Table 2.1 provides an overview of the importance of the traditional energy sources within the overall energy consumption for different countries. It should be noted that the data as presented in table 2.1 in many cases are based on estimates[2] and may under- or over estimate the overall consumption. The estimates of the traditional sources of energy include fuelwood, charcoal and bagasse and it has been assumed that they include other traditional sources of energy such as straw, husks, chaff, dung, etc. as well.

The data, as presented in World Resources 1992-1993 (WRI, 1992) which are based on United Nations data, have been compared with information obtained from other sources such as World Bank reports (Issues and Options in the Energy Sector reports), TFAP and Forest Master Plan reports, etc. For those countries where information exists it appears that the actual energy consumption is considerable higher then what has been estimated within the U.N. system (UN, 1988 and UN, 1991).

This under-estimate is mainly taking place with regard to the amount of traditional energy sources. This is not surprising as these traditional sources of energy often are non-traded, collected for own use, etc. and therefore do not appear in any statistical information. However, although in most cases the differences are large in a few countries the estimates appear to be reasonably close, notably in Thailand. However, preliminary information gathered during studies in a few provinces for the Forest Master Plan indicate that the amount of fuelwood consumed may be far larger then previously estimated. A few examples of the underestimates will be given with WRI/UN estimates (WRI, 1992) normally given for the years 1972, 1976, 1989, 1984 and 1988 while the data for 1986 have been obtained from U.N. information (UN, 1988):

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2 For the commercial energy sources the estimates are based on official statistical information provided by the individual countries. Fuelwood and charcoal consumption data are estimated from population data and country-specific per capita consumption figures. These per capita estimates were prepared by FAO Rome after an assessment of available consumption data. Although energy values of fuelwood and charcoal vary, conversion factors were made using the United Nations Statistical Office standards e.g. 1 cubic meter fuelwood equals 0.33 ton coal equivalent (TCE) and 1 metric ton charcoal equals 0.986 metric ton of coal. The energy of a metric ton of bagasse is valued at 0.264 TCE. A Petajoule is one quadrillion (10^{15}) joules.

Bangladesh: An energy balance prepared for the year 1981 within the framework of the ADB-UNDP supported Bangladesh Energy Planning Project or BEPP (GOB-1987) gives a detailed overview of energy use within the country. As shown in figure 2.1 the amount of energy consumed in 1981 for which BEPP data were used is far larger then the WR/UN data suggest.

Table 2.1: Energy Consumption Data for the RWEDP Countries

Country/Region	Commercial Energy Consumption		Total Energy Requirements		Imports as % of consumption[1]		Traditional Energy as % of Total Consumption	
	Petajoules 1989	% Charge since 1979	Petajoules 1989	% Charge since 1979	1979	1989	1979	1989
RWEDP Countries								
Bangladesh	227	125	502	38	59	30	71	54
Bhutan	1	155	30	9	91	-189	99	95
India	7,528	94	10,693	70	13	8	33	25
Indonesia	1,453	44	2,852	32	-276	-180	53	47
Myanmar	74	36	268	27	-35	-15	71	69
Nepal	13	80	226	67	91	85	94	92
Pakistan	930	119	1,330	102	35	36	26	21
Philippines	527	9	983	21	87	85	38	38
Sri Lanka	55	17	153	21	89	83	54	52
Thailand	1,026	117	1,631	90	94	59	41	34
Vietnam	210	13	465	22	12	12	49	51
Non-RWEDP Countries								
Cambodia	6	1,353	58	41	100	98	99	89
Laos	5	12	43	25	7	15	82	83
Malaysia	705	128	834	117	-89	-151	17	10
RWEDP Countries	12,044	81	18,243	58	----	----	42	34
Non-RWEDP Countries	716	127	935	103	----	----	29	18
ASIA	70,787	54	84,136	52	-72	-194	13	10

Source: World Resources 1992-1993 (WRI, 1992)
Note : 1) Negative numbers indicate net exporters.

The latter estimate for 1980 show a total energy consumption of about 8-9 million TOE made up of about 30% commercial (2.5 million TOE, including other uses) and 70% (about 5.5-6 million TOE) traditional energy sources. The BEPP data indicate a total consumption of about 14 million TOE e.g. made up of about 21% (2.9 million TOE including non-energy use, losses, etc.) commercial energy and 79% (11.2 million TOE) traditional energy.

Myanmar: WRI/UN estimates indicate in 1980 a total energy consumption of about 5 million tons TOE (27% commercial and 73% traditional) while in 1988 the total amount was estimated at close to 6 million TOE (28% commercial and 72% traditional energy). World Bank reports (WB, 1985b and WB, 1991a) however indicate in 1982 a total energy consumption of about 11 million TOE (18% commercial and 82% traditional), rising to about 12 million TOE in 1990 consisting of 17% commercial and 83% traditional sources of energy. Figure 2.2 shows the energy consumption for the different years.

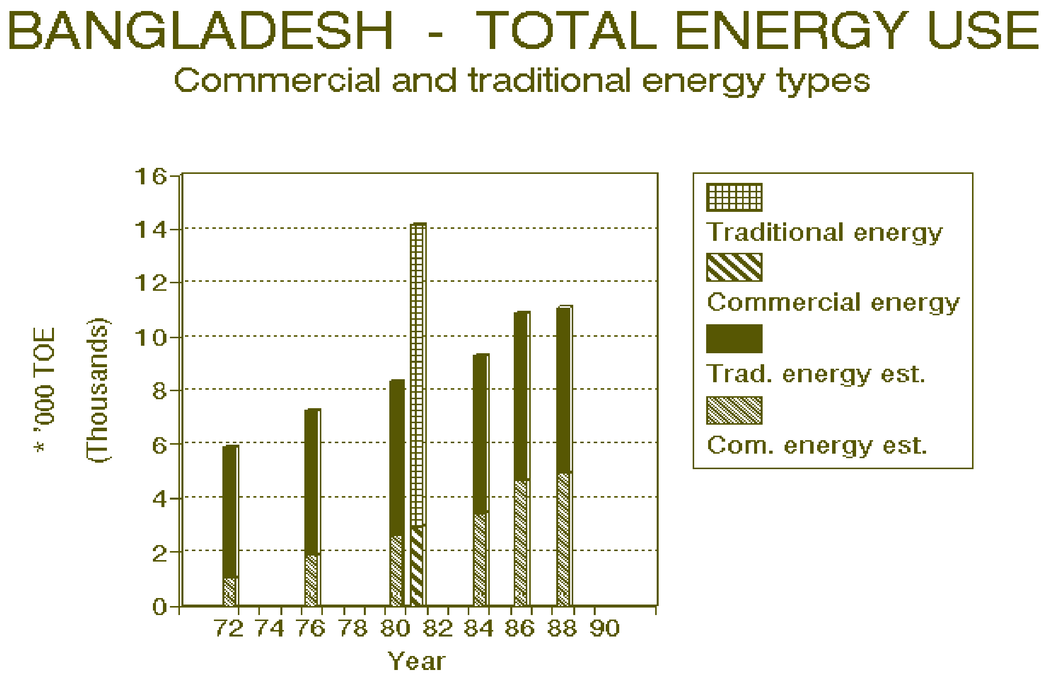

Figure 2.1 Comparison of Energy Consumption Data for Bangladesh

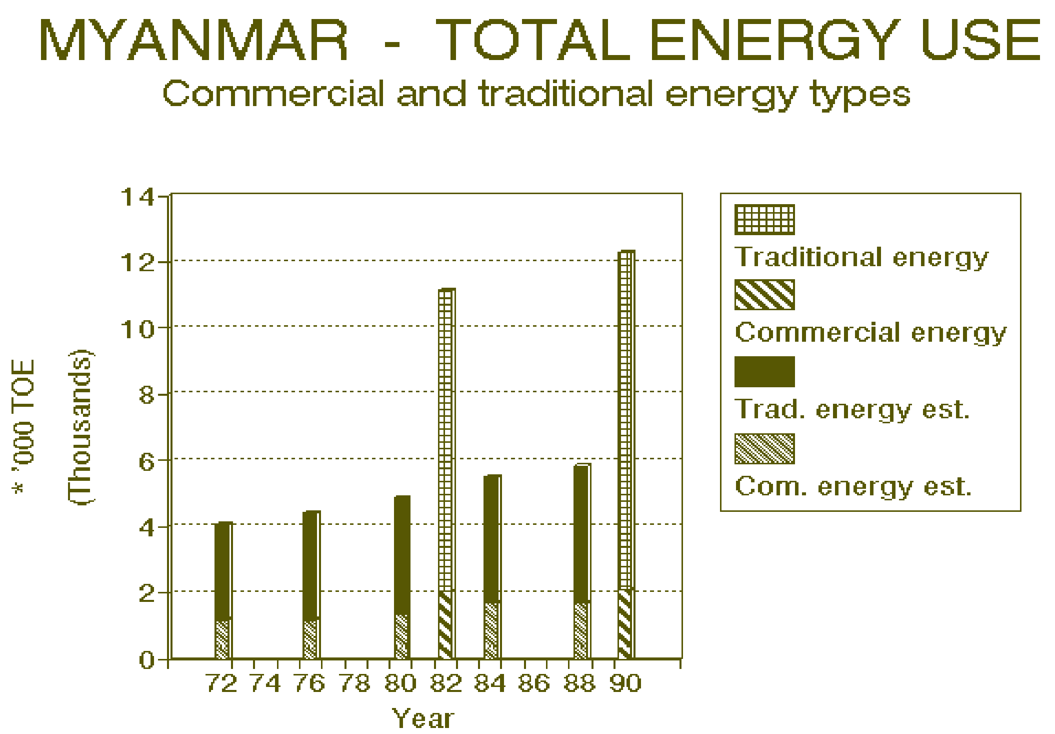

Figure 2.2 Comparison of Energy Consumption Data for Myanmar

Sri Lanka: WRI/UN estimates, as shown in figure 2.3, show for 1980 a consumption of about 3 million TOE (37% commercial and 63% traditional) while for 1989 the total is given as about 3.5 million TOE (36% commercial and 64% traditional). A World Bank report however reports a total energy consumption of 3.7 million TOE in 1980 (46% commercial and 54% traditional) while a recent estimate by the Alternative Energy Unit of Ceylon Electricity Board (CEB, 1990) gives a total consumption of about 6.5-7 million TOE (31% commercial and 69% traditional).

Vietnam: A provisional energy balance prepared within the framework of the Tropical Forestry Action Programme or TFAP (FAO, 1992a) indicates that the share of traditional sources of energy is far larger then what is estimated by WRI. Figure 2.4 shows the amounts of energy consumed with the data for 1988 derived from the TFAP exercise. The share of wood (from forests) amount to about 45% of the total amount of traditional fuels while, if other sources of fuelwood are included (from homesteads, scattered trees, saw dust, waste wood, etc.), fuelwood accounts for about 80% of all traditional sources of energy.

The discrepancy between the WRI/UN estimates with those from other sources are difficult to explain as only limited information is available. The inclusion or exclusion of traditional energy sources other then fuelwood, the manner in which losses (charcoal conversion losses, etc.) and energy sources used for non-energy purposes (feedstock for fertilizer production, etc.) are taken account of, the way in which electricity generation is handled (output or input energy data in particular with regard to hydro power), etc. all may play a role.

However, for as far as could be ascertained, more or less the same methods have been used and the reason for the differences are probably based on weak data sources. The WRI data are based on estimates or official government statistics but both may not be indicative of the actual situation. In this context it is worthwhile to quote the Bangladesh Bureau of Statistics (GOB, 1989) which publishes yearly data on the supply of traditional fuels based on extrapolation of 1974 estimates:

"The data relating to traditional sources of energy are relatively poorer in quality as they had to be assembled from a variety of sources producing information highly elusive in nature and widely scattered over the economy".

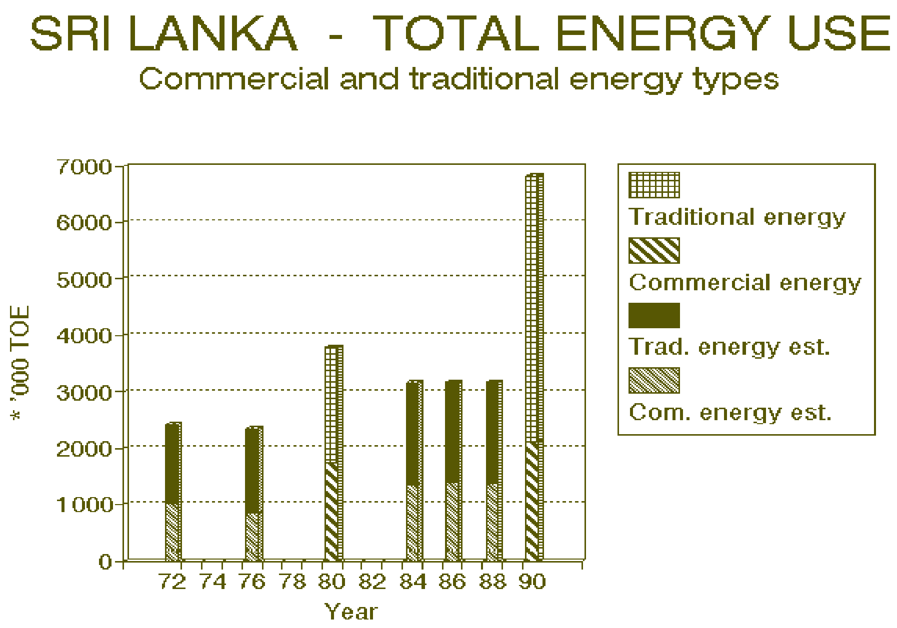

Figure 2.3 Comparison of Energy Consumption Data for Sri Lanka

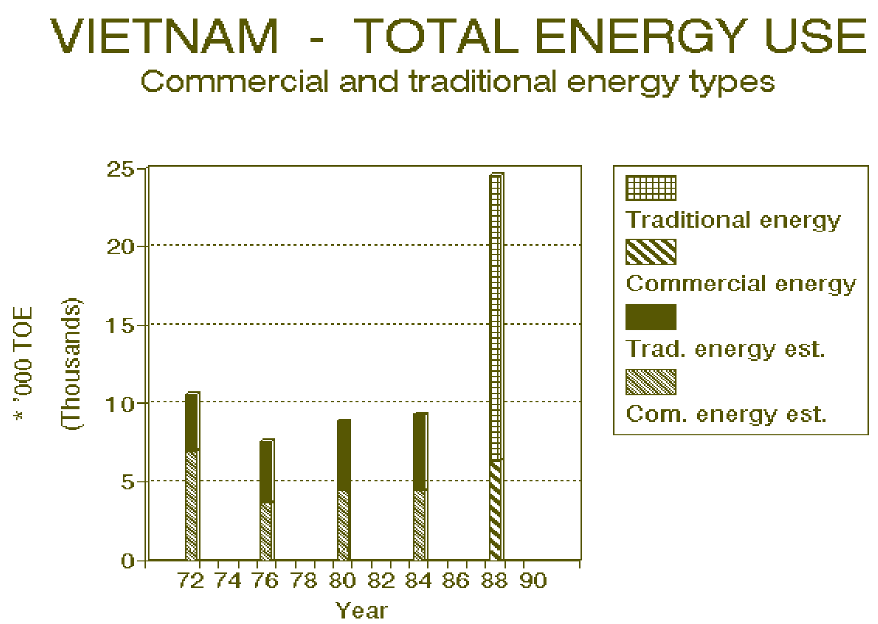

Figure 2.4 Comparison of Energy Consumption Data for Vietnam

The first column of table 2.2 shows the amount of traditional sources of energy used within the countries and was derived from table 2.1. However, for ease of reference, the amounts have been converted from Peta Joules to tons. This table shows, besides the WRI/UN estimates of the amounts of traditional energy consumed within the individual countries, also the amounts consumed according to other sources of information.

Table 2.2: Traditional Energy Use in Tons for the RWEDP Countries

Country/Region	Traditional energy use [1] Million tons in 1989	Traditional Energy Use in Million Tons[2]					Year/Source
		Total[3]	Fuelwood/ Charcoal	Residues	Baggase	Dung	
RWEDP Countries							
Bangladesh	17.98	31.95	5.86	23.88	1.53	6.70	**1981/BEPP, 1987**
Bhutan	1.92	0.94	0.92	0.02	----	----	**1988/FAO, 1991a[4]**
India	176.27	321.8	162.06	51.17	----	119.4	**1990[6]**
Indonesia	89.05	3	----	----	----	----	**1979/WB 1980[5]**
Myanmar	12.31	73.13	26.33	2.46	[7]	----	**1990/WB 1990A**
Nepal	13.92	28.46	----	----	----	----	**1985/TFAP 1988**
Pakistan	18.51	11.33	----	----	----	----	**1991/Ouerghi 1992**
Philippines	24.67	60.82	29.15	6.96	----	----	**1989/WB 1992b**
Sri Lanka	5.29	35.18	12.61	----	0.74	----	**1990/CEB 1990**
Thailand	37.42	13.08	23.86	3.38	6.32	----	**1988/NEA**
Vietnam	15.91	30.37	33.18	13.62	[7]	----	**1988/FAO 1992a**
		46.80					
Non-RWEDP Countries							
Cambodia	3.41		----	----	----	----	
Laos	2.38	----	2.40	----	----	----	**1989/GOL 1990a**
Malaysia	5.63	2.40	----	----	----	----	

RWEDP Countries	413.27	653.8 9	----	----	----	----	

Note: 1) Based on World Resources 1992-1993 (WRI, 1992)
2) Conversion factors used as mentioned in the original documents
3) Converted to fuelwood equivalent by using average conversion factors
4) A direct comparison can not be made as a different population size (700,000 in the FAO study instead of 1.4 million as used in WRI 1992
5) Traditional fuel use based on Soesastro et al (Soesastro, 1983)
6) Unpublished and unofficial estimates by ESMAP
7) Included under residues
-- No data available.

The WRI/UN data are said to be based on official statistics or, where these are not available, on estimates. The consumption of traditional sources of energy are invariably based on estimates provided by FAO. It appears that the consumption estimates of traditional sources of energy have been calculated using per capita consumption data and the amount consumed by other sectors may not have been included.

In other cases, in particular in the case of World Bank "Issues and Options in the Energy Sector" studies, it is not known how the energy consumption data were obtained. However, it may be assumed that these are based on the best available information at that time and in general include consumption by other sectors such as industry.

Comparing the consumption data for these countries where recent and more detailed information is available e.g. Bhutan, Myanmar, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam with the data for the same countries as presented for 1989 by WRI/UN the difference in traditional energy use is striking: 215.65 million tons versus 116.03 million tons or almost double. In some of the countries where in-depth studies have been carried out, the difference appears to be even more striking. Bangladesh and Pakistan are a good example: In these countries detailed studies with regard to energy use have been carried out or are presently being carried out. The results (in the case of Pakistan the preliminary results) indicate that the actual consumption of traditional sources of energy may be even a factor of 3 higher then estimated by WRI/UN.

2.2 Sectoral Consumption of Traditional Sources of Energy

2.2.1 Domestic versus other consumers

The data as given above in general show the total amounts of traditional sources of energy consumed with the exception of the WRI/UN estimates which appear to show only the domestic consumption. Even though the domestic sector is by far the largest consumer of these sources of energy, the other sectors and notably the industry (bricks, lime, textiles, food processing, etc.) also consume considerable amounts. Unfortunately, little information exists on the use of traditional sources of energy by these other sectors, except for a few countries where more in depth studies have been carried out. Table 2.3 provides an overview of the available information of the sectoral consumption of energy.

By comparing the data presented in table 2.3 with those in table 2.1 it is evident, as indicated earlier, that the present share of traditional sources of energy out of the total consumption appears to be quite a bit higher then what had been expected from other sources of information. Comparing the data for those countries for which recent data are available it appears that for most countries the share of traditional sources of energy is about 10-30 percentage points higher then the 1989 data shown in table 2.1. Thailand is an exception but, judging preliminary information gathered during studies carried out for the Thai Forest Master Plan, the amount of traditional sources of energy may be considerable higher then what has been estimated previously (personal communication Dr. Aroon Chomcharn).

Table 2.3: Sectoral Energy Consumption as a % of Total for RWEDP Countries

Country	Commercial Energy		Fuelwood and/or charcoal		Residues Dung, etc.		Total Traditional Energy Sources			Year/ Source
	Domestic	Oths	Domestic	Others	Domestic	Others	Dom.	Oth.	Total	
Bangladesh	3.8	9.8	11.7	3.4	57.6	13.7	69.3	17.1	86.4	1981/BEPP, 1987
Bhutan	1.5	11.3	75.1	11.8	0.6	0.0	75.7	11.8	87.2	1988/FAO, 1991a
India	----	----	-----	----	-----	-----	----	----	39.1	89/90 Est.[5]
Indonesia	12.6	33.1	50.9	3.5	-----	-----	----	----	54.3	1979/WB 1989[3]
Myanmar	0.6	12.0	84.1	----	2.5	0.8	86.6	0.8	87.4	1990/WB 1990a
Nepal	1.2	4.4	92.8	1.5	0.0	-----	92.8	1.5	94.4	1982/WB 1983a
Pakistan	7.1	40.1	41.2	11.6[1]	[1]		41.2	11.6	52.8	1991/Ouerghi 1992
Philippines	10.1	44.8	32.6	5.3	3.5	3.6	36.1	8.9	45.1	1989/WB 1992b
Sri Lanka	6.6	21.6	59.0	10.3[2]		2.3	59.0	12.6	71.8	1990/CEB 1990
Thailand	8.8	60.9	18.9	2.4	1.2	7.6	20.1	10.0	30.3	1988/NEA[4]
Vietnam	2.0	24.0	29.6	4.4	34.7	5.2	64.3	9.6	73.9	1988/FAO 1992a

Note: "Others" includes Industry, Transport, Agriculture, Commerce, Government as well as Other uses. Conversion losses have not been accounted for. -- denotes "No data available" while 0.0 denotes "Neglible amount"
1) Residues are included under fuelwood
2) Domestic fuelwood consumption apparently includes residues also
3) The Domestic sector includes Government use as well as use by Commerce
4) The Domestic use include use by Commerce as well
5) Estimate by the author, based on WRI/UN data for commercial energy and unofficial World Bank data for traditional sources of energy.

A further comparison shows that it appears that the consumption of traditional sources of energy by "Others uses" e.g. industry, transport, etc. have indeed not been included in the estimates as published by WRI, using official statistical information. Bangladesh is a case in point: Ignoring the amount of traditional energy used by the "Others" sector in 1981 (17.1% in 1981), the share of traditional energy becomes about 71.6% more or less equal to the 71% as shown in table 2.1 for the year 1979. However, the data from other countries show less conclusive evidence.

The "Others" sector, when compared with the Domestic sector appears to be rather small but nonetheless significant. Table 2.3 points to that this "Others" sector accounts for about 10-15% out of the total amount of energy consumed within the countries and has a share from 10-30% of the total amount of traditional sources of energy consumed. In fact, the amounts of traditional sources of energy used by the "Others" sector may even be higher. Studies carried out on behalf of the FAO-Regional Wood Energy Programme on fuelwood and other biomass use as a source of energy have identified many industrial activities which use such traditional sources of energy. For instance, in the case of Nepal, the amount of traditional sources of energy was estimated to be close to 3 million tons, far larger then the 0.17 million tons which can be calculated from the information provided in table 2.2 and 2.3 (1.5% of 11.33 million tons). Another source (WB, 1983) mentions that in 1980/81 the industrial consumption of fuelwood was only about 0.1 million tons.

Traditional sources of energy are important for this "Others" sector and can be considered as vital for the rural based industries: itself a vital sector of the economy because it provides income for many people in rural areas. Seen the problems with the reliability of supplies of commercial sources of energy in rural areas, wood fuels are for most of these rural based industries the only large scale heat energy resource which is economically viable and potentially sustainable. It is expected that therefor wood fuels will remain the major source of heat energy for many years to come.

Another reason why the consumption of traditional sources of energy is significant is that, in the case of the "Others" sector" it often involves transactions e.g. fuelwood, charcoal, etc. is traded rather then collected by the users themselves. An exception to this general rule are those activities which themselves generate sources of energy such as the coconut processing industry (coconut husks, -shells, -fronds, etc.), the rubber industry (wood from old rubber trees), sugar (bagasse), etc. Being traded means that it can and does provide opportunities for rural development through the generation of rural employment and income through the production, harvesting, processing and transporting of wood fuels.

2.2.2 Rural versus urban consumption

In the "Domestic" sector quite a lot of the fuelwood is non-traded. Users collect the fuelwood themselves from their own home yard, surrounding areas, forests, etc. This phenomenon s thought to be the main reason why we know so little about consumption as well as the source of supply of fuelwood. However, a part of the domestic use is also in the form of a traded good, in particular in the case of urban and semi-urban areas. For instance in the Philippines about 20% of rural consumers buy fuelwood while in urban areas (other then the National Capital Region) about 60% purchased their fuelwood supplies (WB, 1992b). Seen the trend towards urbanization identified earlier, and its possible implication on supplies of traditional sources of energy, attempts have been made to differentiate between rural and urban use.

Unfortunately, as is also the case for industrial and other use, very little is known about differences between urban and rural consumption. Urban users, having generally a better access to "commercial sources of energy" e.g. electricity, kerosene, etc., tend to shift from fuelwood to such sources as they are considered as being more convenient. The data which are available often only give a "static" overview e.g. only for one year and in most cases without an indication of how this relates to other sources of energy such as quantities, availability, price as well as other factors, notably government policies in the form of subsidies, etc.

In Bangladesh the urban population size was about 13.5 million in 1981 while the rural population size was about 73.6 million. The urban population consumed for cooking and for commercial purposes 1.4 million tons plant residues as well as 2.15 million tons of fuelwood, resulting in a per capita consumption of 104 kg. residues and 159 kg. fuelwood. In rural areas the consumption amounted to 17.97 million tons residues, 2.62 million tons fuelwood and 6.7 millions of dung. On a per capita basis this would result in 244 kg. residues, 36 kg. fuelwood and 91 kg. dung (GOB, 1987).

In India some information on fuelwood consumption is available for 1978/79. For the whole of India, fuelwood consumption was estimated to be 98.31 million tons (unpublished information by World Bank) although other estimates ranging from 93 to 125 million tons are also quoted by other sources. Out of this amount, about 16.14 million tons were consumed by the urban sector. The urban population of India for the year 1979 was approximately 155 million while the total population size was about 674 million. The per capita consumption for whole India would than amount to about 146 kg., the urban per capita consumption about 104 kg. while the rural per capita consumption would be about 158 kg. per capita per year. For comparison, the per capita consumption in 1990 for whole India (urban as well as rural) is reported to be 152 kg. fuelwood, 48 kg. residues and 112 kg. dung cakes (no information available on commercial sources of energy).

In Nepal there are large regional variations in rural areas due to its varied conditions. The population in the Hills consumed in 1980/81 on average about 636 kg. of fuelwood while those in the lower lying Terai used on average about 383 kg. The difference is mainly caused by the greater need for heating in the Hill areas. The national average for rural areas in Nepal was about 510 kg. while in urban areas the consumption was found to be only 248 kg. (WB, 1983).

In the Philippines information for 1989 is available for urban and rural domestic consumption of energy from the Household Energy Consumption Survey (WB, 1992b). The per capita consumption for the Philippines for respectively Fuelwood, Charcoal and Residues amounted to 302 kg. fuelwood, 26 kg. charcoal and 42 kg. residues. In rural areas the consumption amounted to 408 kg. fuelwood, 20 kg. charcoal and 58 kg. residues. In the urban areas on a per capita basis 138 kg. fuelwood, 35 kg. charcoal and 18 kg. residues were consumed annually. In the National Capital Region, comprising about 30% of the Philippine urban population, about 16 kg. fuelwood, 15 kg. charcoal and 2 kg. residues were on average consumed on a per capita basis.

In Thailand in 1983 the size of the urban population stood at 12 million while the rural population size was 36.1 million. The rural population consumed on a per capita basis 116 kg. oil equivalent of traditional energy sources (fuelwood, charcoal, residues) and 10-11 kg. modern fuel sources. In urban areas these figures are about 25 kg. traditional and 35 kg. modern sources of energy, both expressed as oil equivalent. Assuming a ratio of 40% fuelwood and 60% charcoal, the rural per capita consumption would amount to about 135 kg. wood and 104 kg. charcoal while in urban areas the consumption would amount to 29 kg. fuelwood and 23 kg. charcoal both on an annual per capita basis (WB, 1985).

Analyzing the limited data available it is clear that in general the rural population consumes, on a per capita basis, considerable more energy than their urban counterparts. This is not surprising as the same feature had been found to be valid for many other countries as well (Leach, 1987; Leach and Gowan, 1987). It is also evident that there are large variations from country to country, depending on the forest situation, availability and security of supply for alternative and/or substitute sources of energy as well as end-use equipment (stoves, cylinders, etc.).

In urban areas commercial sources of energy like kerosene, electricity, LPG, natural gas tend to be not only more easy available but, probably more important, the supply of such fuels is more reliable when compared to rural areas. In urban areas most, if not all, sources of energy are monetized and people tend to prefer the commercial sources of energy for their ease of use and their "modern" appeal. Fuelwood and charcoal are used by both the urban and rural population. These sources of energy, in particular fuelwood, tend to be more important in rural areas then in urban areas. In Bangladesh, fuelwood was and probably still is more important in urban areas then in rural areas, probably because residues are widely available in rural areas and fuelwood which is available, can be sold to earn cash.

Residues are an important source of energy for the rural population, not surprisingly, as these are the areas where they become available. Having often a low weight to volume ratio, the transport and the costs related with it tend to discourage movements from rural to urban areas. The same is true for dung (cakes and/or sticks). Besides, as wood fuels can be sold for cash to urban areas, rural users sometimes sell their local supplies and use themselves lower grade fuels like residues.

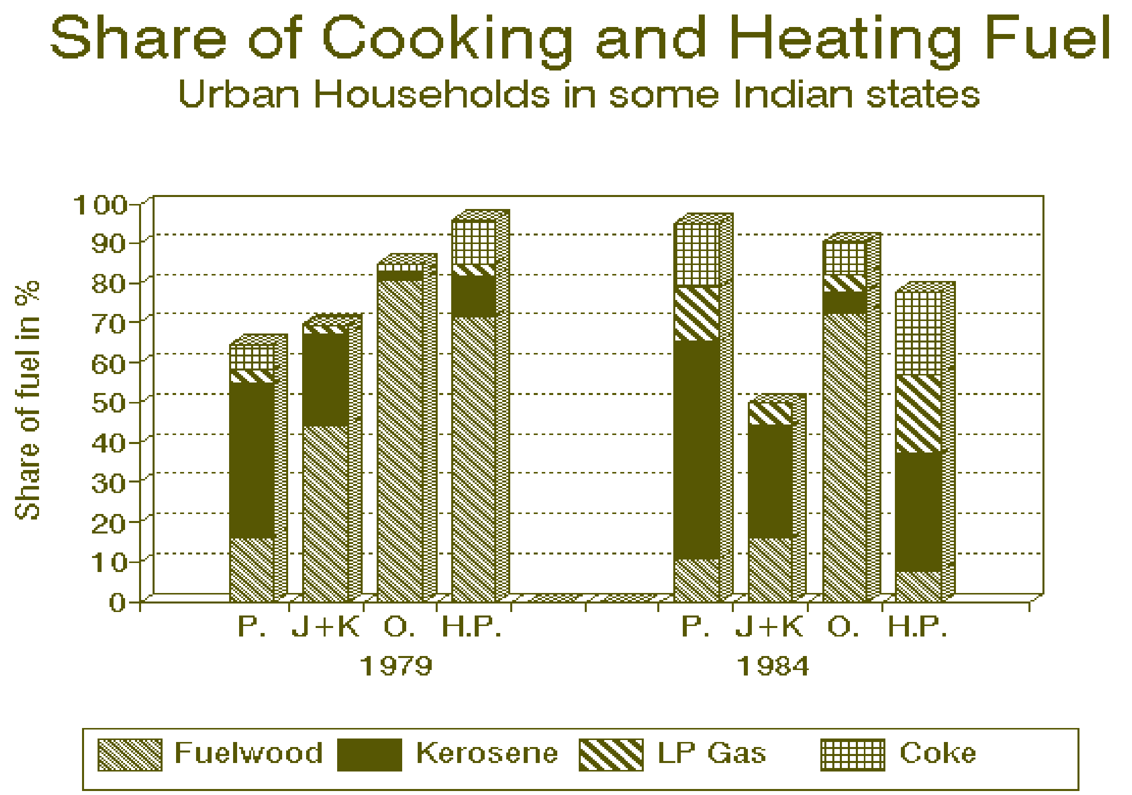

Figure 2.5 Changes in Consumption of Cooking and Heating Fuels in Urban Areas of Some States in India

Changes in the consumption do take place. In general there is a tendency to upgrade e.g. from lower grade fuels like residues and fuelwood to kerosene, electricity, etc. However, much depends on the local situation (price, availability, reliability) and although changes in rural areas tend to be rather slow, conditions is urban areas are known to fluctuate more easily.

This is also evident from figure 2.5, derived from Leach (Leach, 1987) which shows changes from 1979 to 1984 in the composition of fuels used for cooking and heating in urban areas of some Indian states: Punjab (P.), Orissa (O.), Himachal Pradesh (H.P.) and Jammu and Kashmir (J+K). In two states the share of cooking and heating fuels has dropped, in the other states it went up. In Himachal Pradesh fuelwood use has almost disappeared while other states show more or less static shares. These changes in consumption are an indication, at least in the case of urban areas, that country wide aggregate figures for fuel consumption will not be very helpful in predicting what will happen. Apparently there are many factors which govern consumer behaviour and on which probably not much influence can be exerted.

Prices, availability of stoves and other factors also play a role. In the north-eastern part of Thailand stoves fueled with diesel oil are commercially available. Even though dieseloil is cheap and can be bought almost everywhere, the stoves are not popular as spareparts and maintenance services are not available (FAO, 1991c). In the Philippines, the demand for kerosene and LPG doubled from 1985 to 1990, mainly because pricing policies lowered its price considerable in comparison to other sources of energy (WB, 1992b).

2.3 Evolution of Fuelwood Consumption

Very little information exists on the evolution of fuelwood consumption over time, other then estimates mainly with regard to projections of consumption in the future. These projections are mainly based on estimates of substitution of fuelwood by other sources of energy like kerosene, electricity, gas, etc. Only in the case of Sri Lanka, Nepal and India some information exists on fuelwood use on a year by year basis. However, it is not known what has formed the basis for these data.

The information from India (unpublished data from the World Bank) show that from the period 1978/79 to 1983/84 the urban fuelwood consumption dropped by an average of 40% from 16.14 million ADT (air dry tons) to 9.67 million ADT. Kerosene and LPG consumption rose over the same period from 1.61 to 2.52 million kiloliter kerosene and from 0.31 to 0.61 million tons LPG. However, there are large regional variations.

However, the size of and changes in the urban population are not given but, by using other information sources and assuming that in both cases the term "urban population" does not show large differences, the urban population in 1978/79 was calculated as about 155 million while in 1983/84 the urban population stood at about 186 million people. Using these data it can be calculated that fuelwood consumption dropped from 104 kg. to 52 kg. per capita while kerosene and LPG consumption rose respectively from 10.4 to 13.5 litre kerosene and from 2 to 3.3 kg. LPG.

Analyzing the data for India it appears that the per capita consumption of energy in urban areas has dropped by about 10% (assuming end use efficiencies of 15% for fuelwood, 40% for kerosene and 55% for LPG). However, it has to be noted that there are many unknowns as well as assumptions made and the evidence is far from conclusive.

Comparing the available data for the whole of India it appears that the fuelwood consumption on a per capita basis has remained more or less stable with an approximate 146 kg. of fuelwood per capita consumed in 1979. This amount is based on a population size of 674 million and a consumption of 98.31 million tons (unpublished information by World Bank). The same source indicates that in 1990 the per capita consumption of fuelwood was estimated to be about 152 kg.

In Nepal the total consumption of traditional sources of energy (domestic as well as all other sectors) rose from 2,165 million tons oil equivalent (TOE) in 1970/71 to 2,806 million TOE in 1980/81 and 4,954 million TOE in 1988/89 (WB 1983). This represents average annual growth rate of 2.6% from 1970 to 1980 and about 7.4% from 1980 to 1988. It is not known how much fuelwood contributed to the amount in 1970/71 but in 1980/81 fuelwood accounted for 2,723 million TOE, equal to about 8 million tons fuelwood. In 1985/86 fuelwood use amounted to about 11 million tons while in 1988/89 the amount of fuelwood consumed amounted to 11.697 million tons (WECS, 1992). On a per capita basis the fuelwood consumption shows a decline from 696 kg. per capita in 70/71 to 661 kg. in 85/86 and 650 kg. in 88/89. Besides fuelwood, other traditional sources of energy were also consumed.

The projections for the consumption of traditional sources of energy as given by the World Bank (WB, 1983) indicate for 1989/90 a consumption of 3.479 million TOE both for "Accelerated Economic Growth" and "Economic Stagnation" scenarios. However, the actual consumption of 5.179 million TOE for 1988/89 as given by the Ministry of Water Resources (WECS, 1992) is far higher. The latter may be even much higher in case the actual consumption by the industrial sector is indeed about 3 million tons (FAO, 1988), instead of the approximately 0.2 million tons as given in the statistics.

Extensive information from Sri Lanka is available for all sectors of the economy with regard to all sources of energy (GOS, 1992). In the domestic sector the use of traditional sources of energy increased from 6.818 million tons (2.59 million TOE) in 1975 to 7 million tons in 1980 (2.662 million TOE), 8 million tons in 1985 (3.04 million TOE) to 8.6 million tons in 1990, equal to 3.268 million TOE. Including the other sectors, these figures are respectively 3.026 million TOE in 1975, 3.082 million TOE in 1980, 3.536 million TOE in 1985 and 3.904 million TOE in 1990. However, it is not known how much fuelwood contributed to these amounts. Assuming that all is fuelwood the per capita consumption would have changed from about 505 kg. in 1975 to about 509 kg. (domestic consumption only) while, if all sectors are included the per capita consumption would have changed from 590 kg. to 599 kg.

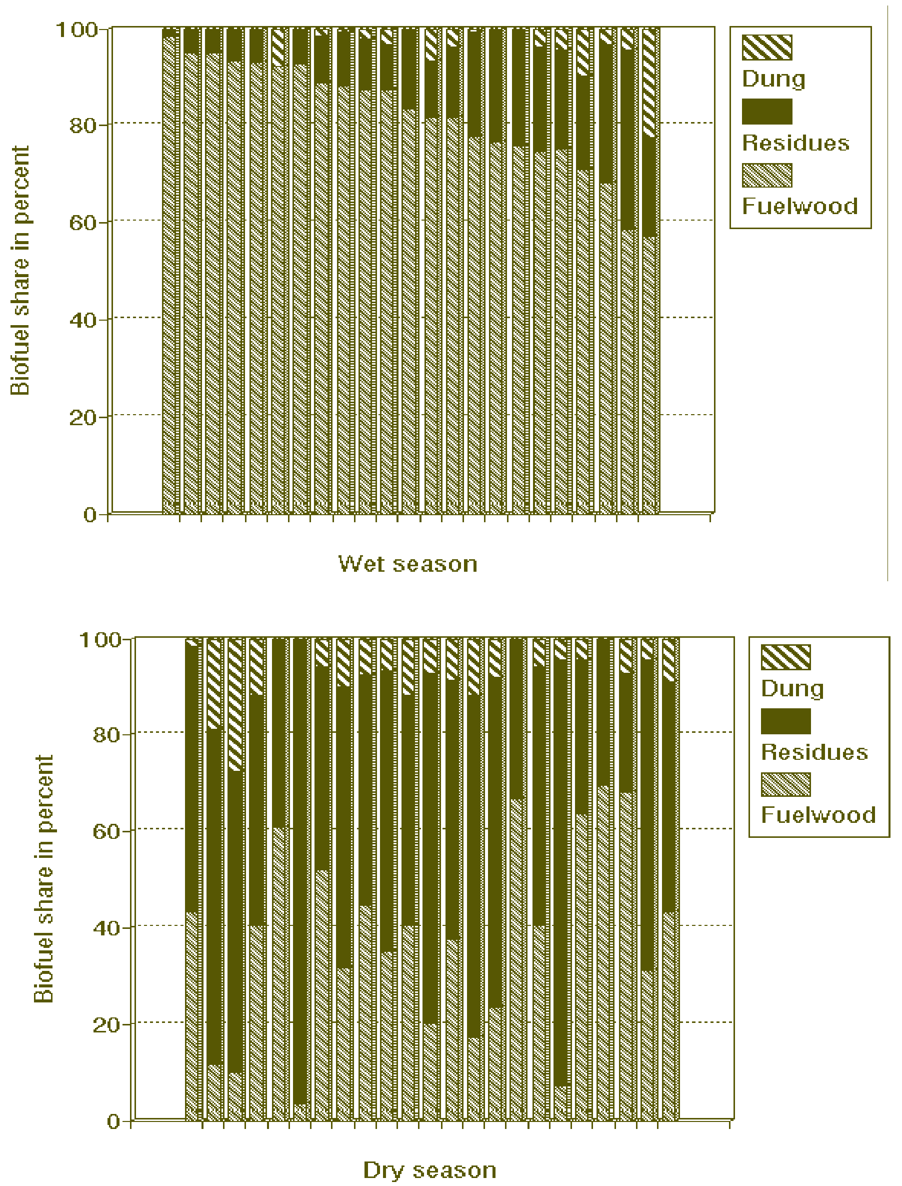

Figure 2.6 Seasonal Variation in Types of Biofuel Consumed During the Wet and Dry Season in 23 Villages in Bangladesh

Although these figures show a small increase in the per capita consumption, the differences are not large and drawing straightforward conclusions that for instance the per capita consumption has risen is not warranted. Seasonal variations (hot or cold, wet or dry, etc.) may cause variations, not only in consumption but also in seasonal shifts in the use of fuel types. This is shown in figure 2.6 which shows seasonal variations in 23 villages in Bangladesh as well as figure 2.7 which gives indications of climatic and agro-climatic variations in energy use and energy mix.

Extrapolation of data (apparently the case in Sri Lanka where consumption figures for each sector and every year are available), differences in the survey technique used, etc. may also have influenced the apparent increase in per capita consumption. Changes in household size and household income, migration from rural to urban or vice-versa or from one rural area to other rural areas are known to have an influence on the per capita use of energy (Leach, 1987).

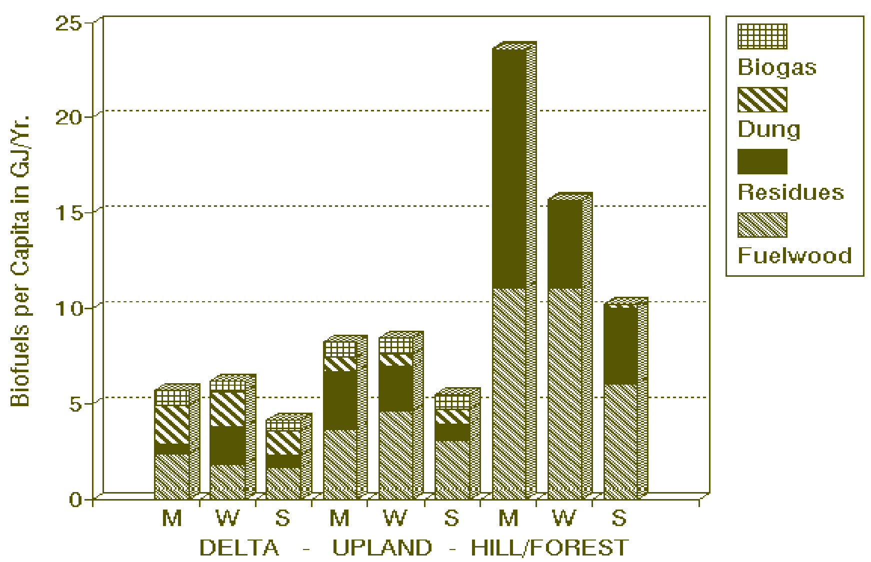

Figure 2.7 Fuel Consumption During the Monsoon (M), Winter (W) and Summer (S) and Agro-climatic Zones in 12 Villages

However, in general it can be expected that changes in factors which influence the per capita use of energy will not happen suddenly. It should be noted though that massive substitution can and does take place if the conditions are right or favour them. Any survey on energy consumption, out of necessity due to cost and time constraints, can only cover a minuscule part of the total consumers. Such an average no doubt will be different from that generated earlier or later and it is felt that, with small differences, these should not considered as being a trend in the total consumption. Only when it is known that sudden changes in conditions have taken place should such relatively small changes being studied more in depth. This, for instance, should be done in the case of Indonesia where early 1993 the government removed subsidies of kerosene, resulting in a price increase of 27% for kerosene. However, changes may be small but the total amounts involved could be considerable: in the case of India the change from 146 to 152 kg. per capita concerns about 5 million tons!

It is expected that the fuelwood consumption in its totality will not drop for the foresee-able future and it probably will continue to rise considerable. This expectation is based on the fact that the rural population in its totality will continue growing although its share in the total population is expected to fall due to increased urbanization. However, this assumption is based on that changes in consumer behaviour in rural areas will not change drastically.

It has been shown that in urban areas changes do take place and in some cases quite rapidly. For rural areas less is known but it may be assumed that, given the right conditions, that changes also will take place here but probably at a slower pace. It is evident that there are large variations between regions and villages, between agro-climatic zones, between climates, etc. In order to be able to have a better indication of the total consumption of traditional fuels on a country wide basis and to draw reasonably valid conclusions with regard to the future it seems useful to have, for as far possible, dis-aggregated data for the consumption. Such dis-aggregated data should not only cover different areas but also different climates.

3. FORESTS AND LAND USE IN THE RWEDP COUNTRIES

In most, if not all countries, the forests once covered large areas but with a growing population there has been an ever increasing need for agricultural land to feed the population. This has resulted in an indiscriminating conversion of forests into agricultural land by various means e.g. shifting cultivation, slash and burn, the conversion of logging areas to other uses once the merchantable wood had been removed, etc. Besides these factors, the need for local construction timber, fuelwood, charcoal, non-wood products, etc. may also have contributed to a loss of forest cover. Large tracts of forests have in some countries also been lost due to flooding for hydro-electric schemes and/or irrigation purposes, road construction, population resettlement schemes, etc.

With regard to land use as well as the extent of changes in land area and land use information is available from several sources. The information provided by the World Resources Institute (WRI, 1992) is reproduced here in table 3.1. However, it should be noted that a cursory review of the information shows that there are large variations between the different sources of information as well as several anomalies.

One of the reasons for the differences is that definitions of land use may vary from country to country, within countries but, maybe more important, different organizations which collect data may use different definitions. Besides, adjustments in the definitions of land-use categories as well as revisions to data do happen also. For instance, the Food and Agriculture Organization of the United Nations (FAO changed in 1985 the definition for "Cropland" by excluding land used for shifting cultivation but currently lying fallow, making comparisons over a longer period difficult if not impossible.

Anomalies in the data are also common. Pakistan, according to WRI data, shows an increase in forest and woodlands of over 17% in a 10 year period. The same publication shows that the annual deforestation from 1981-1985 has been 9,000 ha. and the annual reforestation rate about 7,000 ha. which would indicate a net deforestation.

In the context of table 3.1. "Forest and Woodlands" are defined as "Natural or Planted Trees as well as Logged-over Areas that will be reforested in the near future" and this may be part of the reason for the apparent anomalies in the data. According to the Forestry Sector Master Plan for Pakistan (GOP, 1991) the term "Forest" is used as a legal classification of land under the control of the Forest Department. Private forests are not classified as such and this may be another reason for anomalies.

Another example of the differences and anomalies is Vietnam. "Forest and Woodlands" in Vietnam show an increase of forest cover from 8.5 million ha. to 9.8 million ha. from 1987 to 1989 according to the WRI database. However, statistical data from FAO given in "Selected Indicators of Food and Agriculture Development in Asia Pacific Region for 1978-88" (FAO, 1989d) and comparing these with the 1980-90 edition (FAO, 1991b) show a decrease from 12.95 million ha. in 1987 to 9.8 million ha. in 1989. Studies carried out within the framework of the Tropical Forestry Action Programme for Vietnam show that in 1989 Vietnam had 16.4 million ha. classied as forests (excluding national parks, etc.). Out of this amount 7.3 million ha. had a forest cover while the remaining 9.1 million ha. were non-forested and/or degraded (FAO, 1992a).

Data for other countries show also differences and it is therefore clear that the data presented in table 3.1 and, in particular the trends, should be interpreted with the utmost caution.

Table 3.1: Land Area and Land Use in 1987/1989 and Changes in % from 1977/1979

Country/Region	Land Use in '000 hectares (Area) in 1987/1989 and % Percentage Charge (%) Since 1977/79									
	Cropland		Perm.Pasture		For/Woodland		Other Land		Wilderness[1]	
	Area	%	Area	%	Area	%	Area	%	Area	%
RWEDP Countries										
Bangladesh	9,271	1.5	600	0.0	1,966	-	1,181	8.9	0	0
Bhutan	130	10.5	270	2.5	2,600	10.6	1,700	-5.0	1,179	25
India	169,357	0.5	11,923	-3.4	66,782	2.8	49,258	-0.1	1,161	0
Indonesia	21,233	9.3	11,800	-1.9	113,433	0.7	34,691	15.5	11,761	6
Myanmar	10,035	0.3	362	0.1	32,396	-5.2	22,962	-1.2	2,547	4
Nepal	2,600	11.9	1,997	7.7	2,480	0.7	6,603	-6.0	0	0
Pakistan	20,770	3.3	5,000	0.0	3,293	0.0	48,025	-2.3	2,737	3
Philippines	7,957	4.4	1,220	23.1	10,750	17.3	9,890	18.6	0	0
Sri Lanka	1,898	0.5	439	0.0	1,747	-	2,379	0.7	0	0
Thailand	21,624	21.8	761	26.8	14,373	16.4	14,331	-8.8	2,809	5
Vietnam	6,592	2.3	330	20.5	9,356	-1.5	16,271	28.2	0	0
						-				
Non-RWEDP Countries						15.6				
Cambodia	3,056	0.3	580	0.0	13,372	-	644	-1.5	0	0
Laos	901	4.6	800	0.0	12,900	26.8	8,479	12.8	437	2
Malaysia	4,880	2.5	27	0.0	19,340		8,698	37.5	2,844	9
						0.0				
						-7.2				
						-				
						11.0				

Source: World Resources 1992-1993

Note : 1) Area valid for 1988 and % shows the percentage of the total area

As mentioned before, loss of forests or trees has many reasons and an important one of these will be the demand for more agricultural land. Leach and Mearns in their "Beyond the Woodfuel Crisis" (Leach, 1988) give some examples from African countries to substantiate this claim. They quote a chief forestry advisor of the World Bank as having estimated that from 1950 to 1983 the loss of forest cover in Africa for 75% could be attributed to clearing of land for agricultural purposes. Unfortunately, little information exists to this regard for the RWEDP countries except for Bangladesh, India and Vietnam.

In Bangladesh, based on national statistics (GOB, 1990), the forest area decreased from 1981/82 to 1986/87 from 2.14 million ha. to 1.99 million ha. equal to an annual loss of 31,000 ha. Agricultural land increased on an annual basis with 54,000 ha. (taking the shift from single cropped to multiple cropped area into account the increase is estimated to be 181,000 ha.).

In India, according to the Central Forestry Commission the land under their jurisdiction fell by 4.14 million ha. between 1951/52 and 1975/76 - a loss of only 0.17 million ha. per year. This loss was attributed to the need for agricultural land (61%), hydropower and irrigation dams and lakes (12%) and miscellaneous including fuelwood cutting (23%). More recent estimates, based on satellite imagery, show that the area of closed and open forest cover decreased between 1972/75 and 1980/82 from 55.52 to 46.35 million ha. or an annual loss of 1.2 million ha., a factor of 7 higher than previously estimated. No figures are given for changes in land use for agricultural purposes.

For Vietnam some information is available from the TFAP study on fuelwood demand and supply (FAO, 1992a). Deforestation rates range from 45,000 ha. to 100,000 ha. annually while the increase in agricultural land was said to be about 70,000 to 80,000 ha. annually.

Analyzing these data as well as those presented in table 3.1 with regard to apparent shifts such as from "Forest and Woodland" to "Cropland" for the RWEDP countries is almost impossible: First of all, even though agricultural land may have increased this does not necessarily imply that this has been at the expense of forest land. Changes in land use are thought to be much more complex as is evident from the Bangladesh data where besides the changes in forest and crop land, there have been simultaneously changes in the areas not available for cultivation (increase), culturable waste land (increase as well as decreases), current fallow (decrease) as well as shifts in cropping intensity. On the other hand, seen the anomalies identified in the data as presented in table 3.1 the data presented may not reflect the actual situation.

Another method which possibly may give some indications that the demand for agricultural land has an influence on land use patterns including forestry is by using data on changes in "Cropland" and "Agricultural Population". The "Selected Indicators of Food and Agriculture Development in Asia-Pacific Region" (FAO,1989d and 1991b) show that from 1987 to 1989 the area designated as "Cropland" has increased for most countries. Even though the share of the agricultural population as a percentage of the total population has decreased, the increase in the amount of "Cropland" is not sufficient to stabilize the cropland available on a per capita basis. In most countries the amount of "Cropland" available dropped by about 1-4% per capita of the "agricultural population".

Although such methods certainly will not provide conclusive evidence, it is felt that they indicate the threat to the forest cover from the need for more agricultural land. In order to substantiate this, in-depth studies on land use and changes in land use over a prolonged period will have to be made.

4. FUELWOOD SUPPLY SOURCES IN THE RWEDP COUNTRIES

The amount of fuelwood used as a source of energy, as identified in a previous chapter, comes from various sources of which "Forests" is only one. Previously the conventional wisdom stated that fuelwood is obtained from the forests and fuelwood collection was considered the main cause of deforestation by indiscriminate cutting of trees for fuelwood. Although this view is still sometimes held, in particular in forest departments, the general belief is now that a major part of the fuelwood is obtained from other sources.

This change in thinking has been caused by evidence turned up from several studies at the village and district level. These studies indicate that overall a major, if not the major part of the fuelwood comes from other sources, notably from scattered trees around homesteads, trees along roads and canals, trees on agricultural land, wood from plantation crops, brushwood from waste land, trees on grass and range lands, etc. From the 11 RWEDP countries covered, at present there are six examples from countries where information is available on a country wide basis (Bangladesh, India, Nepal, Philippines, Sri Lanka and Thailand) while it is expected that information for one more country (Pakistan) as well as updated information for Thailand will be available in the near future. The available information from the countries shows that indeed a large part of fuelwood used for domestic and/or industrial use is obtained from non-forest sources.

Bangladesh: The figures for Bangladesh are based on studies carried out for the Bangladesh Energy Planning Project. The figures show that out of the total amount of 479.3 Peta Joules (PJ) of biomass energy consumed in 1981, about 83.7 PJ, equal to about 5.5 million tons, consisted of fuelwood in various forms. Out of the 5.5 million tons about 0.7 million tons came from public forests while the remaining amount of 4.8 million tons were derived from village trees (4.3 million tons), from fallow areas and areas nor cultivable (0.3 million tons) and the remaining 0.2 million tons were recycled biomass e.g. from construction sites, from fencing, etc. In particular the latter is important to note as recycling accounted for about 4% of the wood used as fuel. If the other recycled biomass is included (mainly in the form of straw), the total amounts to 29.3 PJ or over 6% of the total amount of traditional fuels used in the country (Islam, 1990).

India: Based on a study by Natarajan (Natarajan, 1985 as reported in Leach, 1987) it is shown that out of the total amount of 94.5 million tons of fuelwood consumed in 1978-79, about 24 million tons was derived from the forests of which over 19 million tons was in the form of twigs. 44 million tons was collected from own land or neighbor's land with about half of this amount derived from roadsides, canal banks, etc. The remaining 26 million tons was in the form of purchased wood which could either be from forest lands or from other sources. Out of the purchased amount, 47% was used in rural areas while 53% ended up in urban areas. The majority of this amount of 26 million tons consisted of logs (77%) with 23% being bought in the form of twigs. However, it is not known to what extent purchased wood was cut from the forests and it can be assumed that part of it is derived from non forest lands.

Nepal: Some information is available for the domestic sector from the Forest Master Plan study carried out for 1986. Most of the areas have been covered with the exception of the High Mountains (The Himalayas). In the Mid Mountains (from about 1,100 to 2,000 meter elevation) in average about 59% of the fuelwood was obtained from the forests while private trees accounted for 41%. In the Terai (low lying area), which can be considered an agricultural area, forests accounted for 81% of the fuelwood consumed while private trees supplied the remaining 19%. Dung played also a major role in the Terai as a source of energy and accounted for about 171 kg. (166 kg. on a wood equivalent basis) out of a total of 689 kg. of wood equivalent per capita per year. In the Mid Mountains dung accounted for less then 1%. In both areas agricultural residues were also used as fuel, accounting in both areas for less then 10% (on a wood equivalent basis) of the total consumption of traditional sources of energy. Conversion factors used were 0.97 for dung and 0.706 for residues.

Philippines: The most recent study is the Philippine Household Energy Consumption Study by the World Bank which was carried out in cooperation with the National Energy Administration of the Philippines. The study shows that in 1989 out of the 18.3 million tons fuelwood as well as the 7.0 million tons of wood used for charcoal making, used as fuel by the domestic sector in the Philippines, only 2.5 million tons equal to about 15% was derived from the forests. The remaining 15.8 million tons or 85% were obtained from other sources.

Sri Lanka: A study carried out within the framework of the Forest Master Plan for Sri Lanka (GOSL, 1986) shows that in 1985 out of the 8 million tons of fuelwood used by the domestic sector about 23% was obtained from the forests and another 2% was derived from forest plantations. 75% was derived from other sources with the plantation sector (rubber, coconut, tea, etc.) accounting for 62% while the remaining 13% was derived from homegardens, etc. The industrial sector consumed over 1.1 million tons. Forests accounted for 36% and forest plantations for 2% of the total amount consumed. The plantation sector supplied 55% while others, presumably homegardens, etc. supplied the remaining 7%. Overall about 2.2 million tons out of 9.1 million tons of fuelwood were derived from the forests.

Thailand: For Thailand data are available for rural areas for 1980, both for fuelwood as well as for charcoal production, based on a study carried out by the National Energy Administration of Thailand (AIT, 1984). It is reported that 98% of the total amount of fuelwood was collected with the remaining 2% bought. 48% of the fuelwood derived from the forests, 50% from own or neighbor's land and the remaining 2% being unspecified (bought).

For charcoal production, 45% of the wood came from national reserved forests, 5% from forest plantations, 28% from farm woodlots, 8% from sawmills, 4% from rubber trees and 10% from other sources which include land with titles, self planting, cooperative resettlement plans, land allocation programmes, etc. In short about 50% came directly from forests and forest plantations. The amount from the sawmills, although being in principle forest wood, can not be considered as such as it is a waste material from processing.

However, the figures given are averages and large regional variations are found in most of the countries:

* With regard to Nepal little information is available and it is in a form which is difficult to interpret as not sufficient information is available. The main reason for the larger share of forest fuelwood in the Terai is probably caused by that most of the roads are found there (better means of access), it is more densely populated (about double the national average) then the other areas and consequently has need for more agricultural land, obtained from clearing forest areas. Incidently, the Terai showed the highest loss of its forest cover: 3.9% compared to 0.4% for the whole of Nepal both on an annual basis.

* In the Philippines out of the 12 regions the amount of forest fuelwood can be considered as being significant in only 3 regions if compared to the total amount used. In these regions much of the pressure on the forests comes from urban fuelwood demand.

* In Sri Lanka the use of forest fuelwood was found to be highest in the central and south-eastern dry zones where forest fuelwood respectively accounted for 64% and 46%. This is not surprising as these areas are relatively sparsely populated and still have quite a lot of forested areas and brushlands.

* In Thailand, the Southern part of the country showed a high amount of fuelwood derived from the forest both as fuelwood (90%) as well as for charcoal production (66%).

For the other countries little information is available other then some estimates which are mainly based on sustainable supplies of the different land and forest types.

For instance, in Pakistan the demand for fuelwood has been estimated to be about 28 million tons in the domestic sector and about 5 million tons in the non-domestic sector (Ouerghi, 1992). The forest areas (forests, plantations, farmlands and orchards) can supply on a sustainable basis about 8.8 million tons (GOP, 1992), leaving a large gap between the demand and supply of about 24-25 million tons of fuelwood. However, the "Other lands", mainly consisting of rangelands, trees around homesteads, etc. are estimated to be able to supply about 11 million tons. How the remaining gap of 13-14 million tons is covered can not be explained other then that standing stock and sustainable supplies are under-estimated, removal of amounts over the sustainable supply, etc. Within the framework of the "Household Energy Strategy Study" studies are ongoing about the actual amount of standing stock and the growth rates of various land types as well as the amount of fuelwood available from these areas. Only when such information is available and more reliable answers on the fuelwood situation and its supplies can be given.

In Vietnam, with an estimated demand for fuelwood of 33 million tons, the bare forest lands, with no forest cover but still counted as forests, can supply on a sustainable basis about 4.2 million tons of fuelwood. This is almost equal to the sustainable supplies from production forests and plantations which were estimated as being able to supply 2.6 and 2.2 million tons annually on a sustainable basis. In addition fuelwood from trees planted during the period 1961-1990 on homesteads, along roads, etc. was estimated to be able to supply over 8.1 million tons annually on a sustainable basis. This is about double the amount which could be supplied by the forests and the plantations together (FAO, 1992a). When taking into account supplies from other sources like waste wood, forest industries and perennial crops, the demand was found to be about 13 million tons higher then the sustainable supplies.

However, possible supplies from existing trees on "Other lands", "Agricultural lands", etc. which combined are estimated to cover about 14 million ha. were not taken into account, simply because no information was available. Even though nothing is known about the amount of trees or wood available on a sustainable basis, estimates quoted in studies carried out for Forest Master Plans for other countries show that these may range from about 2 cubic meter per ha. for brushlands to 0.05 cubic meter per ha. for grass lands (GOPh, 1991; GOP, 1991). Other estimates made by the World Bank (WB, 1992b) indicate that from 0.5 to 2 ton/ha. of wood can be harvested on a sustainable basis from intensively managed farmlands while extensively managed farmlands would supply on a sustainable basis from 1-3 ton/ha. The 14 million ha. of these other lands in Vietnam could in that case possibly yield from 1 - 2 million tons of fuelwood using a conservative yield of 0.1 to 0.2 cubic meter per ha. On the other hand, as climatic conditions are comparable to those of the Philippines, and by using the World Bank data for the Philippines, the supply from these areas could possibly even reach from 7 to 28 million tons. With other words, the non-forested lands (bare forest land, scattered planted trees, agricultural land and other lands) could supply from 13-40 million tons of fuelwood on a sustainable basis. This would be from 2-8 times as much as the fuelwood which could be obtained on a sustainable basis from the production forests and the forest plantations combined. Incidently, such an amount corresponds more or less with estimates of 16 million tons from shrublands and 20 million tons from savannas, quoted in several reports in Vietnam. Unfortunately, the source of the information, given as a report by Dr. Thomasius, could not be located.

Besides these tree resources, there are many other sources of wood or woody biomass from crops like coconut trees, rubber trees, oil palms, tea bushes, etc. Asian nations produce 93% of the world's rubber (wood from rubber trees), 87% of the coconuts (fronds, husks, shells and wood from trees) and 78% of palmoil (fronds). For instance in Thailand the area covered by rubber trees is about 1.7 million ha. Rubber trees are uprooted every thirty years after becoming unproductive. Uprooting them will supply from 100-140 cubic meter of stem and branchwood per hectare which, in the case of Thailand could yield about 4-5 million tons of wood on an annual basis. Each ha. of coconut trees yields from 3.25 to 8 tons/ha. in fronds, husks and shells which in the case of the Philippines could yield from 15-37 million tons per year. However, there are also many competing uses for part of these products. Rubber wood is at present widely used for furniture making, coconut shells are widely used for charcoal and activated carbon production, many husks and frons are used as a mulch in the plantations, etc.

The available data as given above is shown in table 4.1 and figure 4.1.. Although in the case of Pakistan and Vietnam the data are estimates, based on MAI figures, it is clear that the share of fuelwood from non-forests appears to be high in these countries. It is worthwhile to note that in the case of Pakistan the share of fuelwood from the forests is far higher then the 10% often quoted by the authorities in Pakistan, even though the amount is only based on MAI data for the production forests. The amounts derived from village lands, as shown in figure 4.1 are from village trees proper, from own land, from neighbours land, from roadsides, canal banks, from scattered planted trees, etc. The 85% ,shown as derived from village lands in the Philippines, covers also wood fuels derived from agricultural plantations such as rubber and coconut. The origin of the amount of wood fuels purchased is not known and could be forest wood as well as wood from village lands. It is known that in Bangladesh and India, and possibly in other countries as well, many farmers sell wood from trees on village lands in order to earn cash. They themselves use instead agricultural residues or dung which are available from their agricultural operations.

Table 4.1: Overview of available data on the sources of fuelwood consumed

Country	Total amount of fuelwood consumed	Share (%) of forest wood	Share (%) of wood from other sources
Bangladesh	5.5 million tons	13	87
India	94.5 million tons	26-53	47-74
Nepal	11.3 million tons	66	34
Sri Lanka	9.1 million tons	25	75
Philippines	25.3 million tons	15	85
Thailand[1]	8.8 million tons	48-50	50-52
Thailand[2]	16.0 million tons	50	50
Pakistan[3]	33.0 million tons	27	73
Vietnam[3]	33.0 million tons	25	75

Note: 1 Wood used as fuelwood
2 Wood used for the production of charcoal. Amount has been estimated by the author.
3 The shares are based on estimates, assuming that the only an amount equal to the Mean Annual Increment is removed from the forests.

Although it has been shown that the potential apparently exists, there are many uncertainties with regard to these supplies. Two of these, and probably the most important, are the lack of knowledge of the standing stock, in particular for these other land types. However, it is often also equally true for natural forests and forest plantations.

Coupled with this is the problem of the Mean Annual Increment (MAI) of the standing stock, which would influence the amount of wood (timber, fuelwood, etc.) which can be removed on a sustainable basis for any given area. Standing stock figures for forest areas often only take into account the "merchantable" species e.g. leave out the other species. At the same time often only trees with certain dimensions are covered, leaving out again the many small trees, shrubs, etc. which often form an important part of fuelwood gathered from forests. Therefore, using the MAI figures may underestimate the total amount available on a sustainable basis. On the other hand, browsing by livestock often has a detrimental effect on regeneration and this should also be taken into account, in particular for degraded areas with a large livestock. For the other areas almost nothing is known with regard to the MAI, other then that it could be considerable higher then for forest areas due to growing conditions.

The other uncertainty is the accessibility factor. Even though a certain amount of fuelwood could be removed on a sustainable basis, it is not known if this would be feasible as transport of the fuelwood may cause serious problems due to a lack of roads, etc. For instance, in the case of Bhutan, it was estimated that the natural forests could supply on a sustainable basis about 10-11 million tons. This amount dropped to 1 million tons, once accessibility as well as critical watershed areas and forest and wildlife reserves had been taken into account. In Myanmar, respectively 20% and 84% of the closed forest and the closed forest affected by shifting cultivation is considered as economically accessible for fuelwood production (WB, 1991b). However, Bhutan and Myanmar may be extreme cases seen that few roads are found in the countries while the population is concentrated in some areas.

On the other hand, part of these sustainable supplies from the other lands will be used for other purposes such as local construction timber, furniture making, for fencing, as poles, etc. and only a part may be available as fuelwood. Besides, in particular in the hills and watershed areas, it may not be advisable to remove the wood, even on a sustainable basis, as a better cover of the areas by trees could prevent a further degrading due to erosion.

Reflecting upon this, one may conclude that non-forest lands can be considered as an important, if not the most important source of fuelwood but that at the same time very little is known about it. Looking at the available data, as shown in table 4.1, one may tentatively conclude that in most countries less then half and often as low as 25-30% of the total amount of fuelwood consumed is derived from the forests. Part of this forest wood is probably derived from land clearing activities to increase agricultural land holdings.

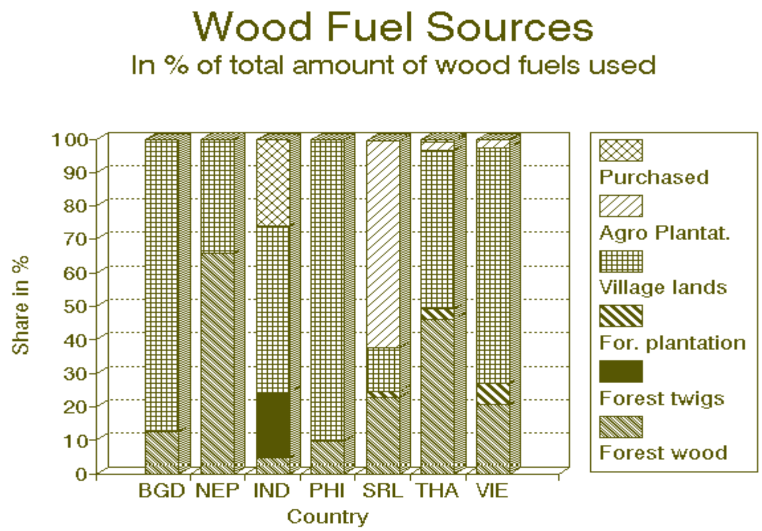

Figure 4.1 Sources of Wood Fuels Used

Forest plantations and even more so other tree growing activities also appear to be important. In Sri Lanka about 0.2 million tons out of 9.1 million tons came from forest plantations. In India out of 131 million tons of fuelwood consumed apparently 4 million tons were derived from social forestry schemes (Leach, 1987). In Vietnam apparently 2.2 million tons were estimated to be available from forest plantations while trees planted by the population under various schemes on their homesteads, along roads, school grounds, village areas, etc. probably supplies a staggering 8 million tons, equal to about 25% of the total amount consumed. This is clear evidence that, where concerted efforts are made by both the private and government sector, tree growing can be successful providing the conditions are favourable.

Even though the data suggest that a low amount of wood is derived from forests, it should also be noted, where the data is based on estimates on the sustainable supplies from production forests and plantations (Pakistan and Vietnam), that the amount of fuelwood derived from the forests actually may be higher. Besides, quite a few of the countries covered have relatively large areas of non-forest wood supplies in the form of rubber and coconut plantations (Philippines, Sri Lanka, Thailand, Vietnam) and this may distort the situation.

While no generalizations should be made, the evidence gathered so far appears to be broadly in line with that reported elsewhere (Leach and Mearns, 1988). Five main supply sources have been identified based on indication from numerous examples in different parts of the world. These five, of which the last two appear to be by far the most important are: Tree/Forest cutting directly for fuel; Dedicated woodfuel plantations; By-product wood (lops and tops, plantation crops, etc.); Dead branches and twigs; Surpluses from land clearing activities. To these five supply sources probably one more could be added: Wood obtained from construction activities (demolition of buildings, shuttering from concrete work, fences, etc.). Wood obtained from this source is thought to be important for many urban poor in quite a few Asian countries and probably also in other parts of the world.

In order to have some very broad indications on the sustainability of the supply system, some calculations on the amount of fuelwood in ton/ha. derived from different types of land use classes are shown in table 4.2. The data, as shown in table 4.1, was used to which the amounts of residues (excluding dung) were added. The amount of fuel, in tons per hectare, were calculated for forest areas and "other" areas. The "other" areas include all non-forest areas, including areas covered by cities, rivers, lakes, etc. As no data were available with regard to production and protection forest areas, the total forest areas has been used to calculate the amount of fuelwood from forest land. Part of these forest areas may be in-accessible due to distances involved or may be located in areas with a very low population density.

All these factors will have an upward influence on the amount of wood derived from the forests and the figures could in some cases be a factor of 2-3 higher for the amount of fuelwood shown.

Table 4.2: Indicators of the Sustainability of Traditional Fuel Supplies (1)

Country	Forest & Woodland[2]	Agric. Land, Pasture & Other Land[2]	Fuel Used in Million Tons			Amount of Fuel Derived per ha Land	
			Forest Wood	Other Wood	Residues	T/ha Forest Land	T/ha Other Land
Bangladesh	1,950	11,067	0.7	6.8	23.1	0.37	0.43 + 2.09
India	66,736	230,583	25-50	70-45	30.6	0.37-0.75	0.30-0.19+0.13
Nepal	2,480	11,200	7.5	3.8	1.4	3.01	0.34 + 0.13
Sri Lanka	1,747	4,716	2.3	6.8	0.6	1.31	1.45 + 0.12
Philippines	10,550	19,267	3.9	4.5	2.6	0.37	1.15 + 0.13
Thailand	14,240	36,849	12.3	12.5	9.7	0.86	0.34 + 0.26
Pakistan[3]	3,500	73,588	8.9	24.1	10.7	2.55	0.33 + 0.15
Vietnam	9,800	22,749	8.3	24.8	0.84	0.84	1.09 + 0.60

Note: (1) Land areas are based on FAO statistics (FAO, 1991b) and are valid for 1990. As pointed out earlier, these figures may not represent the actual situation.
(2) Areas given * 1,000 Ha. Agricultural land, permanent pastures and other land also include built-up areas, rivers, etc.
(3) The amount of residues has been estimated.

For example in the Philippines the production forests cover about 3.8 million ha. out of the total forest area of 6.7 million ha. First of all, the total forest area is considerable smaller then the FAO data suggest (6.7 versus 10.6 million ha.) and assuming that all fuelwood comes from the production forests measuring 3.8 million ha. the amount of fuelwood from each ha. rises to about 1 ton, e.g. 3 times higher the amount shown in table 4.2 (GOPh, 1991). The same is true for Vietnam with 5.5 million ha. considered as production forests (FAO, 1992a).

Such calculations will only provide a very rough indicator on the sustainability of traditional fuel supplies but can be useful to pinpoint countries or areas where pressure on forest areas and/or other areas is serious. It is clear that Nepal and Pakistan are facing problems with the supply of forest fuelwood. Looking at Pakistan which apparently derived about 2.5 tons of fuelwood per ha, from its forests it can be assumed that there is serious overcutting as the mean annual increment of the Pakistani forests are said to range from 0.4-1.0 tons/ha. (FAO, 1985). In Nepal, with many forests in-accessible, the average of 3 tons/ha. can be assumed to be much higher as many forests are in-accessible.

This once again shows that there is a need for more in-depth studies, not only with regard to the demand, but also for supplies, the supply sources, etc. for the countries and preferable for different regions within each country. Only when such information is available can a better insight be gained in the actual situation.

5. THE IMPORTANCE OF FUELWOOD IN THE NATIONAL ECONOMIES

Fuelwood is an important source of energy for most of the RWEDP member countries. Unfortunately, as was shown, statistics on the consumption are hard to come by and this is equally true for its importance within the economy. For most countries, the forestry sector forms part of the agricultural sector and its contribution to the economy in terms of the Gross Domestic Product (GDP) is often included in "Agriculture". Only for a few countries the share of the forestry sector in the GDP was available and these are shown in table 5.1. However, even here there are many uncertainties. For instance in the case of Bangladesh, the share of the Forestry sector is given as 4.0% but this apparently includes other materials also. Although "Fisheries" is shown as a separate sector for the calculation of the GDP, the "Forestry" sector includes also fish production as a forestry product. The reason for this is unknown but may be attributed to fisheries in the "Sundarbans", a large mangrove forest which is under the jurisdiction of the Forest Department.

Table 5.1: Share of the agricultural and forestry sector in the GDP (1988)

Country	Share of Agriculture, Forestry, Fishing and Hunting in GDP	Share of the Forestry Sector in GDP
Bangladesh	37.7	4.00
Bhutan	46.1	-----
India	30.3	1.12
Indonesia	24.1	1.02
Myanmar	37.0	----
Nepal	57.9	0.08
Pakistan	23.4	----
Philippines	27.1	0.59
Sri Lanka	21.1	0.80
Thailand	16.9	0.38
Vietnam	46.1	1.58

Source: United Nations: National Account Statistics. Aggregate and Detailed tables 1989 - Part I and II except for Bangladesh, Indonesia, Nepal and Vietnam for which national statistics were used (GOB, 1989; GOI, 1992b; HMGON, 1991; GOV, 1990).

It is evident that in most countries the contribution of the forestry sector to the GDP is relatively small, when judged by its share in the GDP. However, it is not sure whether the value which can be attributed to the production of fuelwood has been included in all cases. In the case of Bangladesh, Indonesia, Nepal, Sri Lanka and Vietnam fuelwood is included but for the other countries this could not be ascertained. In Indonesia fuelwood alone accounted in 1988 for about 0.2% of the GDP (59 million cubic meters). In Bangladesh, fuelwood is included besides timber, bamboo, honey, *golpata*, sungrass, and fish. But, judging the amount of about 650,000 tons, this apparently only covers the amount officially derived from the forests.

Calculating the value of fuelwood used in the countries could be an option to get a better idea about the importance of fuelwood to the economy. However, setting a value for the fuelwood, how to value peoples time used for collection are just a few of the tricky problems to be solved and the results therefore probably would be highly questionable.

Another option to show the importance of fuelwood to the economy could be by assuming that all fuelwood be replaced by other sources of energy, for instance kerosene. Taking the 9 million tons of forest wood used in Pakistan as fuelwood, approximately 1.5 million tons of kerosene would have to be imported and distributed, assuming appliance efficiencies of 15% (wood stove) and 40% (kerosene stove). Valued at 160 US$ per ton, this would require 240 million US$ of foreign exchange, equal to about 6% of the export earnings. In case all fuelwood would be replaced, the total import value of the kerosene would be equal to about 20-25% of the export earnings.

It is clear that this would be a serious drain on the foreign exchange of the country as well as disruptive to the balance of payments. A huge infrastructure would have to be created and/or streamlined to ensure that kerosene would be available in even the smallest and remotest villages on a continuous basis. Besides, subsidies probably would have to be introduced to make kerosene affordable to all layers of the population.

Another problem associated with such a hypothetical replacement scheme would be that emissions of greenhouse gases would increase considerable. Superficial calculations show that the 5.5 million tons of kerosene to replace the 33 million tons of fuelwood would release about 4 million tons carbon in the form of CO_2, one of the main gases responsible for the greenhouse effect. This effect, however, would probably be more than offset by trees, which at present appear to be overcut resulting in a net loss. In such a case these tress would be left standing, which would then be able to store large amounts of the CO_2 in the form of carbon.

This incidentally shows that the use of wood fuels can be beneficial to the environment in terms of green house gas emissions and for that reason could be advocated for increased use. For as long as there is a positive balance between increments in the growth rate of trees and the removal of trees by cutting thrm, the net effect between carbon dioxide emissions released through burning the wood and the storage of carbon in the growing wood will also be positive e.g. there will be no strain on the environment from that side. In practice however many other factors would have to be considered also such as for instance the health aspects of users of the wood fuels (smoke, soot and other particle emissions, etc.), erosion of soil after trees have been cut, dependence on outside supplies or using local sources of energy (the security of supply aspect on a national basis), just to name a few.

Besides, the manpower required for the supply of kerosene would be considerable lower then that required for fuelwood which would have a detrimental if not disastrous effect on the earnings of many people in rural areas. It has been estimated that the local employment potential of kerosene is about 350 person days per million litre as calculated from the data shown in table 5.2. The 5.5 million tons of kerosene would therefore require a total of about 2 million person days. The supply of fuelwood is estimated to require from 1,600-2,700 person days per 1,000 tons. The 33 million tons of fuelwood would then require from 52 to 89 million person days, a factor of 25 to 45 higher. However, only a small part of the 33 million tons will be in the form of a traded good, mainly for urban areas, and the employment effect would be considerable lower, but still higher than for kerosene, as most of the fuelwood is thought to be collected for own use.

Table 5.2: Estimated Local Employment Potential of Different Household Fuels per Standard Unit of Consumed Energy

Fuel Type	Tons of Fuel Per Tera Joule	Estimated Employment per TJ of Energy Consumed in Person Days[1]
Kerosene[2]	29 Kilo litre	10
LPG[2]	22 tons	10-20
Coal[3]	43 tongs	20-40
Electricity[4]	228 MWh	80-110
Fuelwood[5]	62 tons	110-170
Charcoal[5]	33 tons	200-350

Note: 1) Where applicable employment covers growing, extraction, production, transmission, maintenance, distribution and sales, including reading meters. It excludes employment generated outside the country for fuels that are imported in a semi-finished or finished state.
2) This assumes that crude oil (for refining), kerosene and LPG are imported.
3) This varies according to the capital intensity of the mine, the seam thickness, the energy value of the coal and the distance from the demand centres.
4) This varies according to the production methods, ranging from hydro to traditional oil/coal fired units and the efficiency of electricity generation, transmission and distribution.
5) This depends on the productivity of the site, the efficiency of the producers and the distance from the market.

Source: Estimates by World Bank mission members for the Philippine Household Energy Study (WB, 1992b)

This comparison shows that the supply of fuelwood is labour intensive and generates income for many in rural areas. However, it is felt that the figures quoted above are too low in the case of fuelwood and probably also for charcoal. The figure of 1,600 - 2,700 persons days per 1,000 tons would imply an average production of 370 to 625 kg. per person day. This appears to be high. Information derived from Rapid Rural Appraisal (RRA) studies in several countries (FAO, 1991c) show much lower figures. In Nepal, in mountainous areas, the amount which normally is collected and transported home per person day is about 35-40 kg. (a backload). Transporting it to the market and selling it takes another day. In the Philippines, a family was producing from 450 to 900 kg. fuelwood per week, with the fuelwood being picked up by a middleman. In Indonesia it was reported that a farmer could gather about 0.16 m^3 of fuelwood per day which would weigh about 50-70 kg. but he would need another day to transport and sell it in the market.

The average amount produced per person day appears, based on these RRA studies, to range from 20-80 kg. depending on area, means of transport and distance to the market. This is a factor of about 10 lower then the 1,600-2,700 person days per 1,000 tons reported by the World Bank. The reason for the difference is not known but probably can be found in the way of processing: Small scale and manual versus large scale and mechanized. As in most countries the majority of fuelwood probably will be produced by the rural population, the lower amount of labour input is expected to be closer to the truth. Assuming that the actual labour input is about 10 times higher e.g. 16,000 - 27,000 person days per 1,000 tons this would imply for the Philippines, with about 3.3 million tons of fuelwood traded (consumed in urban areas) that from 250,000 to 450,000 persons would be involved in fuelwood production, each in average for 200 days per year. In average a person would handle from 7-13 tons per year.

The same World Bank Household Energy Study for the Philippines also gives an estimate of the total amount of households involved in fuelwood collection for sale. An estimated 536,000 households are involved in commercial fuelwood gathering/production. A further 158,000 households are making and selling charcoal, 140,000 are traders (40,000 in rural areas and 100,000 in urban areas) while an equal amount is expected to be involved in transportation.

These figures appear to be based on detailed studies carried out for some urban areas. The city of Cagayan de Oro (population 430,000) consumes about 82,000 tons of fuelwood per year. Fuelwood gatherers collected in average about 4.9 tons per year which would indicate that about 17,000 persons or households would be involved. The urban population of about 1 million of the island of Cebu consumes about 180,000 tons of fuelwood. Fuelwood gatherers collected from 200 kg. to 40 tons per year but the average appeared to be 5.9 tons per year. Charcoal makers, in average used 10.8 tons of wood to produce 2.8 tons of charcoal on an annual basis. Fuelwood gatherers which supplied fuelwood to Metro Manilla in average collected 15 tons per year while charcoal makers produced in average 4.5 tons per year. Fuelwood gatherers which supplied fuelwood to Tacloban in average collected 4.4 tons per year. Traders in urban areas were found to sell widely varying amounts of fuelwood, often depending on whether they had many bakeries, restaurants, etc. among their customers. The average appeared to be about 20 tons per year for urban traders but in Tacloban over 70% of the traders handled less than 10 tons and 30% handled less than 2 tons. Rural traders in this area handled in average about 12.8 tons per year.

These amounts, when compared to Sri Lanka, appear to be quite low. Urban traders sell here in average 31 tons per month with some selling 70-80 tons per month. However, the income of most of these traders depend solely on fuelwood selling and they actively look for consumers by employing people who ply the streets with their fuelwood carts.

Overall it was estimated that in the Philippines about 1 million households or about 5 million people - 8% of the total population - are involved in or are dependent on the trade in biomass energy for some of their income/employment. Almost all of these households have other occupations. In rural areas this is principally farming while the traders are mainly shopkeepers or market stall operators, selling wood and charcoal as part of a range of goods. As such, close to 10% of the rural households receive income from selling wood or charcoal. Urban fuel markets were found to provide an average of 40% of the cash income for the households involved. Many were poor with few alternative sources of off-farm income and for them the urban fuel trade is a vital component of their household economy.

A study carried out in Nepal (Paudyal, 1986) found that some 2,800 persons were involved in supplying fuelwood to the population of 48,000 of Bhaktapur. Most of the fuelwood was sold to the 7,200 households with about 20% going to hotels and industries. Assuming an average consumption of 500 kg. per capita, the amount handled by each person would in average be about 8 tons of fuelwood per year. Most of the people involved belonged to the lower castes and low-income groups and they often derived over 60% of their cash income from the fuelwood trade. The income generated from the fuelwood trade compared favourable with that of agricultural wages.

The study in Bhaktapur showed that 12 rural households earned an income from supplying fuelwood to 100 urban households (or 1 fuelwood collector versus 17 consumers) and while this ratio should not be generalized, other information from the Philippines (Cadelina) point also more or less to this ratio of 12:100.

Even though no definite conclusion can be given with regard to the amount of labour involved one may assume that it is considerable. It appears, based on the data from the Philippines, Nepal and Indonesia, that rural fuelwood gatherers in average collect and sell from about 4 to 8 tons of fuelwood per year. For most of the households involved it is thought that fuelwood collection and sales is an important source of income. For many landless people it may be the only way to make enough money to live, in particular during the off-farm season during which very little employment opportunities will be available. For people with land like farmers it probably provides additional income through which they can raise their standard of living.

The fuelwood and charcoal market system can be considered as being complex in most countries although there are exceptions to this rule. For instance in Sri Lanka the trade of fuelwood often involves specialized contractors who extract fuelwood either from the forest but more often from the plantation sector, and who sell the wood either in short log form or as split wood to fuelwood depots in urban areas. These depots in their turn will sell direct to consumers, which can be households or bakeries, restaurants, etc. or to retail outlets. Large consumers like brick and tile factories buy directly from the plantation sector or more often also through the fuelwood contractors for which often tenders are put out. The fuelwood contractors are in registered as such to carry out the trade and therefore the trade is more or less legal and there appears to be little put in their way. Although the formal trade channels account for the majority of the fuelwood traded, there are also many informal channels. People collect wood from their own land, village land as well as from the forest for own use but also for sale either directly along the road or by selling to shop keepers, etc.

In most countries, however, the fuelwood and charcoal supply system is much less uniform and is often more complicated. For instance in the Philippines in the Laguna province, the main source of fuelwood is the forest (mainly obtained in a legal way but illegal supplies are also common) although private farm lands are also an important source of wood. Sales can be direct to the consumers or to retailers but normally involves many types of middlemen. Middlemen may buy and sell on their own behalf but more often collect fuelwood or charcoal for other middlemen, wholesalers or retailers, and may or may not have their own transport. In case they do not have their own transport, they either hire a vehicle or sell to transporters, who then sell the fuelwood or charcoal to other middlemen or wholesalers. Most middlemen work always with the same suppliers/producers and normally a trader has at least 2 or more regular suppliers (one trader maintains a network of 65 suppliers who regularly deliver charcoal).

An informal communication network ensures that everyone in the system is informed about the price, supply and demand throughout the year and in this way they can react quickly to fluctuations in demand and supply. Wholesalers and local traders may stockpile charcoal for later sale as the supply and consequently the price fluctuates with the season with low supplies during the rainy season. The system works with cash on delivery, with credit arrangements, with cash advances, with provision of subsistence, etc. in order to ensure a steady supply to the market. Relationships are established and maintained based on mutual trust of the quality/quantity of the fuelwood and charcoal and mutual satisfaction with the terms agreed upon between the different actors within the network.

Transport is often by truck but many prefer to transport smaller quantities in order to circumvent the many requirements imposed by regulating agencies such as the forest department, the military, police and civilian/military checkpoints posted along the routes going to the urban centres. Larger quantities are often transported during the night because they are less visible and passage can be "arranged" more easy. Even though all legal requirements have been met and all permits can be shown, the traders are often detained at checkpoints with the wood or charcoal sometimes confiscated.

In other countries, and probably in the Philippines as well, truck and bus drivers often transport wood and charcoal from the producing areas to the urban centre in order to earn some extra income. Even though there are legal limits to the amount which can be transported ostensibly for own use, 3 bags of charcoal in Thailand; 5 bundles of fuelwood in Nepal, drivers often take more. For instance in Nepal in Pokhara city it has been estimated that daily from 4-5 tons of fuelwood arrives in this fashion (FAO, 1991c)..

From the producer to the consumer there are many markups in the price but it was found in the Philippines that the retail price in most urban centres did not show much variations with fuelwood prices ranging from 930 to 1,100 Pesos per ton while charcoal sold for 3,350 to 4,000 Pesos per ton. However, the price the producer received showed much larger variations. In the case of fuelwood the price ranged from 140 to 630 Pesos per ton with the latter price valid for supply areas near Manilla. For charcoal the variations were much lower with producers receiving from 1,430 to 1,800 Pesos per ton. This lack of variation in the retail price across areas, even though fuelwood resources in the form of forests showed large variation, can be considered an indication of the degree of competition between traders but also with competing sources of energy, the efficiency and the flexibility of urban fuelwood and charcoal supply systems.

On the other hand, even though some information is available on how the system works, there are still many unknown factors in the fuelwood and charcoal production and distribution process. A major factor is that in most countries the wood fuel trade is an informal sector activity. Being an informal activity is often reinforced by that part of the products has been obtained or produced illegally. Charcoal making is not allowed in Nepal but quite large amounts are made and traded for use by black- and goldsmiths. The illegality drives up prices and traders can make fortunes out of it. Unfortunately, being illegal, production systems are kept to the minimum. In Nepal very simple and small earth and pitkilns are used which results in low output and low quality charcoal. Even where the trade is legal, a large part of the trade often remains an informal activity. This is simply because it is and, in particular so for the many landless and low skilled people, a relatively easy source of income which can be tapped when needed. The possibility of selling fuelwood to earn cash may have an impact on rural supplies but little evidence of this has been found. In Bangladesh it appears to be quite common for farmers to sell wood from trees on their land. They themselves make then do with lower grade fuels like residues. In most of the cases they will only sell branch wood with the tree left standing. Only in the case where large expenses have to be met, such as for dowries, etc. whole trees are sometimes cut.

This use of residues of fuel can have negative side effects. Besides that these fuels in general require more attention (time) during cooking, they often produce also smoke and considerable amounts of ash, making the conditions in the kitchen less healthy. Besides, residues in many cases could be left better in the field (plowed under) for use as organic fertilizer and soil conditioner. In practice, most of the farmers remove residues from the field and use them, not only for fuel, but also as animal feed, as litter, for sale or barter. This practice may lead to fertility loss of the fields and even land degradation.

The degree of such negative impacts, however, is not known but is a concern to many in the agricultural sector. With prudent practices the effect could be minimal and the use as fuel should not be categorically condemned. It appears that virtually no systematic work has been done to document trade-offs between different uses of residues. Very little is known about how farmers themselves see these trade-offs. They are the people who make the decisions and bear the consequences and their views should be taken into account. There appears therefore a need for more investigations into the overall complications in order to reach conclusions beyond the theoretical and largely abstract discussions.

In general, however, only a small part out of the total amount of fuelwood involves trade while the majority of the fuelwood consumption is for own use. This phenomenon, coupled with the large supply areas and different sources involved, makes it more difficult to get a better understanding of the system. This makes any decision on whether, when, how and where assistance to the sector should be given more difficult.

6. REVIEW OF WOOD ENERGY ACTIVITIES: ISSUES, CONSTRAINTS AND PROSPECTS

Although it has always been known that people use wood as a source of energy, interest in it has been minimal in the past. The problem with wood fuel in many Third World countries was only acknowledged during the early seventies when many had to curtail their oil use and switch to wood fuels. This lead to an increased interest in wood fuel use and evidence gathered showed that huge amounts of wood were consumed as fuel while at the same time many faced difficulties in getting sufficient supplies. Deforestation, which at that time had already been recognized, was immediately linked to the use of wood as a source of energy. Although renewable, wood fuels apparently were overused at non-sustainable rates leading to the belief that forests would disappear in the near future.

Based on this belief, FAO prepared a comprehensive overview of the fuelwood situation in the world with the results shown in a map (FAO, 1981) as well as in report form (FAO, 1983). It was based on at that time available information and was considered a first attempt to assess the magnitude and location of existing and potential fuelwood shortages.

The study indicated that out of the 2 billion people who depended on fuelwood as a source of energy, 100 million were facing an acute wood fuel shortage. Over half, or more than a billion people, were living in fuelwood deficit areas and could only provide for their minimum requirements by over-cutting of the forest resources, resulting in a loss of forest cover as well as environmental problems. At the same time, however, the authors acknowledged that large gaps in the knowledge existed mainly with regard to: - Productivity of natural formations other than closed forest; - Specific data on tree and shrub formations; - Actual area covered by non-industrial plantations; - Amounts of agricultural and industrial residues available as fuel. It was also acknowledged that these factors, which are so closely linked to local specific conditions, could never be grasped satisfactorily from a global view and would need more thorough investigation of the widely varying local situations.

Even though these qualifying remarks were made, the warnings sounded were taken seriously, in particular by people in government circles as well as international organizations. This resulted in massive efforts in time and hundreds of million dollars to increase the resource base e.g. the forests through reforestation, tree growing, etc. as well as lessening the deforestation rate through wood energy conservation measures. However, it was soon found that such efforts, even though sometimes successful in itself, did not contribute much in halting the loss of forest cover.

Numerous studies have been carried out since then at village, district and country level with regard to wood fuel use. These have shown that to a large extent the amount of wood fuels obtained from non-forest sources is often far larger than those from the forests itself. At the same time there are indications that deforestation is a result of many complex, often inter-related, factors of which the extraction of wood as a source of energy is only one.

Evidence for the latter point is difficult to come by as apparently very few long term studies have been carried out. The indications, based on the little information available, are that, besides fuelwood extraction, the need for agricultural land to grow food, changes in cropping patterns (shorter fallow periods due to population pressures leading to soil degradation), over-grazing by livestock (damaging to the young undergrowth), timber extraction, a lack of reforestation efforts, insufficient maintenance of forests (re-stocking, enrichment planting, removal of unwanted trees, etc.), the need for increased infrastructure (towns, villages, roads, irrigation and hydropower schemes), etc. are collectively responsible for the loss of forest cover.

With regard to the first point it is now believed that, if the wood obtainable from non-forest land like fallow lands, shrub and grass lands, agricultural lands, trees on homesteads and along roads, etc. had all been included as a source of supply, the FAO study would not have identified a fuelwood deficit for many of the rural areas (Foley, 1987b).

This present regional review more or less confirms that finding. For the RWEDP member countries only a small part, estimated to be from 25-50% out of the total amount of wood fuels consumed, appears to be derived directly from forest resources. A large part of this is in the form of twigs, leaves and dead wood which, although from the forest, did not result in the cutting of trees. The remaining 50-75% comes from non-forest areas like village trees (planted or existing trees), trees from agricultural land, brush- and waste land, etc. This fact has resulted in a more realistic view with regard to the wood fuel sector. This in its turn has resulted in that much more efforts are now being placed on tree growing through agro-forestry, social forestry and other tree planting activities than in the past.

The result of the present study also indicates that the share of fuelwood out of the total amount of energy consumed in the countries is considerable larger than what official statistics (UN, 1991; FAO, 1991d) suggested. The reason for this can probably be attributed to the non-inclusion of other sectors such as rural industries, village activities, etc.

At the same time it has also been noted that for most of the countries covered still little reliable information is available. Only for a few of the RWEDP countries, mainly obtained during studies carried out within the framework of national Forest Master Plan activities, Tropical Forest Action Programmes or Household Energy studies by the World Bank, detailed information is available on the demand, however in general only for the domestic sector.

Unfortunately, in the case of supplies, even though evaluations of forest resources have been carried out in many countries, still little is known. This is not surprising. Country wide surveys of the forest and other wood resources take a lot of time as well as a lot of money and provide only a "static and bird's eye" overview. At present only one country is known, Pakistan, where a comprehensive survey of forest as well as non-forest lands has been carried out but results have not yet been published. It is, however, felt that the studies and evaluations which have been carried out have resulted in a better insight in sources of wood fuel supplies and its their respective supply potential.

Even though the demand/supply imbalance appears now to be considerable less serious than expected in the past, it remains important to monitor the situation as well as to address the imbalance. There will be continuous changes in the demand for wood fuels (population growth is only one factor), changes in land use will occur, influences by other and often unknown factors, etc. all will influence the demand and supply. This will require continuous monitoring of the demand as well as the supply situation.

Data for the supply and consumption of commercial sources of energy like oil, gas and electricity are available for each year unlike the traditional sources of energy. The commercial sources of energy are subject to measurements from beginning to end by automatic equipment which only needs a readout once in a while. Electricity and oil companies can therefore relatively easily balance their input and output as they can easily measure how much is lost along the way.

Wood fuels as well as other traditional sources of energy are for a large part collected by the users themselves and do not pass through official measurement systems and therefore do not appear in official data. Even that part of the wood fuels which passes through checkpoints where they possibly could be measured, in many cases are subject to all kinds of un-official levies and for that reason may not show up in official data. Besides, most of the fuelwood trade is handled by the informal sector which is notorious for its lack of formal bookkeeping. The wood fuel trade is no exception to this general rule.

Forest departments therefore have a much more difficult job. First of all they generally do not know how much they have (mainly in terms of forest cover, crown cover, quality, quantity and types of wood, etc.), how much they gain (annual growth rates) nor how much they loose (due to all sorts of legal and illegal extractions) as their products are not transported through easily controllable and relatively pilfer-proof pipelines and wires.

Not being visible nor measurable in an easy way is only part of the problem. Another important difficulty is that the consumption patterns are site and season (climate as well as agricultural) specific and generalizations at the national level are of little help. These factors combined probably are the main reason why still so little is known about the role of wood energy in the overall energy sector. This can possibly have disheartened many in the energy planning sector and may have resulted in a loss of interest. Besides, as the alarmistic views originally held, proved to be less than true, this may also have contributed to a loss of the interest which originally had been put into it.

It should be noted that, in order to be able to plan interventions in the wood fuel demand and supply in a proper way as well as to draw up policies with regard the wood fuel sector, reliable data are needed with regard to its role in the energy sector, its importance in the economy (direct as well as indirect employment generation) etc. The same argument is also valid with regard to the environmental impacts. The use of wood fuels can be beneficial in reducing the emissions of green house gases. However, this is only true when there is no loss in tree cover e.g. more wood is grown than what is removed. As long as no such data are not available, few arguments can be presented to the governments to justify interventions in the wood energy sector in order to address the problems.

As mentioned earlier, in the past many international donor organizations as well as governments in individual countries appear to have based their decisions on intervention on little else than studies which looked at only one or two aspects of the perceived problem e.g. that wood fuels were a major reason for deforestation rates.

Reduction in the consumption, improving the supplies, promoting alternative sources of supply are a few of the areas where large amounts of funds have been spent. The outcome of these interventions have not always lead to the expected result and sometimes resulted in failures. Conservation of fuelwood through the promotion of more efficient cookstoves was initially advocated as being able to save trees. Although fuel is saved, it is now generally acknowledged that it has had little, if any, effect on deforestation rates. One reason for this is because little wood is obtained from the cutting of trees in forests direct for fuelwood. However, stove programmes were found to have many other benefits besides the saving of fuel. Savings in time spent on cooking and cleaning of cooking pots, more healthy conditions in the kitchen, either through the removal of smoke or by ensuring more complete combustion are just a few of these benefits. Incidentally, these points are often more valued by the users than the fuel savings aspect which shows that users and their needs should be one of the main governing factors for decision makers in interventions. Out of the 11 (or 14) countries covered, there are only 2 countries, India and Sri Lanka, where cookstove programmes have had a considerable impact. In India 17.5 million households, about 10% of the population, have received a new stove (Dussa, 1992) while in Sri Lanka about 300,000 stoves have been introduced (Young, 1992). Little is known though about the savings in fuelwood as well about the survival rate. Information from Thailand, where improved charcoal stoves have been introduced is sketchy (figures of about 200,000 up to 1 million stoves are floating around) and the impact on the overall charcoal consumption in Thailand is not known.

Improving charcoal production is another area where interventions have been made as it was assumed that the conversion rates of the traditional systems were low. However, in many cases, after a more careful evaluation of these traditional systems, the conversion rates were often found to be quite high and sometimes much better than thought (Leach, 1988; FAO, 1992a; WB, 1992b). In other cases, due to the small scale production systems, apparently little was done as improved systems may be too expensive for the informal (and often illegal) sector, commonly found as being the main producers of charcoal. Wood waste which is available in countries like Indonesia, mainly outside the island of Java, at present is often burned to get rid off. Apparently no efforts have been made to convert such waste wood into charcoal, either for domestic use (transport to the island of Java) nor for export.

Substitution efforts through the promotion of alternative sources of energy like solar energy, wind energy, biogas, etc. have often floundered. Extensive resources have been put into the research of and pilot programmes for such substitute energy sources. Even though these systems often looked attractive, the stage of technological development as well as economic development has put and will keep most of them out of reach for those for which they were intended.

In other cases substitution through subsidies has been tried. Even though such schemes can be successful they tend to favour consumers who have switched already to such fuels and do not address the other and possibly the main constraints e.g. poor access, unreliable supplies, expensive stoves and equipment, etc. In other cases, where such constraints have been addressed such as on the island of Java in Indonesia, subsidies for kerosene could not be maintained due to budgetary constraints, resulting in January 1993 in a 27% increase of the price of kerosene.

Briquetting of waste products (saw dust, agro-residues, etc.) was once actively pushed by many. Where local conditions favoured their introduction such as in some areas in India, briquettes have found acceptance. In Thailand several briquetting plants using saw dust as raw material have been in operation for some time. Their main market, however, appeared to be the refugee camps as the traditional markets did not accept it. At present there appears to be a new market with briquettes being carbonized for export to Japan, Korea and Taiwan while the lower grades are sold locally. No information exist on the size of the production nor on the extent of the export market. The little information which is available on the subject shows that in most cases technical as well as economical problems have forced a rethinking in this field (FAO, 1990c).

Rural industries are an important factor in rural development. They often process local raw materials and/or products and generate employment in rural areas. They have received some attention, mainly through the efforts of the Regional Wood Energy Development Programme (FAO, 1990a). However, little evidence other than some isolated cases, has been found of actual follow up in the form of direct assistance to such rural industries by improving their production systems, resulting in energy conservation as well as improved products (bakeries, brick making, etc.).

Interventions on the supply side have also been undertaken. Where these have been in the form of large scale plantations, purely for the supply of fuelwood, these in general appear to have fared less good. However with multi purpose intentions e.g. logs for the pulp industry, for poles or for timber and with the branches, twigs, etc. as fuelwood the plantations have been more successful. Part of the problems encountered apparently can be traced to low survival rates, lower yield than expected, no market for the output, etc.

Gradually a move has been made towards tree planting on a smaller scale through agro-forestry, community forestry, etc. However, in general it appears that much depends in how far people have a say in these activities, in terms of security of land tenure and coupled with it ownership of the trees, selection and availability of species, secure markets for wood, etc. The latter type of schemes do need more inputs in terms of support and extension services, something which is not always available when needed. Part of this problem is caused by that knowledgeable and dedicated manpower in the government sector is limited. Non government organizations (NGO's) have in several countries involved themselves with local tree planting activities and they appear to be generally successful (FAO, 1990b; FAO, 1992b).

There are also many examples of people who have started growing trees on their own initiative and often with success. Incentives to plant trees are often quoted as to provide fodder for livestock, fuelwood for own use, wood for sale as poles or timber, etc. For instance, a farmer in Indonesia planted in 1965 about 100 trees along the boundary of his field. Three years after planting, the farmer started to cut one tree per week for fuelwood for own use. Coppicing and re-growth of the trunk left standing (about 3 m. high) is sufficient to be able to have a rotation period of only two years which provides him with a continuous supply of fuelwood since then (FAO, 1991c). Less fashionable interventions in the supply system are also options such as better managing the existing forest resources. However, in the review of the available sources of information very little evidence of such activities have been found.

However, on the supply side, much depends on market forces e.g. if wood fuels can be sold at prices which give sufficient incentives to people to become involved in tree growing for sale. Little information appears to be available on the mechanisms which drive the wood fuel market except for some studies carried out as a follow-up of a Rapid Rural Appraisal course. These studies of small areas in four countries have come up with information on why people become involved in the wood fuel trade, how the market system works, etc. In all cases the market appears to be far more complex than thought with many players having different motives (FAO, 1991c).

It is clear that both at the demand as well as at the supply side many interventions have been made by various international and national organizations including the government sector. Even though many of these interventions have been successful, albeit not always reaching their stated goal, there have also been many problems as well as failures.

However, based on the results of and knowledge gained from these interventions, new approaches are being taken. These are basically governed by the notion that deforestation is much more complex and that population pressures also imply that more food will have to be grown which in its turn will require more land.

Increases in the population put additional strains on the existing agricultural land, also because very little other job-opportunities exist in rural areas. This often affects in un- or under-employment but more often the size of the landholding. This can and often does result in increases in crop intensity which in its turn leads to exhaustion of the soil which then results in diminished yields. In some cases the exhaustion is augmented by that insufficient organic matter like straw, stubble, dung, etc. is returned to the fields due to that these materials are used as fuel. The results sometimes is that farmers have to borrow money by mortgaging their land in order to buy fertilizer to increase crop yields. In the end they may become indebted and the only way out is to sell their land if they have not forfeited it.

The problem appears therefore to be multi-facetted and more or less a vicious circle: Population pressure - Splitting up of land holdings - Soil degradation - Indebtedness - Migration to urban areas or other areas which could be degraded forest, virgin forest or other areas.

This notion that agriculture practices and/or the need for more agricultural land may be an important factor governing the conversion of forest lands has resulted in that more efforts in this direction are being made. Up to now this has basically covered agro-forestry practices e.g. convincing farmers to grow trees along their farm boundaries, in farm fields, on homesteads, etc. The purpose of such trees can be manifold: Fodder for livestock, Soil enrichment and protection by fixing nitrogen and providing a better cover, As a source of fuelwood, As a potential source of cash income, As boundary markers, etc. However, as many farmers have no legal title to the land they till or are so indebted (with land as collateral), there often are few incentives for the farmers to do this.

However, this is only a solution to one part of the problem. A more comprehensive solution to the problem should cover all facets: Population growth, agricultural practices, forest cover, the need for energy (wood fuels as well as other types) for daily use as well as for industrial purposes, the need for employment, etc.

Even though each part or each sector is doing a lot within their own boundaries they probably will have to do much more. This should include linking up with all interrelated sectors or even taking part in activities of other sectors. Most of the institutions at present involved with wood energy, mainly from the forestry sector and to a much lesser extent from the energy sector, however, would need strengthening both in terms of manpower and skills in order to be able to meet the challenge of finding and implementing solutions to the multi-sectoral problem. It is felt that only, when actions taken in one field are integrated with other fields e.g. a multi-disciplinary approach, progress can be made in overcoming the problems facing many of the population. This will not only require cooperation at the local level but more importantly also at the macro level. Strengthening at the macro level through integration and coordination of policies in it self is not enough. Only when such integrated policies facilitate that opportunities are matched with realities at the micro-level, a task which requires an intimate knowledge (preferably firsthand) of the problems at all levels, can lasting development be achieved.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The countries of the RWEDP region are heavily populated (29% of the world population on 7% of the land area of the world). According to demographic projections, the population size will continue rising for at least the next century before it will stabilize. Much of this increase in population will be in urban areas and although the population in rural areas certainly will grow, the growth rate is expected to be lower when compared to the urban areas.

Part of this disparity in growth rates is thought to be attributable to the low income from activities carried out in rural areas compared to urban areas. This assumption is based on the relatively low share of the agricultural sector in the Gross Domestic product when compared to the size of the labour force which finds their source of income in this sector.

When considered on a per capita basis, the region can be described as using little to very little energy. However, with a large population, the total amount of energy consumed is considerable and the 11 RWEDP countries are estimated to consume more energy then the whole of Africa or the whole of South America based on data from the World Resources Institute (WRI, 1992). Although some of the countries have extensive deposits of conventional energy sources consisting of coal, oil and natural gas, most of them still rely for a large part on the traditional sources of energy.

A main conclusion which can be drawn, based on the available information, is that biomass energy, and wood energy in particular, supply a large part of the total amount of energy consumed in the countries, in particular by the domestic and rural industrial sectors. The amount of traditional sources of energy consumed within the RWEDP countries was estimated to be over 650 million tons annually. However, this figure should be treated with caution as base years are widely varying while at the same time the databases used can be considered to be far from satisfactory. The share of wood fuels (charcoal and fuelwood) in the total amount of traditional sources of energy consumed shows widely varying figures from about 14% in Bangladesh to 94% in Nepal.

In most countries, with the exception of Pakistan, the Philippines and Thailand (and possibly India for which however no data were available), the domestic sector is by far the largest consumer of energy as well as traditional sources of energy. The industrial and other sectors also use considerable amounts of these traditional energy sources, estimated to account for about 10-15% of all sources of energy and 10-30% of the traditional sources of energy. Much of this amount is used by the rural based industrial sector and can be considered as vital for the survival of such industries. The sector itself is vital for the rural economy of many countries as it provides employment for many people while at the same time using and/or processing raw materials from these rural areas.

The result of the present study indicates that the share of traditional sources of energy out of the total amount of energy consumed in the countries is considerable larger, sometimes up to a factor of 2-3, than what official statistics (UN, 1991; FAO, 1991d) suggested. The reason for this probably can be attributed to the non-inclusion of other sectors such as rural industries, village activities, etc.

The same comment can probably be made with regard to the contribution of fuelwood to the economy. Little evidence has been found that the value, which can be attributed to the production, processing and marketing of wood fuels, is accounted for in the National Product. Also statistics with regard to land use e.g. areas covered by forest, land used for agricultural purposes were found to show large differences even though apparently the same sources had been used. Part of this problem is caused that by different as well as changing definitions of land types are used by different organizations. There appears therefore a need to substantially improve the statistics by a) giving a better indication of the actual situation and b) agreeing upon a generally valid set of definitions.

In general rural consumers not only use much more traditional sources of energy than their urban counterparts but at the same time they use more energy. The reason for the difference is partly due to that urban consumers in general use more efficient stoves (kerosene, gas, etc.). This results in that less fuel in terms of energy content has to be used. Another reason can probably be that urban users eat more often outside the home and use more pre-cooked food. However, there are large variations between the countries covered and no general valid conclusion can be drawn. The commercial sources of energy are more widely used in urban areas than in rural areas. This is partly due to that the urban economy is more cash based while, and probably more important, the availability as well as reliability of supplies of these sources of energy are better in urban areas.

Very large variations were found between countries, between regions in countries and even between villages in the same regions. These variations not only concern quantities but there are also large variations between seasons, between agricultural cropping patterns, between resources (land ownership, forest and tree resources, animals, etc.) and access to it, occupation, etc. Such variations influence not only the amount of energy consumed but also the energy mix. Changes in the energy mix as well as total amounts can occur quite rapidly, in particular in urban areas. Changes in rural areas, however, tend to be more slow. Much depends on availability but this is not enough. Favourable conditions for the use of particular types of energy appear to be also a very important factor.

Being location specific but at the same time also part of a much larger system also implies that generalizations for energy consumption, options for substitution, etc. can not be made. This in its turn implies, in case any interventions will be planned, the need for dis-aggregated data and an intimate knowledge of how the system operates.

In general it can be said that traditional sources of energy are used in an inefficient way and there is ample scope for improvements in the domestic as well as in the other sectors. Although the industrial sector, when compared with the domestic sector, uses only a small amount of biomass energy, improvements can be made. This not only concerns the energy efficiency but, maybe more important, the whole production process which could result in improved quality, a larger output, increased labour productivity, increased income, etc.

Supply systems for traditional sources of energy and in particular in rural areas, are of an informal nature often without a clearly defined market structure. Most of the supplies are collected by the users themselves and only part of it is traded. This traded part consists mainly out of charcoal and fuelwood but in some cases residues are traded as well. The main markets for the traded part are urban consumers as well as industrial operations. The available information sources indicate that non-forest areas are the major supply source for wood fuels and may account for 50-75% of the total supplies. The non forest areas include homesteads, common village lands, road sides, canal banks, strips along railroads, agricultural land, bush and shrub land, agricultural plantations (rubber, coconut, palm oil, coffee), etc.

The remaining 25-50% is obtained from the forests. A large but unknown part consist of twigs and dead wood. Planted trees, in particular those planted as scattered trees and under agro-forestry and social forestry schemes and to a much lesser extent forest plantations, appear to be an important source of supply. The notion that the demand for wood fuels is a major reason for the diminishing forest can therefore be questioned. However, it was also shown that in Nepal and Pakistan and to a lesser extent in Sri Lanka the amount of wood fuels derived from the forests, when calculated at a ton/ha. basis probably were close to the mean annual increment e.g. could result in a loss of forest. This in particular appears to be true in Nepal and Pakistan as part of the forest are in-accessible and/or located in areas far away from populated areas.

There are large regional variations and what may appear to be valid for a whole country can be completely different in smaller areas within countries. This shows that, in order to have a better insight in the sources of supply, more in-depth studies will be needed in the field of localized demand and supply situations as well as the forces governing it.

The wood fuel trade provides opportunities for rural development through the generation of employment and income through the production, harvesting, processing and transport of wood fuels. The employment generated in the wood fuel energy sector appears to be enormous. Unfortunately very little is visible of it as much of it is in the informal (and often illegal) sector and therefore very little is known. World Bank estimates show that from 1,600 to 2,700 person days of work is required to handle 1,000 tons of wood from harvesting to consumer. Evidence from R.R.A. studies indicate that this amount of employment may be a factor of 10 too low e.g. 1,000 tons would require from 16,000 to 27,000 person days. Whatever value is nearer to the truth, it is clear that wood fuels are important for employment generation: In the Philippines probably 1 million households (8% of the total) are involved with wood fuels and derive their income partly or wholly out of it.

In many countries the authorities have pushed substitution of fuelwood by other sources of energy like kerosene, electricity and gas in order to redress the problems with loss of forest cover. While this may appear to be beneficial, there are several trade-offs to be made. Using kerosene instead of wood fuels would result in the emission of large amounts of carbon dioxide, one of the gases responsible for the green house effect. Trees, which then presumably would be left standing, would absorb and store an even larger amount of carbon and the net effect could be positive. However, it has been shown that the cause of deforestation is very complex and that the need for more agricultural land is one of the factors involved. It is therefor not sure whether trees would not be cut and burned just to get rid off instead of being used as a source of energy. The outcome of the balancing act between green house gas emission and adsorption of carbon would then become unstable and would probably be negative.

It appears therefore that the use of wood fuels can be beneficial to the environment and for that reason could be advocated for increased use. For as long as there is a positive balance between increments in the growth rate of trees and the removal of trees the net effect between carbon dioxide emissions released through burning the wood and the storage of carbon in the growing wood will also be positive e.g. there will be no added strain on the environment from that side. In practice however many other factors would have to be considered also such as for instance the health aspects of users of the wood fuels (smoke, soot and other particle emissions, etc.), employment effect, dependence on outside supplies or using local sources of energy (the security of supply aspect on a national basis), just to name a few. Therefore the +/- comparison used above is far too simplistic as well as that the existing database is insufficient to come to meaningful and balanced decisions.

This basically confirms that the pro's and con's of fuelwood use are very complex and with it the question of deforestation. A comprehensive solution to such questions or problems should cover all facets: The need for energy, forest cover, the need for agricultural land, agricultural practices, the need for employment, population growth, the environment, etc. This will require a much more close link between all sorts of agencies (government as well as non government), department, ministries, etc. at the micro as well as at the macro level.

Another conclusion which can be drawn is that, although biomass energy plays a very important role in the overall energy scene of many of the countries covered, it has not been accorded that importance in the energy planning process. A main reason for this appears to be its invisibility which results in that little is known about it. Getting a better grip on the situation requires lots of time and money. The former may be available, the latter often is not. Coupled with this is that over time energy use patterns change. While for commercial sources of energy these changes can be relatively easily followed, wood fuels are in a complete different league and would require further time and money. This problem of invisibility probably has caused that some energy planners have lost interest in the subject. This loss in interest may in some cases have been re-enforced by the thinking that the alarm bells sounded in the early eighties over the fuelwood - deforestation link proved to be a false alarm or at best an early warning system.

However, even though it may have been an early warning system, it has resulted in a flurry of activities by international organizations, donor organizations as well as national governments and non-government organizations from which many valuable lessons have been learnt. The activities undertaken were varied and often extensive, covering most possible interventions ranges, and using a wide range of methods, strategies and approaches. Out of these forestry plantations, agro- and social forestry systems, improved cook stoves, charcoal production, densification and gasification have received the largest share of attention while rural industries, vital for rural development, have yet to receive the attention they deserve. Even though lots of activities have been undertaken, the results have not always been positive nor what had been intended on the outset. The reasons for this are not always clear but tackling only one part and often a tiny part out of a very large and complex system may partly be to blame. The non-involvement or only part involvement of the people for which the programmes were intended, and who face many other fundamental issues such as food, jobs, land, shelter, etc. could be another reason.

Problems with wood fuels or wood energy should be tackled in an all encompassing way instead of only focussing on energy or forestry. It requires a much wider approach in which the solutions should be tailored to cope with the specific needs of the region, country, community, village and people involved.

7.2 Recommendations

It is expected that wood fuels, as in the past as well as present will remain a main source of energy for most of the countries covered for a long time to come. Wood energy plays not only an important role in the overall energy scene of many of the countries covered but in the rural economy as well through the harvesting, processing, transport and trade of the wood fuels.

The fact that wood fuels will remain important and that its use is governed by an extremely complex system of inter-related factors should be acknowledged by all parties and should not be just limited to those involved with forestry and energy planning. Such an acknowledgement is important to base activities upon for the future of which improving and enlarging the database should be one of the first steps. Improvements of the data base should not be limited to just numbers on demand and supply. It should include information on how energy is used and its efficiency e.g. charcoal kilns, industrial applications, the effect of improved systems, etc. Definitions used by different organizations involved should for as far as possible and practicle cover the same thing e.g. What is forest land, what is a cubic meter.

It should also be acknowledged that non-forest lands, what ever that term may cover, are an important, if not the most important, source of traditional sources of energy in the form of wood fuels and residues. At present very little is known about the supply base in the form of trees (where, what, how many, for what purpose, who has access, etc.) as well as why residues are used as fuel. The latter issue, often a controversial issue with agriculturalist and soil scientists, needs a better insight in the trade-offs involved as well as an analysis of the overall implications of the practice. This may lead to conclusions beyond the presently held theoretical and largely abstract discussions on its pro and cons. Besides, the non-forest lands, more information on the supply base of forests in terms of area, standing stock, growth rates, accessibility, availability for supplies (protected areas, national park, critical water shed) should be collected.

At the same time it should be acknowledged that wood fuel use is not static and that changes in overall consumption as well as in the energy mix do take place and sometimes quite rapidly. This calls also for a constant updating of the database with regard to wood fuel use. As this is a very time consuming task it is recommended to look for or develop indicators for such changes in consumption. This calls for a much better understanding of what factors govern fuel use, the selection of fuels and the trade-offs made. Such an understanding at present only exists at the user level as here the decisions are made and the grass root level should be included in the information chain.

From here it is only a short step to applying or finding solutions to problems. As the grass root level is often most affected it is imperative that they are included in any decision making process and that their knowledge of the local system, their needs and wishes are taken into account. This calls for the setting up or streamlining of information channels. These should not be limited to from top to bottom or in the reverse direction but may be more importantly also in horizontal directions e.g. inter agency exchange of information. However, it should not be limited to information only. Close cooperation in activities in what ever form and which can affect activities by other agencies is also important.

This may have implications for many. Tasks may have to be shared or some tasks taken over by other agencies due to limits in manpower. Agricultural extension people may take over forestry extension tasks, become involved with the introduction of stoves. Health care workers, now sometimes already involved with stove programmes could act as extension worker for the agricultural and forestry sector or act as a liaison between the people and the agencies concerned. However, at present this would be almost impossible as the different agencies and the personnel would not be ready to tackle the increased workload nor have the skills for such multi-facetted tasks. This would require strengthening of the institutes and its personnel in terms of manpower, training, budget, etc. More over, it would also call for changes at the macro level e.g. at the policy making level in order to facilitate the inter-agency cooperation and sharing of tasks.

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Woodfuel Use in Pakistan: Sustainability of Supply and Socio-Economic and Environmental Implications

by

Azedine Ouerghi[1]

1. INTRODUCTION

1.1 Importance of Woodfuel in Pakistan

Pakistan consumed about 16.3 million TOE of modern fuels in 1991. Information regarding the use of traditional fuels was mainly based on rough estimates until the Household Energy Strategy Study (HESS) was undertaken. The results of this study indicates that with 20 million TOE, traditional fuels constitute over half of the total energy consumed in this country and woodfuel has the largest share.

The energy consumption of the household sector represented about 57% of the total consumption of 1991, which makes it the largest single energy consuming sector in Pakistan. Out of the 20.8 million TOE being consumed by this sector over half is represented by woodfuel and an other third is represented by crop residues and dung. It is believed that this heavy reliance on biomass fuels is not sustainable and is contributing significantly to environmental degradation as well as causing hardship to households. The use of inferior fuels such as dung and crop residues by a relatively large proportion of the population suggests that there is a woodfuel shortage. However, the relative price stability of traded woodfuel in urban markets seems to indicate that the level of supply to the cities has been satisfactory. Figure 1 shows that since 1957, the national average for urban woodfuel price has risen in two main jumps in 1973-74 and 1980-81, with fairly steady prices in between. The main reason for these jumps could be higher transport costs due to increased diesel prices following the two oil crisis. Price rises for kerosene, the main competing purchased fuel in urban areas, may have also contributed to these jumps. Using low quality fuels seems then to indicate that low income households who cannot afford to purchase woodfuel are facing hardship in collecting their needs.On the other hand an accelerated inter-fuel substitution to reduce the pressure on biomass resources could place severe stress on modern fuel supply infrastructure, so that considerable investment would be required to keep pace with the increasing demand.The major issue related to the use of woodfuel by the household sector in Pakistan is therefore to establish: (i) whether the present level of consumption is sustainable, (ii) whether an aggressive inter-fuel substitution is justifiable, (iii) what are the prospects of increased biomass supply; and (iv) to highlight the broader policy implications.

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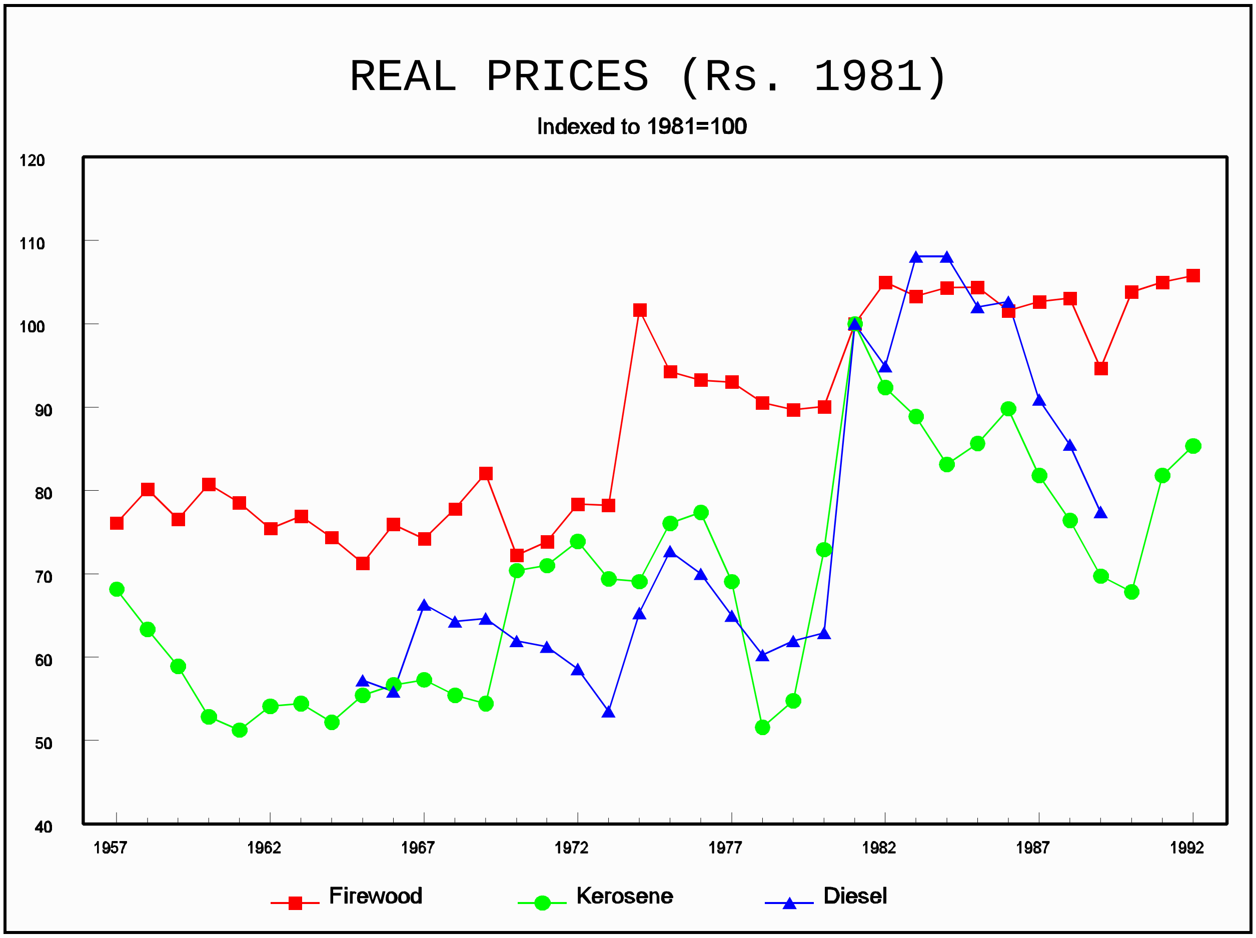


Table 1. Amount and Relative Sector Share of Delivered Energy ('000 toe) Pakistan 1991.

Sector	Modern Fuels		Traditional Fuels		Total Fuel	
	(*)	Share		Share		Share
Residential	2,900	17.9	17,850	88.9	20,750	57.1
Comm. & Inst.	1,030	6.3	770	3.8	1,800	5.0
Industrial	6,500	40.0	1,450	7.3	7,950	21.9
Agriculture	730	4.5	0	0.0	730	2.0
Transport	5,090	31.3	0	0.0	5,090	4.0
Total Energy Delivered	16,250	100.0	20,070	100.0	36,320	100.0
% Share		44.7		55.3		100.0

(*) Include 1,260,000 toe of natural gas as feed stock to fertilizer

Source: Energy Wing and HESS data base

Several studies and assessments have reported severe land degradation and advanced deforestation in many parts of the country. There is a consensus that poor land-use management, over-exploitation of wood resources, over-grazing and the high population growth rate are the main causes. The Forestry Sector Master Plan (FSMP) noted that the major forests such as the coastal mangrove forests in Sindh, the Juniper forests in Baluchistan and the Upland coniferous forests are overexploited and under severe pressure. The deterioration of watersheds has also increased the risk of soil erosion, dams siltation and severity of floods as observed in 1992. The depletion of these natural resources has dramatic implications as they constitute important ecosystems by protecting the environment, preserving bio-diversity and providing wood and non-wood products to local communities.

These concerns have been clearly expressed by the National Conservation Strategy (NCS) and are reflected in its broader objectives dealing with conservation of natural resources, sustainable development and improved efficiency in the use and management of resources.

In light of the HESS findings, the FSMP conclusions and the recommendations of the NCS, a new approach is emerging which puts more emphasis on the broader issues of the sustainability of natural resources taking into account socio-economic and cultural constraints. This approach is dramatically different from the popular wisdom according to which woodfuel use is the major cause of deforestation and substituting woodfuel would solve the problem. It is interesting to note that the USAID sponsored Pakistan Forestry Planning and Development project (1985-1993) was initially designed to "help Pakistan increase its energy self sufficiency and reduce deforestation". However, shortly after the start it became clear that the energy aspect of farm forestry is secondary and the project would have to broaden its approach if it wanted to achieve its primary objective. In fact the project enlarged its scope and adopted a social forestry approach aimed at "improving farm forestry systems to produce fuel, fodder, and timber that is compatible with agricultural needs". Training and field operations were based on joint participation of farmers, foresters and wood-based industry leaders.

Woodfuel has been a major source of energy for households in Pakistan, and will continue to play a major role in the next decades. Its use has some negative impacts on the environment, but certainly has other implications that need to be addressed in an integrated manner. Unfortunately, woodfuel use has often been considered as mainly an energy problem that could be addressed within the energy sector based on the same economics and using similar techniques. The fact that in general households collect most of their needs and therefore not incurring any financial expenses, adds another complication to the issue. One has to deal with labor availability and employment opportunities especially for women, who mainly responsible for fuelwood collection and use in rural areas. This in turn needs to be linked to education opportunities for women to value their time which will certainly make it less profitable to collect fuelwood and hence trigger inter-fuel substitution in a natural way. More importantly is the fact that the household sector itself is not really similar to the other productive sectors of the economy and therefore needs to be addressed in a broader manner that reflects its close interaction with other aspects such as the role of women and social development in general, and land-use management and environmental impacts in particular.

1.2 The Need for Database Development

The Government of Pakistan felt the need and the urgency to deal with household energy because of its heavy reliance on biomass resources and its suspected environmental implications on one hand, and its high growth rate of modern fuels consumption and its impact on modern fuel supply systems on the other.

However, the development of a comprehensive strategy capable of fully addressing the issue of sustainability of the resources faces two major obstacles i.e. (i) non availability of reliable data in a disaggregated form regarding the supply and demand of biomass resources, and (ii) absence of good understanding of the woodfuel transition and users' behavior towards resources availability. The HESS project was designed among other things to provide reliable information and help develop an economically viable energy strategy based on resource sustainability.

The project was executed according to three phases namely (i) database development based on large-scale statistically sound field surveys, (ii) data analysis and identification of sectoral issues, and (iii) strategy formulation. In order to comprehend the biomass energy situation in totality, the study paid special attention to the three major components of the chain i.e. supply, marketing and demand of woodfuel.

The project was primarily based on field surveys and data gathering and analysis. A major effort was undertaken in order to ensure compatibility of the data collected through the various components, and smooth integration of the various databases. Although the three major components used different techniques taking into consideration their own specificities, the linkages are assured through a master sample frame that relies to a certain extent on the country's agro-ecological characteristics. An agro-ecological zonation was therefore developed under the project. About 14 zones were delineated using daily AVHRR imagery for 12 growing seasons covering almost 8 years. The zonation was primarily used to expand the supply field work results to the national level. However, when overlaid with the demand survey sample areas it provides the link to the supply/demand integration and traded woodfuel flows.

- Supply Resources Assessment

Higher resolution satellite imagery (Landsat TM) representative of the various agro-ecological zones were then acquired, processed and used for the actual field work for woody biomass and crop residues assessment.

About 580 plots were selected and visited by field teams over a period of 10 months for the woody biomass component. The teams measured the woody biomass resource and conducted some destructive sampling for further laboratory tests. The information gathered helped determine the stock of biomass resources and its sustainable productivity not only at the level of every agro-ecological zone but also taking into account the type of biomass i.e. timber, roundwood, twigs and shrubs.

About 470 plots were visited over two harvesting periods to measure selected crop whose residues could be utilized as fuel. Laboratory tests of sample crops helped in determining crop to residue ratios.

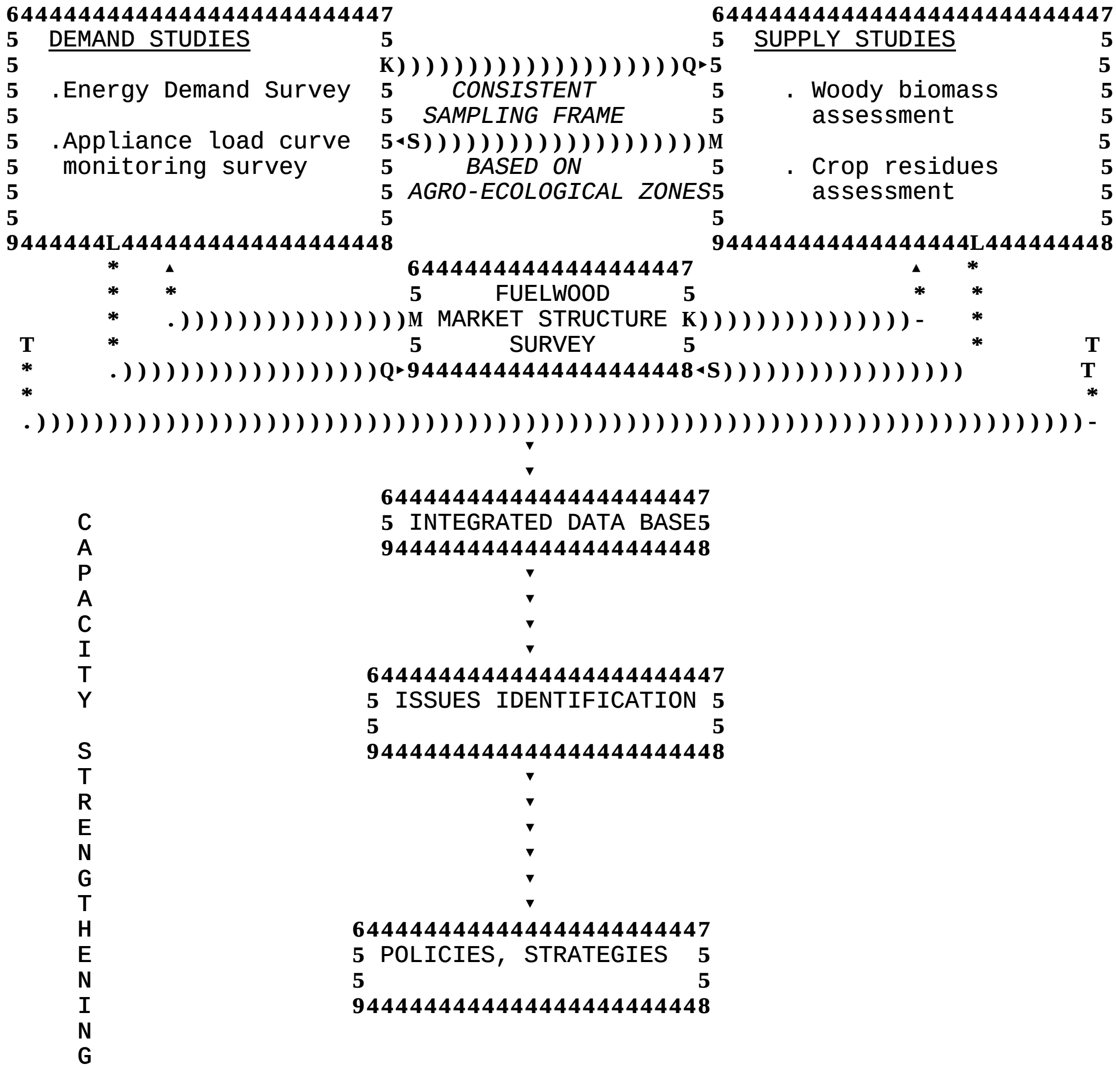
- **Woodfuel Market Structure**

Extensive surveys were designed to depict woodfuel market mechanisms, price build-up and catchment areas. The field work was conducted over 2 seasons and targeted various traders in urban and rural areas as well as transporters and producers. As no master sample frame existed, the project had to design and develop its own sample frame based on the developed agro-ecological zonation which allowed the expansion of the sample results to the national level.

- **Energy Demand Study**

The energy demand survey was designed in order to have complete and reliable information on household energy consumption patterns, their behavior and the appliances used as well as a complete set of socio-demographic and economic details. About 4,800 households were interviewed over a period of one year in order to capture seasonality effect. This component was characterized by integrated, pre-coded questionnaires, extensive training and supervision of field staff and the use of computers in the field for data entry and consistency checking designed to improve data quality and to reduce the elapsed time between the collection of raw data and their ultimate use in policy analysis. Taking into consideration Pakistani cultural conditions, female enumerators were employed during the field work in order to have access to women (the main energy users). In fact female and male heads of households were interviewed separately by female and male enumerators respectively. Biomass fuels which are either collected or purchased in a variety of non-standard units, were physically weighed in order to minimize the uncertainties traditionally linked to their assessment.

Interaction Between The Different Components of The Project



2. FUELWOOD CONSUMPTION PATTERNS AND SUPPLY LEVELS

The analysis of the demand survey confirmed that fuelwood is a major fuel in the household sector. Its use is widespread in rural and urban areas, across provinces and across agro-ecological zones. The results revealed that 79% of all households use fuelwood and consume about 29 million tons per year. In rural areas 91% of the households use this fuel and consume on the average 6.7 kg/day; whereas in urban areas 52% of households are fuelwood users and burn on the average 5 kg/day.

This level of consumption confirms the findings of other limited surveys conducted during the past few years[2]. However, it is in contradiction with the most frequently cited and used figure in Pakistan (0.2 m3 per person per year). This amount was estimated by a World Bank team in 1978 and was based on FAO estimates of firewood requirements for space heating and cooking in other developing countries, using conversion factors to reflect appliance efficiency and a presumed high level of scarcity.

Most of the fuelwood is consumed for cooking purposes (81.1%), Water heating and space heating end-uses represent only 9.8% and 8.3% of the total consumption respectively. These shares should be used as indicative of a certain order of magnitude because of multiple use. For instance, while cooking the household can benefit from the emitted heat to warm the space and in some cases the water.

2.1 Driving Factors of Fuelwood Consumption

Although fuelwood is widely consumed by households all over the country, consumption levels differ according to location, income level, household size and availability of other fuels.

2.1.1 Household size effect: The economy of scale

There is a strong link between the household size and the level of fuelwood consumption. Households that have a size of 16 or higher consume 2.17 times more than those having a size lower than 5 i.e. 3,867 kg/year and 1,785 kg respectively. The observed trend is similar in both urban and rural areas (Figure 2). As expected the per capita consumption of large households is much lower than small households: 198 kg/year and 568 kg respectively making a ratio of 0.35 compared to the above mentioned 2.17 (figure 3). Larger household size provides households with a substantial economy of scale for fuelwood consumption and certainly higher income due to larger number of earners. The availability of more labor for fuelwood collection in rural areas would offset the increased level in absolute terms of the needed fuel.

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[2] A PFI survey conducted in Barani areas in 1988/89, found out that 100% of the sampled households (119 cases) used fuelwood and consumed 7.8 kg per day per household.

In her PhD thesis, Dr Qazi presented the findings of her survey which indicated that 95% of the sampled households (197 rural cases in the northern most part of the Pothowar Plateau) were fuelwood users and their consumption averaged 6.9 kg per day per household.

Other studies based on survey results indicated high level of consumptions.

Table 2: Fuelwood Consumption by Household Size
By Area for Fuelwood Users

Size Class	URBAN Yearly Consumption (in kg)		Average size	RURAL Yearly Consumption (in kg)		Average Size
	Per H'Hold	Per Capita		per H'Hold	Per Capita	
1 - 4	1,394	456	3.06	1,893	559	3.16
5 - 7	1,673	276	6.07	2,284	375	6.09
8 - 10	2,031	231	8.79	2,648	299	8.86
11 - 15	2,289	194	12.43	3,208	257	12.46
+ 16	3,282	170	19.29	3,986	204	19.56
Total	1,820	252	7.22	2,455	334	7.36

It is therefore important to allow for changes in household size in projecting the demand and identification of major determinant factors of the woodfuel consumption patterns.

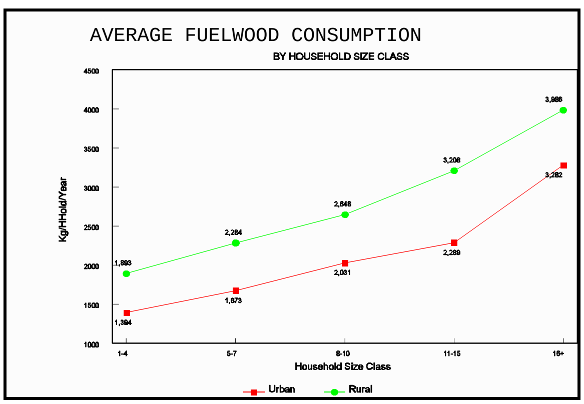

Figure 2: Consumption Per Household

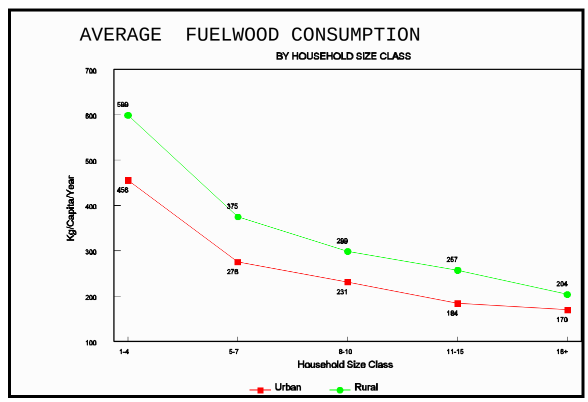

Figure 3: Consumption Per Capita

2.1.2 Urbanization and income level: Major determinants of woodfuel transition

Rural and urban households have completely different woodfuel consumption patterns as well as different driving factors as shown by figure 4. It clearly indicates that the fuelwood transition is driven by urbanization and that income plays an important role only in urban areas. As indicated above, a relatively lower proportion of urban households use fuelwood to meet their energy needs. Their average consumption amounts to 1,819 kg per year whereas rural households use 2,454 kg for the same period.

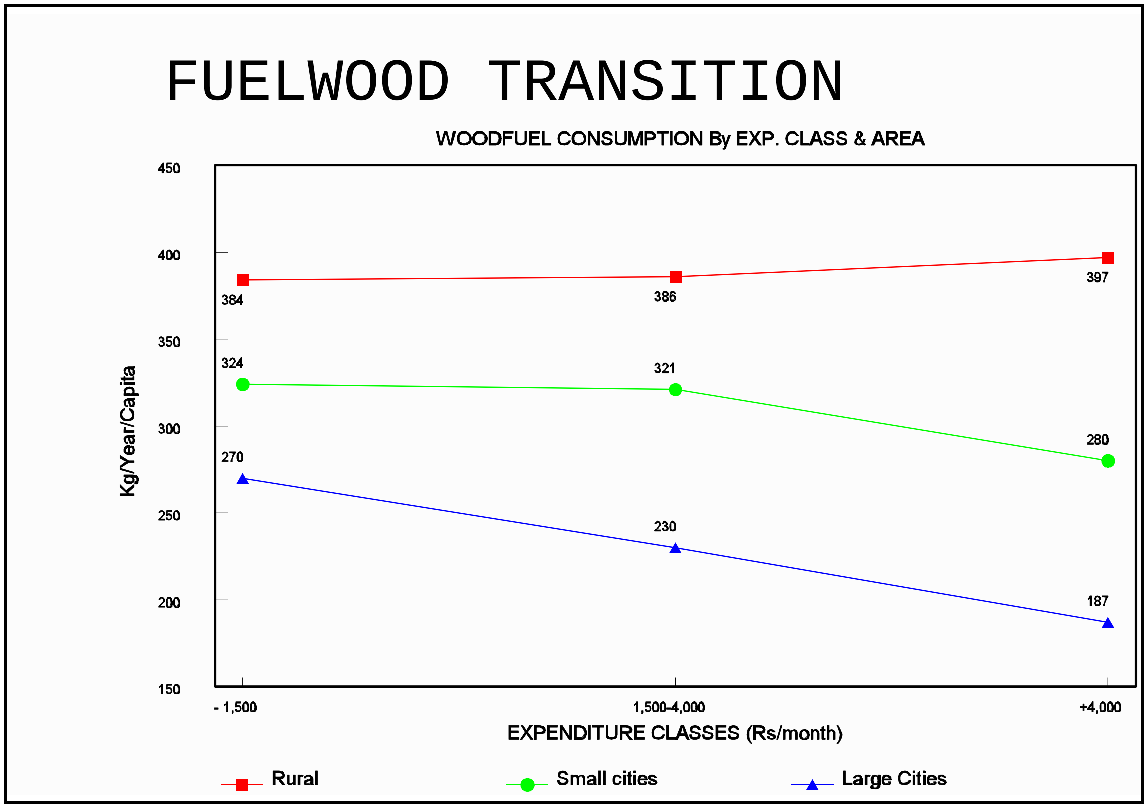

Figure 4.

In urban areas the size of the city is strongly correlated with the proportion of fuelwood users and their level of consumption. Only 28.5% of households residing in large cities of 1 million inhabitants and above, which house about half of the urban population, use firewood and their average consumption is almost 30% lower than consumption of households living in smaller cities. Large cities generally enjoy a better supply of modern fuels such as piped gas (almost half of the households have access to it); and display higher income. The level of average expenditure in large cities is about 43% higher than in the smaller ones. In urban areas fuelwood is generally purchased: less than 15% collect their needs and over 70% of these belong to medium-low and low income households with an average expenditure less than Rs 2,000 per month[3].

[3] 1 US$=25 PRs.

Table 3: Fuelwood Consumption in Urban Areas By City Size and Income Level

(in kg/year/capita for woodfuel users)

Income Level	City Size			
	Large		Medium/Small	
	% Users	Qty	% Users	Qty
Low	36.3	342	76.0	371
Medium	31.6	244	76.5	310
High	20.3	188	64.5	196
Total	29.0	248	74.7	326

In rural areas, where about 84% of the fuelwood is consumed, the level of consumption, after correcting for the household size effect, was not found to be sensitive to the level of income. However, the patterns varied significantly from one province to another denoting agro-ecological influences.

Baluchistan, surprisingly, has the highest level of consumption (561 kg/year/capita), followed by Sindh (486 kg). Rural households in NWFP and Punjab use 403 kg and 340 kg respectively. The high consumption in Baluchistan, which is located in a semi-arid and desert area, is explained by the non-availability of alternative fuels, especially crop residues and dung cake, for medium and low income households. Rural Baluchistan has the lowest proportions of households using crop residues (4.3%) and dung cakes (48.5%), whereas the national levels are 40.4% and 69.4% respectively. Although Sindh and Punjab are dominated by the same type of agro-ecological zone (irrigated type), households in Sindh consume considerable quantities of fuelwood which can largely be attributed to the presence of the riverain forests. In Punjab the availability of alternative fuels such as cotton sticks and dung cake has probably contributed to a lower demand on fuelwood. Incidently, Punjab province grows about 80% of the cotton and raises over 60% of the cattle. NWFP has the largest forest cover in the country, and its relatively high consumption is directly related to its rigorous winter and better availability of woody biomass resources.

A closer analysis of consumption patterns helped understanding why consumption levels in rural areas are not sensitive to income. The database revealed that most of the fuelwood is collected (69% of the total consumption) and therefore considered financially free. However, in urban areas over 86% of the fuelwood is purchased which constitutes a direct financial burden (over 57% of total fuel expenditure- Figure 5). This makes urban households more sensitive to relative prices and inter-fuel substitution as their income changes.

Table 4: Collected and Purchased Fuelwood Consumption in Urban and Rural Households

	Collection		Total consumption '000 tons	Purchasing		Total consumption '000 tons
	Proportion of woodfuel collectors*	Average consumption kg/yr for collectors		Proportion of woodfuel purchasers*	Average consumption kg/yr for purchasers	
Urban	14.1	1,841	655	85.9	1,850	4,119
Rural	65.7	2,581	17,000	34.4	2,187	7,555
Total	55.0	2,547	17,655	45.0	1,975	11,674

* For woodfuel users

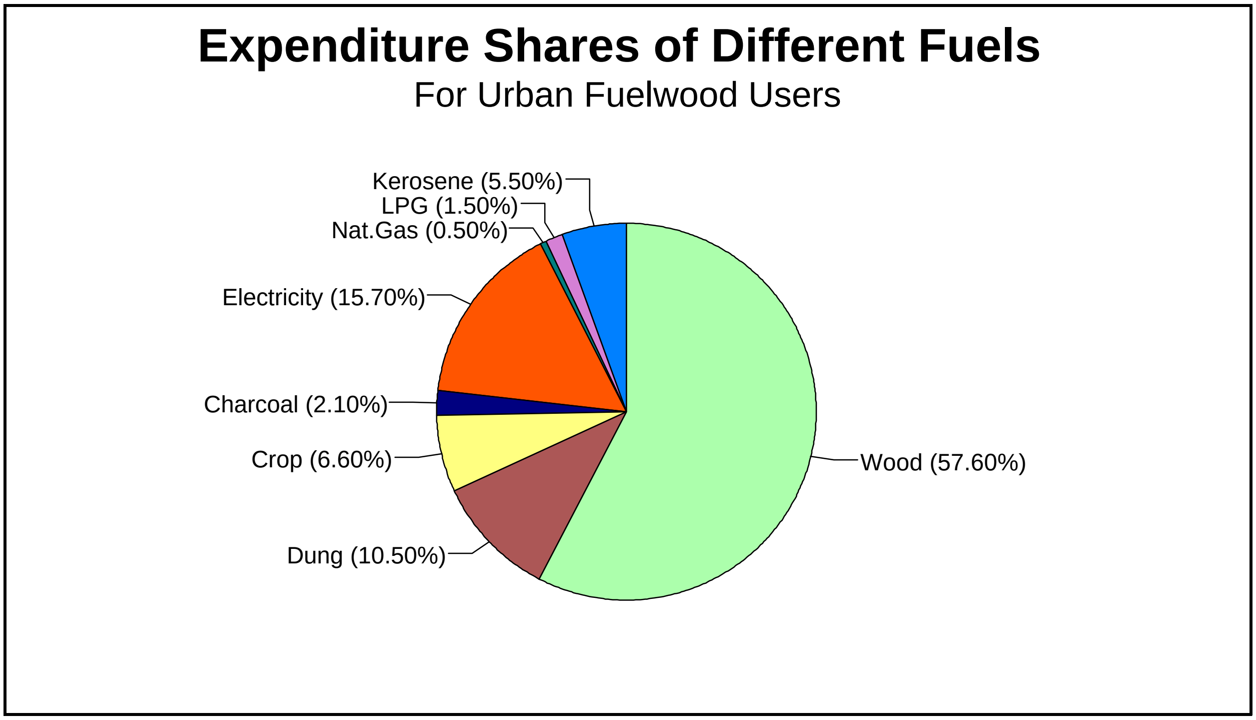

Figure 5

To conclude, it is clear that the city size and the income level are the major driving factors of woodfuel transition. In rural areas, where almost all households use fuelwood, the consumption patterns are not affected by the income level. They are rather linked to the availability of alternative fuels and woody biomass resources on one hand and the availability of free labor to collect fuelwood on the other. The four provinces display different consumption patterns reflecting the influence of their respective agro-ecological conditions.

2.2 Sustainability of Biomass Resources

2.2.1 Stock levels and sustainable production

Final results of the HESS supply surveys indicate that the country has a standing stock of 210.8 million tons of biomass resources (including shrubs and bushes). This standing stock could generate a sustainable production of about 22.7 million tons per year (Table 5). The relatively high productivity of the resources is mainly due to a large proportion of very young trees and the high productivity of shrubs. It was observed that 70.4% of the trees with visible dbh -which represent almost 87% of all trees- had a dbh of 10 cm or under[4].

The level of sustainable supply is below the actual consumption estimated at 32.5 million tons (including non-households consumers and industrial wood) indicating that the present demand is not sustainable. Under the classic gap theory the difference between the sustainable supply and the level of consumption would be considered as the annual depletion rate. Furthermore, at this rate the gap theory would lead to a complete depletion of the resources in less than 20 years time. However, this theory is static and does not take into consideration behavioral changes due to increasing scarcity, higher demand and socio-economic and cultural changes.

Table 5: Biomass Standing Stock and Productivity by Agro-Ecological Zone (1991)

Agro-Ecological Zone	Irrigated (NWFP-Punjab)	Irrigated (Sindh-Baluchistan)	Barani (Rain-fed)	Forested/ Highlands	Semi-Arid	Desert	Total
Geo-Demographic							
- Area (Km^2)	123,708	64,481	27,878	129,966	253,832	252,342	852,208
- Population (million)	63.3	15.90	7.10	5.90	20.80	2.70	115.70
- % Rural Population	70.1	74.70	92.20	80.30	51.80	7.56	69.50
Biomass Resources (million tons)							
- Standing Stock	85.9	19.70	4.50	81.60	11.20	7.90	210.80
- Sustainable Productivity	11.1	3.60	0.40	5.20	0.90	1.50	22.70
Density (tons/hectare)							
- Standing Stock	6.94	3.06	1.61	6.28	0.44	0.31	2.47
- Sustainable Productivity	0.90	0.56	0.14	0.40	0.04	0.06	0.27
Biomass Resources (kg/capita)							
- Standing Stock	1,357	1,239	634	13,831	538	2,926	1,822
- Sustainable Productivity	175	226	56	881	43	556	196

It is therefore crucial to carry out an in depth analysis of wood products consumption and the sustainable production taking into accounts the various types of wood consumed and produced, and their source, as well as the dynamics of the process.

[4] The productivity estimates were generated by modelling the growth of each tree in the sample, using models of relative growth rates dependent on total tree biomass, species, extent of crown damage and agro-ecological zone.

2.2.2 Understanding the gap

About 32.5 million tons of wood were consumed in Pakistan in 1991. This consists of industrial wood and woodfuel including shrubs and bushes consumed by all sectors. The household sector consumes about 90% of this amount as fuel and as much as 60% of the household consumption was collected. A large proportion of the collected fuelwood is made of small twigs and shrubs. A rough estimates[5] based on household responses showed that this sector consumed 12.4 million tons of roundwood and 17 million tons of small twigs and bushes. An additional 1.9 million tons were consumed as woodfuel by non-households (derived from the woodfuel trader surveys) and 2.3 million tons of industrial wood (roundwood for timber, poles etc).

The supply study shows a sustainable supply of the order of 10 million tons for roundwood (including off-cuts from industrial wood), 10.1 million tons of small twigs and shrubs, and 2.6 million tons of timber (as final product). As shown by table 6 there is a annual deficit of 6.8 million tons of roundwood and timber which is certainly being met at the expense of the sustainability of the resources. The level of deficit represents 4% of the total standing stock. However, this level is not really dramatic especially if tackled promptly and efficiently. As indicated below farmers have already realized that tree growing could be a lucrative activity and have started planting trees on a large scale to meet the increasing demand. The demand survey indicated that household farmers have planted a total of 125 million trees in 1990-91, a rate which if sustained could generate substantial amount of wood.

The consumption of twigs as fuel is estimated at about 5.5 million tons for a sustainable level of 4.4 million tons per year. This indicates that households are more or less using this product in a sustainable manner to meet their needs. This fact is supported by the supply survey which showed that only 8% of all trees have 75% or more of their crown removed and almost 68% of the trees were intact.

During the same period of time households consumed 7.6 million tons of shrubs which represents almost 78% of the total stock, and in spite of their high productivity rate it seems that this level of consumption combined with grazing is causing land degradation especially in rain-fed and semi-arid areas.

Table 6: Biomass Resource, Sustainable Productivity and Consumption Levels by Type of Wood Product ('000 tons)

Type	Standing Stock	Sustain. Product.	Consum. Levels	Deficit
Roundwood (incl. timber)	169,000	12,590	19,400	6,810
Twigs	31,390	4,360	5,500	1,140
Shrubs	9,780	5,740	7,600	1,860
Total	210,770	22,690	32,500	9,810

About 2.3 million tons of industrial wood and 1.9 million tons consumed by non- households are added to the roundwood consumed.

[5] It is estimated that 90% of the purchased fuelwood by households is roundwood and that 2/3 of the collected fuelwood are twigs and shrubs.

If the observed wave of tree planting by farmers is sustained and assuming a survival rate of 80% and a growth rate of 17 Kg per tree per year, the standing stock would even increase by some 10 to 15% by the year 2,008 (figure 6) . However, the gap would widen and would almost represent 3 times its present level if the projected demand is met (see below: Future Demand in page 30). This suggests that the gap is not a good indicator of sustainability and is totally inappropriate to measure the rate of resource depletion. This concept has been widely misused as it has invariably predicted a complete depletion of biomass cover within few decades in several countries. This of course did not happen. It is even suspected that the gap has existed all along in Pakistan and any similar study conducted a few years ago would have identified a gap. The growing demand is actually being met through extensive tree planting. The relative stability of woodfuel prices and the young age of trees, which suggests short rotations, seem to confirm this aspect. Monitoring tree planting trends through periodic agricultural surveys and wood prices can provide early warnings.

It is however, important to note that extensive tree planting by farmers to meet the growing demand does not mean that there is no environmental degradation. Trees on irrigated farms can certainly not preserve the endangered ecosystems due to over-harvesting of natural forests and the deterioration of watersheds. Although the observed tree planting wave - if maintained- seems to be capable of sustaining the demand, there are localized areas suffering from land degradation. Semi-arid and rain-fed areas have the lowest per capita standing stock and rural household are mainly relying on collected fuelwood. If tree planting does not extend to these areas fuelwood use will certainly have negative impacts on the environment causing more hardship to poor households who can not afford to purchase fuelwood transported from other areas or switch to modern fuels.

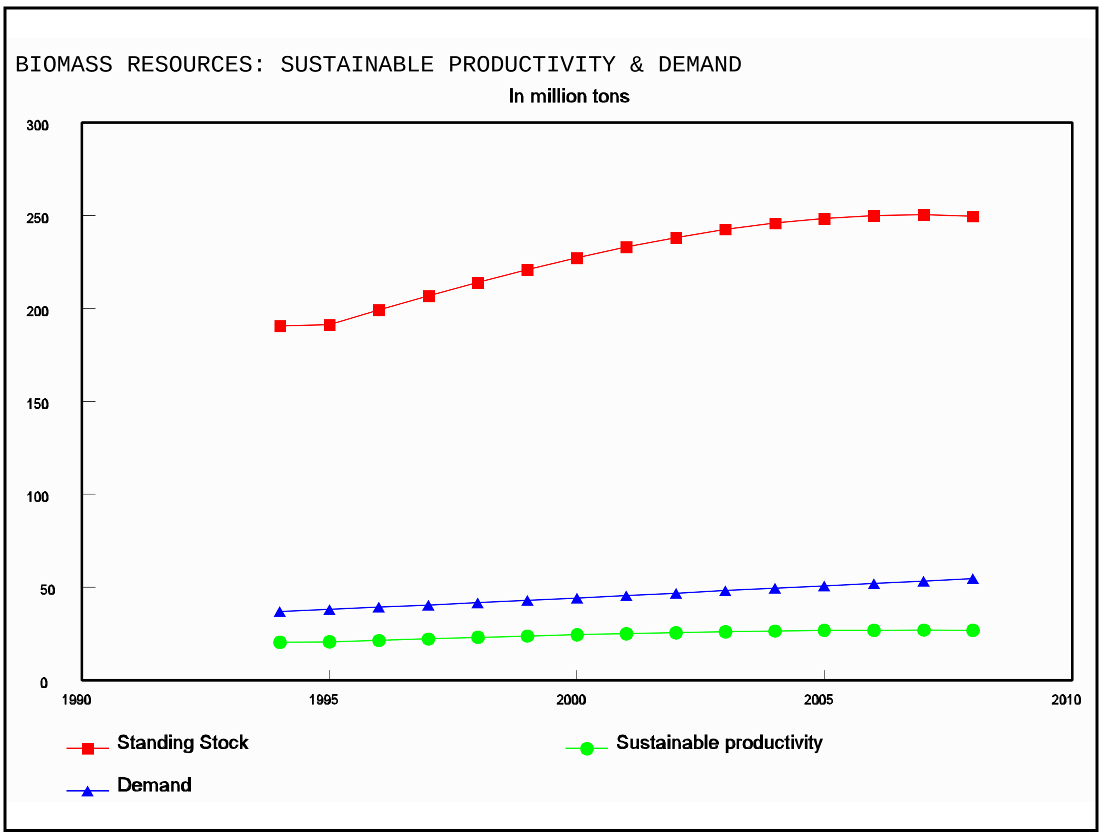

Figure 6.

Finally, it is important to distinguish between trees grown on farm lands, which will be regarded as commercial/industrial trees, and trees grown in natural forests to protect and preserve the eco-systems. The former are treated by farmers as any agricultural crop and their fate will be dictated by market mechanisms including the risk of glut. The latter will have to be protected by the state because of broader environmental implications and conflict of interest. The following Chart, devised by G. Shepherd for ODI, suggests that Pakistan has already reached stage 5 where trees are planted on farm land and new resources are created. The situation has to be carefully monitored to ensure stability and avoid a possible return to stages of unsustainability.

From Forest Management to Tree Planting
- Options Dictated by Population Density and External Intervention -

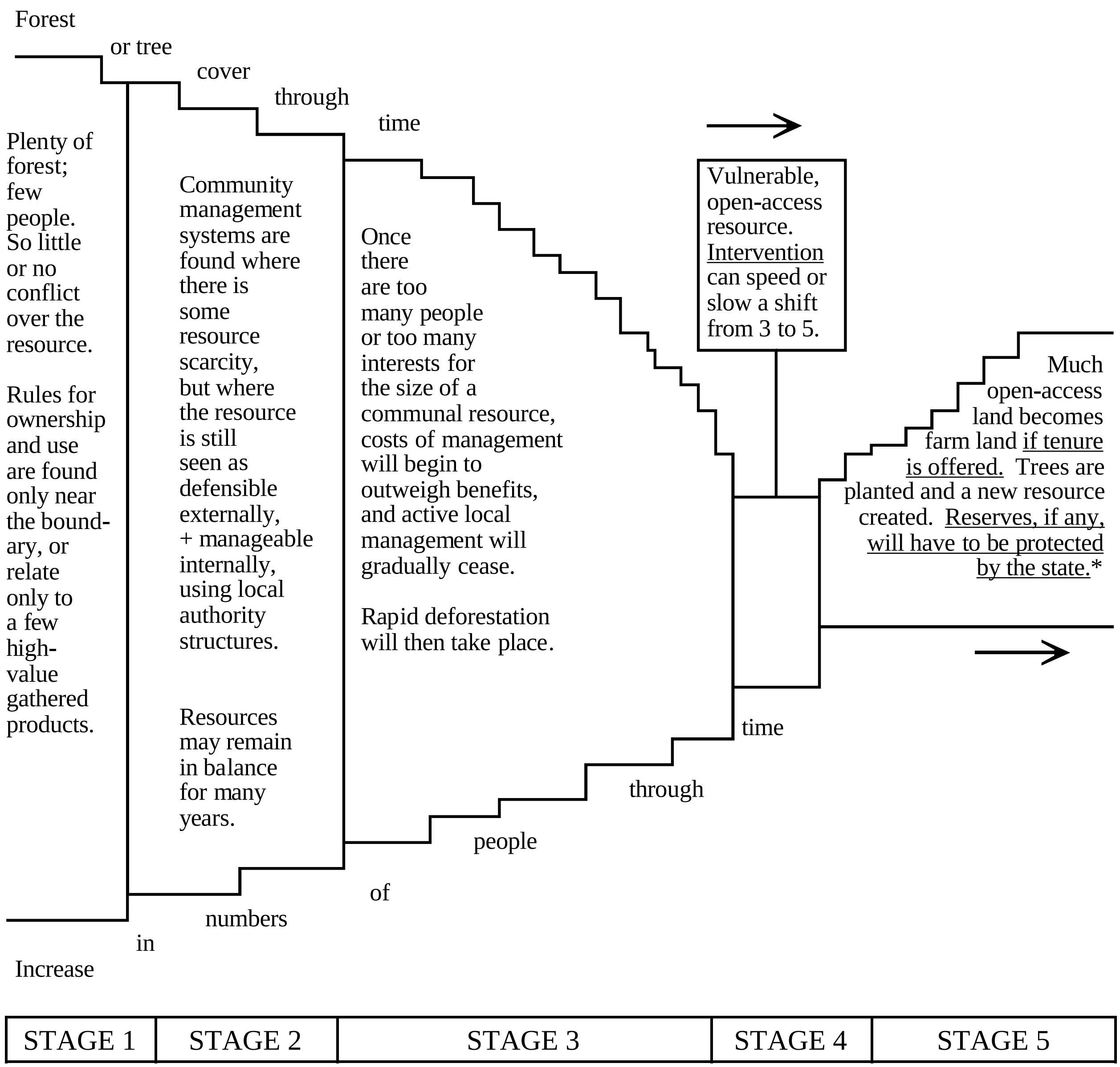

Chart devised by Gill Shepherd, ODI, autumn 1992/spring 1993.

* *or dereserved and allowed to become farmland of some kind.*

2.2.3 Woodfuel scarcity: physical scarcity and household perceptions

Although households spend considerable time and effort collecting fuelwood, most of them (91.1%) did not experience any problem of shortage. Moreover, almost half of fuelwood users reported higher consumption levels than four years ago (certainly due to larger family size). Furthermore the survey results indicate that the majority of those who stopped using fuelwood did not switch because of scarcity. They rather switched to better fuels i.e. natural gas (41.9% of the cases) and kerosene (35.8%). However, the vast majority of those who switched fuel are located in urban areas which enjoy better supply of alternative fuels and a good woodfuel marketing network. This also explains why woodfuel prices have been relatively steady in urban areas. Therefore, substitution was dictated by higher income level rather than woodfuel scarcity. In fact very few cases in rural areas have substituted their traditional fuelwood and although the supply survey indicated that the present level of consumption is not sustainable, households seem not to be preoccupied by the scarcity. This attitude seems to be in contradiction with the popular wisdom according to which there is a severe woodfuel shortage and confirms the irrelevance of the gap as indicator of scarcity and depletion rate.

If there is really a widespread scarcity, this divergence between what households perceive and what the reality seems to be can be explained by the fact that depletion is a slow process that takes place over several years in a very localized areas and therefore is not immediately noticeable by households.

The more plausible and maybe the more controversial explanation is that availability of labor and its value are the most important determinants of woodfuel scarcity as far as households are concerned. As G. Leach[6] pointed out "if spare labour is abundant it may not matter if woodfuel-collecting trips are long or getting longer. If labour is very scarce, even the collection of abundant woodfuel supplies may be perceived as a serious problem". This aspect is extremely important and should be taken into account during strategy formulation and implementation. It shows clearly that households do not perceive woodfuel scarcity in physical terms even though there is scarcity of quality wood. They are much more concerned about "labor availability, land endowments, social constraints on access to wood resources, or cultural practices" and many other constraints not directly related to the energy problem. Therefore, it is crucial during implementation to identify priorities and perceptions at the community level. This will have high chances of success if Participatory Rural Appraisals (PRA) are conducted and experienced NGO's working at the grass roots level are associated.

3. IMPACTS OF WOODFUEL USE ON THE ECONOMY

3.1 Traded Woodfuel and Employment Opportunities

The traded woodfuel amounted to about 12.4 million tons in 1991-1992 which represents only 41% of the total fuelwood consumed in Pakistan. However, woodfuel trade activity plays an important role in the economy by generating considerable employment opportunities.

According to the HESS woodfuel market structure surveys there is a woodfuel business for every 2,500 inhabitants in Pakistan and about 80,000 to 100,000 people are directly involved in this trade. The business generates annually about Rs 11.3 billions ($450 millions) which is equivalent to about 10% of the value of all Pakistan's exports in 1991-92. Most of the traded woodfuel is

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[6] Beyond the woodfuel crisis: G. Leach & R. Mearns.

coming from private farms constituting a substantial earnings for farmers. It also constitutes an important activity for the transport sector as the woodfuel transport effort is believed to exceed 100 million ton-kilometers per year.

3.2 Market Value of Collected Woodfuel and Social Impacts

Fuelwood collection is widely practiced in Pakistan especially in rural areas where households satisfy over 69% of their needs through collection. This activity is of course time consuming as rural households spent on the average 699 person-hour per year (Table 7). If this labor is valued, it would cost a rural household almost Rs. 2,800 and the economy almost Rs. 19 billion, whereas the market value of the collected fuelwood does not exceed Rs. 14 billion[7] .

As far as households are concerned the difference constitutes the annual loss incurred due to fuelwood collection. This loss could have been avoided if household members were engaged in an income generating activity and were able to purchase their fuelwood. However, this implies that job opportunities are easily available which is not the case for women and children in rural areas. The effort provided by these represents about 60% of the total effort required to collect the fuel and if their labor is not valued, the fuelwood activity becomes lucrative to the households as they will save annually over Rs 900 (about 3% of their total annual expenditure).

It is clear from the above that fuelwood collection will continue to play a major role in rural households. It is cheaper so long as women's labor is not valued and if there are real hardships in obtaining the needed quantities households would start using lower quality fuels such as shrubs, dung cake and crop residues. This also explains the reasons why fuelwood transition is not linked to the income level and is not happening in rural areas. The consequences are tremendous at the social levels (heavy burden on women and children), at the economic levels (high opportunity cost of collected woodfuel) and at the environmental levels (through land degradation).

The situation is quite different in urban areas as fuelwood collecting activities have negative opportunity costs in all cases which indicates that jobs are not easily available and this activity will basically disappear as soon as employment conditions improve in the cities.

Table 7: Opportunity Cost of Fuelwood Collection Activity

	Urban	Rural	Total
Number of households collecting fuelwood ('000)	373.00	6,763.00	7,138.00
Average distance from the collection source (in Km)	3.51	1.70	1.80
Average time spent in collecting (hrs per round trip)	2.25	1.89	1.92
Average number of trips per year	145.20	161.90	161.0
Number of participants in collection:	1.93	2.27	2.25
- Males	1.03	0.91	0.92
- Other members (women and children)	0.90	1.36	1.34
Level of effort (person-hr per year)	693.00	699.00	699.00
Cost of labor			
- Case 1	4,422.00	2,797.00	3,493.00
- Case 2	2,414.00	1,119.00	1,419.00
Fuelwood collected			
- Quantity (kg/year/household)	1,904.00	2,571.00	2,537.00
- Market cost (Rs)	1,435.00	1,988.00	1,958.00
Opportunity cost			
- Case 1	(2,987)	(809)	(1,535)
- Case 2	(979)	869	539

[7] 1 US$ = 25 PRs.

1. The labor is valued at Rs. 7 and Rs. 4/hour in urban and rural areas respectively.
2. The collected fuelwood is valued at 80% of the price of traded woodfuel in the same area, to account for its lower quality.
3. Case 1 means that all labor is valued, and case 2 means that only the male members' labor is valued.

3.3 Inter-Fuel Substitution and Its Impacts

Woodfuel is an important fuel in Pakistan and will continue to play a major role in the future.

The transition between firewood and other fuels is already happening in urban areas and is mainly driven by the income. As the urbanization rate in Pakistan is growing very fast, one should expect the growth rate of firewood consumption to slow. Moreover, with income increase the consumption level per household will decrease. There are opportunities for fuel savings by introducing improved stoves which could be commercialized through firewood traders.

It is difficult at the household level and at this stage to work out the economics of switching from fuelwood to other modern fuels in rural areas as the use of fuelwood does not require initial investment and most of it is collected at a low cost. A possible action is to promote and encourage income generating activities for women in the rural areas. This will not only provide additional cash to poor households but will also put a value on women's time, which makes it more economical to purchase fuelwood instead of collecting it, and prepares households for switching to modern fuels by creating a more city-like situation. This will also help reducing the pressure on the land cover. Improved woodfuel stoves may not be the appropriate solution to conserve energy in rural settings as most of the woodfuel consumed is collected and financially free of charge as mentioned above. Moreover, the stoves used are self-made by households and do not require financial expenditure. On the other hand, an improved efficiency of 15 to 20% does not constitute a real incentive to households compared to the related financial cost of an improved stove, and a much higher efficiency will eliminate the advantages of multiple uses.

However, it is maybe not economically a better solution for the country to force fuelwood transition in rural areas. Woodfuel is an indigenous source which is renewable if managed in a sustainable manner. This does not imply that households should be discouraged from using modern and cleaner fuels. It simply means that the use of woodfuel could be a viable solution for both the country and households if the resources are sustainably managed and the use is done in an efficient and less hazardous manner. It also provides poor households with the opportunity to switch from low quality fuels such as dung and crop residues to woodfuel, permitting the use of these as manure and soil conditioner.

Among the fuels that could substitute fuelwood only natural gas is a totally indigenous source[8]. However, it is unlikely that rural households will get significant connections in the next two decades due to limited reserves discovered so far and the amount of infrastructure related investments required to connect a widely scattered rural population in a vast country.

About half of the amount of kerosene consumed is imported and substituting for example the total rural fuelwood consumption would cost the country an additional $ 650 millions in foreign exchange. This would further deteriorate the balance of payment situation.

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[8] Although, the county is contemplating the import of natural gas from Iran, the Golf or Central Asia, if no substantial resources are discovered in the near future.

Very little LPG is locally produced and there is evidences that a significant proportion is being used by the transport sector. Recently the country started importing through private firms to make up for the present shortage. However, it is expected that the LPG price will increase substantially deterring its use in the transport sector but putting it also out of reach of poor households. At present it is reported that an 11.8 Kg LPG cylinder costs over Rs. 100 compared to Rs. 52 a year ago.

Increased wood supply from farm lands, income generation and better social conditions for rural women combined with educational programs regarding more efficient and less health hazardous use of fuelwood are certainly viable options worth considering.

4. FUTURE DEMAND AND PROSPECTS OF FARM FORESTRY

4.1 Future Demand

By the end of the 10th five year plan i.e. 2,008 wood consumption would reach about 54.7 million tons. The household sector would use 90% of this quantity as fuel, 2.3 million tons will be consumed as final product by the wood-based industry[9], and non-household sector would burn 3.2 million tons as fuel[10].

The fuelwood consumption of the household sector would therefore increase by about 3% per annum whereas the number of households is expected to increase by about 2.67% per annum during the same period. This suggests that the average consumption per household and/or the proportion of users are increasing. In fact this is the result of inter-fuel substitution from low quality fuels such as dung and crop residues to fuelwood. The consumption of dung and crop residues would increase by only 1.7% and 1% per annum respectively during the same period. In terms of energy and after correcting for the population increase the projections indicated that the amount of traditional fuels would actually decrease by some 0.8 million toe. This is partially due to higher calorific value of fuelwood by comparison to dung and crop residues, and also to switching to modern fuels such as LPG, kerosene and natural gas. It also confirms earlier observations regarding the low rate of inter-fuel substitution.

Figure 6 shows that if the number of households did not increase during the period of 1991-2008, household fuelwood consumption would have increased by only 0.38% per annum. In fact the proportion of users would have decreased by about 0.73% per annum suggesting an increase of 1.09% of the average consumption. This is due to reduced use of dung and crop residues which registered a respective decrease of 0.91 and 1.62% per annum over the same period.

Of course these projections rely essentially on voluntary attitude of households and assumes that the modern fuels supply can meet an increasing demand. If the supply is constrained households would resort to increased use of traditional fuels.

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[9] Based on surveys conducted for the USAID Forestry Planning and Development project, The Forestry Sector Master Plan estimated the total demand of roundwood at 4.5 million tons in the year 2,008. However, it is considered that in general about half is wasted as off-cuts and therefore used as fuel.

[10] Using the same ratio observed for 1991 i.e. 1.9 million tons for 29.4 consumed by the household sector.

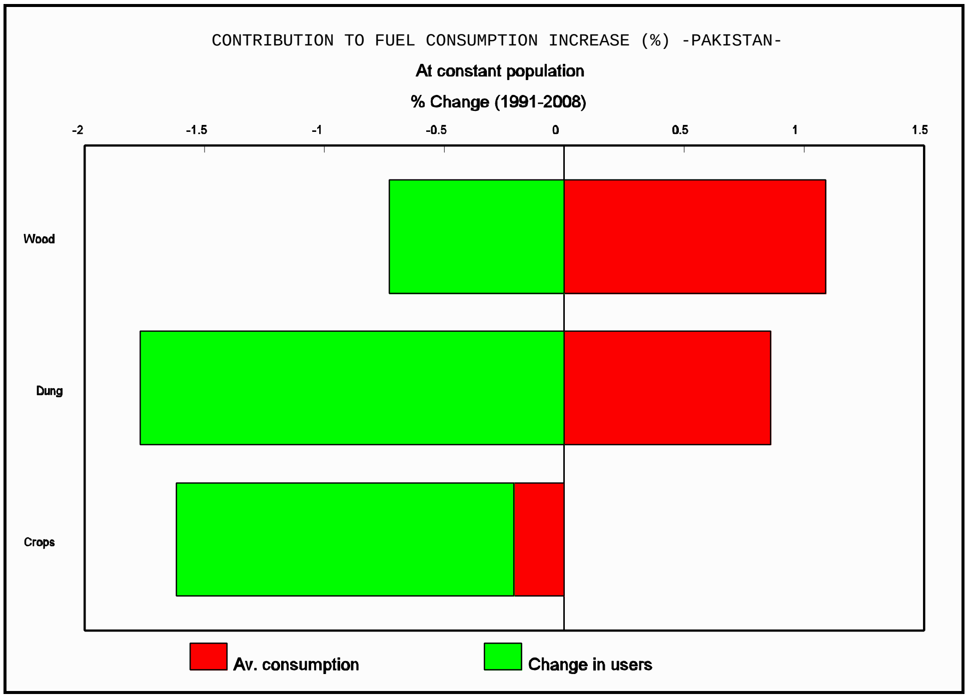


Figure 6.

This scenario implies that the wood demand would almost double in a period of 17 years. The demand will have to be satisfied partly from public land and partly from private farms. However, the recorded wood production on Government forests and plantations has been stagnant over the past decade and meets only a small fraction of the total demand, although it is believed that large quantities are being illegally removed each year contributing to devastating environmental degradation. The bulk of the demand especially fuelwood is being met from private and community lands. It is evident from past performance and present share that public forests cannot meet Pakistan's wood requirements. This failure to deliver and the growing demand has prompted farmers to pay a special attention to tree growing.

4.2 Prospects of Farm Forestry

According to the HESS demand survey 125 million trees were planted during 1990-91 and the share of non-fruit trees was almost 90%. Although trees have multiple functions, the farmers' answers regarding the reasons for planting trees were aggregated according to the main purpose. The largest proportion of the planted trees (44.9%) was for timber, a significant proportion of 29.8% was destined for fuel purposes and the remainder being planted for fruits, shade, fodder and other purposes (figure 6). However, only less than 7% of households planted trees for the sole purpose of fuelwood although the average number of planted trees was much higher (130 trees) than the average number of trees planted for timber (84). This wave of tree planting indicates that farmers realized that tree planting is a lucrative business. However, it is clear that they regard woodfuel as a by-product of wood plantation.

It is important to note that the observed wave is extremely fragile as the distribution of tree planting is skewed towards large quantities i.e. among those who planted trees 1.6% accounted for 54.7% of the total of non-fruit trees planted with an average of 1,971 trees per farmer, whereas 75.7% planted only 6.6% of the total trees with an average of 5.2 trees as shown by table 8. This indicates that some few farmers are considering tree planting as a major business and the sustainability of this trend is highly sensitive to the timber and woodfuel market mechanisms. The low number of trees planted by the majority of the farmers is an indication that farmers are growing trees mainly on the boundaries of their fields and therefore not directly competing with other traditional crops.

Table 8: Distribution of Planted Non-Fruit Trees and Farms by Class

Class	No. of Trees Planted '000	Proportion (%)	No. of Farmers '000	Proportion (%)	Average no. of trees/ farmer
1 to 25	7,363	6.6	1,416	75.7	5.2
26 to 90	12,447	11.1	262	14.0	47.5
91 to 700	30,880	27.6	161	8.7	191.8
701 to above	61,110	54.7	31	1.6	1,971.3
Total	111,790	100.0	1,870	100.0	59.8

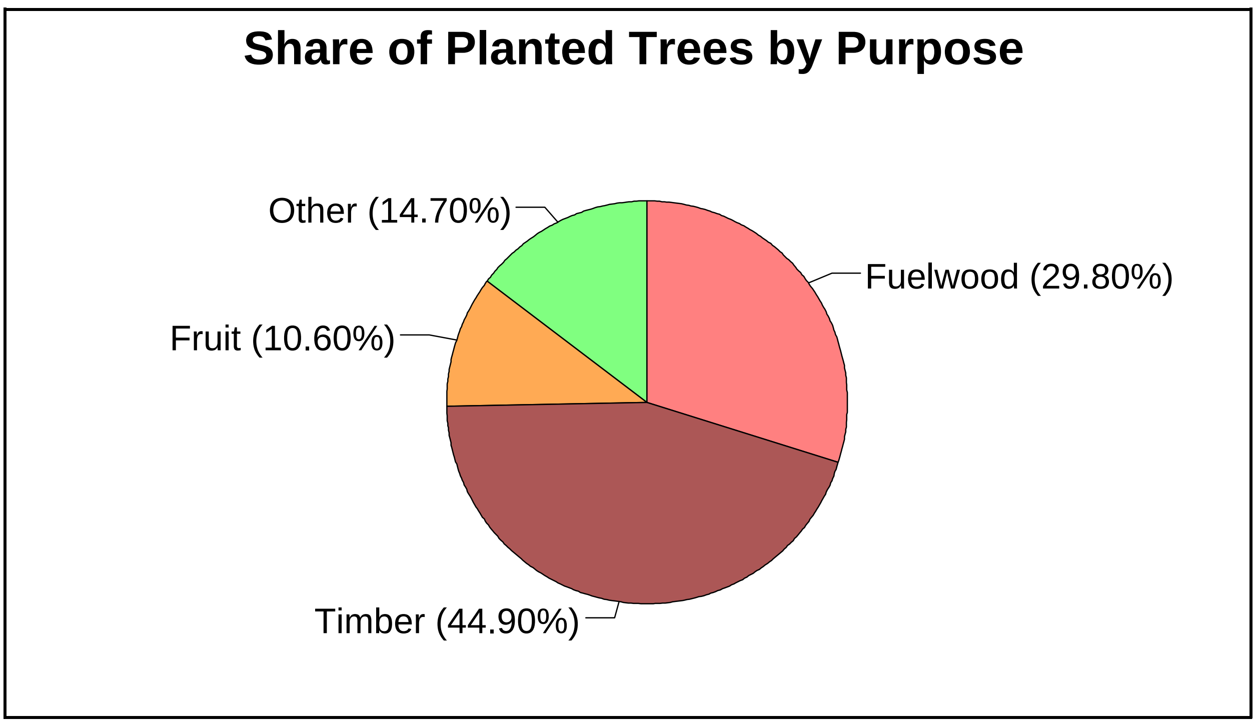


Figure 7.

About 40% of the total number of farmers[11] participated in 1990-91 tree planting which suggested that this effort could be maintained if the remainder were involved. It was possible from the survey to determine the reasons that kept the latter away from planting trees. The major obstacle seems to be the lack of water, especially in Baluchistan (56% of the responses) followed by the Sindh province (48%). However, when land tenure is taken into consideration, it was observed that there is a significant difference in the reasons given for not planting trees between landowner and tenants. Although the lack of water is of a concern to both of them, tenants mentioned the lack of land as the main obstacle. This could be one of the reasons behind the low average number of trees planted per cultivated area in Sindh where only 42.4% of the farmers are landowners.

It is therefore, crucial to check periodically whether new farmers are following the same trend which will provide early warning of slow down in the rate of tree planting.

As farm trees seem to be the only option for Pakistan to meet its growing demand, and as agricultural self reliance is an important Government policy, there are apprehensions that if growing tress become more lucrative farmers may substitute their agricultural crops with block plantations. the HESS project conducted a detailed analysis to understand the economics of farmland trees, comprehend farmers motivations and expectations and to identify major obstacles that could impede the observed trend (see HESS Farm Trees and Wood Market).

Using the surveys results the report identified two types of activities i.e. small and large-scale farm forestry.

- **Small-Scale Forestry**

The majority of farmers (about 73%) who have been involved in non-fruit tree planting during 1990-91 have planted less than 20 trees each. The low ratio of number of trees planted per acre suggests that these trees are scattered or planted in rows, and therefore are not displacing other agricultural crops. It has also been observed that farmers harvest their trees at a rather short rotation of about 6 years, which minimizes the negative impacts generally attributed to the shade of trees and maximize their returns at 10 and 15% discount rates.

This form of social forestry presents several benefits to the farmers. Besides the fact that trees shelter crops from desiccating wind and can improve soil nutrients, they generate substantial additional cash income to small farmers once they are sold. The study demonstrated that 100 border trees per hectare, as recommended by the National Conservation Strategy (NCS), give a discounted annual revenue of 10% of the returns from cotton-wheat and 60% from rice-wheat double cropping (when land rents are included). It also provides households with an important source of fuel that would have to be either purchased representing a financial burden or collected which would be translated into additional burden for women and children. With over half of the farms falling under 2 hectares or less, the potential for tree growing alongside the boundaries is significant and should therefore be encouraged and sustained.

[11] According to the demand survey 5.6 million households were involved in farming activities. Out of these about 4.1 million were landowner.

- Large-Scale Forestry

Tree plantations could be attractive to farmers as it requires considerably less labor and limited administration and management. It is also less sensitive to weather conditions and the harvest could be done at periods which are more convenient to the farmers (during seasons where the labor is easily available and cheaper, or when cash is urgently needed). However, the time span needed between planting and harvesting could be a major obstacle for small farmers, although the up-front cost is generally low.

The study compared the economics of wood plantation and major field crops i.e. cotton-wheat double crop, rice-wheat double crop, and sugar cane. It has revealed that on irrigated land and at the present costs and prices wood block plantations could compete with all crops except cotton. In cotton-growing areas it would be more profitable for farmers to grow trees along their field boundaries. However, the prospects are limited because this would generate no more than 5 to 6% of the net return from cotton-wheat. Moreover, a hectare of cotton could generate as much as 4.7 tons of cotton stick that could be used as fuel.

One of the major findings of the study is that returns from wood plantations are very sensitive to wood prices, yields and the discount rate. This leads to the fact that farmers need extension services from forestry departments to be trained how to maximize yields and manage their plantations as a business. The issue of wood prices is a very critical as it could affect very much the viability of farm forestry in Pakistan. Excessive supply of industrial wood or market imperfections could contribute to lowering the prices leading to a crash. The HESS market structure survey findings indicated that with about a trader for every 2,500 inhabitants wood markets are operating fairly competitively. However, it has revealed that the tax system on wood transport across division boundaries is "onerous, inconsistent and poorly understood resulting in increasing opportunities for abuse". It was also found that farmers could increase substantially their income if they undertake their own harvesting and transport, and if they are provided with proper training on volume measurement and wood grading. However, in order to reduce the risk of a glut due to excessive supply, wood-based industries should be encouraged. Though there are signs that wood-based paper production would emerge provided the supply of raw materials is guaranteed. These industries are offering to pay higher prices to farmers. On the other hand farmers seem to be waiting for firmer signs before embarking into large scale plantations.

There are also prospects of wood plantations on water logged and saline lands which will help rehabilitate these areas. A mixed tree and field crop system to improve the soil on impoverished lands could also be a potential for tree growing.

Charcoal in Northeast Thailand
Implications for Sustainable Rural Resource Management

by

Opart Panya[1]

1. BACKGROUND

Since the publication of *Charcoal in Northeast Thailand: Rapid Rural Appraisal of a Wood-based, Small-scale Enterprise* (Panya et al. 1988), much interest has been directed at the application of the methodology employed by the study. It was seen as surprising that such a very time-effective (4 months of fieldwork) and inexpensive research has produced such a thorough understanding of charcoal production system at the village and household levels in the Northeastern context. Charcoal making is very important to rural people and the low-income urban sector, as cooking fuel and as a source of increased income. This study also indicates that wood used for making charcoal is not necessarily obtained from national forests, as has always been perceived. Most wood used in making charcoal, as I shall describe, is obtained from trees planted and protected on private lands.

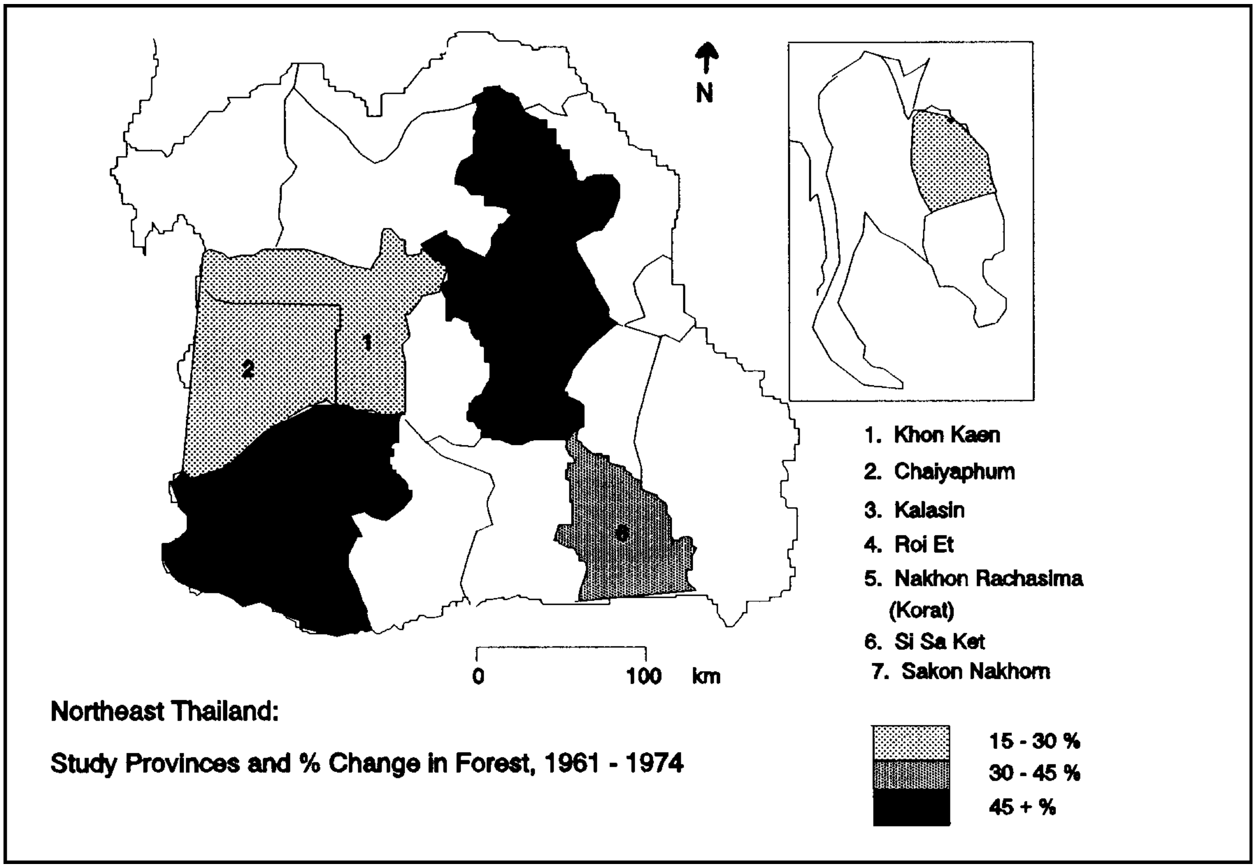
For the two years after completion of the above study I worked in a social forestry pilot project in the Northeast. Four years altogether after the research I returned to the Northeast and undertook ten-months comprehensive fieldwork (for my thesis) in three rural communities, one of which is next to a charcoal sample village (see map, below). Finally, I am gratified to see that there is also an interest shown at implications of the study for rural resource-related programme planning and development.

In this paper, I thus examine certain implications for sustainable development of rural wood energy. The charcoal study and the later research will form a database for discussion and analysis. The charcoal study itself, from which the bulk of data will be drawn, consist of observations, direct measurements, and 57 interviews with households and key informants in 29 villages and 5 urban areas spread across 6 provinces of the Northeast. *Figure 1* below shows the five provinces visited during the charcoal study and two provinces of the social forestry project, Nakhon Rachasima (Korat) and Kalasin.

To accomplish this, I will begin by describing the pattern of charcoal production activities in the Northeast. I will then focus on a discussion of its social and economic viability in order to identify design and promotion considerations for potential development of sustainable rural resource management.

[1] At the time of preparing this paper, the author, a Ph.D. Student (Human Geography) at Victoria University of Wellington, New Zealand, has just completed a seven-month field research in Northeast Thailand and is now writing his thesis.

Figure 1: Study Areas and Percentage Change in Forest, 1961-1974



Source: RFD 1975 O. Panya VUW 1993

For those interested in more detail of other charcoal-related issues, I would refer to the original report and fuelwood study undertaken by researchers at Khon Kaen University (see, for example, Subhadhira et al. 1987; S. Grandstaff et al. 1986).

2. CHARCOAL AS AN ADAPTIVE WOOD-BASED ENTERPRISE

Charcoal making is characterized as a production system which transforms wood resources into usable products. It is an enterprise because it requires certain steps and a series of activities in the whole production process, from acquisition of the wood, then transformation of the wood to charcoal, and to distribution of charcoal made (see Grandstaff et al. 1980). Charcoal, after being produced, flows into a network across the space (households, villages, cities, etc.) through at least three groups of people involved: 1) producers, 2) distributors/traders, and 3) consumers/users. The concept of the flow and production of charcoal, as being conceptualized in *Figure 2* will serve as a "core" pattern of an enterprise which will be referred back and forth in the course of discussion.

Following this, charcoal activities in the Northeast can be seen as a resource-based enterprise adaptive to changes in both the resource base and socio-economic conditions in a wider-scale.

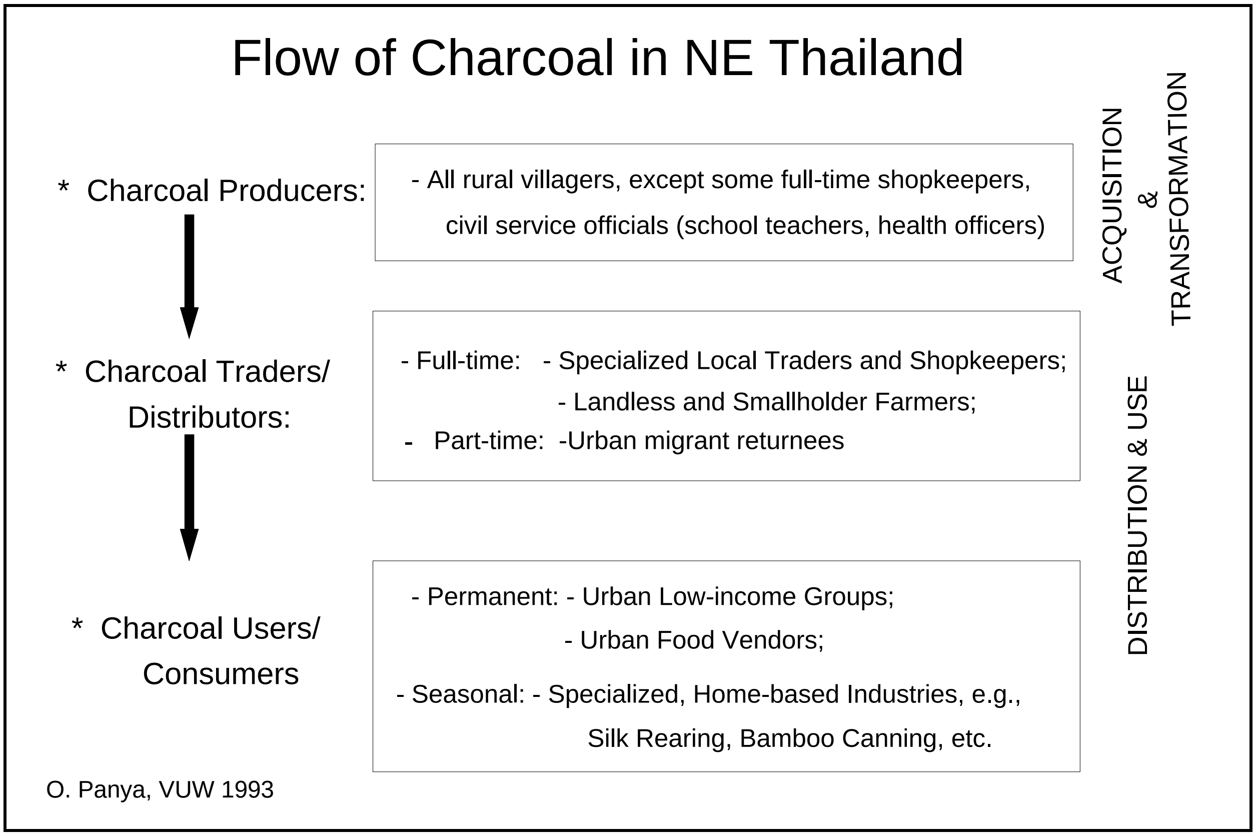


Figure 2: Production and Flow of Charcoal in Northeast Thailand

2.1 Charcoal Use in Northeast Thailand: A Historical Perspective

Traditionally, only artisans and blacksmiths were known to have used charcoal. The Northeast used to be a major supplier of charcoal to the Central region, namely Bangkok and its surrounding provincial cities. Charcoal was produced mainly for commercial purposes by large-scale enterprises operated by urban-based wealthy businessmen. Charcoal was made in the region, transported by trucks to wholesalers in major cities, and later sold by retailers to urban households, shops and restaurants. In some areas charcoal was reported to have made a few urban Northeasterners so wealthy and influential that they became established politicians in the Thai parliamentary system.[2]

Traditionally, fuelwood was used as the main source of domestic energy in the Northeast, much like other regions. Only until fifty to sixty years ago did northeasters begin use charcoal in food preparation.[3] The large-scale commercial production exporting charcoal to the Central region (above), and the spread of the "chinese" bucket stove (*tao ung lo*) in the 1960s is believed to have made charcoal use increasingly attractive to the people in the Northeast.

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[2] A former member of parliament in Phu Khiew district of Chaiyaphum was reported by key informants to have been associated with large-scale commercial charcoal production during the 1970s.

[3] Many key informants roughly at the age of 50 to 60 reported that their first make and use of charcoal were when they were small children. Charcoal was collected from burnt tree trunks exinguished by overnight rain during the time when families were out to clear lands.

The period of 1970s is characterized as the "charcoal boom" in which village key informants (mostly in Chaiyapum) described, "every household, rich and poor, was engaged in charcoal making for sale." (Panya et al. 1988:57). A key informant, once a full-time charcoal producer, reported that he made an average of 200-400 sacks (40-50 kgs.), making "about 8,000-10,000 baht per month." (Panya et al. 1988:58). During this period a large number of villages, particularly those located in the urban-village transitional area, are reported to have experienced a severe shortage of wood due to expansion of agricultural lands. For example, several villages near Khon Kaen municipality were reported to have increasingly bought charcoal from other wood-abundant villages. These villages became growing charcoal markets for rural small-scale charcoal entrepreneurs.

It was this period that researchers and planners began to show great concern over the charcoal situation and different estimates were made. Smitinand and Pragtong (1984) at RFD, for example, estimates that an average fuelwood consumption per capita in the Northeast was 1.36 cubic metres, which was the highest of other regions in the country. This could mean that more than 10,000,000 cubic metres of fuelwood and charcoal were produced yearly in the Northeast in the 1970s. The authors go on in predicting that critical shortage of fuelwood would occur in 1986. Later estimates (Boonruang 1986:21; Royal Thai Forest Department 1983) suggest that the overall annual demand for charcoal in Northeast Thailand was around 3,000,000-5,000,000 cubic metres.

The period of the 1970s also coincides with emerging problems of forest encroachment and rapid decline of forest resources in all rural areas of Thailand. In Northeast, in particular, there is a sharp decline in deforestation during the first half of the 1970s at the rate between 10%-18%, or 2.6-3.2 million *rai* per year (RFD 1983, see also *Figure 3*). It was also reported that there were roughly more than one million people living inside national forest in the Northeast alone (Dulyapach and Pragtong 1984). This is a context into which charcoal activity has been drawn. Such facts and figures attributed to the fear that, with continuing increase of population, "wood energy crisis" would seem likely to occur.

As a result of this perceived "crisis," a general policy regarding charcoal activity has centred around discouraging the use of charcoal or total banning unlicensed small-scale charcoal entrepreneurial activities (see for example, in Tingsabadh 1988; Secretariat of the Cabinet, Thailand 1983).[4]

[4] Charit Tingsabadh (1988:5), in his recommendation with regard to charcoal, writes, "...... slowing down the needs for fuelwood can be accomplished through imposing increased tax on stoves that use fuel in order that people will turn to other sources of fuel, e.g., LPG, etc.".

2.2 Charcoal Use and Demand in the Northeast

Today, substantial changes in charcoal use in the Northeast can be observed. In fact the differences of the two above estimates undertaken at different points in time suggest that the demand for charcoal is not constant. There also appears to be an increased use of commercial forms of energy, namely electricity and Liquid Petroleum Gas (LPG), particularly in urban areas. It can easily be observed that charcoal, while formally used by side-walk food vendors, restaurants, hotels and specialized businesses (Panya et al. 1988: Rathakette 1984), has increasingly been replaced by these two forms of energy.[5]

Although there appears to be a decline in the use of charcoal among certain types of urban users, it is likely that the use by the poor segments of urban society will continue (see *Figure 1*). A switch to commercial forms may have been related to urbanization, which made electricity and LPG readily available. But for people of lower income, as reported in the study, switching involves not only the price of alternative energy sources, but also an amount of cash needed for new cooking appliances (Panya et al. 1988). In addition, the fact that the Northeast is said to be the least urbanized[6] suggests that the majority of rural people will likely to continue to use wood-based energy.

2.3 Who Makes Charcoal and Why?

As above evidence suggests, the use of charcoal in cooking in rural Northeast has occurred in recent times by the introduction of large-scale commercial charcoal production, new stoves and appliances. Fuelwood was and has remained to be used as the main energy source for most rural households. Today, most households interviewed use both fuelwood and charcoal in cooking. In fact, I am never quite certain about when people use fuelwood and when they use charcoal. The general response is something like this: "we use fuelwood when we have fuelwood, and charcoal when we have charcoal." It seems they can easily be substituted.

From a local perspective, charcoal is produced for two reasons: 1) for making extra income, and 2) for supplementing fuelwood in cooking. In general, when charcoal is made, good quality charcoal will be packed ready for sale, while small debris and left-overs are kept for use in the household along with fuelwood.

As *Figure 1* shows, most rural households make charcoal. Annual land preparation and clearance allow them to collect wood: big pieces of trees cleared are made into charcoal on the spot; smaller ones are carried home to be used as fuelwood. Most younger persons (mostly girls who I assumed at the time do most of the cooking) tend to use charcoal, if available. When probed, most of them indicated that what makes charcoal a preferred cooking fuel is its "cleanliness" of having less smoke and "convenience" provided by the use of charcoal. In the rainy season, in particular, charcoal can easily be stored to prevent damp caused by rain.

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5 At the time of research, most side-walk food vendors observed in 5 urban areas still used charcoal. Today in Khon Kaen, in particular, increased use of LPG by this particular group can be observed.

6 The 1988 UN?ESCAP study indicates that 96% of the Northeast's population live in rural areas throughout period between 1960-1980. Thomas (1988) reportes that 90% labour force is employed in agriculture, compared to 60% of the national labour force employed in 1990 (S. Grandstaff 1992). Grandstaff (1992:121) also argues that the manufacturing sector has been very low in absorbing the country's rapidly expanding labour force, employing only 8% in 1980 and 10% in 1990 of the work force.

However, should an opportunity to make extra income arise from selling charcoal just made, most households interviewed would do so and wood simply rely more on fuelwood.

2.4 Charcoal as a Wood-based, Small-scale Income Generating Enterprise

The overall production and distribution of charcoal in the Northeast has also changed in the last decade or so. Charcoal has become a wood-based, small-scale enterprise operated mostly by the rural "poor" to generate income. Locally referred to as *Wing Tharn* (literally, "charcoal running)", charcoal is produced in villages where wood resources are still available, and transported to other wood-scarce villages, and to urban markets for sale.

The current dominance of small-scale rural enterprises of the overall charcoal system appears to be a relatively recent phenomenon, apparently occurring widely, which is the result of a series of interrelated factors. They include: 1) an overall decrease in, and greater dispersion of, the region's remaining wood resources (a spatial pattern that makes it difficult to produce large quantities of charcoal at any one location, and therefore economically unattractive to larger-scale commercial entities); 2) a 1983 legal regulation passed by the cabinet that significantly reduced to 0.5 cubic meter the amount of charcoal which can be possessed for commercial purposes without a license (Secretariat of the Cabinet 1983); 3) increased villager awareness and knowledge of urban markets; 4) the growth of the rural market for charcoal (villages where wood is scarce) which posed distribution problems for larger-scale commercial entities; 5) continuing poverty and increasing cash needs in many rural areas which have increased the incentive for villagers to become involved in small-scale commercial charcoal activity; and, 6) improved entrepreneurial awareness and skills of urban migrant returnees who see small-scale charcoal and fuelwood trades as the first step into other kinds of commerce.

As *Figure 1* shows, most full-time charcoal "runners" are members of landless and smallholder households, and those beginner small local traders, who do other trading businesses at the same time. Part-timers include laid-off wage employers and migrant returnees, whose entrepreneurial awareness and skills have been accumulated from urban experiences. Many returnees see this as a learning experience for getting into commercial channels. Some see charcoal "running" as an opportunity to make quick and extra cash, while waiting for better and more permanent employment.

2.5 Response to Wood Scarcity

First of all, how do we tell "wood scarcity?" From the study, availability and proximity to wood resources does not necessarily correspond with the intensity of charcoal making. Wood scarcity is better understood in the context of the flow and production of charcoal. The flow of charcoal begins at the producing village and goes through wood-scarce semi-urban communities and finally to urban households.

Where demand for charcoal occurs and the source is within one days travel, charcoal entrepreneurial activity appears to be pronounced. For example, we found less intense charcoal activities in Sakon Nakorn (where wood resources are more abundant compared to the lower part of the region), than in wood-scarce areas in the likes of Khon Kaen, Roi-Et and particularly Si Sa Ket.

As mentioned earlier, charcoal is better thought of as an adaptive enterprise in response to changing conditions of both the economy as a whole and local resources. In making charcoal, different villages have developed different strategies for acquiring wood resources. In wood-abundant areas (not necessary government lands, see below) the primary concern in making charcoal is normally on its quality and therefore charcoal is made from certain species known locally for making high quality charcoal. In contrast, charcoal makers in wood-scarce areas, such as those in Khon Kaen and Roi-Et, use virtually every kind of tree available, from forest to fruit-tree species. Wood is obtained by pruning large standing trees, digging roots and stumps of dead trees, and so on (see list of species in *Annex I*).

In Si Sa Ket where lands are flat and mostly dominated by paddy cultivation, farmers have planted indigenous trees on paddy buns and carefully manage "rotating cutting" to make fuelwood and charcoal. Most households interviewed reported that this method has provided them with more than enough fuelwood and charcoal supplies for all the year round. Coupled with tree pruning in annual land preparation, most of them were able to sell charcoal and fuelwood made from trees obtained from their private lands.

Adaptation also takes place at the process of transformation. Charcoal kilns vary in types as well as size in different areas. Kiln types (e.g., shallow pit, fired clay kilns, etc.) appear to be associated with the amount of time and differing quality of charcoal an individual maker has in his/her mind, although technical skills and suitable soil materials locally available also play important roles. In general, people who use shallow pits are usually concerned about getting any amount of charcoal produced at the shortest time, while those who build fired clay kilns are concerned about the quality of charcoal. A household can have many small-size fired clay kilns that produce quality charcoal instead of a single or few large ones. It was indicated that small kilns produce charcoal faster than that of larger ones. Larger kilns are not suitable in wood-scare areas, because they require large amounts of wood at any one time. They would have to spend more time in obtaining enough wood for the kiln. In short, it takes a longer time for charcoal made by larger kilns to be ready for sale. Large size kilns also require more labour beyond the household in the production process, particularly in obtaining wood. Finally the predominant sandy-based soil found in many places of the Northeast makes large-size kilns technically infeasible.

2.6 How Economically Viable Is a Charcoal Enterprise?

Charcoal prices vary seasonally, locationally and with respect to factors such as quality, acuteness of need, and bargaining skills of sellers and buyers. In general, however, the price of charcoal was found to roughly double between the producer village and the urban area, with the price of charcoal sold in another village falling into a middle range (see also Sterk and van Ginnekin 1987:21).

Income received from selling charcoal depends on different levels and degrees of involvement in an enterprise, as discussed earlier (see *Figure 1*). For example, a housewife, who needs to buy school uniforms for her children, would go into a town, bringing with her a few sacks of charcoal (not exceeding 4 sixty-kilogram rice sacks). Since market prices are usually known beforehand, she would have some ideas of roughly how much cash she can expect to receive. Her neighbouring friends and relatives, all of whom also need cash but could not afford the time to do so, may ask the same housewife to "bring along" their charcoal and do the selling for them. In return, they would share the cost of transportation. In general, given the demand is constant as it was at the time of study, a days work of charcoal "running" (buying and selling) would earn double to what the local wage employment could provide.

However, it must be stressed that generating income from a charcoal enterprise of Northeasters, represents only one option along with other "diversified portfolio." In the Northeast, it is common to find that single community and even household may have its members doing different things (e.g., rain-fed farming, fish ponds, farm-and off-farm wage employments, etc.) It is believed that they do this to minimize uncertainties derived from both highly variable, rain-fed environments and marginalized market system (see Grandstaff 1992; Thomas 1988). The decision to take part in small-scale charcoal entrepreneurial activity usually depends on whether or not the other economic options exist, and in most cases, on those which offer the best "return." On the other hand, when people find that other economic options are relatively unavailable and less rewarding, charcoal activity will at least be taken as a "better than doing nothing" option. For smallholder and very poor landless households with a need for supplementary income, however, a low ratio of income generated to labour expended is of little or no concern: what is important is the generation of any income.

2.7 Rural Poverty, Charcoal and the Resource Base

We now have a clearer picture of charcoal in Northeast Thailand. In the following, I shall discuss what we have "learned" from the charcoal study. Study shows that charcoal is related to three issues highly relevant to development of sustainable rural resource management: 1) rural poverty, 2) change of the local resource base, and 3) adaptive and innovative capability of local inhabitants in coping with changes. And any attempts to discuss the future and trends of charcoal must understand these issues more adequately.

Regarding rural poverty, charcoal is important to the livelihood of poor segments of the population. The poor in the wood-available village produces charcoal to make extra income by selling it to other poor, whether they live in the urban or the rural wood-scarce areas. To better understand future use and demand of charcoal and fuelwood, it must be discussed in the context of rural poverty embedded in regional or national scale economic development.

Rural poverty in the Northeast has begun to draw attention and receive major development efforts since the late 1950s to early 1960s. However, these efforts have had mixed results. After the first twenty years or more of intense development in the Northeast, there were still roughly ten million people estimated living under "absolute poverty"[7], accounting for over forty percent of the region's population (Meesook 1979). About another twenty years later, despite the country's continued growth of investment reaching a double-digit figure in the 1990s, much poverty still persists. Recent UN reports indicate that 34% of the rural population in Thailand as a whole were critically "poor" (under the minimum nutritionally defined poverty line) throughout the period from early 1970s to late 1980s. Though the rural poverty remains constant, the number of urban poor has increased two fold, from 15%-30% (UNDP 1990;1992). It means that while the problem of rural poverty has not effectively been dealt with, increased urban poverty (from those who migrated from rural areas) has emerged.

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[7] Meesuk's "poverty line", on the basis of the 1975-76 socio-economic survey, uses a minimum level of income necessary for basic human need within a year.

Table 1: Number of Landless Households in the Country and in the Northeast, 1990

Population Groups	Total in Country	in the Northeast
No. of landless households depending entirely on wage employment	727,928	140,429
No. of landless households renting all lands	552,977	133,972

Source: Community Development Department (CDD 1992b:19)

As for the Northeast, according to a recent government report[8], there are still over a million people living in critical poverty. These are landless households, as shown in *Table 1*, above. The report also shows (*Table 2*) that there are a high percentage of Northeastern villages faced with major problems of socio-economic improvement.

Table 2: Number and Percentage of Villages Facing Major Development Problems

Problems still persist	No. Villages	% of Total Northeast
1. Paddy Rice Production	28,171	58.22
2. Upland Crop Production	31,511	36.70
3. Alternative Occupations	46,234	95.56
4. Migration	20,098	41.54

Source: Community Development Department (CDD 1992b:19)

From above discussion, future demand for rural wood energy will rest with these people. Any change in the use of and demand for charcoal will depend on the ability the currently-used 7th Plan (1992-1996) to solve the problem of development disparities occurring between regions as well as between high and low-income sectors (S. Grandstaff 1992). As experience shows, charcoal will still be of importance to poor people, both in rural and urban areas.

With regards to rural resources, the currently pressing problem of forest resource degradation is also linked with rural poverty just discussed. Together, they form a vicious circle within which rural people struggle. The "troubled" Northeast has been known not only for its poor resources and backwardness, but also for the serious deforestation. It is estimated that in the past three decades, forest-covered areas in the Northeast have declined from roughly 42% to 13% (Dulyapach and Pragtong 1988:2; TDRI 1987:12), though the rate of deforestation appears to have been stable in the last decade (NTUSF 1986). While the estimate suggests nearly half of nation's designated forest (31% of the region's total area) has also been degraded, a recent study of forest encroachment has indicated that timber concession has been the primary force of national forest decline (Neitayarak

[8] The report is based on the Village Baseline Data known officially as *Kor Chor Chor Song Khor*. Compiled by government committee at the district level, which chaired by Community Development Department, the baseline is updated every two years. This particular report analyzes and compares village data between the first (1974) and last (1990) year data.

and Ondum 1992)[9]. However, since the early 1970s, as *Figure 3* below shows, the government has tried, with considerable achievements, to increase areas designated as national forest in the Northeast. Major rehabilitation and protection works of these areas are underway.

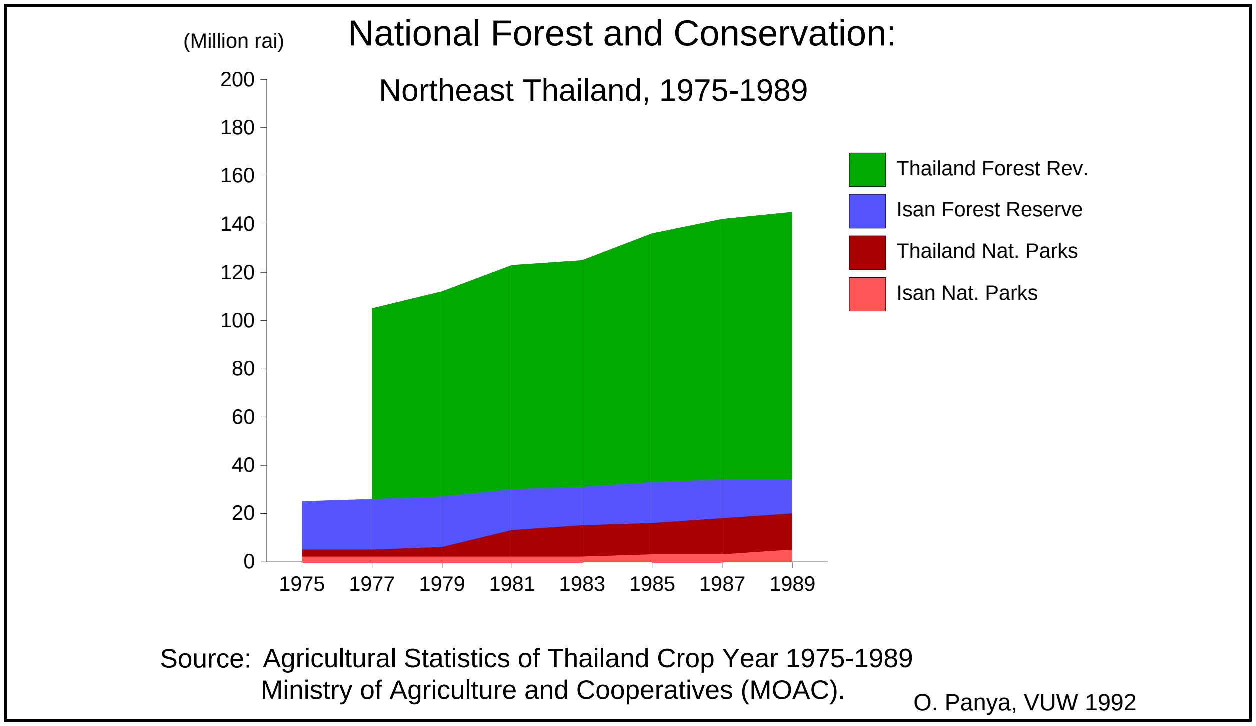

Figure 3: Designated National Forest and Conservation Areas in Northeast Thailand

In charcoal and fuelwood discussion, analysts often begin by drawing the causal relationship between charcoal production and the degradation of resource conditions discussed above. This often gives charcoal activity a destructive image and consequently becomes the basis for policy development, which does every thing to discourage the use and produce charcoal. To have a clearer image of charcoal in the Northeast, I shall now examine land-use change which occurred at the village level.

From the rural perspective, there are three types of land tenurial and management systems: 1) designated national forest (including reserved and protected forests); 2) designated non-national forest, common land, known as *thii sahtharana* (including burial grounds and sacred groves); and, 3) privately owned land. Of the three, the second type is the least explored. Attention has generally been given to problems concerning national lands and forests. Though estimates of area per village are not available, my experience in three villages in Khon Kaen recently studied, as well as over a dozen in Nakhon Sawan of the lower North (see, de Pater and Panya 1992), suggests that most, if not all, rural villages have or can have access to non-national forest common lands.

9 The authors (1992:180) point out that the government began granting large timber concession in the Northeast in 1972. And in the following year of 1973 saw the largest concession, covering up to 83% of total timber forest or 1.6 million hectares.

Common lands are important to the rural population as a natural resource for gathering and collecting food, medicinal plants, fuelwood, and as grazing for animals. Because of legal ambiguity, common lands tend to be either over-exploited or encroached, or both. Particularly in areas where the common land exceeds village boundaries, existing village-based organizations do not seem to work well in protecting and managing it.[10] More research is needed to understand the tenurial and management problems of the common land.

The second--common land-- and third types, private lands resources have increasingly become important areas for rural people to obtain wood resources. Our charcoal study indicates that the present-day charcoal entrepreneurial activities are less and less dependent on wood resources from national forest. In less wood-abundant areas, wood resources are obtained from privately owned lands. In relatively wood-abundant areas, public lands and uncultivated uplands provide most of the wood for making charcoal. In a less abundant or relatively wood scarce areas, trees standing on uplands are pruned, and those on paddy field are planted and carefully managed as the long-term supply for fuelwood and charcoal making.

What is seen here implies that we may see a better and more effective tree management. We can think that decrease in forest land gives substantially expanded agricultural lands owned by individual households (see *Figure 4*). As our study indicates, rural Northeasterners, as long as charcoal is important to them, are adaptive and innovative in "managing" wood resource to meet the charcoal demand and making a fairly decent living out of it. What might also occur is that tree species preferred by local people may be different from what foresters may expect. As shown in *Annex 1*, most of the species planted and preferred are those that are fast-growing and multi-purpose (as human food and/or animal fodders, fence, house construction, etc.), and better adapted to the local environment.

Finally, another very important issue of charcoal often absent in discussion is the ability of rural dwellers to learn to adapt to the rapidly changing economic and resource conditions. As study shows, changed conditions (e.g., local resources decline, new legal frameworks are in place, and so on) made large-scale commercial charcoal production and distribution no long profitable and were soon replaced by small-scale rural enterprises. As wood resources are scarce, rural charcoal producers pay more attention to wood on common and private lands. Local people always value trees grown on their agricultural lands. Trees in paddy and upland fields are reserved, protected and carefully selected for multiple uses (S. Grandstaff et al. 1986; Subhadhira, et al. 1985). In severely wood-scarce areas, trees are planted on paddy buns and carefully harvested when the need for fuelwood and charcoal arises.

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10 My observation together with de Pater (de Pater and Panya 1992) in over ten villages in Nakhon Sawan and experience in the RFD-KKU Social Forestry in the Northeast suggest that both a single "village committee" or Tambon councils (inter-village committee) have not been effective in managing local resources. The matter is being addressed more thoroughly in my study (in preparation).

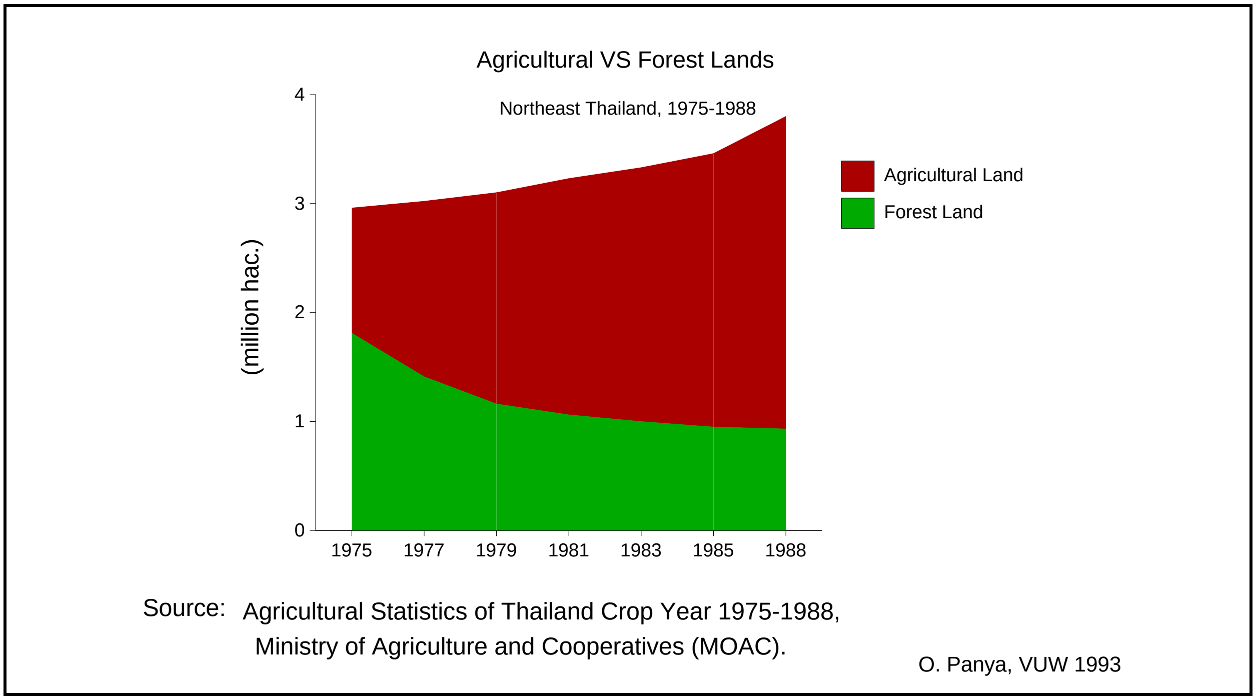

Figure 4: Agricultural and Forest Lands in Comparison: Northeast Thailand, 1975-1988

Adaptation can also be seen at the village level, as rural farmers' responses to the growth of Thailand's economy as a whole. As reflected in the population structure of two villages (*Figure 5* and *6*, below)[11], it appears the population "boom" in the rural Northeastern has been under control. Furthermore, the two villages respond differently to current development of the Thai economy, within which "export-oriented" economic development has been emphasized. One village (*Figure 5*) chooses to grow cash crops (mostly cassava), but fails, due to price fluctuation and yield decline. As a result, most young people (14-18) after completing primary school education leave the village to find work elsewhere. The other village (*Figure 6*), on the other hand, successfully manages to develop small-scale, home-based industries, taking advantages of exporting markets of jewellery. As a result most people stay at the village. This evidence suggests that current and future pressure on local forest and land resources will vary between the two villages. In general, some villages will do better than others in developing household strategies in response to economic change taken place in the region and the country.

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11 These are two of the three study villages I selected for my Ph.D. study. They are the 1992 population data recorded in the Village Baseline Report Form (*Kor Chor Chor song Khor*) available at local district offices.

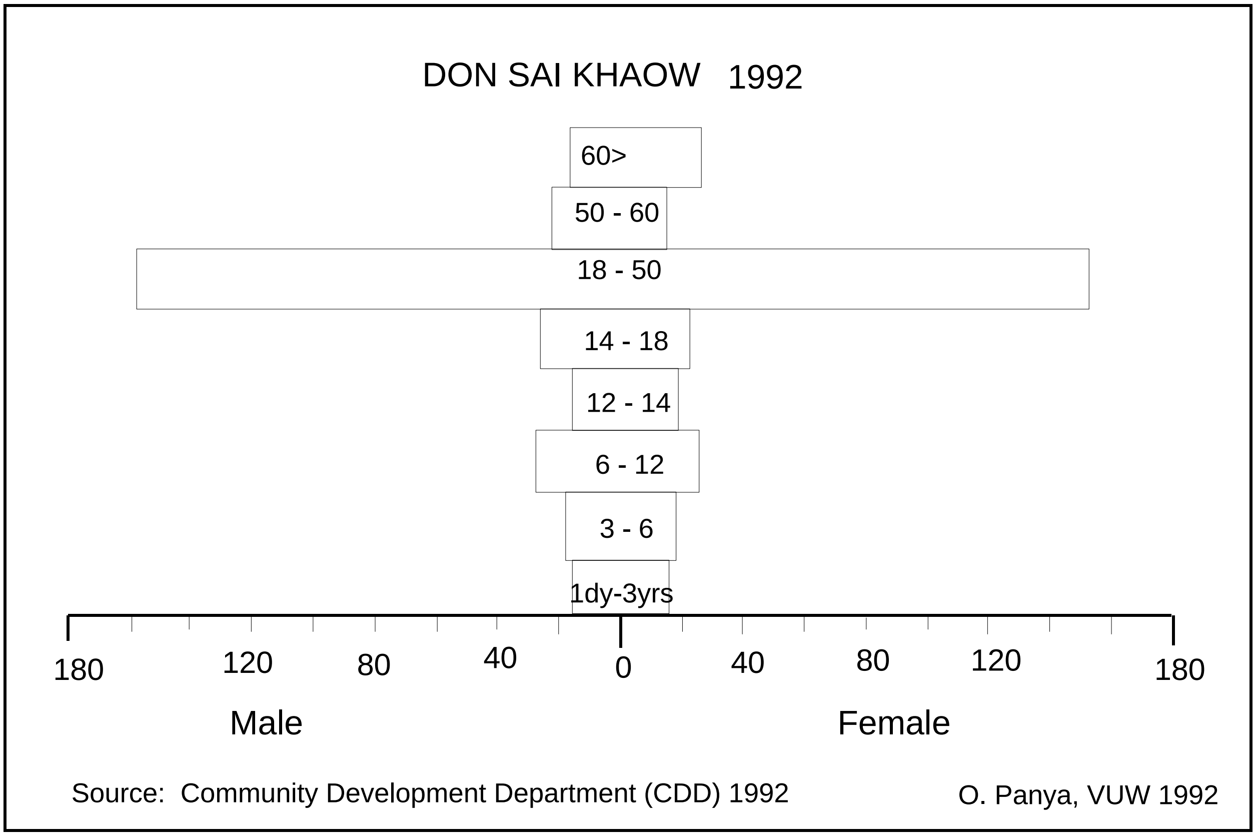

Figure 5: Population Pyramid of the a rain-fed community of Don Sai Khaow, NE Thailand

3. IMPLICATIONS FOR RURAL FOREST RESOURCE MANAGEMENT

Several implications and recommendations have already been made on different occasions, based on the findings of the charcoal and other resource-related studies in the Northeast (see for example, Panya 1992;1989; Lovelace and Panya 1988). Many will not be repeated here, and some of them have been refined as a result of my subsequent studies.

3.1 Linking Small-scale, Wood-based Enterprise with Tree-planting Incentives

Thailand is not used to an idea of applying tree-planting "incentives" into managing national resources. Form observation, the Thai government has been managing rural resources through a traditional regulatory approach. Differential degrees of restriction and control are applied to the use and management of national forest resources. For example, an area is first designated as national reserved forest which is controlled by a modest set of regulations. When this does not seem to work, more severely controlling measures are applied. The same area is then re-designated to be national park and so on. The change in the Phu Wiang watershed management is the case in point (Panya 1986).

The Northeast's experience suggests that tree-planting incentives in rural areas can be induced through promotion of small-scale, wood-based income-generating enterprises; for example, fuelwood and charcoal making, forest minor products, and so on. What makes charcoal attractive to rural people is not only its ability to generate high income relative to return of labour. Flexibility

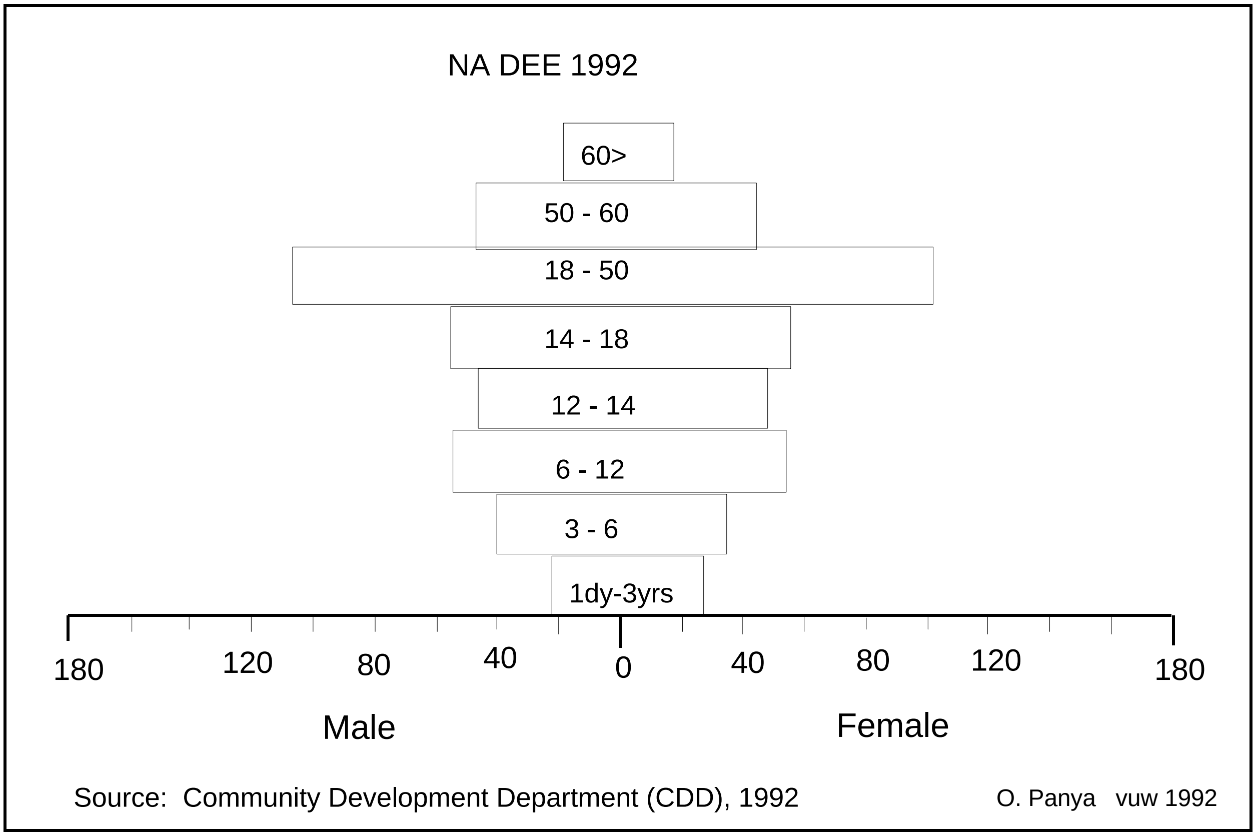

Figure 6: Population Pyramid of a Rain-fed Agricultural Community, Ban Na Dee, in NE Thailand

in scheduling and its low-capital investment are also important factors which make charcoal attractive. Charcoal does not conflict with, and can often be easily incorporated into, the seasonal pattern of household activities and needs. With regard to low capital income, what we see happening in the Northeast is that most charcoal is produced at relatively low cost. Wood is obtained with little or no capital investment involved. Regeneration of wood resources in fallowed uplands privately owned by large landowners appear to be the main source of the wood supply. Share-cropping between landless and large landowners is also common and likely to continue.

Given the current rate of tree scarcity occurring in the region and demands from a large number of poor segments of the population, costs in making charcoal will increase, due to the fact that more labour and cash will be needed to obtain wood resources. This will put charcoal in price competition with other forms of fuel, namely electricity and LPG. To rural entrepreneurs, one way to compete with commercial energy sources is to maintain the low cost of charcoal. As the case of Si Sa Ket and Khon Kaen shows, the competition will likely encourage rural people to turn to wood resources in their own lands in order to keep the cost of production down. It is therefore safe to say that enhancing economic attractiveness of charcoal entrepreneurial activities would inevitably create rural incentives for tree planting and alternative managements. Current evidence of active selling of household-based bamboo and Eucalypt in rural areas of the Northeast to a paper pulp factory in Khon Kaen also seems to support the argument.

3.2 Combining Rural Learning and a Grass-roots Community Approaches in Promoting Sustainable Management of Wood Resources

Our experience in the Northeast suggests that the problem of local resources is not simply about finding proper knowledge and information for the resource in question. It also involves changing attitudes and perceptions of local people about resource use, and researchers and planners involved with local people. The emphasis has so far been given to providing new information and knowledge from researchers and planners to the local farmers. There has not been enough attention given to the latter. Drawing from the KKU-Ford Northeast Thailand Social Forestry, I demonstrate (Panya 1992) that the problem of rural resources can be best tackled by bringing people together and "learning" to be aware of, or to effectively assess, the changing resource conditions so that they themselves be best prepared to cope with them. Researchers and planners too must be prepared to alter their views about local people, because the way in which people perceive realities is much influenced by their training, professionalism, "sub-culture," class, and so on (Jamieson 1991;1987). In areas where attitudes and perceptions are involved, they work best in a grass-root approach, which allows increased inter-personal communication and group-based problem-solving processes to take place (see Rogers and Shoemaker 1971).

Table 3: Community Learning and Forestry Development

	Steps	*Procedures*	*Tools/techniques*
1.	Build trusts: Get to know people and let them know "you," new foresters.	Visit every household as well as farms in the village; make clear introduction of the task to be undertaken.	:- Inter-personal relation skills; :- Census survey :- Keeping journals
2.	Look for key informants or potential leaders.	Follow up visits; ask them about local knowledge, interest, and his own resource problems as well as opportunities; invite them to join study of local resources.	:- Semi-structured interviewing of key informants, :- Resource-based analysis, :- Use of aerial photo, maps, :- Sketch-mapping techniques.
3.	Form interest groups.	Encourage key informants to help identify friends and relatives; invite/offer group training and study tours.	:- Self-critical and resource assessments, :- Group-based problem solving, :- Plans of action.
4.	Undertake and follow up activities.	Pay regular home/site visits; discuss technical assistance needed.	:- Household /group record keeping, :- Project assessment and evaluation.

The community approach is an equally important in forming small interest groups which, as I shall discuss below, is an appropriate management unit alternative to existing village-based organizations (see also Lovelace and Panya 1988:7-99).

Those involved in rural resource development, whether as a GO or NGO agency must recognize a balance between both research/learning and a grass-roots community approaches in design and implementation of rural resource management programmes. *Table 3* above provides an example of a combined research and development approach developed and tested by myself and colleagues in the social forestry project in the Northeast. It is a process-centred approach which will identify households and interest groups and facilitate resource management strategies appropriate to local conditions (see above).

3.3 Using Household and/or Small-scale, Interest Group as Unit of Organization

In the discussion of local participation in resource management, not much thought or experience has gone into forming new groups of individual households, all of which have similar interest and pursue similar goals, and making them into a viable unit of organization in managing local resources. Attention has always been given to village-based or inter-village organizations as a social unit of management. In other words, the current thinking has been to "identify" local organizations which already exist either formally (e.g., village committee) or informally, such as religious groups, senior citizens, and so on.

Study suggests that in an enterprise which forms to generate income, the "household" or extended household, is a more appropriate unit of social organization. Existing village-based organizations either formally or informally set up, though working well on problems in a village, are often seen as ineffective in the case where the wood resources exceed village boundaries. There are some hopes that the situation might change in the near future, as the government expresses the willingness to give more resource management authority to the existing village organization setting.

Based on the charcoal study and social forestry experience, work is in progress in communities residing in or nearby government forests in the Northeast. Some results are encouraging to suggest that the above "process-centred" approach has some potential in involving landless and smallholder farmers in managing government's degraded forest. Local farmers are brought in the process to "learn" to enhance their own skills in solving their own and local problems, and thereby form themselves as a small group(s), based on similar interest and goals. A small-scale, wood-based enterprise is thought of as a vehicle for tree planting and management of government's degraded areas (conventionally given concession to large tree-plantation firms). A grass-roots community approach is to be combined with a learning process in order to strengthen local development consciousness (self-help, self-determination, group-based problem-solving, etc.) up to a point where they can organize themselves into small-scale, wood-based enterprises and finally are able to negotiate the use and management of some parts of government's degraded forests. This is, I believe, a process of sincere and active involvement of local people in planning sustainable land-use from which they themselves will benefit.

3.4 Tree Planting, Management and Use Rights in Government Lands

It remains to be seen, however, whether or not the forestry authorities are prepared to accept this kind of participation. This will involve not only reorientation of tasks involved in the field and also modification of existing laws and regulations. The 1975 Forest Act, in particular, discourages private individuals and entities, other than those who have or have access to economic, legal and sometimes political power, from engaging in planting trees on government lands. Once planted, trees technically belong to the government. As a consequence, official permission must be obtained to harvest and transport, and fees must also be paid in this long and complicated processes.

3.5 Focusing on Non-national Forest, Village Public/common Lands

Much effort in promoting tree-planting and management has gone into government forest lands, which amounts only to 31% of the total area. Private (below) and village public lands together make up to 69% of the region's area. This shows great potential in promoting tree-planting and more sustainable management systems which will allow long-term availability of wood resources in rural areas. Studies show that livelihood of rural population is highly dependent on common lands nearby the village settlement. Mostly identified as upland rock outcrops, village common land serves as a multi-resource pool. To poor people in the village, the common land provides daily food consumption, medicines, firewood, some of which contribute even a considerable amount of income (up to 20% in Phu Wiang, for example) for most rural people (Somnasaen et al. 1987; Chiangi 1987). They are also used as animal grazing areas, particularly in the planting season when most agricultural lands are either under cultivation or water logged.

As rural forest resources continue to decline, there is an urgent need to better understand the current status of village common land: how has it been used, managed and protected, both legally and in reality? A workable legal framework for the use and management needs to be re-defined, based on the knowledge and information generated by study. Social and community forestry efforts, using a combined research and grass-root approach similar to the above, are highly recommended to be applied in promoting tree planting and management of the village common land.

3.6 Focusing on Private Lands

As charcoal study shows, most wood resources used in charcoal making are obtained from privately own lands, which include, upland, paddy, and orchard areas. People take care of trees in their land. Good timber trees are reserved for future needs in house construction of the children. Healthy trees are seasonally pruned, small or crooked trees are felled, and in wood-scarce areas, even tree stumps and roots are dug out to be used for making charcoal. Where common and forest lands are not available in the area, as in the paddy-dominated Si Sa Ket in the lower Northeast, trees on private lands are well protected and managed. Tree are planted on paddy buns and cyclically cut for use as fuelwood and making charcoal.

One thing common to all areas of study is that trees planted or reserved on private lands are often selected for multiple uses, and charcoal happens to be one of them. It is therefore important to keep this view in mind in designing and promoting tree-planting programs. In such programs, priority should be given to those edible species which can be used as food, medicines, and animal fodder. Providing tree propagation techniques and free distribution of seedlings in rural areas would encourage tree planting on private lands, making wood resources available in local areas. Improved varieties of all kinds of food trees are most welcome in rural communities.

4. CONCLUSION

Rural problems are complex, as we deal with not only the people and resource, but also persistent ideas and assumptions about them. As the society as a whole and resources continue to change, old ideas and assumptions may no longer reliable and thus need to be continually re-assessed.

Charcoal has traditionally been discussed in a narrowly-defined context of demand and supply of wood resources. As a result, it has been viewed as a major cause of current forest destruction in the Northeast Thailand. This kind of false perception influenced the way in which certain strategies were formulated. Policies, namely totally banning small-scale charcoal production and taxing charcoal stoves, would severely hurt a certain group of the Northeast's population which is already the most economically disadvantaged. Such a ban would be unwise until such time that rural poverty is more effectively dealt with and viable economic alternatives are readily available to the region's rural poor.

As our study shows, charcoal activity is critically important to low-income segments of the Northeast's population in both urban and rural areas. Charcoal provides an extremely important low cost source of energy for many "poor" urban households. Charcoal making generates needed income for smallholder and landless households.

Study shows that rural dwellers have practical ideas and ability to cope with rapidly changing resources. This type of local strength and attractiveness of small-scale, wood-based enterprises, for example, can be incorporated into design and plan for local involvement in the use and management of government lands. More attention should be given to improvement of private and community-based common/public lands. As for common lands, more adequate knowledge is needed in order to formulate a legal framework which is applicable to the current situation of local resources.

Finally, information about charcoal in the Northeast should not be taken as universally applicable. As study has shown, charcoal production in the Northeast is highly complex and diverse, due mainly to adaptive responses by rural people in differing circumstances to the rapidly changing conditions (e.g., wood scarcity, and expansion of the market economy). The popular misconception that charcoal activity is destructive to forest resources has its root on the fact that researchers do not fully appreciate local adaptive capability and the value of their experiences. An inter-disciplinary approach with an emphasis on exploratory learning from local people should prevent researchers and planners from making false assumptions about rural problems.

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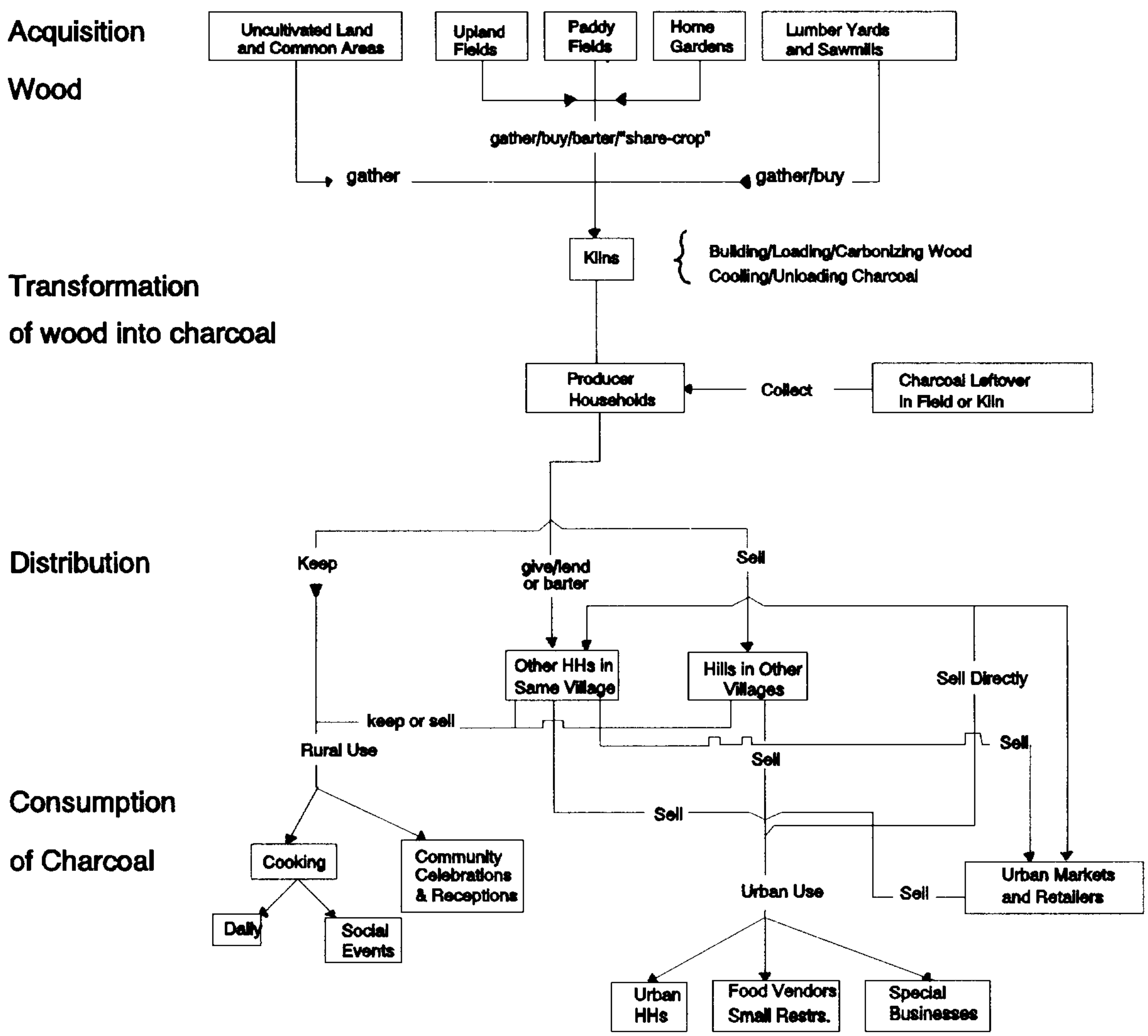
Annex I

Tree Species Used to Make Charcoal in Different Provinces

Scientific Name	Local Name	Provinces	Source of Information
Shorea obtusa	Jik	Khon Kaen	2 villages
Shorea siamensis	Rang		
Sindora siamensis	Tae		
Xylia xylocarpa	Daeng		
Grewia elatostemoides	Kean-tao		
Tamarindus indica	Ma-kham		
Pterocarpus macrocarpus	Pra-doo		
Morinda tinctoria	Yor-pa		
Sindora siamensis	Tae	Chaiyaphum	3 villages
Diospyros rhodocalyx	Ta-go		
Combretum quadrangulare	Sakae-na		
Azadirachta indica	Sadao		
Dipterocarpus alatus	Yang	Roi-Et	2 villages
Combretum quadrangulare	Sakae-na		
Pterospermum semisagittatum	Kra-nuan		
Xylia xylocarpa	Daeng		
Irvingia malayana	Kabok		
Shoria floribunda	Pha-yorm		
Dipterocarpus intricatus	Sa-baeng		
Cratoxylong formosum	Tiew	Sakhon Nakhon	4 villages
Iroingia malayana	Kabok		
Eugenia cumini	Waa	Si Sa Ket	6 villages
Mangifera indica	Ma-munag		
Parinarium annamtense	Phok		
Phyllanthus polythyllus	Sio		
Peltophorum dasyrachis	A-raang		
Dalbergia chochinchinensis	Yoong		
Meringo oleifera	E-lum		
Hyminocardia wallichii	Hua-ling		
Azadirachta indica	Sadao		
Ficus benghalensis	Wang-sai		
Erythrophloeum succirubrum	Phan-chat		
?	Kradook-ngau		
Memecylon scutellatum	Muad-aa		
Dipterocarpus obtusifolius	Saad		
?	Maang		
Samanea samans	Chum-cha		
Iroingia malayana	Kabok		
Dipterocarpus intricatus	Sa-baeng		
Tamarindus indica	Ma-kham		

Annex II

Simplified Model of the Small-Scale Charcoal System in Northeast Thailand



Wood Energy as a Commercial and Industrial Fuel in Cebu City, Philippines

by

Terrence Bensel[1]

1. INTRODUCTION

This paper presents the preliminary findings of an on-going study of the commercial[2] woodfuel system in the City and Province of Cebu, Philippines. The study was divided into three broad phases designed to focus on: 1) the end- uses of commercially-traded woodfuels in the Metro Cebu area; 2) the trading and distribution network for woodfuels in the city, and; 3) the supply-side of the commercial woodfuel markets. Though each phase was conceived of and carried-out separately from the others, information gathered during one part of the study often shed light on and helped supplement data gathered in others. Our goal is to develop a comprehensive understanding of how the commercial woodfuel industry functions in Cebu, from production to transport to marketing and finally end-use. This study has gone a long way towards fulfilling that goal, however, some areas still need further work especially with regards to the extent of commercial woodfuel demand in rural areas, as well as the complex interaction of land-use, tenure, social and economic factors in these areas and the impact they have on woodfuel supply.

Cebu has proven itself an interesting site for the study of commercial woodfuel markets for a number of reasons. First, the market itself is well- developed, employing a significant number of rural and urban dwellers, moving a large volume of woodfuels as well as other biofuels, and serving the energy needs not only of urban households and small-scale businesses but also those of a number of medium- to large-scale industries. Second, Cebu has the dubious distinction of being perhaps the most deforested province in the country with less than one-half of one percent of its land area forested (World Bank, 1989). This situation is often immediately tied-up with woodfuel use by government/NGO officials and other urban-dwellers either by <u>blaming</u> the deforestation on woodfuel extraction or by agonizing over impending woodfuel shortages <u>because</u> of the extent of deforestation. The fact that a significant trade in woodfuels continues year after year and that according to at least one source Cebu was already 94% deforested by 1876 has not served to alter this state of affairs (Vander Meer, 1962). Third, there are a number of indications that devoted planting of fuelwood species can be an economically rational use of private lands in Cebu, which runs contrary to the usually-reported scenario whereby "open-access" extraction of woodfuels keeps prices too low to encourage planting on private land. There is even more evidence that a significant amount of woodfuel in the form of branches, trimmings and off-cuts can be sourced from private lands planted to higher value trees intended for use as mine poles, lumber or for fruit production and that fuelwood species are being incorporated into a whole range of agroforestry schemes by Cebuano farmers. Overall, Cebu appears to possess a number of characteristics (economic, ecological, social,

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[2] By commercial we are referring to woodfuels that are traded as a commodity as opposed to freely grathered or collected.

political among others) that have led to what many would find an unusual (or unbelievable) situation, namely, a near-completely deforested island supporting a burgeoning trade in fuelwood and charcoal.

For a number of reasons (least of which is deforestation), it seems likely that woodfuels will account for a declining relative share of commercial energy consumption in Cebu City in the years to come. Many, but by no means all, woodfuel-using households that can afford to would like to "move- up" the energy ladder, most especially to the use of liquefied petroleum gas (LPG). Strong taste preferences for baking or cooking with woodfuels in the food industry will likely decrease as the "old-time" bakers and kusineros (chefs) give way to a new generation less concerned with perhaps imagined taste differences and more concerned with convenience and ease of use. The behavior of larger industries more concerned with price than any other factor are harder to predict, but stable world oil markets would likely decrease the attractiveness of woodfuels. On the supply-side, Metro Cebu has become the industrial/commercial/tourism hub of the Southern Philippines, and shows little indication of stagnation. Already, one export processing zone (EPZ) is operating and Filipino and multinational firms are building new plants further and further outside of what had been considered "Metro" Cebu. Simultaneously, the development of housing subdivisions, corporate parks, golf courses and other tourism-related projects has created a real estate boom and intensified land speculation in many parts of the province. The impact of these developments on woodfuel supplies is difficult to predict and will vary depending on local circumstances. However, besides a possible initial "pulse" of woodfuels in the wake of land clearance for such developments, it seems likely that these projects will have long-term negative impacts on woodfuel supply, and that rampant land speculation will exacerbate the already uncertain tenure status of many farmers with consequent negative impacts on tree-planting activities.

Nevertheless, in absolute terms, the consumption of woodfuels and other biofuels appears likely to remain significant in Cebu City for some time to come, and under certain circumstances (e.g. world oil crises, internal political instability), not at all far-fetched, it is possible that the use of these fuels could even increase relative to fossil fuels. With this in mind, our study set out to establish a comprehensive baseline understanding of the current commercial woodfuel situation from which various scenarios and policy options on both the demand- and supply-side could be analyzed. Along the way we were interested in answering a number of questions, or testing hypotheses, ranging from the reasons for household fuel choices to the degree of "competition" in woodfuel trading to the role of woodfuel production as a source of employment.

For ease of discussion the paper will be divided into the different phases undertaken in the study. After the most relevant findings of each phase have been presented the commercial woodfuel system in Cebu will be discussed as a whole with an emphasis on the many current misunderstandings surrounding the functioning of this industry and possible research/policy actions that could be taken not only to improve our knowledge of the industry but also to improve the functioning of the industry itself and its ultimate "sustainability." Before going to a discussion of the various phases of the research, a brief introduction to Cebu Province is in order.

2. DESCRIPTION OF STUDY SITE

The island province of Cebu is situated in the Central Visayan region of the Philippines, some 750 km. southeast of Manila (see figure 1). The island is long and narrow, stretching 220 kilometers on a north-south trend, and only 40 km. in breadth at its widest point. Rugged mountains rising as high as 1000 meters dominate the landscape, but most of the island's 2.65 million residents inhabit the narrow coastal plains with close to 1 million concentrated in the cities of Cebu, Mandaue and Lapu-Lapu alone (see figure 2). With a total land area of 5088 square kilometers and a 1990 population of 2,645,735 Cebu had one of the highest population density levels in the country at 520 persons per square kilometer, and the provincial government is forecasting a year 2000 population of over 4 million (NSO, 1990: PPDS, 1987: PPDO, 1990).

The economy of Cebu is essentially dualistic in nature with a large percentage of the population (close to 50%) engaged in near-subsistence agriculture and fisheries activities while a smaller (although extremely high by Philippine standards) percentage is involved in manufacturing, services, tourism, commerce and mining. However, it is the latter sectors that account for the bulk of economic activity in the province. The manufacturing sector is highly export-oriented and includes among its products electronics, watches, fashion accessories, furniture, food additives (carageenan), activated carbon, glassware, garments and coconut products. The mining sector is dominated by perhaps the largest copper mine in all of Asia, Atlas Consolidated, which alone accounts for 7% of the island's economic output and 15% of its export earnings (Tiglao, 1991). A significant number of small coal mines (open-pit and underground) produce some of the highest quality coal found in the country, but most of these deposits have seams which are thin, steeply-sloping and broken which has limited the exploitation of this resource. Cebu also serves as the banking, shipping, air, communication, insurance, and trading hub for the rest of the Visayas and Mindanao.

The island's topography is dominated by the uplands. Only 24.1% of the total land area is in the 0 to 18 degree slope category while 64% is in the 18 to 30 degree range and 11.9% greater than 30 degrees in slope. The province receives an annual average rainfall of around 1500 mm with no pronounced dry or wet season although November is generally the wettest month and April the driest. The location of Cebu in the central portion of the Visayan region helps to shelter it from the typhoons (usually 10-20 a year) that batter the eastern and northern provinces. Despite this, occasional "direct hits" have been scored by typhoons on the province, the most recent of which struck in November 1990 crippling the province for over a month (and resulting in some very interesting developments/adjustments in commercial woodfuel markets). Based on SPOT satellite images of 1987, the most predominant land-use patterns for the island are "crop land mixed with coconut plantations" and "cultivated area mixed with bushland and grassland" (NAMRIA, 1988: World Bank, 1989). The most widely cultivated crop on Cebu is corn which is grown mainly, but by no means solely, as a staple crop for home consumption.

The combination of high population densities, near total lack of forest cover, and generally "poor" farming practices in the uplands has led many to forecast a dire environmental future for this island province, especially with regards to soil erosion and water resources. In a 1981 paper on reforestation in the Philippines, Durst reported that some officials were at that time predicting that the island would be "uninhabitable" before the end of the century unless massive watershed improvements were undertaken (few have been). Such talk continues today, and the issue of woodfuel extraction is often brought up in the same vein as part of the problem. However, despite such talk, Cebu continues to experience population and economic growth often greater than the rest of the country, and has been touted by politicians and trade representatives as the next island "tiger economy" in Asia (PPDO, 1990).

Figure 1: Map of the Philippines

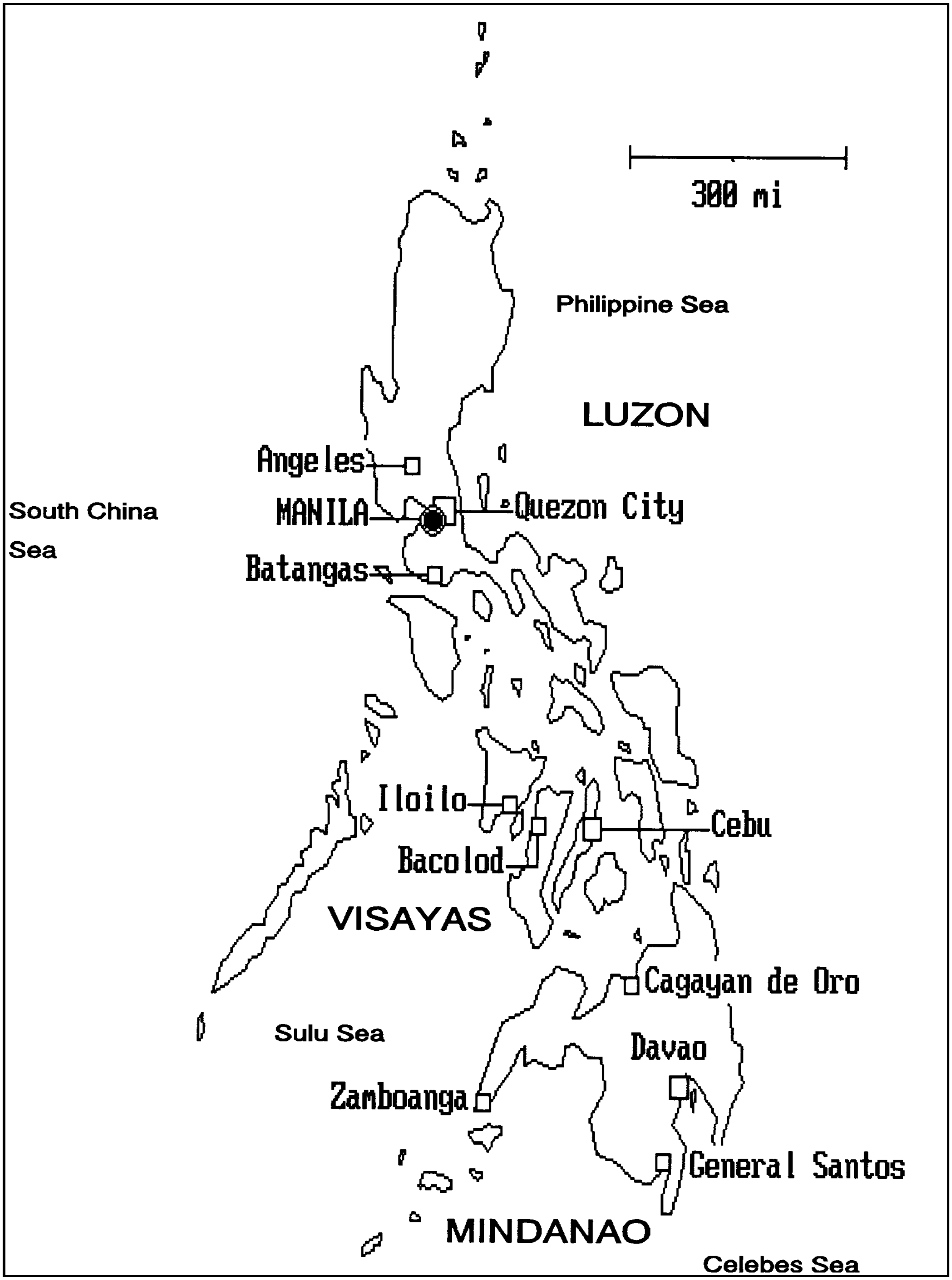
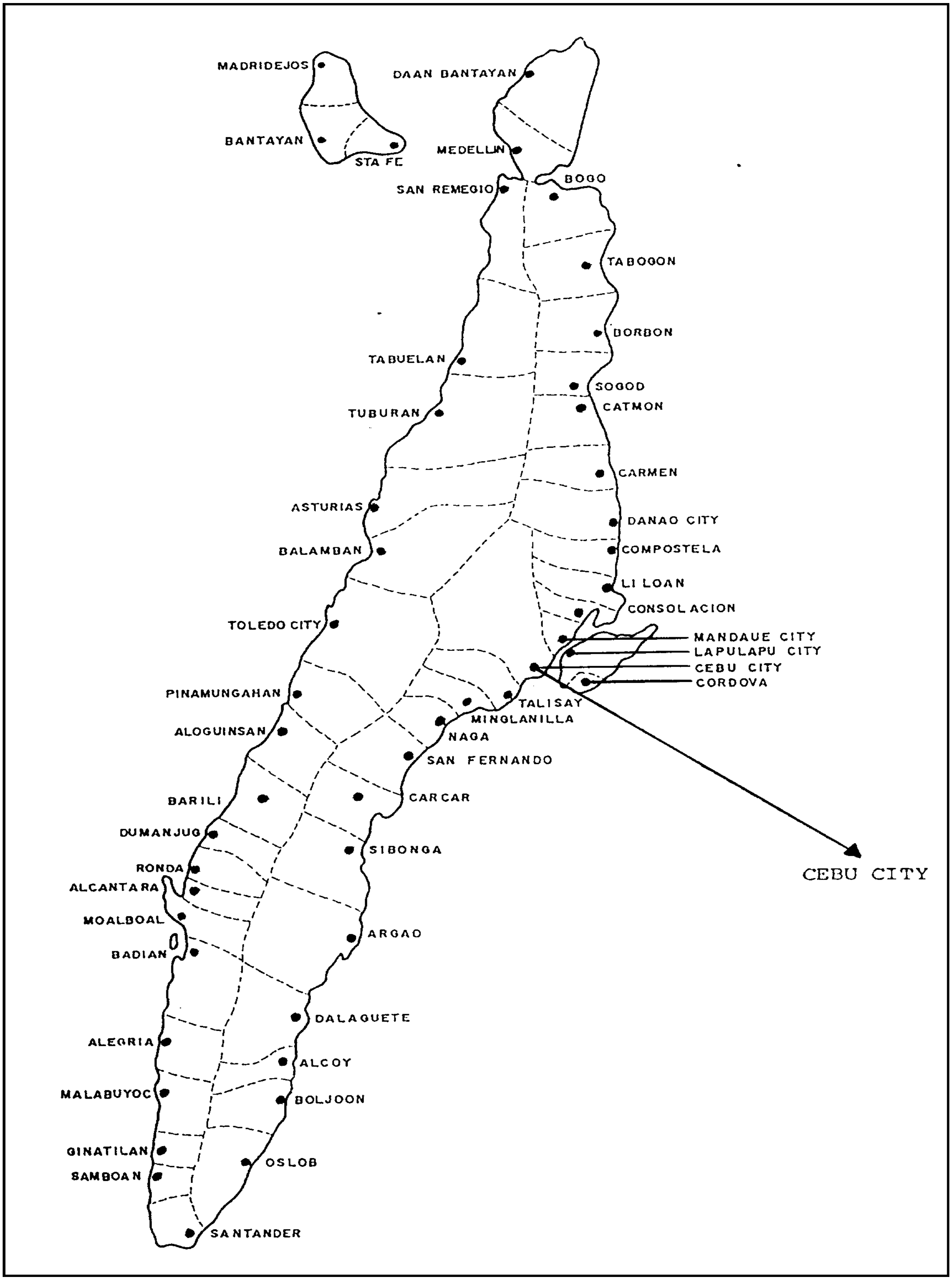


Figure 2: Map of Cebu Province



3. PHASE I: DEMAND FOR WOODFUELS IN THE METRO CEBU AREA

This phase of the study consisted of two distinct surveys on energy use. The first targeted approximately 600 Cebu City households chosen randomly from government census records. The second targeted institutions, businesses, commercial and industrial establishments using a combination of random, cluster and purposive sampling techniques. A more detailed discussion of the sampling techniques used and the logic and justification for each can be found in the companion paper by Remedio (1993).

The main purpose of this phase of the study was to quantify the consumption of woodfuels (as well as other fuels) by various sectors in the city and to probe in detail the factors that drive fuel-choice decisions in Cebu households, institutions and commercial establishments. From this we could develop a highly quantitative baseline estimate of current levels of woodfuel consumption and to explore the factors "driving" this consumption in order to form future estimates and inform appropriate policy measures to meet this demand.

The most significant findings of this phase of the study are that: 1) the household sector dominates consumption of woodfuels in Cebu City, although commercial sector consumption is as high as one-third to one-half of the total; 2) in the commercial sector, the largest number of consumers are small- scale informal eateries and food vendors, however, a number of large-scale industries also make use of woodfuels, often in significant quantities; 3) multiple fuel-use is common in households as well as many commercial establishments with woodfuels being preferred for a number of specific cooking purposes; 4) there is a clear trend towards a fuel-switching transition away from woodfuels, however, in absolute terms this trend is being offset by increasing population, and; 5) a significant portion of woodfuel consumption takes the form of scrap wood, palwa (coconut fronds), and other forms of non- wood biomass.

3.1 Household Energy Use

A total of 603 households in Cebu City were interviewed between February and May 1992. The survey questionnaire was 54 pages long and contained questions on the socioeconomic background of the household, types and amounts of fuels used (both biofuels and fossil fuels), cooking patterns, fuel-switching behavior and reasons for choosing or not choosing certain fuels. Despite its length the survey only took an average of 25 minutes to complete due to the structure of the questionnaire (skipping patterns, pre-coded responses) and enumerator training. This section will present some of the major findings of this survey, focusing mainly on the use of woodfuels.

Table 1 shows the primary cooking fuel breakdown for the surveyed households on the basis of income range. Not surprisingly, the table shows the strong influence that household income plays on fuel choice, with 63% of the lowest income households relying on fuelwood while 80% of the highest income households utilize LPG. However, table 1 only scratches the surface in looking at the complexity and diversity of household fuel-use patterns in Cebu City. For example, some 7.3% of the surveyed households could not be placed in a single "primary fuel" category since they utilized two or more fuels near equally and often simultaneously (the most common combination being fuelwood and kerosene). Likewise, the average household keeps on the premises and uses at least once a month 1.6 different types of "stoves". What this really means is that even those households that have a clear "primary" cooking fuel frequently make use of one or more secondary cooking fuels for special cooking needs and/or for back-up purposes. This point is especially important in discussing fuelwood and charcoal since these are the most widely utilized secondary fuels.

A total of 276 households, or 45.8% of the sample, utilize fuelwood at least once a month for their cooking needs. Of these 276, only 168, or 60.9% of the fuelwood-using households utilize it as their primary cooking fuel. Another 30, or 10.9% of the fuelwood-using households utilize it in a near equal combination with one or two other fuels (e.g. kerosene is used for cooking meat/vegetable dishes, while fuelwood is used for cooking rice). The remaining 78, or 28.3% of the fuelwood-using households utilize this fuel only in a secondary fashion.

Before continuing, we should qualify the term "fuelwood" as we are using it here. In the conduct of our survey we included under the fuelwood category regular "wood" (e.g. Leucaena leucocephala, Gliricidia sepium) both purchased from retailers/wholesalers/roving vendors as well as collected from woodlots, riverbanks, parks, open spaces, along the coastline, etc.. In addition, we also included "scrap wood" and coconut fronds, locally referred to as palwa, both of which are obtained through a combination of market purchases and collecting activities. However, questions were included so that we could then seperate-out the amounts of these fuels being used. For example, the surveyed households consumed an average of 894.3 kg. of "fuelwood" daily, of this, 202.3 kg. (22.6%) was palwa and 143.1 kg. (16.0%) was scrap wood. In addition, households were also making use of a negligible amount of commercially traded bamboo and coconut logs, although these fuels do find much wider use in the commercial sector. Therefore, when we speak of fuelwood use the reader should keep in mind that close to 40% of the fuelwood needs of Cebu City households is being met by coconut fronds and scrap wood.

Of the 276 households using fuelwood, 205, or close to 75%, purchase the fuel from a store or market. The most common pattern is to purchase once daily with the average household making six purchases a week. There are some indications that the lowest-income households do tend to make more frequent purchases in smaller quantities than those somewhat better off, but other factors such as distance to place of purchase and the extent to which the household relies on freely collected wood are also important.

Another 24 fuelwood-using households have supplies delivered to them. These households were often engaged in some form of small-scale commercial activity such as food-vending and so therefore found it convenient to make arrangements for deliveries. Others were simply located in areas of the city where roving fuelwood/charcoal vendors still ply their trade. Still another 81 household collected their own fuelwood, with some relying on this method for all of their fuelwood needs. Many of these households live in suburban barangays [3] where woodlots and coconut plots can still be found and 63% of those collecting wood reported getting it primarily from their own or a neighbor's land. However, even households in the built-up districts of the city were able to scour fuelwood from a number of different sources including riverbanks, shorelines, parks and open spaces.

[3] A barangay is the smallest political unit in the Philippines.

Table 1: Primary Cooking Fuel for Cebu City Households, by Income Range, 1992

Income Range (P)

Primary Fuel	0-1999		2000-4999		5000-9999		10000-19999		20000-highest		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Fuelwood	52	53.4	75	31.9	33	20.0	8	9.9	0	0.0	168	27.9
Charcoal	3	9.8	15	6.4	7	4.2	1	1.2	1	2.5	32	5.3
Kerosene	13	15.9	57	24.3	36	21.3	3	9.9	2	5.0	116	19.2
LPG	4	4.9	56	23.8	76	46.1	56	69.1	32	30.0	224	37.1
Electric	1	1.2	0	0.0	0	0.0	1	1.2	2	5.0	4	0.7
Sawdus	0	0.0	7	3.0	1	0.6	0	0.0	0	0.0	8	1.3
Others	1	1.2	1	0.4	1	0.6	0	0.0	0	0.0	3	0.5
Multiple Fuels	2	2.4	21	8.9	11	6.7	7	8.6	3	7.5	44	7.3
Not Cooking	1	1.2	3	1.3	0	0.0	0	0.0	0	0.0	4	0.7
	32	100.0	235	100.0	165	100.0	81	100.0	40	100.0	603	100.0

It was mentioned above that coconut fronds or palwa account for nearly one-fourth of all fuelwood consumption, and scrap wood some 16%. In fact, of all the fuelwood-using households, 38% make some use of palwa and 50% some use of scrap wood. The most common source of supply for scrap wood is some type of construction, demolition or renovation of a respondents or a neighbors house. Carpenters working on construction jobs regularly seek permission to bring home a bundle of scrap wood each day for home use. Others get their scrap from garbage dumps, warehouses, piers, furniture shops, woodcraft factories or lumber yards which also supply households with sawdust, utilized in what is locally referred to as a san-san (compress) stove. It appears that there is an increasing trend towards commoditization of scrap wood and sawdust, with many households reporting that they used to be able to secure these fuels for free but now they have to pay for it. During phase 2 of the study we even came across what local residents were calling a scrap wood "factory" which was really an open space in a squatter settlement where loads of scrap wood were dumped from construction sites with a middleman making the arrangements for transport and payments. The wood was then split, sized and bundled with the better pieces retained for making packing crates and cinder block molds. The middleman then "purchased" the bundles back and sold them either directly to bakeries and eateries or to retailers and roving vendors. In the case of palwa most of the fuel is purchased from urban traders although suburban households are still able to gather this fuel from their own or a neighbors land planted with coconuts.

Nearly one-fourth of household fuelwood consumption was found to actually be going to commercial activities taking place within the household premises rather than directly for household cooking needs. Most notable was the operation of informal food-vendors preparing and selling pre-cooked dishes out of their residence. The majority of these were found in low-income squatter settlements where they sell small portions of vegetable and meat dishes to neighboring households. In fact, nearly half of the households in the P0-5,000 income range were found to be purchasing foods from such vendors at least once a day, many patronizing these establishments 2 or 3 times a day and only cooking rice at their residence.

This pattern has important implications (mainly positive) with regards to fuelwood consumption. Essentially, what has happened is that a significant portion of household cooking activities have been "shifted" to the commercial sector. Such a development appears quite logical from the perspective of many low-income urban households since time spent marketing and preparing foods could often be spent more productively elsewhere. It's possible that this trend will serve to reduce woodfuel consumption (and therefore expenses associated with its purchase) without adversely affecting the nutrition or culinary preferences of these households. This is the case since it is likely that commercial food-vendors are capable of achieving economies of scale in their use of woodfuels. By cooking larger amounts at one time these establishments will tend to reduce per capita woodfuel needs. Furthermore, surveys of these businesses (see section 3.2) reveal that the owners show a keen sense for costs of inputs, especially fuels, and are likely to try and use these in a more efficient manner than a typical household.

Table 2 lists the most important reasons cited by households for using fuelwood. We were a bit surprised that taste was the most important factor for nearly one-third of all fuelwood-using households, but a perceived inexpensiveness and in many cases free access to some form of fuelwood are also important. These findings suggest that many woodfuel-using households have strong reasons for preferring this fuel and might not be automatically inclined to fuel-switch even in cases where such a switch is economically feasible. Indeed, less than 10% of current fuelwood-users reported that they would discontinue using this fuel five years from now, although it's possible that some might only continue using it in a secondary fashion.

Table 2: Most Important Reasons Cited for Using Fuelwood

Reason	% of Respondents
- Food tastes better when cooked with fuelwood	30.4
- Fuelwood is inexpensive	15.9
- Able to obtain fuelwood for free	13.4
- Fuelwood is available nearby/easy to purchase	10.9
- Others	10.9
- Gives off high heat/cooks food fast	9.1
- For specific cooking end-uses (long cooking of stews, beans,	4.0
etc.)	2.9
- Fuelwood is always available	2.5
- Fuelwood stoves are inexpensive	
	100.0
Total	

In trying to define a figure such as "average daily household fuelwood consumption" or "per capita fuelwood consumption" we run into a number of difficulties. First, should averages be based on all households, fuelwood- using households only, fuelwood-using households where this fuel is the primary fuel, households with or without fuelwood-using commercial activities taking place, and so on. Second, how should scrap wood, palwa and other non- wood biomass be treated? What follows then are a number of different estimates and their corresponding extrapolations/analyses.

There were 603 respondent households using an average of 894.3 kg. of fuelwood daily for a household average of 1.5 kg. a day or 541.3 kg. a year. Since the average sample household size was 5.8 members this translates into a per capita consumption of .26 kg. a day or 62.9 kg. a year. Looking only at fuelwood-using households, the daily average increases to 3.24 kg a day or 1182 kg a year per family, with a per capita consumption level of .64 kg. a day or 233.2 kg a year. If we look only at those households that consume fuelwood as their primary cooking fuel, per capita consumption rises to .83 kg a day or 304.8 kg a year. Overall, in Cebu City alone there are 46,891 households out of a total of 102,446 consuming on average 3.24 kg. of fuelwood a day for a daily consumption of 152 metric tons or 55,456.7 metric tons annually[4].

Charcoal: The percentage of respondent households using charcoal (71.6%) is actually much higher than that for fuelwood (45.8%). However, only about one in ten of these households make use of charcoal for regular cooking purposes with the rest using this fuel for special cooking needs (e.g. stewing meats, barbecue) or for ironing. The typical household purchases 1 to 2 cellophane packs of charcoal (weighing around .5 kg. each) 1 to 2 times a week. However, for those households doing more cooking with charcoal this fuel can also be purchased by the sack (weighing around 15 kg.) or by the taro (usually a cooking oil can holding around 5 kg.). As with fuelwood, one of the attractions of charcoal is its ready availability, with 95% of the households using this fuel reporting that they were able to purchase it within a 1 km. radius of their residence.

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4 The final report on this study will attempt to standardize all energy types into a single unit to allow for direct comparison between various forms of energy.

Overall, the 603 respondent households consumed an average of 128.8 kg. of charcoal daily. If this figure is extrapolated to the city as a whole the household sector alone will be seen to be consuming 21.9 metric tons (about 1500 sacks) of charcoal a day or close to 8000 metric tons (532,470 sacks) a year. Of this charcoal consumption, around 13.8% is actually being used for commercial purposes within the household premises, most commonly for small barbecue or eatery businesses operating out of the household. Of the 432 respondent households using charcoal, some 110 (25.5%) reported using this fuel solely for ironing clothes, while 141 (32.6%) reported its use solely for cooking (including barbecuing) purposes. The remaining households utilized charcoal for some combination of the two. When we break these uses down we find that close to 70% of all charcoal used goes for cooking and around 30% for ironing.

With respect to cooking, over half of the charcoal used for this purpose is for preparing sinugba (barbecued meats, fish or vegetables) and/or for inasal (roasted pig) a common site at family occasions/gatherings. A number of households also make use of charcoal for cooking linat-an (stews) or kan-on (rice). Since charcoal tends to give off a steady, uniform heat it is deemed a highly desirable fuel for preparing stews and rice and many households using mainly LPG find using charcoal more economical for such "long-cooking" needs.

Additional advantages to using charcoal as a cooking fuel are that this fuel is relatively smokeless and far less bulky than fuelwood, an important consideration in crowded squatter settlements. Also, charcoal is considered a fairly safe fuel compared to fuelwood and LPG, and we even encountered some upper-income households cooking with this fuel primarily for reasons of safety.

Cooking Practices/Fuel Switching: Two important considerations in assessing current and likely future woodfuel use involve household cooking practices and the extent to which a fuel-switching transition has, or is, taking place. Therefore, our questionnaire included a seperate section on these topics, which looked into types and numbers of stoves owned, frequency of use, stove/cooking device costs, outside food purchases, past fuel switching behavior and the reasons for such switching.

The most widely owned "cooking device" were woodstoves with 47% of the households reporting ownership of such a device. However, it should be mentioned that the question was asked in a way that even a traditional "3-stone" arrangement for cooking with fuelwood would qualify as a woodstove as long as this was a fairly permanent fixture of the household and was used at least once a month. The point was whether or not the household maintained the capability to use a certain fuel or not. The other most widely kept cooking devices were LPG stoves (44.3%), kerosene stoves (36.2%), charcoal stoves (24.7%), electric stoves (6.0%), and sansan or sawdust stoves (3.5%).

The frequency of use of these stoves (for households using them for most or all of their cooking) varied little from a low of 16.4 times a week for charcoal stoves to a high of 20.5 times a week for LPG stoves. We were expecting that the frequency of use of woodfuel stoves would be lower than that for LPG since, as reported above, lower-income households have a higher propensity to purchase ready-made foods from food vendors or eateries. In fact, average weekly use of fuelwood stoves was 19.4 times, lower than the 20.5 reported for LPG. However, it is possible that not all of this difference is being captured because many of the low-income households that purchase ready-made foods still prepare their own rice and thus make use of their stove anyhow.

Overall, the mean price paid for the purchase of a fuelwood stove was P24.63 (around US$1.00). However, close to 45% of the fuelwood "stoves" being used by respondents were obtained for free, most of which were fashioned from 3 stones or 2 cinder blocks with a metal grate. These arrangements need not be as inefficient as is commonly assumed since we have observed that most of these home-made cooking schemes also utilize something like a piece or pieces of tin roofing to protect the fire from the wind. Excluding the free stoves, as well as one or two outliers on the high price end, the mean price paid for a woodstove was ₱30, or around $1.20, a clearly affordable purchase for nearly any household. The design of these stoves is usually either ceramic or simply welded iron bars. Another common design is to encase a biscuit can in cement. Household respondents and traders of these devices report that they are useful for anywhere from 6 months up to 20 years, with most lasting in the 2-5 year range.

In contrast, the mean price for kerosene and LPG stoves was ₱240 ($9.60) and ₱1946 ($77.84), respectively. Although kerosene stoves are fairly reasonable in price compared to LPG stoves, their cost was still cited as the most important reason for not using them by 20% of the respondents not cooking with kerosene. Other major reasons cited for not cooking with kerosene were that these stoves are unsafe (13.7%), that food cooked using a kerosene stove tastes bad (12.4%), that kerosene stoves "break" too easily and require too much maintenance (8.7%) and that kerosene stoves (namely the pressure type) are difficult to use and require constant tending (6.2%).

In the case of LPG, stove cost (which should include either purchase of or deposit on a cylinder tank) is clearly the largest hindrance to utilization of this fuel, with 47% of the non LPG-using households citing this as the most important reason. Interestingly, the second most important reason, cited by 31% of non-using households, is that LPG is "dangerous" and considered a hazard. The only other significant reason given for not using this fuel was that the fuel itself is too expensive and/or the payment mode is too "bulky" requiring a one-time cash outlay of around ₱130-140 ($5-6) per tank, unlike fuelwood or kerosene which can be purchased in small amounts more commensurate with the budget of many urban households.

Turning to the issue of fuel-switching, 113 of the 603 respondent households reported at least one fuel-switch in the previous five years, with 14 of these undergoing two such switches and three households experiencing three switches over that time period. Out of these switches, the three most common were from fuelwood to kerosene (32.7% of all switches), kerosene to LPG (15% of total), and kerosene to fuelwood (11.5% of total). Of the 603 respondents there were 30 fewer fuelwood users than 5 years ago, 13 more kerosene users and 20 more LPG users, supporting the general notion of a fuel-switching transition from fuelwood to kerosene and then to LPG. However, it's obvious that this transition is not always a one way trip for many households, as can be seen by the fairly large number of households reporting a switch from kerosene back to fuelwood. In fact, five of the 37 households that switched from fuelwood to kerosene went back to using fuelwood within a five year period, the main reason being that their kerosene stove needed repair and they could not afford or had no desire to fix it. Overall, however, there is a clear trend away from fuelwood use and towards more wider use of kerosene and LPG. This is supported by table 3 which is based on data obtained from the National Census and Statistics Office (NCSO) showing the breakdown of major cooking fuels for Cebu City households in 1970, 1980, and 1990.

Interpreting table 3 is a bit problematic since the census years might not always represent normal periods in household fuel markets. At the time the 1980 census was taken world oil prices were relatively high, the opposite being the case for 1990. It's also interesting to note that even though the percentage of fuelwood-using households declined nearly 30% between 1970 and 1990, the actual number of such households increased due to population growth. The future pace and direction of household fuel-switching will depend on numerous factors. Of interest to the Philippines, in particular, is the impending deregulation of the oil industry and elimination of cross-subsidies between petroleum products. At present, LPG, kerosene and diesel are socially priced around 30% lower than they would be under a deregulated market. The sales of these products are cross-subsidized from gasoline sales. If these subsidies are eliminated, all other things constant, LPG and kerosene prices can be expected to increase significantly with perhaps a smaller increase in the price of fuelwood due to increasing costs for diesel, used in the transport of woodfuels. Although few households currently using LPG and kerosene are likely to drop these fuels altogether in the face of a 30% price increase, it is possible that such a development will slow down the pace of fuel-switching and increase the attractiveness of fuelwood as a secondary or supplemental fuel.

Table 3: Primary Cooking Fuel of Cebu City Households, 1970, 1980 and 1990

	1970	1980	1990
(household population)	(56032)	(88770)	(114708)
Primary Fuel	(Percentage)	(Percentage)	(Percentage)
Fuelwood	65.1	57.6	36.9
Charcoal	0.2	*	4.6
Kerosene	14.4	12.5	22.5
LPG	18.4	27.6	31.6
Electric	1.7	1.8	4.1
Others	0.3	0.5	0.3
None	-	-	0.2

* including sawdust for 1970, 1980 and 1990 and charcoal for 1980.
Source: NSO, 1990

Other factors to consider in fuel-switching trends would include developments in stove costs, economic developments in Cebu and associated impacts on income, lifestyles and settlement patterns, demographics and a whole host of other issues the discussion of which is beyond the scope of this paper. In the end, however, it appears certain that woodfuels will continue to be an important fuel in the household sector of Cebu for some time to come.

3.2 Commercial/Industrial/Institutional Energy Use

While woodfuel studies often acknowledge that the commercial/industrial/institutional sectors (hereinafter referred to as the commercial sector) are significant consumers of fuelwood and charcoal, most of the attention is usually focused on the household sector since it typically accounts for the bulk of consumption. A preliminary analysis of our data suggest that in Cebu the commercial sector accounts for one-third to one-half of woodfuel consumption, justifying a closer investigation of this sectors fuel-use patterns. In a number of ways the woodfuel market serving commercial users is qualitatively different from that serving households. For example, many commercial users are supplied directly by rural traders, although not all of them choose to by-pass urban traders all of the time. In addition, commercial users are often more interested in being supplied with larger logs and portions of felled trees whereas fuelwood being marketed to households tend to be split many times and packaged in affordable bundles. Finally, the commercial sector appears to make wider use of commercially-traded wood wastes and non-wood biomass including coconut shells and husks, coconut fronds, coconut lumber off-cuts, bamboo, sawdust, wood shavings and various other forms of scrap wood.

In order to accurately study the commercial sector we were forced to employ a range of sampling and survey techniques (see Remedio, 1993 for more details). First, budget and time considerations would not allow us to investigate all types of business establishments and institutions. Therefore, it was decided to narrow the range of business/institution "types" for study to those that we already knew or suspected were using woodfuels (i.e. bakeries, restaurants and other food-service establishments, rattan furniture making, fashion accessory and handicraft manufacturers, schools, hospitals, prisons, etc.). Second, a significant portion of economic activity in a city like Cebu takes place in what we've termed the "informal" or "unlisted" sector, which essentially operates beyond the purview of the government. Therefore, conducting any survey of business establishments based solely on lists provided by the government would tend to leave out much activity, especially since the "unlisted" businesses are those more likely to be utilizing woodfuels. As a result we conducted both random surveys of listed businesses as well as cluster sampling techniques to survey unlisted businesses. Third, larger businesses were often difficult to approach for face-to-face interviews and so in a number of cases interviewing was done via telephone. Although our investigation into commercial woodfuel use cannot be said to be as truly "random" and representative of the sector as that of the household survey, we do believe that we've accounted for and surveyed at least some members of nearly all types of woodfuel-using businesses and institutions in Cebu. Table 4 gives a breakdown of the fuel-usage patterns of a number of business-types surveyed. Note that the larger industries and institutions are not included in table 4 since these tend to utilize a whole range of fuels for specific end-uses. Instead, these industries and institutions are covered in table 5, broken down on the basis of whether or not they use woodfuels and if so, for what purpose. The discussion below is divided into major user groups.

Bakeries: Approximately 17% of the registered bakeries in Cebu City were selected at random and interviewed. In addition, four bakeries in Mandaue City and four in Lapu-Lapu City were also interviewed, as were eleven bakeries purposively selected on the basis of information provided to us by woodfuel traders. Table 4 shows only the results for the randomly selected bakeries in Cebu City, indicating that LPG is the fuel of choice for two-thirds of the city's bakeries, while fuelwood is the main fuel for 18.6%. Charcoal is also fairly important, and there are a number of bakeries using a combination of fuels, usually either a fuelwood/LPG or charcoal/LPG combination with the woodfuels being used for cooking larger batches of bread while LPG is reserved for smaller batches, cakes, pastries and other special baking needs.

It's interesting to look at the differences in the types of bakeries making use of different fuels. Most notable was the fact that for those bakeries utilizing mainly LPG the mean number of years in business is less than six, while for those using fuelwood the figure is 17. A good number of fuel-wood-using bakeries are located in the old commercial district of the city and were built around huge wood-fired pogons (ovens). These bakeries continue to use fuelwood for a number of reasons. First, many of them find this fuel economical, and an initial analysis would suggest that this could very well be the case since nearly all of them are getting fuelwood delivered directly from the province at about half the per-unit price paid by household consumers. Second, bakers accustomed to using fuelwood prefer to continue with the use of this fuel, many even claiming it holds advantages over modern fuels in terms of high heat and a better tasting product. Lastly, in order for a bakery to switch fuels a huge investment would be required in installing new ovens. As a result, bakery owners are satisfied to leave things as they are as long as they can be guaranteed a steady supply of fuelwood. Apparently, however, very few new bakeries will start by using fuelwood, preferring to make use of the cleaner and less bulky LPG.

Table 4: Primary Fuel for Sample of Selected Business Types

Business Type	Fuelwood		LPG		Kerosene		Charcoal		Multiple Fuels		Others		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Bakeries	11	18.6	39	66.1	0	0.0	4	6.8	4	6.8	1	1.7	59	100.0
Listed Restaurants & Eateries	6	9.4	39	60.9	6	9.4	2	3.1	10	15.6	1	1.6	64	100.0
Unlisted Restaurants & Eateries	19	33.3	2	3.5	11	19.3	1	1.8	24	42.1	0	0.0	57	100.0
Lechon/Barbecue	0	0.0	0	0.0	0	0.0	172	100.0	0	0.0	0	0.0	172	100.0
Poso Making	17	89.5	0	0.0	2	10.5	0	0.0	0	0.0	0	0.0	19	100.0
Asst'd Food Processors	6	42.9	6	42.9	0	0.0	1	7.1	1	7.1	0	0.0	14	100.0

Table 5: Woodfuel Use Patterns of Selected Industries and Institutions

Type of Establishment	Number Surveyed	Woodfuel-Using		End-Uses
		Yes	No	
Noodle and Bijon Making	7	6	1	Boiler fuel
Rattan Furniture Mfg.	12	9	3	Boiler fuel for rattan pole bending
Feeds/Seaweed Processing	6	3	3	Boiler fuel/dryer fuel
Fashing Accessories Mfg.	3	3	0	Boiler fuel for bleaching and drying
Dried Mangoes/Fruits	4	0	4	Dryer fuel
Schools	39	22	17	Cooking fuel
Hospitals	15	4	11	Cooking fuel
Prisons	2	2	0	Cooking fuel
Mosquito Coil Mfg.	1	1	0	Dryer fuel

Overall, the bakeries in Cebu City are estimated to consume around 10 metric tons of fuelwood and 1.5 metric tons of charcoal each day. These figures about 7% of the consumption estimates for the household sector.

Restaurants/Eateries: It is clear from table 4 that the fuel use patterns of the listed eating establishments differ greatly from those not listed with the city government. The former, like the bakeries, rely to a much greater extent on LPG than on any other fuel. The latter, however, make use mainly of fuelwood, and kerosene. Extrapolating from the data collected from the survey of listed eateries it appears that their consumption of fuelwood and charcoal is only two and one metric ton a day, respectively, which pales in comparison to household consumption.

When the unlisted eateries are included, however, this changes dramatically. An actual estimate of woodfuel consumption for the unlisted eateries would depend on the number of such eateries we assume exists. Since we have no reliable figure for this we've chosen instead to adopt some plausible figures based on results of an investigation into "street food" in Iloilo City, also in the Philippines (Tinker and Cohen, 1985). There they found that for every 50 people there is one street food vendor. Considering only the 540,000 residents of urban Cebu City this would lead to around 11,000 street food vendors. From this we can subtract 3500 barbecue vendors who will be discussed below, leaving 7500. Of these, let us assume that a minimum of 20% are "eateries" as we define them here, as opposed to snack vendors and other forms of food processors. This results in an estimate of 1500 unlisted eateries in urban Cebu City. Using this figure and extrapolating from our data we estimate that the informal street food sector alone consumes around 16 metric tons of fuelwood and one ton of charcoal a day.

It's interesting to look closer at the composition of woodfuel consumption by the unlisted street food industry. Whereas only about 20% of the listed eateries woodfuel consumption and 22% of the household sectors woodfuel consumption is in the form of palwa, 60.6% of the unlisted eateries woodfuel needs are met by this biofuel. Since palwa is generally some 20-30% cheaper on a per unit basis than regular fuelwood it appears that street food vendors are more cost-conscious. In general, those using palwa do not consider this an "inferior" fuel in any way. They find that palwa burns fast giving off plenty of heat and that it's readily available, the fact that it is less expensive is an added incentive in its use. In addition to palwa and regular fuelwood, the street food sector also makes varying use of sawdust, wood shavings, scrapwood, coconut shells/husks and bamboo. As with palwa, all of these are generally cheaper than regular fuelwood, but their ultimate use often depends more upon the preference of the user and their availability.

As with households, unlisted street food vendors often make use of more than one fuel simultaneously. Over 40% of these could be classified as multiple fuel users with the most common combination being some form of fuelwood and kerosene. Often, multiple fuel use is a result of simply having too many pots to cook on one stove, but more frequently it results from specific end-uses. For example, many food vendors do the bulk of their "heavy" cooking (large pots of viands or rice) or "long" cooking (stews, beans) with fuelwood, reserving a kerosene stove for the re-heating of these foods and for fast frying or other quick cooking needs.

As was discussed in section 3.1, the existence of such a significant number of food vendors should be seen as a positive development with regards to efficiencies of woodfuel consumption. The fact that a number of studies point to these establishments as a source of inexpensive as well as relatively nutritious meals for some of the most disadvantaged sectors of urban society is also encouraging. It appears that as a result of their specific cooking needs, involving a number of different dishes being cooked in large containers for fairly long periods, the informal sector street food vendors will continue to make extensive use of woodfuels in the future.

Barbecue/Lechon: Judging from the number and variety of barbecue stalls in the city, one easily gets the impression that Cebuanos have a voracious appetite for grilled foods. Since restaurants serving barbecued foods would have been included in the above discussion this section deals with two distinct types of establishments. The first are those preparing and selling lechon, or roasted pig. The second is the nearly ubiquitous barbecue stand which can be found on street corners, sidewalks, piers, parks, outside hospitals, schools, bus stations, usually selling their wares (sticks of roasted pork, chicken, chicken entrails, dried squid, sausage and fish, among others) in the evening hours to students, bus and boat passengers, construction workers, beer-drinkers and regular household consumers.

According to city records there are 15 lechon dealers in the city, however, this excludes a large number of such businesses that only prepare on an "order" basis and/or on Sundays when this specialty is vended outside of churches, markets or just within a neighborhood. As for the small barbecue stalls no official records exist as to their number. In order to arrive at a first approximation we convened all of our field workers in the office and did a district-by-district mental estimate of the number of such establishments arriving at a figure of from 3000-4000 for Cebu City alone. Interestingly enough, we recently came across a study prepared by a local NGO on the feasibility of constructing a coal-briquetting plant in Cebu. A part of this study involved an estimate of the size of the market for wood charcoal, including barbecue vendors. This NGO simply did an ocular tally of barbecue stands from a moving car which should serve as a good minimum estimate and they arrived at a figure of 3200.

Therefore, using a bottom-line figure of 25 lechon dealers and 3500 barbecue stalls, it appears that the preparation of lechon consumes around 2000 sacks of charcoal a month, while barbecue stalls consume some 23,400 sacks a month. This translates into an average overall consumption of around 12.5 metric tons daily, or around 60% of the level of consumption of the household sector.

Poso/Chicharon Makers: Besides the regular eateries, there are a large number of businesses preparing a range of food products including poso (rice cooked in coconut leaves), chicharon (fried pork rind), puto (steamed rice cakes), bibingka (baked rice cakes) and others. Among these, probably the most significant consumers of woodfuels are poso and chicharon makers. According to city records there are only six poso makers. However, we identified and interviewed another 13, and estimate that there are perhaps between 70-120 of such businesses in the city. The number of chicharon makers are likewise difficult to quantify, the bulk of them being unlisted, but we estimate that there are approximately 50 such establishments. The other types of food-related businesses are even harder to quantify since they operate at an even lower profile than poso or chicharon makers. However, most of these businesses are extremely small-scale and although fairly common in many neighborhoods their overall consumption is probably much less than that of other businesses discussed above.

The fuel of choice for poso makers is palwa, with 15 of the 19 interviewed making use of this fuel alone or in combination with regular fuelwood, coconut lumber off-cuts, or bamboo logs. Once again, cost appears to be a key factor. Woodfuels in general are more appropriate for the cooking of poso since this is often done in large 55-gallon drums placed on metal or stone stands, clearly too heavy for most available kerosene or LPG stoves. Since the poso makers are concerned with getting the water in the barrel as hot as possible in the quickest way possible they find palwa a suitable fuel. Likewise, bamboo is known to burn fast and give off tremendous heat but it usually has to be used in combination with coco-lumber off-cuts or regular fuelwood since it turns to ashes too fast.

Chicharon makers are more likely to utilize regular fuelwood, although often in combination with palwa, since the object is to maintain a steady heat and not burn the product. Overall, assuming a low figure of 70 poso makers and 30 chicharon makers, it appears that these two users alone consume around 210 metric tons of fuelwood a month, or around 7 metric tons a day, nearly as much as that being consumed by bakeries. Unlike bakeries, however, which use almost exclusively regular fuelwood, around 43% of fuelwood consumption by poso and chicharon makers is in the form of palwa with another 15% in the form of bamboo logs and 10% in the form of coconut lumber off-cuts.

Due to the methods used in cooking foods like poso and chicharon whereby large barrels, kettles or deep pans are utilized, it is unlikely that any significant switch will take place in the types of fuels used in cooking these foods. Once again, the makers of these products usually do not view palwa, bamboo or coconut slabs as inferior fuels. Instead, the ultimate consideration is price, availability and the type of cooking being done.

Industrial Users: Although the largest number of woodfuel users in the commercial sector are small-scale establishments, there are also a number of larger manufacturers utilizing woodfuels as a boiler fuel and/or for some form of drying. In the conduct of our research we identified and gathered data on six such types of manufacturers, although it is possible that there could be more. These include noodle and bijon makers, rattan furniture manufacturers, producers of feeds for poultry and aquaculture as well as sea-based products such as carageenan from seaweed, fashion accessory/costume jewelry manufacturers, producers of dried fruits, and producers of mosquito coil insect repellents. Collecting data on energy use from many of these businesses was especially difficult for a number of reasons including mistrust of the interviewers, difficulty finding the right person to interview and, when found, arranging a time for interview. Nonetheless, we've been able to gather a reasonable amount of data on fuel-use patterns for a number of firms.

Of the seven noodle and bijon makers interviewed, six make use of fuelwood. Out of these six only two make use of regular firewood, with the rest using alone or in combination lumber yard off-cuts, wood chips, shavings, sawdust, construction scrap lumber and coconut shells and husks.

Nine of the twelve rattan manufacturers interviewed also make use of some types of fuelwood, although once again the most common practice is to use scrap either generated from within the plants or purchased from the outside. However, we did encounter a number of factories purchasing regular firewood logs and/or coconut shells and husks for their boilers where steam is produced to prepare the rattan poles for bending and shaping. Given that there are as many as 100 rattan factories in the Metro Cebu area this industry is considered a significant consumer of woodfuels.

Only one producer of feeds (fish meals and poultry raisers) and two carageenan producers were identified as using fuelwood. The carageenan and chopped seaweed producers were using fuelwood for their dryers but both are now in the process of phasing out the use of these fuels. One of them is doing so because of problems with supply that they feel is a result of stricter enforcement of forestry laws. The other is doing so because of quality control problems and because of criticism from European and Japanese buyers that they are "destroying the environment" by using such large quantities of fuelwood. Ironically, we later encountered and interviewed a number of suppliers to these firms and discovered that the bulk of the firewood being delivered was in the form of fast-growing species grown on agricultural lands, coconut lumber wastes, fallen branches of and typhoon-damaged fruit trees.

Another big export industry in Cebu is the manufacture of fashion accessories and costume jewelry. These industries use fuelwood for "bleaching and drying" of materials to be crafted, although as of this writing we've been unable to get inside any of these firms to witness the process first hand. As with many of the above industries these firms also make extensive use of scrap and non-wood biomass because of cost savings.

Of the 15 or so dried fruit producers in Cebu we've only been able to interview four, none of whom report any usage of fuelwood. However, there is at least one producer who refused to give us any information but who, according to a former supplier, is apparently using a significant amount of fuelwood for drying purposes. This industry will be looked into further.

The largest producer of mosquito coils in Metro Cebu, and one of the largest companies in the city, is alone reported to use some three to four truckloads of fuelwood a day (approximately 6 tons) in the production process. Once again, we've so far been unable to conduct a direct interview but this information was supplied to us by a number of the firms suppliers as well as by a top official of a sister firm who is currently attempting to arrange an interview and plant visit.

Overall, our data on industrial consumption of woodfuels is less complete than that obtained for the household and small-scale commercial sectors. However, we have identified the major user types and gotten a rough approximation of consumption levels. A key point to note is that a significant portion of consumption in this sector is in the form of scrap wood (often generated from within the firm), lumber and construction wastes, and various forms of non-wood biomass.

Institutions: The three main institutions identified as potential woodfuel- users were schools, hospitals and prisons. A fourth possible institutional user not investigated at this time are factory canteens, these being more difficult to identify and approach then the other three. However, it appears that only the larger factories have such canteens, and that the bulk of the workers at small- to medium-scale plants patronize the types of street food vendors discussed above.

Of the 22 schools identified as using fuelwood, only three use this fuel in any significant quantities. The rest make use of around 10 to 20 kg. a day for their feeding centers where lugaw (rice porridge) is prepared for morning and sometimes afternoon feedings. About half of the schools using fuelwood purchase their supplies from urban traders, the rest make use of branches collected from trees on school grounds and/or scrap wood from school renovation or other projects. In addition, some schools make use of a small amount of fuelwood on an irregular basis for home economics lessons. Overall, it appears that schools probably consume close to 1 metric ton of fuelwood daily, much of it collected from school grounds.

For a number of fairly obvious reasons, the more modern hospitals in the city proper choose not to make use of fuelwood. Of the four we've identified as using fuelwood, three are located in less-crowded suburban areas, one of them being the station hospital at an army camp. As with schools, hospitals are found to make extensive use of scrap wood, and in two cases, wood collected from on the grounds. Overall, consumption of fuelwood by hospitals is probably only around .2 to .3 metric tons a day.

To our knowledge there are only two large prisons in the Metro Cebu area, although most police stations have a small holding cell. Both of these prisons utilize approximately 100 bundles of fuelwood each day for cooking. The provincial jail makes use of regular fuelwood delivered weekly from the Municipality of Lilo-an to the north, while the national prison utilizes palwa delivered from Catmon, also to the north. Total consumption is around 6 tons of wood and 9 tons of palwa monthly.

Others: Since our investigation of commercial and institutional woodfuel consumption was confined to the urban areas of Cebu, we have not accounted for a number of other potentially significant consumers of woodfuels throughout the province. For example, we were able to interview four lime-makers on nearby Mactan Island, all using significant amounts of coconut shells/husks mixed with charcoal fines for firing their kilns. Brick and pottery-making is a big industry in Lilo-an, and to our knowledge this business makes extensive use of bamboo trunks for fuel. We've been informed by rural woodfuel traders that some poultry farms make use of charcoal for heaters. Finally, a whole range of commercial food-preparation activities take place in rural towns throughout the province, with some places famous for a specific local delicacy.

3.3 Discussion of Household/Commercial Woodfuel Use

Overall, it appears that close to 200 metric tons of fuelwood and 37 metric tons of charcoal are consumed daily in Cebu City. These estimates will have to be refined in order to account for the greater Metro Cebu area, but as of this writing they provide room for discussion.

Beginning with fuelwood, it appears that around three-fourths of total consumption goes to the household sector, although this figure drops to two- thirds if we include household-based commercial usage in the commercial sector category. Only about 60% of fuelwood consumption is actually "fuelwood" in the proper sense, with the rest coming in the form of coconut fronds, shells, husks and various forms of scrap wood and lumber by-products. Many households are able to collect some form of fuelwood for free, but it appears that over three-fourths of overall consumption still passes through urban retailers and wholesalers.

In the case of charcoal, around 60% of total consumption is going to the household sector, declining to around 50% if we once again place household- based commercial usage of charcoal in the commercial sector. Really, the only other significant users of charcoal are barbecue/lechon dealers, bakeries and eateries.

Finally, it's worth reiterating that in many ways the woodfuel market supplying the household sector is often distinct from that supplying the commercial sector. This is the case for the types of woodfuels being sold, the forms they come in, and the way in which these fuels are marketed and delivered.

4. PHASE 2: THE WOODFUEL MARKETING SYSTEM FOR METRO CEBU

The primary purpose of this phase of the study was to gain insights into how the commercial woodfuel market functions in urban Cebu, especially with regards to socioeconomic backgrounds of the traders, volumes and types of woodfuels traded, sources of supply, transport modes utilized, and pricing/costing patterns in the trade. In addition to addressing the above issues, the phase 2 survey of urban woodfuel traders also provided a wealth of information that proved helpful in designing and carrying out phases 3 and 1-B of the project. In the first case, urban traders informed us of their principal sources of supply, often providing us with names and approximate addresses of their suppliers. This proved helpful in site selection for phase 3 and in first approaching the rural traders. In the latter case, urban traders were able to give us an idea of the principal commercial sector users of woodfuels in the city, which became important when it was time to define the scope of the commercial woodfuel-user survey.

A total of 81 urban woodfuel traders were interviewed. Respondent selection was purposive in nature, with the survey team focusing on "medium- to large-scale" dealers which could often only be determined from outward appearance. Overall, the majority of urban woodfuel traders made receptive and willing respondents. However, there were some who were convinced that we were there to collect taxes, enforce forestry laws, or spy on behalf of other traders, and were therefore reluctant to provide us with answers or appeared to be deliberately misleading us.

The discussion below is broken into five broad categories, socioeconomic background of traders, sales patterns of the woodfuel trader, sources of supply, transportation patterns, and pricing/costing patterns.

Socioeconomic Background: The "typical" woodfuel trader in Cebu City is female, in her late-40s with little more than elementary-level education. However, as should be expected, person-to-person variation is great. Around one-third of the traders are men, traders are as young as 18 and as old as 78, some have no education while a few have college degrees. Therefore, rather than present simple averages this discussion will highlight the variations in circumstances encountered by traders and, if appropriate, discuss any broad commonalities that exist.

The majority of the urban woodfuel traders encountered were operating out of either a market stall, a bodega-style warehouse attached to a market, or out of a sari-sari (small retail) store. In addition some carenderias (eateries) were stockpiling wood for own use and for sale while other traders operated out of their house or simply off of the sidewalk. Rarely did a trader "own" the building or the land they were operating from. Instead, they were either squatting on public lands or renting stall space from the city. A general impression is that the majority of the traders are in a very precarious position tenure-wise, and uncertainty over future demolitions was often cited as a reason for not expanding or staying in the business.

For most of the traders, sales of woodfuels was the most important source of household income, but very rarely was it the only source. Among the portfolio of other income-generating activities engaged in were retail sales of basic household items (cooking oil, grains, soap, etc.), food vending, liquor sales, trading driftwood (for orchids), fruits and other products sourced from rural areas. Other working household members also provided income. Although very few traders could be said to have achieved even middle- income status from woodfuel sales, there are notable exceptions including a "king and queen" of charcoal who have parlayed their business savvy into peso 20,000 plus a month incomes and a number of traders who have seen children through college and who now engage in woodfuel trade more as a way to keep busy than for income-generating purposes.

Traders vary greatly as to the number of years they've been in the business but we encountered over ten who have been selling wood and charcoal for 30 to 40 years. Among the most common reasons cited for entering into this business in the first place were that they were approached by a rural supplier desperate to unload wood and willing to sell it cheap or leave it on an angkat (consignment) basis. This was often the case where traders homes or stores were strategically located and where they had enough space to store stocks. A number of urban traders were, at one time, themselves rural traders of woodfuels. Some of them moved to urban trading because it was considered less risky, or because they wanted to be closer to urban-based relatives (e.g. children studying in the city). Many of the newer traders entered the business in a follow-the-leader fashion after observing the success of a more established trading neighbor. This has resulted in a number of woodfuel trading "clusters" around the city, and although competition for customers can sometimes be keen it's interesting to note how much cooperation often takes place between traders in terms of guarding stocks, lending money and/or supplies.

Very few traders show any inclination to give up woodfuel-trading in the immediate future although many complain of uncertainties with regards to tenure status of their dwelling or stall, supply and demand of woodfuels, and increased competition in the trade. On the whole, while woodfuel traders complain often of the difficulties of their occupation (declining sales, increased competition, theft, wastage, dirt, etc.) they also acknowledge the importance of this trade as a source of past, present and, in most cases, future income.

Sales Patterns: In addition to trying to obtain from traders "average" sales volumes for a "typical" day, an attempt was made to look closer at variations in sales as a function of seasons (rainy vs. dry), regular events (holidays, school vacations), and non-regular events (typhoons, the Gulf War). Nearly all of the traders reported better sales during the rainy months and low sales during the dry. A number of reasons were given for this situation. First, the dry months include April and May, the time of year when schools let out and many students return to the province affecting both household as well as commercial (eateries) consumption of woodfuels. Second, during dry months even urban households are able to make use of dry scrap wood and fallen branches from the surroundings, but in the rainy months these are not available and cramped living spaces preclude any pre-rainy season stockpiling of such fuels. As a result, commercial sales of woodfuels pick up in the rainy months. Finally, urban traders are near unanimous in reporting increased supplies during dry months since farmers in the province are less busy with crop-related activities. Since much of this increased supply cannot be absorbed by urban traders, the rural traders resort to roving vending of their supplies, selling directly to smaller sari-sari stores and commercial users that might otherwise purchase from urban traders. The more cynical among the respondents report that sales are bad "all the time."

In addition to seasonal fluctuations traders report wide swings in day- to-day activity with sales ranging from nil on bad days to one buyer purchasing their whole stock on "jackpot" days. Typically, a jackpot sale is to a bakery which is usually supplied directly from the province but has temporarily run out of stock. Peak sales also occur around specific holidays and times of year including graduation months, All Souls/Saints Day, and the Christmas/New Year season.

A number of recent events stand out in many traders minds as either a time of terrible or wonderful sales. During the early months of the Gulf War crisis, LPG and kerosene were often in short supply tending to improve woodfuel sales. However, a number of traders also pointed out that diesel fuel was also in short supply and so woodfuel deliveries from the province also declined often leaving them with no stocks. In November 1990, Cebu was struck by a super-typhoon codenamed Ruping. In the wake of Ruping critical oil handling facilities were shut down and once again LPG and kerosene were rationed. For the woodfuel trader who had enough stocks before the storm, and was able to keep them from blowing or floating away during these storm, this was a period of peak demand. On the other hand, scrap wood and fallen trees within the city were abundant, families prioritized their spending, and major bridges linking the city with other parts of the province were washed-out and so few supplies could enter. Up to the time we conducted field work for this phase (June-July 1992), nearly two years after the typhoon struck, some traders were still speaking of a "glut" in the market due to the inflow of fuelwood and charcoal in the form of storm-damaged fruit trees.

There is a tendency for many urban traders to practice some specialization in the forms of woodfuels being sold, primarily as a result of the types of customers they sell to. For example, the largest trader in Pasil stocks significant quantities of palwa, bamboo and coconut logs since her place is near to a cluster of some 15-20 poso makers who, for cost reasons among others, prefer the use of these fuels (see section 3.2).

Traders in the Ramos, Tabo-an and Carbon market areas often supply bakeries on a supplemental basis and are therefore prone to carry stocks of larger logs, whereas those selling mainly to households (residential areas) sell bundles containing smaller pieces of wood split a number of times, well- dried with the bark removed. Traders in the lowest-income squatter settlements are usually the only ones to practice any "break of bulk" with regard to fuelwood, re-bundling 4-5 kg. bundles into bundles weighing as little as .6 kg. and sold for ₱1.00, presumably enough wood to cook a pot of rice.

With regards to charcoal, larger traders sell almost exclusively by the sack (12-20 kg.), with many of their sales going to small neighborhood sari- sari stores who then re-pack this charcoal into small plastic bags weighing from .2 to 1 kg. each. Other charcoal traders will do all of the re-packing themselves in fairly large warehouses and then sell baskets of 100 packs to smaller stores or to roving vendors who hawk the charcoal from a push cart or trisikad (bicycle with sidecar).

Generally, the traders are fairly concerned about the species composition and the quality of the woodfuels they sell, although rarely does this concern extend to being able to pick out a particular species from a pile of wood, or to refusing deliveries of less-desirable species. For fuelwood, preference is often expressed for wood that is pula (red), characteristic of a number of high-quality native species, but by far the largest volumes traded are giant ipil-ipil (*Leucaena leucocephala*) and madre de cacao (*Gliricidia sepium*). In the case of charcoal, the premium species in Cebu is tugas or molave (*Vitex parviflora*). Here, traders (and their customers) are able to distinguish whether the charcoal is made from this species or not, and sacks of charcoal made from molave often fetch a price 15-20% higher than those made from other species.

Overall, the majority of urban woodfuel traders reported that their sales have remained fairly steady over the past few years, although many complain that this has not allowed them to maintain their standard of living in the face of generalized inflation and eroding purchasing power. Very few report sales getting better while a larger number, but less than half, report things getting worse due mainly to a combination of increased competition, declining household sales due to fuel-switching and declining commercial sales due to these users being supplied directly from the province.

Sources of Supply: An extensive amount of information on sources of supply and arrangements with suppliers was collected from the urban woodfuel traders. In some cases, traders knew nearly nothing of where their supplies came from, simply saying that they came from the "mountains" or "the north" or "the south." Others, however, were not only capable of telling us which towns the fuels came from but were also able to give us names of specific barangays and the traders supplying them. This information proved helpful in site selection for phase 3, and in combination with data collected from the Department of Environment and Natural Resources (DENR) woodfuel transport permits gave us a good idea of the volumes being sourced from specific locations.

A variety of delivery schemes/arrangements between urban traders and rural suppliers exist. In some cases the supplier simply arrives and sells to the trader any amount needed, in other cases specific arrangements for a set amount are made in advance. The notion of a suki (regular customer) relation between trader and supplier is often important. Some urban traders prefer to deal with only one supplier and to receive only full truckloads. This is done in order to ensure that they are not last on the delivery route after the best bundles/sacks have been taken. In addition, if there are problems later the trader will not confuse the suppliers. This appears more important in the case of charcoal since a number of urban traders report sacks being partially filled with rocks, dirt or half-charred logs. Having a regular buyer and/or supplier also facilitates the granting of credit, with most urban traders reporting that they can avail of supplies without having to pay for 2-4 weeks. Despite the advantages of suki relations the ultimate concern of the urban trader is to maintain enough stocks, and so under certain circumstances they are willing to buy from anyone, even other urban traders.

When asked if they knew anything about how their suppliers actually obtain woodfuels and what types of land these come from, most urban traders expressed disinterest. Those that did respond nearly always reported that their supplier is simply a "middleman" and that all of the wood is being sourced from "private lands." The latter assessment appears to be a result of the urban traders awareness of forestry laws which have deregulated most cutting on titled lands but severely restricted cutting on government land.

With regards to problems obtaining supplies, changes in regular supply areas, seasonality to supply, and the existence of periodic gluts or shortages, responses were mixed. About half of all the urban traders report no problem in obtaining adequate supplies, while the other half do report problems for a number of reasons, most notably an increased strictness on the part of DENR personnel. Others claim that housing subdivisions, corporate parks, and poultry farms have eaten up large tracts of land that used to be woodfuel- supplying areas and now the supplies are coming from further away. Interestingly, only a few mention a lack of trees, or "deforestation" as a supply problem. As reported above traders generally perceive the months of February to May (dry season) as the period of peak supply, and they almost all reported a significant increase in supply starting about 1-2 months after typhoon Ruping truck the province. Apparently, for sometime after the typhoon the DENR did not enforce the need to acquire permits for transport of woodfuel and the market was flooded with the remnants of a good portion of Central Cebu's fruit trees.

Transportation Patterns: It appears that the largest percentage of woodfuels entering the city do so in six-wheeler trucks which usually hold from one to six tons of cargo depending on the condition of the truck and the route being taken. Most of these trucks hauling woodfuels are carrying only this cargo and tend to return to the province empty, there is little evidence of back- hauling.

While the six-wheeler trucks ply the longer distance routes from the northern and southern municipalities, woodfuels being sourced from the mountain barangays of Cebu City and nearer municipalities are often transported in smaller jeepneys which can hold around 1 ton. Even smaller amounts of woodfuels enter the city on the roofs of buses, on pushcarts coming from close-by mountain barangays, and on small"pumpboats" from Bohol and some of the smaller islands between Cebu and Bohol. With regards to the latter, some have taken the fact that fuelwood enters the province by boat as evidence of widespread or impending shortage. In reality, this trade hardly amounts to more than 3 tons/month and only exists due to a specific demand for a certain species of woodfuel more available on these other islands. Namely, some city bakeries have a strong preference for mangrove firewood which some fishermen cut some of the time and bring to Cebu in order to be able to purchase basic necessities to bring back to their islands.

Once in the city fuelwood and charcoal is often re-transported on a whole range of transport modes. For example, many urban traders either own or have access to a bicycle with sidecar or push cart used to deliver to larger buyers. In some cases the trader will assume responsibility for delivery, in some cases the buyer, but either way appropriate transportation can usually be hired if neither party owns some. Besides the manual forms of inter-urban transport, use is also made of jeepneys, motorcycle with sidecar and horse- drawn wagon.

Pricing/Costing Patterns: Data collected on current pricing patterns (per unit prices, price mark-ups, discounts) will be combined with estimates of costs encountered in the trade at all stages including labor, transport, permit fees, various operating costs, as well as a host of other possible costs usually ignored or assumed away (e.g. bribe money, wastage or spoilage, theft) in order to arrive at a complete accounting of woodfuel pricing from source to end-use. Such an analysis is, however, beyond the scope of this paper and not all of the data has been properly analyzed at this time. For now some general observations with regards to pricing and operating costs can be presented.

A few veteran traders were able to supply us with fairly consistent price data over as much as a 30-year period. This data showed that woodfuel prices have been increasing steadily over the years and have taken sharp fluctuations in response to certain events such as oil crises or natural disasters.

Traders typically employ a simple mark-up scheme whereby ₱0.50 to ₱2.00 is added to their purchase price. The actual selling price often depends on the volume being purchased and the type of customer making the purchase. Small discounts are occasionally offered to bulk buyers or regular customers. On the other hand, many traders will intentionally quote a higher than usual price to customers they perceive to be "rich", as might be the case if an upper-income family purchases a sack of charcoal for roasting a pig.

As mentioned above, few traders of fuelwood practice any break of bulk with the exception of some in extremely low-income areas. Fuelwood bundles destined for sale to households arrive in the city ready for final sale, with the wood well-split, sized, dried, and the bark usually removed. In the case of charcoal, extensive break of bulk or repacking does takes place. Usually, however, it is not the larger traders that do the repacking. Instead, they sell sacks to smaller neighborhood stores who re-pack 15 kg. sacks into .2 - 1.0 kg. cellophane bags. In the few cases where large traders do re-pack, this work is often hired-out at a rate of from ₱3 to ₱5 per sack.

In general, the labor put into the urban woodfuel trade tends to come from within the household of the trader herself. The only exception to this are the larger traders that usually need to hire extra help (often on a live- in basis) and the charcoal repackers. Beyond that, the woodfuel industry provides indirect employment and income opportunities to those involved in inter-urban transport of wood and charcoal and retailing of smaller units such as roving vendors of re-packed charcoal. The final draft of this report will attempt to more precisely quantify the employment and income generated by the urban woodfuel trade.

Less than half the traders surveyed reported any "seasonal" fluctuations in the prices they pay or charge, with most simply reporting steady increases in prices over time. Some charcoal dealers did, however, mention reduced supplies and increased prices during rainy months. A number of these traders even kept their selling price constant during these times so as not to lose customers, recouping their lower margins when the price returned to more normal levels. In general, the traders don't think that fluctuations in prices of "substitute" fuels (kerosene, LPG) have any effect on the prices they pay or charge for woodfuels. Instead, they believe that woodfuel prices shadow fossil fuel prices because when prices of LPG or kerosene go up or down so do prices of diesel, the transport fuel used in moving the woodfuels.

Any accurate assessment of the competitiveness of the urban woodfuel trade should consider a number of other expenses encountered. Most of the urban traders are paying some form of rent either to the city (for market stalls) or to private owners. Those operating out of public markets have to pay a "landing fee" to the city for the unloading of woodfuels, typically about 1% of the value of the delivery. Few are registered with the city in any way, the only exception being the ones that sell woodfuels in addition to operating a retail store or eatery in which case an annual business permit has to be procured. Nearly all the traders report some theft and wastage of their stocks, although asking them to quantify the volume involved usually leads to laughter. However, the existence of such losses should be considered. Charcoal traders often complain of poor-quality sacks of this fuel filled with large amounts of dirt and fines. There is a market for fines, with blacksmiths, barbecue stalls and lime-makers making use of this by-product. However, the price is very low and hardly justifies the effort involved in returning the fines to a sack. As mentioned above, most of the labor involved is coming from within the household, but this should not preclude an accounting of opportunity costs and incidental expenses (i.e. food). Other minor costs include the purchase of cellophane bags for charcoal re-packing and twine for re-bundling of fuelwood.

In order to start in woodfuel trading respondents made use of a number of different sources of capital. As mentioned above, a number were simply approached by rural suppliers and left stocks on consignment. Profits generated from sales were then "rolled" or re-invested back into the next purchase. The largest number of traders, however, made use of their own savings to initially finance their trade. These savings usually came from sales of other commodities sourced from rural areas including fish, fruit, vegetables and grains. Other sources of start-up capital were loan-sharks (locally referred to as 5-6 money lenders), money from relatives, from retirement benefits and from sale of livestock.

Approximately 60% of the traders surveyed reported that profits from woodfuel sales provide over half of their total household income, with a number reporting this as their only source. Actual monthly income (clear profit) generated from these sales ranged from Peso 300 to over Peso 20,000 a month.

5. PHASE III: SOURCES OF WOODFUEL SUPPLY FOR METRO CEBU

This phase of the study dealt with perhaps the most complex aspect of any commercial woodfuel system, that of supply. Knowing what types of lands woodfuels are sourced from, how trees are grown and harvested, and how rural people view the potential urban woodfuel market are all critical to designing a policy framework to ensure the sustainability of this sector. Given the complexity and scope of the study area (Cebu Province) we can only claim to have scratched the surface with regards to understanding woodfuel supply. However, during our visits to eight rural areas of Cebu (covering approximately 25 barangays) we were able to observe a number of favorable developments with regards to woodfuel supply. Whether these cases are the rule or the exception is difficult to determine, and whether the positive developments can be maintained and replicated remains to be seen. But the fact alone that some rural residents have reacted in a positive fashion to urban woodfuel demand is an encouraging sign.

The primary method of collecting data for this phase of the study was semi-structured interviews with residents of woodfuel-producing barangays. Data obtained from these interviews is being supplemented with information from in-the-field ocular assessments of resource use patterns, DENR records of fuelwood transport permits, analysis of land-use and topographic maps of study sites, government/NGO/academic literature, and discussions with local influential, NGO and government officials working in or familiar with the study site.

The discussion below is broken into five broad areas relating to different aspects of the woodfuel supply system. These include land types, tree species, cutting/harvesting practices, marketing/transport arrangements, and "others" such as issues of land speculation, agrarian reform, government/NGO reforestation efforts and alternate land uses.

Land Types/Land Use: The Department of Environment and Natural Resources (DENR) Administrative Order No. 26 (February 22, 1990) amending DENR AO No. 86, Series of 1988, states: "no permit is required in the cutting of planted trees within titled lands or tax-declared alienable and disposable lands[5] with corresponding application for patent or acquired through court proceedings, except those belonging to premium species listed under DENR AO No. 78, provided, that a certification of the CENRO (Community Environment and Natural Resources Officer) concerned to the effect that the forest products came from a titled land or tax-declared alienable and disposable land is issued accompanying the shipment" (emphasis added).

This simple "deregulation" of the cutting of planted trees on private lands was a big step over previous regulations and probably has done much in the way of achieving the objective of "promoting the planting of trees by owners of private lands." However, actual knowledge of this policy change is not always present in rural areas, many landowners are still not interested in planting trees, many alienable and disposable (A&D) lands have no clear owner, and much of the upland population of Cebu and the Philippines actually live on "timberland" not A&D lands which essentially excludes then from availing of this tree-cutting deregulation.

In Cebu, as in many other parts of the country, the A & D vs. timberland classification implies little in terms of actual land-use. There are A & D areas covered with trees and timberland areas covered with farms. In fact, given current laws, it makes more sense to see tree-planting on A & D lands since only there are the owners legally entitled to harvest. The DENR does have a number of programs to improve land-use practices within timberland areas. These center around accepting the presence of upland cultivators in these areas and providing them with stewardship contracts to encourage them to check resource denudation on their plots. However, implementation of such programs is slow and they are running into some unexpected obstacles such as absentee claimants and cultivator reluctance to sever ties with a landlord even if the DENR insists that the landlord has no legal basis for his claim.

Technically speaking, all of the woodfuels being traded in urban Cebu should originate from private or titled A & D lands. In reality, we know this not to be the case. To begin with, there is outright "smuggling" of fuelwood and charcoal originating from both timberland and A & D areas. Such smuggling involves the transport of woodfuels without any certification and takes place because the trader could not, or did not, want to bother obtaining the required papers. If the woodfuels originated from timberland areas, or if they originated from A & D land and consisted of "naturally-growing" as opposed to planted" trees, then certification could not be obtained[6]. The DENR, to our knowledge, only maintains one permanent checkpoint in the province, but they do field roving checkpoints at strategic entry points to the metropolitan area. If caught conveying woodfuels without a permit the DENR has the right to confiscate both the cargo and the conveyance and later sell these by bidding. This policy appears to act as a strong enough deterrent to large scale

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[5] The division of lands in the Philippines into alienable and disposable or timberland is a source of much confusion. Some believe that all lands above 18% slope are timberland while those below are A & D. In reality, however, many lands classified A & D are over 18% in slope such as in the case with mangrove forests. The only real distinction that can be drawn is that only lands classified as A & D can be privately titled while timberland areas are reserved for public ownership in perpetuity.

[6] With the exception of occasional "bans", land-owners are also allowed to cut naturally-growing species on their lands if they first apply for a cutting permot, not be confused with a transport permot of certificate of origin for planted species. In February 1992, all cutting of naturally-growing species on private lands was banned. This ban was later lifted for trees less than 15 cm. in diameter in order to exempt trees usually used for wood for charcoal as opposed to timber species.

outright smuggling and our field work in phases 2 and 3 suggest that few traders are willing to take such risks.

However, a larger problem exists with regards to the thoroughness and effectiveness of the certification process and this results in what we might call "legal smuggling". As mentioned above, in order to transport trees from A & D lands a "certificate of origin" is needed in order to ensure that these trees really did originate from A & D lands. In applying for such a certificate the land-owner, or more commonly the woodfuel trader representing the land-owner, presents the necessary documents to show title to the land. This should be followed by a visit to the land by someone from DENR during which time a listing of the species to be cut and the approximate volume to be cut would be made. In fact, such visits rarely take place and certification is granted on the basis of information provided by the applicant. It's possible that the lands referred to in the certificate have absolutely not trees on them but a permit was still granted which could "cover" for trees cut from timberland areas instead.

In order to avoid problems later at a checkpoint (since the timberland species are often different from those listed in the certificate) some bundles of fuelwood consisting of planted species are placed on top of the bundles of timberland species to give the guard at the checkpoint the impression that the whole shipment is planted species. This could be considered "legal smuggling" since the trader does in fact have a permit, but the permit is not intended for the woodfuel actually being shipped.

Two other forms of cheating with regards to permits involve the recycling of certifications and under-reporting of volumes shipped. In the first instance, since certifications to transport are granted for a 4-7 day period, and since not all shipments actually encounter checkpoints, it's possible for a trader to go back and continually bring more loads in to the city before the certification expires. However, we have only met a handful of traders with enough finances and access to supplies to even make this possible, and such recycling of permits is usually only done to save the trader the hassle and cost of securing a new certificate, not to cover for any type of smuggling of timberland species. In the second instance, more fuelwood or charcoal is shipped that reported in the certificate.

The important issue is to determine the extent to which smuggling and cheating actually takes place and what can, if anything, be done about it. Arriving at a highly accurate figure for volumes shipped from timberland or A & D areas, or shipped legally or illegally, is difficult. However, all of our field experience suggests to us that probably 80-90% of all the woodfuels entering the city do, in fact, originate from A & D lands and consist mainly of various planted species. Not all of these shipments are accompanied by certificates and there does appear to be a fair amount of recycling of certificates and under-reporting of volumes shipped. The important point to stress is that the wood is originating from A & D lands and is mainly in the form of planted species. The various forms of cheating taking place within this context is more a result of deficiencies in the certification process and not in the woodfuel supply system itself.

Trees eventually intended for woodfuel use are grown in a variety of ways and for a number of purposes. One arrangement is to propagate fast-growing species as a form of semi-permanent fallow. In barangay Pulangbato, only 15 km. from downtown Cebu and within city limits, whole mountainsides are covered with madre cacao *(Gliricidia sepium)*, giant and native ipil-ipil *(Leucaena leucocephala and Leucaena glauca)*. The hills are considered too steep to farm on any regular basis, although corn is regularly grown around the stumps of newly-coppiced trees for a single planting season. One charcoal maker we spoke with reported that he, his father, and his grandfather had been using the same pit-kiln in the same location for over 60 years, suggesting permanency and sustainability in the system.

In the municipality of Compostela, around 25 km. to the north of the city, we found a number of land-owners operating what could be considered dedicated tree plantations. The largest, covering 6 hectares, began in the late 70s when the land-owner took the lands out of corn cultivation and began experimenting with fast growing tree species, cacao and various fruit trees. At this time, most of the land is simply in *Leucaena leucocephala*, with the straighter trees being left to grow for five years at which time they are cut for mine poles (with the crown and branches used for fuelwood). Other trees are harvested every two years for fuelwood and occasionally for charcoaling.

Far more common than large-scale tree fallows or plantations are scattered plots of trees planted as hedgerows, live fencing, property boundary markers or simply for additional income purposes. To the untrained eye much of this planting appears unsystematic, but in reality it often involved careful considerations of benefits to be derived and possible alternative land uses. In the above cases, planting of fuelwood species is only marginally done at the expense of other crops, and in addition to fuelwood these threes also provide fodder and enhance soil fertility.

Finally, fairly large areas of A & D and timberland in Cebu Province are still covered with what we have labeled "native" shrub forests, consisting of such species as molave *(Vitex parviflora)*, kamanchilis *(Pithecolobium dulce)*, bayabas *(Psidium guajava)*, binonga *(Macaranga bicolor)*, bagalnga *(Melia dubia)*, anan *(Buchanania arborescens)*, pagulingan *(Cratoxylon blancoi)*, and scores of other species common to thickets and secondary forests in the Philippines. According to old-time residents of fuelwood producng areas these species used to be far more abundant, and they are noticeably less common the closer one gets to the city. *Vitex parviflora* and *Cratoxylon blancoi* were, for example, considered excellent charcoaling species, while *Pithecolobium dulce* and *Buchanania arborescens* are preferred as regular fuelwood. Cutting for fuelwood and charcoaling is one, but not the only, reason cited for the decline in area of native shrub forests. Land clearance for agriculture, housing or other development, cutting for lumber, woodcraft and for mine poles are all regularly mentioned as well. Although the species making up the shrub forests od regenerate, they do so slowly. As a result , fuelwood cutters and charcoal makers with some control over the area they harvest prefer to propagate fast-growing exotic varieties. It appears to us that this change in species has been more widespread in woodfuel producing areas closer to the city suggesting that the native forests in these areas were probably overexploited for some time. A discussion of the possible drawback of widespread propagation of a few exotic species at the expense of probably better-suited native species is beyond the copy of this paper. However, it is possible that increased planting of exotic species on private lands closer to the city could serve to take some of the pressure off the remaining shrub forests in more distant municipalities.

Woodfuel Species. A number of approaches have been used to try and determine the species breakdown for the commercial woodfuel markets of Cebu. First, during phase 2, urban traders were asked to try and break down their sales volume on the basis of species. Although this question often met with blank stares, some dealers were quite astute at recognizing species, even if this was already in the form of charcoal. Second, during phase 3 our own observations and discussions with fuelwood-cutters, charcoal-makers and rural traders formed the basis of our understanding of species composition. Finally, certificates of origin to transport woodfuels granted by the DENR were scanned for a one-year period and all information was recorded including volume shipped, species, and destination. As mentioned above, this certification system has a number of flaws and therefore, by itself, should not be considered totally accurate. However, with regards to species the permits did show a fairly close correspondence with knowledge actually gained in the field.

Table 6 summarizes our estimates with regards to species breakdown of fuelwood and charcoal. Three species, *Gliricidia sepium*, *Leucaena leucocephala* and *glauca*, accounted for around 57 and 70% of all the fuelwood and charcoal (respectively) traded. Five varieties of fruit trees, notably mango, star apple, guava, jackfruit and tamarind accounted for 18 and 13% of fuelwood and charcoal, respectively.

Table 6: Species Breakdown of Commercially Traded Woodfuels in Cebu City, 1991-1992

Local/Common Name	Scientific Name	Percentage of Total	
		Fuelwood	Charcoal
Giant ipil-ipil	*Leucaena leucocephala*	32.6	29.3
Madre cacao	*Gliricidia sepium*	17.1	27.9
Kabahero/Native ipil-ipil	*Leucaena galuca*	7.0	12.0
Manga/Mango	*Mangifera indica*	7.4	5.1
Caimito/Starapple	*Chrysophyllum cainito*	4.7	4.1
Anan	*Buchanania arborescens*	4.1	neg.
Bayabas/Guava	*Psidium guajava*	2.2	0.9
Tugas/Molave	*Vitex parviflora*	neg.	6.3
Lomboy	*Eugenia cumini*	2.2	0.3
Nangka/Jackfruit	*Artocarpus integra*	2.1	1.5
Mahogany	*Swietenia mahogoni*	2.0	1.5
Sambag/Tamarind	*Tamarindus indica*	1.9	1.0
Kamanchillis	*Pithecolobium dulce*	1.7	0.3
Robles	*Cassia siamea*	1.3	1.7
Gmelina/Yemane	*Gmelina arborea*	1.0	0.9
Bagalnga	*Melia dubia*	0.9	neg.
Santol	*Sandoricum koetjape*	0.8	0.4
Manga-manga or Malatamban	*Cyclostemon bordenii*	0.8	0.4
Avocado	*Perseas americana*	0.6	0.9
Dita	*Alstonia scholaris*	0.5	neg.
Agoho	*Casuarina rumphiana*	0.3	neg.
Cha	*Ehretia microphylla*	neg.	0.5
Other fruit species		3.2	1.1
Other secondary forest/shrub species		5.6	3.3
Total		100.0%	100.0%

Giant/native ipil-ipil and madre cacao are all excellent coppicers and are all leguminous. They grow well in most areas of the province, even on severely eroded hillsides where they are often planted as a last resort after corn cultivation becomes futile. The native ipil-ipil and madre cacao are denser than gain ipil-ipil and are preferred over the latter for charcoaling. Although many farmers reported they would not use these species as their only source of fodder, these trees do provide good supplemental forage. Typically, these trees are coppiced for woodfuel on a one and one-half to two year basis, with gain ipil-ipil also being propagated for mine poles.

The hillylands of central Cebu hold large numbers of fruit trees, and Cebu is famous throughout the country for its mangoes, fresh and dried. As long as these fruit trees are still productive they would never be cut for woodfuels. However, since the hillylands have apparently been widely settled for over a century, there are always old trees too be cut. In addition, fallen branches and trees felled by storms or for land clearance also find their way either into woodfuel markets, as raw material for packing create manufacturing, or for woodcrafting.

Three species popular in government, NGO and private reforestation efforts that are beginning to show up in woodfuel markets are mahogany, gmelina and robles. Mahogany and gmelina are nearly always planted for higher value end uses such as lumber or mine poles, but the crowns, branches, and even roots of these trees end up ind woodfuel markets, often in the form of charcoal. *Cassia siamea* (robles) is being encouraged in some northern municipalities since it is found to grow faster and coppice better than giant ipil-ipil in those locations. Farmers report that this tree is good in places where wandering livestock are a problem since these tend to avoid robles because the leaves are halang (spicy).

Older, more knowledgeable urban traders, as well as elderly residents of woodfuel producing barangays, are one in reporting that even as little as 20 years ago much of the charcoal being traded in the city was made from molave, and that large stands of this species could still be found as little as 10 km from downtown. Molave charcoal is still traded, and it fetches a higher price than other charcoal, but this species is becoming harder and harder to find. Although cutting for charcoal making could have been a major cause of this species decline, a number of respondents point out that these trees were also widely cut for home-building and for sale to woodcraft factories and coal mining companies for mine props.

Cutting Practices. As mentioned above, the most common woodfuel species are usually coppiced around every two years. Occasionally, the new shoots of a coppiced tree are cut back to allow a single planting of corn between the stumps. A simple bolo-type machete (sundang) is used in cutting the trees as well as for sizing, splitting and removing the bark. Depending on the conditions (slope, shade) at the point where the trees are cut, the sizing and splitting can be done there or the poles can be bundled and carried to a more suitable place, preferably close to a roadside collection point.

If the wood is intended for sale to commercial users such as bakeries than splitting and removal of bark from already-sized pieces is usually unnecessary. The resulting bundle, sometimes referred to as ukay-ukay, generally fetches a much lower price per unit than the raja bundle which is well-split, well-dried, with all bark removed, but many fuelwood cutters prefer preparing ukay-ukay since it requires much less work. In making charcoal, all portions of the tree can be utilized. Except for in the municipality of Sogod, charcoal-makers in Cebu utilize pit kilns dug from the ground. In Sodod, they have only recently begun making charcoal using a pile techniques. Here the wood is piled above ground, covered with a mesh of coconut fronds and then dirt, and fired that way. Charcoal-makers that have tried this techniques report it to be easier and less wasteful since the process can be more clearly monitored. As a rule, kilns are usually located near to the source of wood since it's easier to transport the charcoal to roadside than the wood to make it.

Farmers growing trees on their own land will often do all of the cutting and preparations themselves. However, large land-owners or more successful farmers will usually leave wood-cutting and/or charcoal-making to others while ensuring themselves of a return. This is typically done in two distinct ways. One is the bahin (sharing) arrangement whereby the land-owner and the one doing the work agree to split the returns. The other is pakyaw (contract) arrangement where the land-owner is paid a fixed amount up front for the right to cut the trees on a certain piece of land. Pakyaw arrangements are usually facilitated by rural traders since they are more capable of putting up larger amounts of cash. The rural trader will then often employ cutters on either a sharing arrangement or on a daily basis to be paid in cash. If a sharing arrangement is used, the wood-cutter will usually get from one-half to two-thirds of the returns, depending on the site conditions and distance the wood or charcoal has to be moved for final transport. Whether to use a bahin or pakyaw arrangement depends on a number of factors. Some land-owners complain that with a pakyaw arrangement there is a tendency to cut everything and anything in order to make back as much as possible. Others, however, prefer this arrangement because it encourages the wood-cutter (who usually is the same persons or persons harvest after harvest) to keep an eye on the area and discourage poaching by others. In general, it is interesting to note that returns to all parties appear to be near equal regardless of what arrangement is used, suggesting a good understanding on the part of land-owners, traders and wood-cutters of the situation at hand.

Determining the extent to which woodfuel production contributes to rural employment and income-generation is difficult, to say the least. In some barangays only a few families are engaged in any aspect of the trade while in others it provides a crucial source of cash income to the majority of families. We are really asking two questions, how widespread is woodfuel-related employment? And where it does exist, how important is this related to other sources of income? While we cannot yet accurately answer the first, we can make some estimates with regards to the second. Looking at eleven barangyas in three municipalities and two cities (namely, Minglanilla, Balamban, Sodog, Danao City and Ceuby City) that, according to DENR certifications, produce 11.9% and 50.6% of the fuelwood and charcoal (respectively) shipped to metro Cebu. And assuming a low estimate of 100 tons of fuelwood and 30 tons of charcoal traded daily at a (low) price of Peso 0.80 and Peso 4.00 per kg., respectively, with 30% of the proceeds of this trade returning to the supplying barangay. This results in an annual cash inflow of around Peso 7.6 million to these eleven barangays. With a combined 1990 population of 3,754 households this leads to an "average" household in one of these barangays earning around Peso 2050 annually or Peso 170 monthly. When this figure is compared with the monthly cash income of a "typical" family in rural Cebu, which is probably in the Peso 100 to 1,000 range, then it is earl that woodfuel production is a significant source of income in these places.

While the above analysis may be biased in the choice of the eleven barangays, it could also be pointed out that not all families in these or any other barangay are actually involved int eh trade and so therefore average incomes from woodfuel production could still remain fairly high. But perhaps more important than the quantitative aspect of woodfuel-generated income are some of the qualitative aspects which will only be mentioned briefly here. These center around the flexibility of woodfuel production as a source of income. Flexibility in who can do it (while men nearly always do the actual tree felling, women and even children help with the hauling, sizing, splitting and de-barking), when it can be done (specific times of year when other sources of income dry up), and how it can be done (a few trees can be cut everyday on the way home from a farm plot and then split, bundled and sold at end of week for purchase of necessities).

Marketing/Transport. The decision as to where to size and split fuelwood, or to kiln charcoal, depends on a number of factors. In the case of fuelwood, if the cutting area is not too steep/inaccessible, and there is some shade nearby, then felled trees are sized, split and de-barked on the spot. Otherwise, only the smaller branches are removed and the poles are carried to a more suitable location for sizing and splitting. In the case of charcoal, kilning is usually done near the source of the wood, although a number of charcoal makers bring wood to a kiln near their residence in order to be better able to monitor the process.

If the fuelwood is bundled or charcoal kilned away from the road, then these have to be hauled to a drop-off point. Most of this hauling is done manually, often with the aid of a specially designed device such as a back-pack - type contraption for holding bundled fuelwood or a bamboo shoulder pole with sacks of charcoal or bundled fuelwood attached to each end. Only in a few cases did we encounter the use of animals for hauling, as with the use of a carabao water buffalo) "sled" for fuelwood or horses for charcoal. Most of the time it is the fuelwood-cutter or charcoal maker that is responsible for the hauling. Occasionally, however, this activity is hired cut to others on a per piece basis.

The rural traders serve as the link between cutters, land-owners and transporters. In cases where a large land-owner has an area to be cut it is typically the rural trader that settles on an arrangement for the cutting and sharing of returns. The trader will then usually be the one to go to the DeNR and present land titles and other appropriate papers in order to secure a certificate of origin. The trader then arranges with woodcutters and/or charcoal-makers, in some cases also taking part in this work him/herself. Arrangements also need to be made with some form of transport, although a number of more successful traders have been able to purchase their own vehicle.

In addition to such large-scale arrangements, traders also buy smaller quantities of fuelwood and charcoal from farmers who have access to small woodlots and/or trees on their own lands. Usually such farmers will simply go to a trader and inform them of the quantity available and then the woodfuels are left at an agreed-upon point along the road. This network of drop-off points spare the woodfuel-cutters the trouble of having to haul the fuels all the way to the trader's place. The system is well-established and to our surprise nobody every complained of having bundles get stolen or misplaced.

There are many variations on this trading system such as the existence of "stockholders" in the northern municipalities of Catmon and Sogod. These traders do not get involved in arranging with land-owners, securing permits or contacting transport. They simply buy and sell large quantities of woodfuels cutters/charcoal-makers and cash-strapped rural traders.

It became increasingly apparent to us in the course of ours tudy that there rural traders play a crucial role in the systems and that ideas of "eliminating the middleman or of developing woodfuel-cutter cooperatives would probably be ill-advised. In the first place, the traders have to undertake an incredible amount of "Leg-Work" in order to facilitate cutting of trees on other lands, securing permits and arranging for transport. Second, traders often have to guarantee enough coordination and timing to fill a truck by a certain day, otherwise permits expire, the truck may no longer be available, and urban buyers may look for there, more dependable, suppliers. Finally, traders are constantly putting their finances at risk, having to pay for supplies in advanced while giving these very same supplies away on credit to urban buyers. Add to that the occasional bribes that have to be paid to get the delivery through, the incidental expenses of feeding the truck driver and his "Helpers", and a host of other hard to identify but very real expenses and it becomes apparent that the traders at any given time have large volumes of cash extended.

The practice of rural traders paying in advance for future deliveries of fuelwood and charcoal is common, and in some cases is the only way to ensure deliveries. These advances take the form of cash, or , if the trader also operates a store, in the form of goods such as corn or rice, sugar, kerosene, medicine, soap, etc. The fact that these traders then turn around and deliver to urban buyers who in the majority of cases (see section 4.0) ask for 2 to 4 weeks of credit, indicates that involvement in this aspect of the trade requires a certain degree of entrepreneurial ability. Contrary tot he popular perception of greedy middlemen exploiting helpless farmers, many traders seemed to be telling us that they actually were uninterested in the woodfuel trade due to the hassle involved but they were essentially "recruited" by local residents to take on this responsibility since they were they only ones capable of doing so financially. Combine this with the fact that many traders have been, are, or plan on taking part in local politics, dictating the they show some degree of concern for the community, and it becomes apparent that in most cases it is the woodfuel cutters, rather than the traders, that are the more satisfied party inn the whole arrangement.

Other issues in Woodfuel Supply. In addition to relatively strength-forward issues of land-use, species preference and marketing arrangements, a whole host of other issues affecting woodfuel supply patterns were encountered. Some of the more important among them were those of land speculation/urbanization, labour markets, agrarian reform, reforestation efforts, alternative land-uses and other end-uses for planted trees.

Since around 1987, the metro Cebu area has been a rapid increase in prices of real estate and in the turnover of property. Although most of this activity has been concentrated in the relatively flat areas of coastal plain 20-30 km. to the north and south of down town, real estate speculation is now becoming more widespread in the mountainous areas to the west of the city known as the Central Cebu Hillylands (CCH). Land speculation and rapidly increasing property values are most apparent in the "foothill" barangays of Cebu City due to development of exclusive housing subdivisions, but even interior barangays are being eyed for tourism projects such as the Kang-Irag golf complex in barangay Malubog. So accustomed are the residents of the CCH barangays to land selling that while conducting field work there it was not uncommon for us to be asked if our purpose in visiting that place was to look for land to buy.

For the moment, this situation is having a mixed impact on woodfuel supply. On the hand, tenant farmers are even more uncertain of their status while small land-owning farmers are finding it hard to resist selling their plots to urban buyers (many of whom are simply agents for foreign investors). As a result, little effort is put into what might be called "sustainable" land-use or farming. On the other hand, speculation and rapid turnover of lands has created a situation where large areas are being left idle, and these areas are often then invaded by and covered with prime woodfuel-species shrubs. There are numerous advantages to the and-owner in keeping these lands covered in shrubs or trees for the meantime. These range from not having to worry about managing these lands to the possibility that as long as the lands are in trees they do not come under the ralm of current agrarian reform laws. We are not 100% certain of this latter concept, but we twice encountered situation were land-owners reported leaving large tracts of land to trees in order to prevent cultivation of a crop such as corn and the possibility of the land falling under the purview of agrarian reform. Finally, the land-owner does derive cash income from the woodfuel grown on their lands since rural traders will either pay them a lump sum for harvest or arrange for some sharing of the returns. If these proceeds are even just enough to pay for the taxes on the land then the owner is usually satisfied since the land is mainly being held for speculative purposes anyhow.

Actually development along the foothills has already wiped out prime woodfuel-producing areas. Judging from land speculation activities in some interior barangyas these areas may not be far behind. Ironically, a foreign funded development project intended to improve the sustainability of the CCH are appears to be one factor behind increased speculation in some interior barangyas. One showcase feature of this project is "farm-to-market" roads intended to increase farm gate prices and fee hillyland farmers from supposedly disadvantageous trading systems. Our observations, however anecdotal and preliminary they may be, suggest that these roads have served mainly to make large areas of hillyland real estate accessible to urban developers. Instead of farm-to-market, the roads have become market-to-farm.

Another factor that has had mixed impacts on woodfuel supply is that of labour. High out-migration of men and young adults is commonplace in nearly all rural areas of the Central Visayas. With a construction boom, export processing zones, a massive service sector, and an expanding manufacturing base producing very labour-intensive products, the urban center of Cebu Province is a magnet for job-seekers from underdeveloped rural areas. Single parent household re increasingly common in rural areas. Once again, such a development should lead to less-sustainable farming practices since many farming households would face a labour shortage. The impact on woodfuel supply, however, could actually be positive because one again there is a tendency to let lands fall idle and, under the right circumstances, these lands could convert to supporting woodfuel species.

Uncertain land tenure and labour shortages are probably two of the biggest problems facing government and NGO reforestation efforts. Oddly enough, this appears to be to the benefit of woodfuel production since such reforestation efforts often center around higher-value tree species such as mahogany, gmelina and eucalyptus, often at the expense of fuelwood species like ipi-ipil which are usually considered as being an "idle" use of land. We find it unfortunate that even in Cebu, where there is a flourishing trade in woodfuels, reforestation or tree-growing projects rarely make mention of woodfuel potential, and so species selection is biased towards types of trees that in many cases are less suitable to current social conditions of land speculation and labor shortage.

6. DISCUSSION

The common perception of most urban residents of Cebu is that the use of fuelwood and charcoal is one, if not the major, reason for deforestation and resource denudation in the province. This perception is far less common in the rural areas although, terms such as deforestation and environment have been pick-up from newspapers and radio shows and are often interspersed in conversations about woodfuel systems. Time after time we were confronted with two or three reactions to a mention of our study. These included, "how can you study firewood in Cebu when there are no forests left", "how can we stop people from cutting our forests for firewood before we run out of trees", and "if we keep using firewood Cebu will run out of water and heavy storms will cause deadly floods like what happened in Ormoc, Leyte" (where 8,000 people died in flash floods blamed by media on deforestation).

It seemed as if no amount of discussion about large areas planted to fast-growing trees coppiced on a rotating basis would make any difference, the listener would must utter another lamentation on the state of Cebu's forests. When we told rural residents of the despair of city-dwellers over the cutting of trees they usually reacted with a polite smile expressing both surprise over the need to worry and some sorrow for having caused anybody any anguish. We are convinced, then, that there is a huge gap in local understanding not only of the woodfuel system but of upland resource use and management in general. Part of the problem stems from the archipelagic nature of the Philippines. so much media and government attention is focussed on the very real problem of forest destruction in the country that it's natural for Cebuanos to begin to share these worries with regards to their own province. However, Cebu is unlike most other islands in the extent of its forest cover, and this has probably been the case for over 100 years. Rather than fret over the extent of deforestation in the mountains of Cebu, government and NGO officials here should take a closer look at what has evolved in place of forests and what can further be done to maintain the sustainability of these land-use systems.

We have found that rather than being a cause of resource degradation, much of the woodfuel systems of Cebu plays a crucial role in preventing it. If all woodfuel use in the province were to stop tomorrow the environment would probably and up being the worse for it. This is not meant to deny the very real problem of cutting prime species in remaining forest/secondary growth/native shrub forest areas. What needs to be remembered is that such cutting is done for numerous reasons and that the commercial woodfuel market is encouraging planting on private lands which might take some pressure off the few remaining forest areas. given this, and the fact that we are still in the process of analyzing much of our data, we can make the following preliminary suggestions with regards to woodfuel demand, reforestation, woodfuel regulation, and public education relating to the state of Cebu's environment.

Section 3.0 illustrated the importance of woodfuels to the household and commercial sectors of urban Cebu. It appears that the process of development in Cebu is leading to the expected pattern of fuel-switching from woodfuels to kerosene and LPG but that the overall (absolute) consumption of woodfuels is not likely to change much due to growth in population. It might also be possible that increased commoditization of scrap wood, sawdust and non-woody biomass such as coconut fuels suggest some stress in terms of rural environments meeting this demand. In light of these development, what role could demand-side policies such as improved cookstoves or price subsidies for alternative fuels (or their devices) play in improving the woodfuel situation? At this point in time we would suggest that such programs are probably unnecessary for the following reasons. first, fuelwood use in urban areas already appears to be fairly efficient, and households and commercial establishments have made positive adjustments in cooking and food purchasing patterns to improve this even further. Second, kerosene and LPG are already heavily subsidized and the policy direction of the Philippine government is going in the opposite direction with the impending deregulation of the industry and elimination of cross-subsidies. Third, we are not totally convinced that increased use of scrap and non-wood biomass is an indication of widespread woodfuel shortage. In the case of scrap, increasing transport costs for woodfuels produced in distant rural sites is obviously making scrap generated within the city an attractive alternative. Non-wood biomass, however, appears to be enjoying increased use simply because it is less expensive than fuelwood on a per unit basis since these fuels are only a by-product of other activities, such as coconut fronds from plantations. Lastly, we have observed first-hand how strong urban demand for woodfuels has reached rural areas as a positive incentive to plant trees for income-generation purposes. Therefore, with regards to the demand-side of the woodfuel market the best policy for now appears to be no policy at all. Should there be upheavals in petroleum markets or unexpected development s in terms of woodfuel supply then naturally such an assessment would have to be reconsidered.

Current government and NGO reforestation efforts in Cebu appear to be biased towards the planting of higher-valued tree species. In fact, areas covered in fuelwood-appropriate shrubs are often cleared and planted to other species since the former are rarely perceived to be of any value. Successful agroforestry programs are few and far between in Cebu perhaps because many of the systems being promoted are cash-and labour-intensive. Little attention is paid to obviously successful (though not nearly as fancy) local agroforestry systems that revolve around long cultivation of crops followed by tree fallow or a system of planting crops on a related basis between coppiced shrubs and trees.

DENR reforestation efforts being applied in Cebu were likely developed for places like Mindanao and Luzon and may not be suitable to local conditions. Given the tenure status of upland residents, the need for fairly immediate returns, the relatively poor soil and water conditions of the island, the inavailability of labour, and the long-term uncertainty over land-use in the fact of speculation, it may be more appropriate to develop far simpler reforestation and agroforestry "packages" for Cebu. This need not imply planting of fast growing species only, but rather the realization that some areas planted to these types of trees could serve as a "bridge" to more long-term development of lands. It seems unfortunate that the woodfuel market and areas planted to woodfuel species are rarely mentioned in discussions of reforestation, or if they are mentioned it is in a negative light. Knowledge of such a market, and the tree-growing done to supply that market, should form an integral part of local forestry policy. Probably the best place to start is to inquire into those areas where massive tree-planting has been done independent of any government or NGO presence. Knowledge gain there, combined with a realistic assessment of the social and natural constraints to reforestation on Cebu, could form the basis for a more meaningful set of programs.

Section 5.0 discussed the current regulations of the DENR with regards to the harvesting and transport of woodfuels and other so-called minor forest products. As was pointed out, the cutting of planted trees on titled lands has been deregulated, but in order to transport these trees certification of their origin is needed. Such a policy is a big improvement over past regulations, but it's possible that this could be improved even further.

As it now stands, this policy is not really being followed since DENR field personnel are unable to certify the true origin of most of those applying for permits. Therefore, in some cases certification is being granted and used to transport "illegally" cut trees. On the other hand, in cases where a land-owner or farmer has only a small area planted to trees, it hardly seems worthwhile for them to make a trip to one of the DENR's eight offices in the province that grant certificates, even if the certification it self costs only a token amount. In this case "legally" cut trees would be transported illegally.

In talking with rural traders a number of interesting ideas were put forward for improving the policy on woodfuel transport that would save both the government and the traders and tree-growers time and money. One would be for the DENR to "license" legitimate traders/ transporters of woodfuels with the determination of legitimacy based on prior experience and random checks on deliveries. Another, more general approach, that is probably more realistic, is to drop the idea of certifying the origin of trees and instead pay attention to species. What this would imply is granting free passage to select planted species, namely *Leucaena leucocephala*, *Gliricidia sepium*, *Leucaena glauca* and *Cassia siamea* among others. Such an approach should be considered in light of the failure of the current system to determine origin anyhow, leading to a de facto species-based enforcement mechanism.

Combining a species-based approach with a licensing system could open some interesting possibilities. First, "small" loads of wood or charcoal could be totally deregulated provided again that they consist of approved species. Larger loads could only be carried by licensed traders with the licensing being done over a 6, 12 or 24-month period. Money and time saved by the DENR in not having to certify origins of trees could be put into the establishment of permanent checkpoints at the major entry points to the city, a task made easier by the topography and road network of the island. Volumes shipped by larger traders would be recorded each delivery and at time of license renewal a fee would be charged on per cubic meter basis with this money to be used for manning of checkpoints and/or for reforestation programs.

Most of the traders we talked with would be agreeable to such a system since it would save them the hassle of having to regularly secure certification. The biggest obstacle to implementation of this or any other policy change is the highly centralized structure of all Philippine government agencies. This proposal is being made for Cebu Province only and may not be appropriate for other areas. Given the current system it is unlikely that something like this could be implemented unless the impetus came from above. We intend, however, to refine our formulation of this policy alternative, defining "large" and "small", and what species might be acceptable, and then to present these to local, regional, and perhaps even national DENR officials.

One final recommendation we would like to make relates to the way government and NGO officials are trained to view rural resource management systems. This recommendation is not specific to Cebu, and we are surely not the first nor the last to voice this concern. but the product of the educated/urban-based view of rural resource management in Cebu seems particularly disturbing. A casual scanning of government (GO)/NGO project proposals and progress reports, or conversations with GO/NGO workers regarding rural resource use, consistently leads to the use of terminology such as unsustainable, inappropriate, primitive, destructive, ignorant and poorly managed. The next logical step in this process is to declare Cebu to be on the verge of ecological collapse and in need of massive reforestation or rehabilitation. To call this the current "paradigm" in rural development thinking in Cebu is probably an understatement. Yet, our brief period of field work in 25 rural barangyas of Cebu has left us with much to be optimistic about, especially with regards to woodfuel supply which is usually touted as one of the major causes (or victims) of rural resource denudation.

7. SUMMARY OF CONCLUSIONS

Based on the proceeding text, the following conclusions can be put forward:

1. The household sector is the largest consumer of woodfuels in the urban areas of Cebu, accounting for approximately 60-70% of all consumption. Commercial users are mainly small to idem-scale food related establishments, although a number of large industrial users make use of a variety of woodfuels in their production process.

2. Woodfuels and other biomass fuels are a critical source of energy to urban Cebu, although we are not yet in a position to make direct comparison with other fuels. Close to 30% of all urban households use biomass fuels as their main cooking fuel, as do a wide range of commercial and industrial users.

3. In an absolute sense woodfuels are likely to remain important in urban Cebu for some time to come, although, their relative importance may decline.

4. Interesting adaptations in cooking (such as multiple fuel-use) and food purchasing patterns have been observed in urban households suggesting the need to go beyond simple further extrapolations in predicting future energy needs and the impact of fuel-switching on future woodfuel demand.

5. The urban retail/wholesale trading network for woodfuels appears to be a highly organized, efficient and competitive allocator of the resource. This network provides both direct and indirect employment and income opportunities to urban dwellers.

6. The woodfuel supply system for Metro Cebu is extremely varied and complex. But the general situation appears favorable and the nature of the woodfuel supply system here seems to fly in the face of many common perceptions of woodfuel-environment interactions.

7. Most commercially-traded woodfuels are sourced from private lands and are in the form of planted species. The arrangements for planting, harvesting, preparing, and transporting woodfuels are varied and complex but reflect a certain degree of sophistication on the part of those involved.

8. Woodfuel supply systems provide varying degrees of income/employment opportunities depending on the site. In some areas it serves as one of the major sources of income to the majority of families while in others it is considered mainly a "sideline" activity.

9. Current thinking in government and NGO circles in cebu regarding woodfuel seem totally out of sync with what we have observed. The anti-woodfuel bias can be seen in official reports and in the implementation of reforestation and other projects.

10. Policy changes associated with the woodfuel system in Cebu need to be based on a good understanding of factors specific to Cebu. A combination of social, historical, economic and natural factors has created a rather unique situation in Cebu that demands equally unique approaches.

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Wood Energy Data Assessment and Planning Activities in Asia

by

Conrado S. Heruela[1]

"Topical Outline of Presentation"[2]

1. DEVELOPMENT OF NATIONAL ENERGY PLANNING ACTIVITIES IN THE REGION

1.1 Emergence of Energy Planning

1.1.1 Early energy planning activities were confined to:

* electricity - dominated by the government
* oil - handled by the private sector

Strategy:
"keep increasing the levels of supply on a least cost basis to meet increases in demand"

1.1.2 Constraints to broadening energy planning activities:

* inadequate data due to lack of energy planning in the past
* data on energy demands unclear and inadequate
* supply side data also inadequate from economic, social and environmental perspective
* difficulty in analyzing and assessing data in the face of bewildering array of analytical tools and computational techniques
* insufficient capable and trained manpower

1.1.3 General features on planning activities:

* independent analysis for each sub-sector (or even projects)
* does not allow integrated analysis for considering inter-fuel substitution
* energy analyses uses aggregated data so it was difficult to assess economic impacts
* **GDP** and price indices were used to project future energy demands
* gross primary energy data was used in energy analyses rather that useful energy
* non-commercial energy or rural sector was often disregarded

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[2] The materials used for this presentation were obtained mostly from the *Integrated Energy Planning: A Manual - 3 Volumes (1985)*, a publication by the Asia Pacific Development Centre, Kuala Lumpur, Malaysia

1.1.4 Problems Encountered in Energy Planning:

* inter-sectoral conflict of objectives
* inter-sectoral sub-optimization
* lack of balanced resource development
* diffusion of conservation efforts
* no mechanisms for analyzing larger interface issues

1.1.5 Positive Impacts of Strengthening Energy Policy Making and Planning - Development of "Energy Master Plans":

* energy elevated to a higher position in the political agenda
* responsibility for the sector brought closer to centers of decision making
* establishment of high level bodies for policy and planning coordination
* strengthen infrastructure for energy decision-making
* emphasized the role of centralized agencies such as energy ministry or planning commission

1.1.6 Contributions of "Energy Master Plans" in Expanding Energy Planning Activities:

* renewable energy/non-conventional energy research and development
* energy conservation promotion
* improved cookstoves programmes
* traditional/biomass energy studies
* rural energy planning
* wood fuels consumption studies

1.1.7 Weaknesses of "Energy Master Plans":

* inadequate and questionable reliability of data base
* indiscriminate and at times inappropriate use of over-sophisticated analytical tools
* excessive reliance on external consultants with their inadequate perception of the country situations
* failure to link the process of plan formulation with the implementation measures required to achieve the realization of the plan
* contrived and generally inadequate linkages with economic plans, and
* lack of continuity in the planning process - absence of iterative dimension

1.2 Broadening Planning Approaches - "Integrated Energy Planning"

1.2.1 Three level of integrations:

* energy plan and economic plan
* different energy sub-sectors
* various components of the energy sub-sectors

1.2.2 Description of the energy plan:

* a set of agreed, feasible and consistent targets for energy policy
* not a once-for-all defined entity
* will take different forms in different economic, political, social and institutional environments
* key tool for energy policy formulation
  - an information assembly and coordination stage
  - a forum for assessing energy management tools

"Countries in the region are in the various level of adaption or use of the Integrated Energy Planning Approach. This is an important factor in determining the entry point in which a country will start to built up its capabilities for wood energy planning."

2. INITIATIVES IN WOOD ENERGY DATA ASSESSMENT AND ANALYSIS IN ENERGY PLANNING

2.1 Wood Energy in Analysis of the Traditional Energy Sector:

* two broad categories of traditional energy sources:
  - biomass energy
    - primarily wood fuels
    - agricultural residues
  - animate sources

* characterestics of biomass energy:
  - primarily used for domestic purposes (cooking/heating/lighting)
  - consumption patterns involved economic and socio-cultural factors
  - women play a significant role in supply and use of energy

"The traditional energy sector, which in some countries of the region is estimated to form up to 80% of the total energy consumed, has been the *bete noire* of energy planners..."

"Any attempt to undertake comprehensive national energy planning in developing countries should draw into the framework the patterns of rural energy supply and consumption"

"The overwhelmingly majority of work that has been carried out in the rural energy context has been directed at establishing facts and figures from an academic and/or technological viewpoint or at recapitulating micro-level project/programme formulation experiences in isolated contexts without serious attention to the problem of drawing empirical lessons for energy planning in the larger sense."

2.2 Aspects of Rural Energy Planning Relevant to Wood Energy Planning:

* Characteristics of Rural Energy Systems Applicable to Wood Energy Systems:
  - highly decentralized -final level of decentralization is the individual consumer - also the producer of energy
  - many layers of disaggregation - not all under the influence of governments

* Implications on the Planning Process:
  - further division in each level of disaggregation in both the demand and supply side into rural and non-rural
  - intermediate level of integration with rural development plans before ultimate integration with national economic plans

* Three Dimensions of Rural Energy Planning:
  - *technical* - means to determine an agreed, feasible and consistent set of target and goals for energy policy decision
  - *political* - an exercise in information dissemination, co-ordination and conflict resolution between various groups involved in policy formulation and decision making
  - *iterative* - the output is the planning process itself and the product of this process are either a set of policies, the plan or programmes

* Characterestics of a Rural Energy System in an Integrated Energy Planning Framework Applicable to Wood Energy Planning:
  - "the highly decentralized approach that distinguishes rural energy planning from planning conventional energy systems renders the process of the former considerably different"
  - "the final level of decentralization in rural energy planning is the individual consumer who is also often the producer of energy"
  - "there are many layers of disaggregation, not all of which are under the influence of the governments"
  - "conceptually, the framework of iep at the national level is sufficiently broad to include the rural energy planning componrent, however there is a need for:
  - further bifurcation in each level of disaggregation in both the demand and supply side into rural and non-rural
  - intermediate level of integration with rural development plans before ultimate integration with national economic plans
  - the framework of integrated energy planning includes all the necessary steps that need to be covered by the rural energy planning process - the differences between the two lies mainly in the visualization of the socio-economic context and a number of procedural aspects like data base for planning.

* Suggested Organizational Classification in Response to the Need to Integrate the Disaggregated levels in Rural Energy Planning :
  - a "plan" at the national/provincial level
  - a "programme" (denoting a group of projects for a cluster of villages) at the district/ sub-district level, and
  - a "project" at the village level.

3. WOOD IN ENERGY PLANNING

3.1 Planning Activities

- data base development
- analysis of energy demand
- analysis of energy supply
- balancing supply and demand
- establishing energy plan targets

* "The energy data base will usually be created by and maintained by persons who are not energy specialists as part of a wider data base dealing with non-energy matters."

* "It is necessary to relate energy consumption with levels of income, agricultural development, topography, livestock population, prices and availability of commercial sources."

* "Ensure a balanced coverage of demand-side and supply-side data - a balance which is deficient in most contemporary rural energy surveys which stress the collection of demand-side data and make questionable assumptions on the supply side"

* "The task of national energy planners is to identify the general data base needed to be maintained at the programme as well as the project levels, specifying the types of data which are collected at periodic intervals by various agencies contributing to rural development, the energy components of such data, and the non-energy related data"

* While energy planning depends on the availability and quality of data, gaps and efficiencies in the data base can be identified and assessed as a result of planning

* "It is difficult to collect data because of the decentralized nature of rural energy systems:
    - involves million of households which do not keep records of their energy production and consumption
    - most fuels do not have market and rural households collects fuels mainly for their own consumption
    - further problems with measurement of fuels and efficiencies ofend-use devices such as stoves
    - required at macro level to estimate the consumption of these sources at national/regional levels
    - need to obtain information at the village levels in order to understand the process of generation and use of these energy sources"

* "The merging of rural energy balances with overall balances covering conventional energy systems is an important step since the two types of data tend to differ in terms of consistency and reliability:
    - "necessary to exercise great caution while attempting to integrate such data into formal energy data systems like an energy balance table or res"
    - "traditional energy sources data are prone to approximations and estimations on a fairly wide scale - may lead to exaggerated forecasts of resource potential and consumption"
    - "aspects of demand side disaggregations consistent with rural/non-rural classifications require special attention."

An Approach to Energy Assessment and Planning for Sustainable Development - Status of Implementation in Asia

by

G. Best[1]

1. BACKGROUND

A central component of FAO's activities in the field of energy is that of providing technical assistance in the field of assessment and planning of energy for rural development. The main aim of this work is to promote a more systematic treatment of the rural energy problems and solutions, at least in the manner and level with which most countries face the energy problems of the industrial, transport and residential sectors. As will be discussed, rural energy problems have a higher and different kind of complexity, calling for equivalently different approaches, since classical planning methodologies and strategies used in the modern sectors cannot be applied to the dispersed and normally small and decentralized energy requirements of rural populations.

In the context of the UNDP/ESCAP Regional Energy Development Programme - REDP, FAO was responsible for the implementation of various subactivities dealing with rural energy matters. It is the scope of this paper to describe the approach used in those activities, and to discuss the experiences gained in the light of the on-going efforts of the Regional Wood Energy Development Programme in Asia to establish a closer link between the policy and planning efforts on wood energy with overall rural energy planning, and with overall energy policies at the country level. It is FAO's position that only through this closer integration can sectoral energy programmes dealing with wood or with renewable or conventional energy sources be effective. The fulfillment of the varied energy requirements of rural people and the large spectrum of local resource bases and socioeconomic situations within countries, require a "mix" of energy sources and conversion technologies.

2. INTRODUCTION

The use of energy for rural development is seen as a continuous and orderly process to meet household, transport, service and production requirements in such a way as to improve living conditions and the quality and quantity of products generated, while at the same time safeguarding the production potential of the environment.

The provision of appropriate energy services, with its direct impact on rural living standards and the environment, and its contribution towards the generation of economic activities, is a vital requisite for sustainable rural development. For the purposes of this paper, sustainable rural development is defined as that which: (i) permits the full satisfaction of the present and future needs

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of all rural inhabitants - beginning with the poorest and taking into account their broad socio-cultural differences; (ii) is environment-friendly; (iii) favours regional and national self-determination.

Energy can be used to: (i) increase work productivity; (ii) conserve natural resources through more efficient technologies; (iii) raise the quality of life by providing basic services such as potable water, electricity and food preservation; (iv) improve health by reducing household contamination and improving working conditions; (v) rehabilitate degraded natural resources through, for example, energy plantations; (vi) safeguard biodiversity; (vii) generate employment.

The concept of energy for rural development should be closely associated to that of rational energy use. Energy for rural development does not necessarily imply higher energy consumption but rather energy savings and substitute fuels. It should therefore be seen as an essential constituent of a broader framework of integrated rural development actions, bearing in mind that analysis of energy aspects is fundamental to development but not sufficient in itself, as evidenced by the rural electrification programmes which have only been partially successful.

Current integrated or comprehensive rural development programmes fail to, or barely, consider the concept of energy for development. This limits rural development possibilities to technical enhancements such as improved efficiency of agricultural machinery or labour, and higher unit yields or output value per cropped hectare. Broader objectives such as keeping the economically active population in the countryside or breaking the poverty cycle by substantially increasing available income and conserving the production potential of the environment are disregarded or very rare. On-going programmes generally fail to consider the important and special relationship of rural populations with their environment and fail to promote present investments, which would avert higher future investments, because of production base deterioration.

In view of these limitations, FAO, in consultation with a number of experts from the Asian Region developed a methodology to include "energy for development" in the energy and rural development planning process. The guiding principle was to implement the "energy for development" concept to foster sustainable rural development. The implementation of energy for rural development efforts is based on a planned-management approach that links a series of actions to upgrade and reshape on-going processes. It actively reorients or even substitutes, if necessary, prevailing trends so as to implant management models capable of opening new strategy directions, exploiting existing potentials and introducing new trends.

Such a method also needs to be rational at the organizational and decision-making levels,as it will have to produce strategies that enjoy the commitment and cooperation of the various parties involved. This methodological approach is referred to as *management-planning,* whereby planning and management are part and parcel of the same instrument. In other words, planning and management go hand in hand, are inseparable.

3. RATIONALE OF THE APPROACH PROPOSED

(material based on: FAO Environment and Energy Paper 12: A New Approach to Energy Planning for Sustainable Rural Development)

A new approach for integrated rural energy planning for the accelerated and sustainable development of rural areas within the constraints of resources and environment, was developed. The central feature of the new approach is the preparation and implementation of area-based decentralized energy plans for meeting energy needs for subsistence and development at the least cost to the economy and the environment, and linking the micro-level plans with national economic planning and development programmes, including those for the energy, agriculture and rural development sectors.

Energy scenarios in the Asian countries vary widely. However, there are certain features common to most of these countries which can be taken into account in developing an integrated approach for energy planning for the sustainable development of their rural areas. These common features include:

* Total energy, as well as per capita energy consumption, is very much lower than the energy requirements for economic development. This shows the need to augment energy production from all sources as a first priority in meeting development needs for subsistence and production.

* A major proportion of the total "commercial energy" is consumed in the urban and industrial sectors, and for transportation, with agriculture and the rural sector getting a relatively small share of the available commercial energy.

* A major proportion of the total energy consumed in many countries continues to be provided by "non-commercial" energy sources - firewood, manure draught and pack animals and agricultural wastes - which are mostly utilized in the rural areas.

* Energy is not only scarce, but it is used inefficiently both in urban and rural areas, with the result that the per unit consumption of energy is much higher than the per unit increase in national gross domestic product. Energy elasticity with respect to gross domestic product is much higher than unity in most Asian countries, as compared to less than unity in the industrialized countries.

The above features bring out the sharp disparities between the energy consumption of developing and industrialized countries, as well as between the rural and urban areas within the developing countries. These areas require urgent interventions which have to be undertaken through integrated energy planning mechanisms which specifically take into account energy requirements for sustainable agriculture and rural development.

Recognizing the critical role of energy for sustaining their economic growth, most developing countries have set up institutional mechanisms for energy sector policies and planning. However, energy sector planning in the developing countries, in its present form does not specifically meet the energy requirements for sustainable agriculture and rural development, except perhaps on a very aggregate, country-wide basis. The result is that there is often a lack of energy in the rural sector, as compared with the high energy consuming urban and industrial sectors. Agriculture, for example, which contributes to the major proportion of national income and provides employment for more than half the work force, usually gets 5 to 10% of the total commercial energy in these countries. The growth of other non-agricultural income-generating activities (such as agro and other rural industries) which have potential for providing employment to the growing labour force, and stem large scale rural/urban migration, is often seriously constrained due to the scarcity of commercial energy for rural development.

Rural economies are characterized by an intensity of energy consumption which is significantly lower when compared to that for urban areas. Moreover, energy in rural areas is used mainly for household consumption (as compared to urban areas, where the main consumers of energy are industry and transport). These household energy needs are met by "non-commercial" energy sources which are secured by private efforts at almost zero private cost. Non-commercial energy forms are outside the planning process and, even if awareness exists in conserving their resource base, the rural people often have no other alternative for their survival. Thus, economic and fiscal sanctions, and legal and administrative measures, make little impact in controlling the damage that is being caused to the environment by the continuing, widespread and often unsustainable use of these resources.

While the broad features of the rural energy consumption pattern in most countries may be similar, there is a marked variation in the specific end-uses and energy forms used from region to region, and from micro-region to micro-region, representing different agro-climatic and eco-systems within a country. This brings out the need for carrying out energy assessment and planning for sustainable agriculture and rural development, not only at the national or macro levels, but also at the decentralized and micro-levels.

3.1 Micro-Level Area-Based Planning

Such micro-level area-based integrated planning would also have to take into account socio-cultural and economic variables, their relationship to the existing and desired patters of energy consumption, environmental constraints in the micro-region, and, above all, the needs and priorities of the rural people as they see them.

Area-based micro level integrated planning for meeting rural energy needs for subsistence and development, would therefore have to include, not only renewable energy resources which may be tapped locally, but also various commercial energy sources, including electricity, petroleum products, and coal, required for productive agricultural and non-agricultural activities for the economic development of the rural region. These commercial sources of energy often have to come from outside the rural region, or even from outside the country, and their production, procurement and distribution is usually planned and regulated at the national and provincial levels.

The proposed integrated approach for rural energy planning, therefore, while being area-based, with a micro-focus, and prepared with the active involvement of the potential rural beneficiaries, needs to be closely integrated with energy supply and demand and the economic situation at the national and provincial level. Such an integrated approach will ensure the equitable distribution of energy and bring about a reduction in the existing sharp rural/urban imbalances in energy consumption, and, within a rural micro-region, between the rural rich and the rural poor.

In summary, the multi-dimensional and complex rural "other energy crisis" needs a comprehensive, integrated approach for tackling it. This integrated approach involves the preparation of micro-level area-base integrated rural energy plans, through which the most cost-effective mixture of different energy sources - commercial, non-commercial, renewable and non-renewable - for meeting the diverse energy need for subsistence and production of the different income groups in the rural area, are determined. The approach needs to take into account various technical, socio-economic and cultural constraints, including the people's needs and priorities, and coordination and integration of environmental concerns at local, regional and global levels, with existing and proposed development programmes in the micro region. The integrated area-based energy plans have to be linked with the total economy and energy sectors of the country in order to ensure the integration of energy with employment and environment as part of the total development process.

The linking of micro-planning for energy with other sectors of development at the micro-level on the one hand, and with the energy sector, environmental concerns and the economic development programmes and plans at the provincial and national level, on the other, is a complex process which involves overcoming a large number of institutional and sectoral barriers and constraints. The proposed new integrated approach, therefore, requires a new framework for planning to make it operational.

3.2 Preparation of and Energy Plan

The steps in the preparation of the area-based integrated rural energy plan are briefly discussed below:

i) Selection of the area

The unit of micro-level planning has to be decided after taking into account the broad economic and administrative set-up of the country. The size of the micro-planning unit has to be large enough to bring out the inter-relationship between development programmes and energy requirements for subsistence and production, and to justify the building up of a decentralized data base for the planning process. A village may be too small a planning unit in most countries because this unit would require a very large and desegregated data based for the whole country: a collection or cluster of an appropriate number of villages, which also coincides with a local administrative unit, such as a block or municipal county may be more suitable, especially if this micro-region also has specific ecological characteristics.

ii) Energy Surveys

Rural energy surveys provide the data from which the existing pattern of energy consumption for different end-uses for domestic consumption and productive activities are determined, and also an initial assessment of available energy resources and technologies are made. Several rural energy studies have been carried out in many developing countries by national and international agencies and groups, which provide the detailed methodology for such surveys. The survey formats, however, have to be modified to suit the specific situation of the country or, sometimes, of the micro-region being surveyed. The needs, priorities and socio-cultural preferences of the intended rural beneficiaries have to be assessed during these surveys. The Participatory Action Research Programme, sponsored by FAO, has developed useful methodology for such surveys, which can be appropriately modified and utilized for the specific country situation.

iii) Energy Demand Projections

Demand projections for energy have to be worked out for subsistence needs (i.e. cooking, heating and lighting) and for the economic development needs (including agricultural and non-agricultural productive activities) of the micro-region.

Subsistence-level needs may be projected by taking into account existing consumption patterns, substitution possibilities and using norms, such as **per capita** energy consumption assumptions and increase of population growth for the region, as well as changes in consumption patterns as a result of increase in income and improvements in standards of living. Projections for energy requirements for economic development is, however, a complex exercise in which the needs and priorities of the rural beneficiaries have to be considered together with the existing and proposed development activities and programmes and other on-going and proposed programmes for rural development programmes. Energy requirements for agricultural production over the selected planning period have to take into account existing and proposed cropping patters, level of farm mechanization, irrigation requirements, pre and post-harvesting operations a well as fertilizer requirements. The methodology for energy demand projections is in the developmental stages, though several working formats and models are now available. Computer software packages for energy demand projections are also now available and are reported to have been utilized in some developing countries.

iv) Energy Supply Assessment

Assessment of all available energy resources over the planning horizon, including commercial sources of energy - wood, electricity, petroleum products, coal-based products (which may come from outside the area), non-commercial energy resources, which include traditional biomass resources - firewood, agricultural residues, manure and animal power, and the renewable energy resources - solar and win energies, water (including streams and canal dropping), etc. - have to be made through separate detailed surveys and studies.

v) Energy Conversion Technologies

Energy conversion technologies for each resource and for matching different end-uses, have to be assessed along with the availability of the corresponding energy resource options for different periods of the planning horizon. This assessment should include conversion efficiencies, performance, criteria, operational features and other appropriate technical characteristics of each technology option. Only those technologies which are commercially available, or would become commercially available during the planning horizon, should be considered. While making the assessment of energy technologies, related inputs required to make the technology operational, including marketing and installation arrangements, repair and maintenance services, financing packages etc., may also be assessed to determine whether it would be viable to operate the technology in the micro-region in the time period under consideration.

vi) Energy Costs and Prices Including Environmental Impact

The delivered cost, including the capital cost of resources and technology, based on assumptions of the life cycle for the option, and the interest rate used in the country's planning exercises, plus the annual operating and maintenance costs, as well as the cost of transportation and distribution, have to be worked out for each energy option. The administrative prices, as well as the financial and social costs for each option to (a) the user, (b) the area or micro-region, and (c) the country have also to be worked out, for different phases of the planning horizon. Environmental impact costs, where these can be quantified (e.g. cost of incorporating environmental safeguards in a particular energy option, for example petrol engines to control emissions), should be incorporated in the costs. The cost to the economy may include, where possible, the quantification or assessment of the environmental impact of the option. Where such quantification is no possible, some classification of the different options may be made in regard to their environmental implications, including the trade-offs between the impact of the option on the local environment and the global and regional environment.

vii) Energy Plan

An integrated rural energy plan is prepared on the basis of the above data for the micro-region. The plan should provide the energy resources and technologies needed to meet the different types of energy demand for subsistence and production activities for the different income groups in the micro-region, over the duration of the planning horizon, and at the least cost to the overall economy and the environment. Specific targets for the different commercial and renewable energy option including electricity, kerosene, wood, diesel, LPG, soft coke, solar heating equipment, wind pumps, biogas, etc., are worked out on the basis of this plan. A computer programming model may be used for preparing such micro-level optimal plans. Alternatively, a computer simulation model may be used for processing data and preparing alternative plans for different areas. However, if computing capabilities are not readily available, data from the surveys, and for the compilation of integrated rural energy plans can be processed manually, and steps may be taken for developing computer software packages suitable for the specific situation of the country with appropriate technical assistance.

FAO activities under REDP were designed to provide direct support for national efforts to overcome the problems that have limited energy-based rural development. They were based on the methodological approach described above, on regional topical papers discussion the main aspects of energy for rural development (planning, technology, community participation, environment, institutional structure and legislation) and on the recommendations of a Regional Workshop on Energy Planning for Sustainable Rural Development held in Beijing, China in September 1989.

4. EXPERIENCE GAINED AND RELEVANCE TO FUTURE ACTIVITIES

4.1 General

The planning and management of "energy for rural development" is necessarily a national activity, so FAO activities were directed towards supporting these efforts. The political, environmental and social context of each country and of its constituent regions provides the framework for the technological and institutional interventions required. The rural sector is still cut off from energy-related decision making, which focuses on the industrial, transport and commercial sectors, where energy supply and demand patterns and future needs are clearly perceived, and where the institutional structures needed to negotiate, or at least submit, their tailored energy development plans do already exist. This is not the case with the agricultural/rural sector which lacks appropriate energy inputs, both in terms of quality and quantity, to satisfy its socio-economic objectives. Energy interventions in this sector are normally ad hoc and sub-sectoral, such as rural electrification and reforestation for fuelwood. The lack of linkage between technical research into areas such as alternate energy sources and efficient energy use, which are obviously applicable to the industrial, household and trade sectors, is even more drastic in the case of the rural sector. The lack of funds for "energy for rural development", which is a reflection of energy price policies normally biased toward the urban sector, compounds the problems of energy-based rural development.

In addition, changes taking place in the national structures are now rather dramatically altering the role of each of the parties involved in "energy for rural development". The new responsibilities of government authorities, the increased involvement of the private sector in energy investment and marketing, and awareness of the need for more genuine and effective community participation call for revised planning and management models. These structural changes imply an apparent "downsizing" in the role of planning, while decentralization and deregulation should open new avenues for jointly managed development and therefore for "energy self-production". The environmental dimension, in which energy is preponderant, also affects strategies of development and technological innovation.

The activities carried out were designed to help countries face the challenges of the above situation and to seize a number of opportunities for interdisciplinary collaboration on the social and institutional levels, thereby integrating the sectoral approaches of individual ministries, associations, non-governmental organizations, universities and industries for coordinated rural development.

As a pilot effort, a selected number of REDP member countries were assisted in the adaptation of the Comprehensive Approach to Energy Assessment and Planning for Rural and Agricultural Development formulated during Phase III of REDP. The adaptation of this approach to specific national conditions would permit an accelerated integration of the rural sector into the overall energy development thrust enjoyed by other sectors of Asian countries. In particular, this adaptation was geared to bridging the present lack of policies and "vacuum" of institutional responsibilities regarding rural energy issues.

4.2 National Consultations

In order to implement this activity, FAO took a flexible, but normalized approach. The central objective was to prepare a National Energy Strategy for Rural Areas. The first step was to work closely with the REDP sub-focal points for rural energy matters in identifying the key institutions which were, or needed to become, involved in the preparation and implementation of a national strategy. This strategy was discussed and, in various cases adopted during National

Consultations organized by the governments which were attended by all relevant national institutions. This central document prepared in each country presented the main characteristics and problems of energy in rural areas and discussed the potential role of energy inputs in promoting socio-economic growth of rural populations by permitting the establishment of new income-generating activities. In most cases they also reflected upon the perspectives for energy supply and demand in a horizon of the next 10 years. The scope and magnitude of the problem was identified and the need for concerted action and for an integrated approach was discussed. References were made to ongoing efforts and to the need for their expansion and consolidation. Policies regarding micro and macro energy planning, institutional coordination, energy technologies and implementation strategies were identified in the context of the national economic, energy and overall development plans.

The National Consultations also discussed other documents prepared by specialized or sectoral national authorities. In most cases, these touched upon issues such as wood-energy, environment and energy interrelations and implementation of micro plans by local authorities. In various cases, the National Consultation discussed pilot energy plans for specific countries or regions, in the context of broader based national rural energy policies and priorities.

The pilot activities covered the following countries: The Philippines, Indonesia, Sri Lanka, Laos and Vietnam. It is important to assess the results obtained and the problems faced. The process of preparation for the National Consultations was as important as the meetings themselves. In many cases, it was precisely during these preparations that contacts, sometimes for the first time, were catalyzed between different national agencies. The integrated approach called for by this activity relies strongly on concerted inter-ministerial action, and these contacts were critical steps in that direction. These contacts were followed by joint activities in preparing the specialized documentation and the National Strategy for Rural Energy Development. In various instances, these first contacts served to identify possibilities for collaboration on various energy related fields. A further result in this preparation process was the breaking down of inter-ministerial communication barriers. In most countries, a National Working Group in Rural Energy Development was established, which became an important instrumental mechanism in the follow up of the decisions of the Consultation. These working groups should also facilitate follow up efforts.

4.3 Problem Areas

Among the main problems faced in advancing in the implementation of this activity were the following:

* not always was it possible to identify the sub-focal point for rural energy matters; changes of personnel or of responsibilities are not always notified, with the resultant loss of time and efficiency;

* political interest on rural energy matters is sometimes low and the sub-focal point found it difficult to catalyze the support commensurate with the objectives; this could lead to a weakening of the results and to the holding of just "another workshop" on rural energy issues;

* although the Consultations should have also discussed and given a sense of priority to field projects, the fact that financial support for these activities is not included in REDP, weakened this discussion.

Of particular relevance to the results of the activities described was the effect of the drastic institutional reforms being implemented in most countries. Many ministries of energy, agriculture and forestry are being redimensioned in both qualitative and quantitative terms; the role of these institutions is shifting away from operational responsibilities towards becoming mainly regulatory bodies, with the private sector and other social structures acquiring field and operational responsibilities. Not only were the first steps of these adjustments taking place in the midst of REDP activities, but they coincided with new UNDP implementational policies. This double and symbiotic effect was captured in the discussions of the Consultations and impacted the design of new institutional structures behind rural energy development.

4.4 Achievements

The activity opened new opportunities for project identification and formulation. On the one hand, based on the studies prepared, specific fields for which international assistance is necessary were highlighted. The revised and enhanced interest on the environment has motivated most countries to identify this field as a subject for specific discussion.

The success of these activities can only be judged on the long term, since the catalytic effect of the contacts promoted and the idea itself for the need of a more comprehensive approach to rural energy problems requires not only cosmetic changes but new and innovative strategies and institutional arrangements. The activities achieved their objective, but consolidation of the new approach depends on the political will behind rural development activities. The inter-ministerial contacts established need nourishing in order to achieve dynamic action; the full integration of people's participation requires information and training; and the effective integration of environmental issues needs further knowledge and data. Only by persistent efforts on the part of governments and with genuine interest from NGOs, the private sector and local organizations can rural energy development gain the necessary new thrust. Unfortunately REDP was late in working in this field. It was only in the last 2/3 years when rural energy matters were given higher priority. There are nevertheless positive signs in this direction under the new UNDP programme started recently. It will depend largely on the management of that programme and on the orientation given by the countries themselves, if rural energy matters are stressed in the future. If so, it is hoped that the catalytic effect of the FAO activities still remains and can be revived.

With no doubt, the large number of documents prepared represent a major success due to the also large number of people involved in their preparation and revision. In all countries at least six specialized studies were prepared. The documents and reports prepared at the regional level represent a wealth of knowledge and consensus thinking. In fact, it is interesting to note that these regional documents served as basis for work initiated by FAO in other regions of the world.

4.5 Specific Discussions on Wood-Energy

In all cases there was a specific call for an assessment of the wood-energy situation in the country. The need for the integration of wood-energy issues into overall policy and planning efforts was stressed, and the barriers to this effect were identified. These barriers refer mainly to institutional and methodological reasons rooted in the traditional pattern existing in most countries where the forestry and energy authorities touch base only occasionally. In some cases, it is the energy authorities taking initiatives regarding wood-energy, whilst the forestry authorities give little priority to the energy aspects of wood, concentrating mainly on the high income producing aspects linked to timber and other products. In other cases, the forestry authorities give appropriate relevance to wood-energy issues but in isolation from energy policies or substitution requirements.

Still, in some cases, only the traditional use of fuelwood is considered, with little attention to the potential of wood-energy applications in rural industry or to modern conversion technologies.

In some countries, documents on wood-energy were prepared by the Forestry or Energy authorities in this topic. When wood-energy documents were prepared by other than the focal point, efforts were made to coordinate this preparation in order to arrive at a comprehensive set of studies which could serve as basis for the discussions and, in particular, to the preparation of the overall strategy paper. This exercise was found to be very useful in most cases. The following are some of the issues highlighted during the discussions on wood-energy in the above mentioned National Consultations, which reflect some of the thinking in this field, and which prove the awareness on the need for a broader approach to solving wood-energy problems and to tapping its full potential:

* "it is difficult to address the problem of firewood shortages in isolation of the causes which produce it"

* "most fuelwood available today comes from forest clearance activities...what will happen when this is reduced or phased out?..."

* "....under the present growth of privatization, and the unlikely concern for social welfare, what are the prospects of people at a fuelwood subsistence level?"

* "the shrinkage of the governmental role in the energy field will strongly affect wood-energy programmes"

* "since overall national wood-energy data hides local deficits, it is necessary to go to the local level for planning and management of energy programmes"

* "it is by a close combination of forests and energy policies that it will be possible to solve two contradictory aspects of one same problem : forest protection and fuelwood exploitation"

* "it is necessary to establish a *system of policy measures* for overall rural development composed of policies for rural development, rural electrification, food and fuels for cooking"

* "....it is necessary to build up an implementation mechanism for a rural sector energy plan with defined tasks for the agricultural, energy, forestry and fisheries authorities"

* "...all parties shall strengthen their planning units and incorporate an operational framework for energy plans for sustainable agriculture and rural development"

5. CONCLUSIONS AND RECOMMENDATIONS

The activities carried out during 1990-92 in the context of FAO's responsibilities within the UNDP/ESCAP Regional Energy Development Programme regarding rural energy planning achieved the following objectives:

* formulating a new approach to energy assessment and planning for sustainable rural development
  and
* assisting in the national adaptation of this approach through a series of pilot activities in selected countries.

Through the formulation of the methodological document on the new approach and other regional documentation, the ideas and experience of more than 60 people from over 15 Asian countries were tapped. These same people were exposed to new ways of thinking on rural energy problems and solutions and it is hoped that this will have influenced their work. The methodological approach prepared has had wide diffusion in Asia and in other regions of the world.

The organization of national consultation meetings was an intense pilot programme carried out in five countries which set into motion contacts among relevant national institutions such as the energy, agriculture and forestry authorities, in many case for the first time. These preparations, as important as the meetings themselves, were vital in setting the ground for the formulation of a strategy paper to be discussed by an interdisciplinary policy group. Although the impact of these meetings can only be judged in the near future, once the concepts imbedded in the documentation and the modalities for implementation are made operational, there seems to be general consensus on the importance of innovative approaches to the energy problems facing rural populations. The experience gained in the countries active in this activity will most probably influence future efforts in this field, both at the national and regional levels.

There is the need and demand from countries for assistance in this field. The activities described were only pilot, and full technical assistance activities are still to be in place. It is hoped that political will at the national level and priority setting in the international cooperation arena will coincide towards an enhanced effort in the rural energy field. Technical expertise in the Asian region is more than mature to implement effective programmes on rural energy planning.

The activities carried out showed clearly the need for a closer integration of wood-energy planning with overall energy planning. Wood-energy programmes cannot be carried out in isolation from other programmes which have a strong bearing and definite influence on the future patterns of wood utilization. Of particular importance is the influence of the institutional reforms being promoted in most countries. The apparent "shrink" in the role of the state regarding operational energy matters should not lead to a further impoverishment of rural people, especially those at the energy subsistence level. In fact, the enhanced stress on private sector and peoples participation should open new doors for energy development through the establishment of small enterprises and the liberalization of production and conversion rights. It is nevertheless necessary for the governments to retain and consolidate their role as regulatory bodies for the establishment of appropriate natural resource and taxing policies, and to make sure that the poorest of the rural people are not, even more than before, left out of the economic development thrust enjoyed by other groups.

The Use of Secondary Data Cum Field Observations as a Preliminary Method for Wood Energy Analysis

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INTRODUCTION

Wood fuels are a very important source of energy within the region and in many countries account for 40% to 95 % of the total amount of energy consumed. It is expected, seen the overall situation in most of the RWEDP countries, that at least for the foreseeable future the reliance on wood fuels will remain high.

This reliance has in many countries resulted in that numerous programs have been initiated to develop the resource base, develop alternative sources of energy as well as programs on conservation of energy. Unfortunately, many of these programs have not or only partly achieved the intended goals due to various reasons. One of the main reasons why goals have not always been achieved appears to be that so little was known about the situation. Identification of the key issues and options for the wood fuel energy sector and its linkages with the overall energy sector as well as forestry, agriculture, industry, etc. are important and should form the first step for planners and analysts in order to identify policy as well as project goals.

The Tropical Forestry Action Programs (TFAP) as well as National Forest Master Plan Programs, carried out in several of the RWEDP countries, has provided an opportunity to study the wood fuel energy sector more in-depth and look into the problems and constraints faced. "Fuelwood and Energy" is one of the five inter-related areas which, besides "Forestry in Land Use", "Forest-based Industrial Development", "Conservation of Tropical Forest Ecosystems" and "Institution Building" are expected to be looked into within Tropical Forest Action Programme studies in order to address the challenges and needs related to the conservation and development of tropical forests (WRI, 1990a). Within the framework of TFAP, guidelines for studies to be carried out were drawn up for the various sectors. This paper basically discusses the use of these guidelines as a method to assess the wood fuel energy situation in countries and shows what can be learnt from it with regard to what follow-up activities related to wood energy planning may have to be contemplated.

2. WOOD ENERGY IN NATIONAL FORESTRY AND TFAP STUDIES

From the 11 RWEDP countries (Bangladesh, Bhutan, India, Indonesia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam) as well as three other countries in the same region (Cambodia, Laos and Malaysia), 9 countries have now more or less completed studies of the forest sector. Out of these nine countries Indonesia, Laos and Vietnam carried out the studies within the framework of TFAP while Bhutan, Malaysia, Nepal, Pakistan, Philippines and Sri Lanka carried it out in the form of a National Forest Master Plan. Bangladesh, India and Thailand are at present carrying out studies, Myanmar is contemplating a study while for Cambodia no information is available (FAO, undated). For as far as could be ascertained all studies which have been finished or are being in progress, include to a greater or lesser degree a section on fuelwood and energy.

In countries where the database on forestry and wood fuel was found to be extremely weak, such as for instance in the case of Laos, no separate studies on the sector have been carried out. A cursory review, consisting merely of a rough estimate of the domestic consumption of wood fuels, based on FAO standard data, and remarks that in general wood fuels do not pose any problem except for some of the urban areas, was all what has been mentioned (GOL, 1990a, 1990b). In Indonesia apparently also no separate study on wood fuels has been carried out but here it was combined with other studies on the demand for forest supplies (GOI, 1990a, 1990b).

In other countries elaborate studies have been or are being carried out. Examples of the latter are Nepal and Sri Lanka. In Nepal, based on existing information, extensive modelling and forecasting activities on wood fuel use and related factors such as the fodder situation for livestock, the need for timber, non-wood forest products, etc. have been carried out on an integrated basis. Sri Lanka appears to be the only country where, within the framework of a Forest Master Plan, extensive interviews with users and suppliers have formed part of the study on wood fuel energy. These interviews covered topics of the demand for and supply of wood fuels, preferences, pricing, etc. and were carried out with close to 1,000 households as well as 500 industrial establishments (GOS, 1986).

In Pakistan where a separate study on wood fuel energy was carried out for the Forest Master Plan (GOP, 1990a, 1991a), the results were abandoned as much more detailed information from a Household Energy Study carried out by the World Bank (ESMAP) became available. The ESMAP study measured wood fuel consumption in about 4,800 households all over the country and resulted in an overall consumption of 28 million tons of fuelwood (Ouerghi, 1992). The wood fuel energy study of the Forest Master Plan estimated that the total consumption of fuelwood amounted to about 31.5 million cubic meter which would be equal to about 22 million tons (GOP, 1991a). The estimate was based on an aggregate figure on wood fuel consumption per capita valid for the whole country. Some actual measurements were carried out and this showed considerable higher consumption figures than the final aggregate figure used. These actual measurements incidentally were found to be more or less the same as consumption figures reported in other available and quoted reports on wood fuel use. The report unfortunately does not clearly state why lower figures were used for the overall estimate.

In the Philippines, where also a Household Energy Study has been carried out the results were not yet available at the time the Forest Master Plan study was finalized. However, it appears that the estimates made in the separate study on wood fuel energy do not differ much from those obtained through the ESMAP study (21.7 versus 19.9 million tons). In the case of the Philippines dis-aggregated (by area and urban/rural) per capita consumption figures were used, based on an extensive survey and study of existing sources of information.

The studies on the wood energy sector, carried out within TFAP or as part of a Forest Master Plan were short term e.g. little time, in general not more than 2 man month external consultants aided by local counterparts, was allocated to it. It should be noted that, although local counterparts are assigned to carry out and assist with the study, that in practice due to their heavy workload they often can spend a limited amount of time on it.

Considering the short term nature, it can be assumed that the costs associated with such studies are quite low and it is estimated that these probably range from 20-40,000 US$. This compares favorable, for instance, with the costs associated with the ESMAP Household Energy Studies (about US$ 700,000 in the Philippines and over US$ 3,000,000 in Pakistan). However, such a direct comparison should not be made as the ESMAP studies covered in both cases, besides the wood fuel energy sector, also all other domestic energy sources and in Pakistan a very thorough and comprehensive study on the wood fuel supply base as well.

It is also clear that within a short period of about 2 month, considering the size of most of the countries as well as the diversity, studies on the wood energy sector can only be as good as the underlying data unless consultants have a thorough knowledge of the local situation. On the other side, wood energy studies in general form part of a much larger framework of studies on the forest sector in its totality. Therefor in most cases a database has been built up which can be accessed. Such a database, as well as related information gathered, in most cases is a good starting point for wood fuel and energy studies.

2.1 Data Needs for Wood Fuel Energy Studies

In order to be able to plan and draw up policies and strategies for the wood fuel energy sector, reliable information on at least two items are required:

- Energy consumption and/or demand in the past, present and future.
- Energy supplies and its sustainability in the past, present and future.

Besides these two major items, other information which may shed light on the consumption of, demand for and supply of wood fuels should also be collected for as far is possible and practical. This includes data on related areas like agriculture (supply of and demand for residues as a source of energy as well as other purposes), the industrial sector (industrial residues as well as use of wood and other biomass fuels), transport costs (wood fuels, etc.), commercial trade of sources of energy as well as energy conversion equipment, etc. However, while gathering and analyzing such secondary information, the main objective e.g. to study the wood fuel energy sector more in-depth and look into the problems and constraints faced should not be lost in the maze of details.

2.1.1 Sources of Information on Wood Fuel Energy Consumption and/or Demand

National statistics often provide, besides population data, land use data, etc. information on energy use and production of different sources of energy. This concerns basically the commercial sources of energy like kerosene, LPG, electricity and sometimes wood fuels, if supplied or traded through the formal sector as well. Permits for wood fuel production, cutting or transport issued by Forest Departments, Wood Fuel Corporations, local government organizations, etc. often form the basis for such statistics. Informal activities such as collection of fuelwood for own use as well as for trade, in most countries accounting for the bulk of wood fuel use, are normally not included.

In order to get a better view on the informal part of wood fuel flows and use, available written information on wood fuel use in the country has to be relied upon. Even though in most countries reports and papers are available on fuelwood, energy and forestry sectors, most of the information is related to only one or two technical aspects, often valid for a specific region of the country. Such information, although useful, in most cases can not be easily correlated with any degree of accuracy to the country as a whole. Other studies, apparently conducted on a nationwide basis, often lack information on sample size and intensity and, considering that budgets are often constrained, a question mark may be put at the statistical accuracy. Seasonal variations (wet/dry, cold/warm), coupled with agricultural seasons (availability of residues), size and growth of urban areas, household size, household income, etc. can result in substantial variations in wood fuel use over time.

Available information is often found to be a repetition of old data of which the data base may have changed. For instance in Vietnam, data on supplies of wood fuels from different land types are given in many papers. All quote the same undated paper which, even after extensive efforts, could not be located (FAO, 1992a). Wood fuel consumption data, widely quoted in Pakistan, apparently are based on rough estimates made by the World Bank in 1978 (GOP, 1991a). By making assumptions (often without stating the basics behind these assumptions) and extrapolations, data on wood fuel consumption on a national level are then derived for the future.

In some cases large scale household energy surveys have been carried out on a national basis. Is such the case, normally a wealth of information, not only on the demand side but also on attitudes towards the use of fuels, preferences, technologies (type of cook stoves, heaters, etc. used) is available and this normally on a dis-aggregated basis.

Where little information is available on energy use other than commercial sources of energy like kerosene, LPG and electricity, household consumption and/or budget surveys can form another source of information as energy consumption, sometimes specified to source, is included. For urban areas, where wood fuels are monetized, such surveys can give a useful indication on the amount of energy used, as long as information on prices of the sources of energy for different consumer groups at the time of the survey is known. For rural areas, where the bulk of wood fuels used are non-traded e.g. many people collect their own wood fuel supplies, normally little information is available on how wood fuels have been valued (wood fuel prices, labour time versus cost, etc.). Such information, necessary to calculate amounts of energy consumed, can in most cases be traced but the information is normally aggregated by rural and urban sectors. This makes understanding of the figures difficult due to large variations in different parts of the country with regard to climate, occupation, household size, personal as well as household income, availability of substitute sources of energy, its reliability of supply and availability and price of equipment to be used with it, prices of wood fuels, etc. Besides, the information is normally based on respondents' recollection of cash spent over a certain period. With traded fuels e.g. electricity, gas, etc. amounts can be easily cross-checked with bills. Where no billing system exists such as in the case of wood fuels and often also kerosene, there are risks that the amount is under- or over estimated.

In case only little or unreliable information is available, resort has to be taken to estimates based on demand data valid for other areas with similar conditions. Examples of these are for instance the FAO estimates, based on nearly 350 surveys and rough estimates in 88 countries, as published in "Fuelwood supplies in the developing countries" (FAO, 1983) as well as figures presented in "Household Energy Handbook" (WB, 1987). By using such data in a prudent way, a reasonable good judgement on how reliable the available information is, can be made. This, however, is conditional on that some knowledge of the local situation exists with regard to energy use, use and availability of substitutes like kerosene, gas and electricity but also agricultural residues, animal dung, etc., climatic conditions, etc.

The above covers basically the domestic sector but this is only part of the demand side. Industries such as brick making, lime burning, yarn dyeing, foundries, food processing, crop processing, etc. and other sectors (restaurants, bakeries, etc.) normally use also considerable amounts of wood fuels. Even though national statistics may shed some light on the existence and size of these users, the bulk of it is normally not registered e.g. the informal sector. Therefore very little is known about the overall size of these informal sector activities.

However, even though little may be known about these non-household activities, they should not be neglected as they often account for 10-30% of the total wood fuel consumption in countries. In this case recourse will have to be taken to estimates on the number of industries and often on the demand and use of wood fuels as well. Local research institutes, trade or manufacturing associations, large traders and/or large consumers often can provide information on parts of these sectors. For other parts estimates may have to be based on information from other comparable regions or neighbouring countries.

However, a main problem both for the domestic as well as for the other sectors is that existing information, even updated through various means, only gives a snapshot of wood fuel use at a certain period. Where data is available for several periods, some insight may be gleaned from this how things developed over time. Unfortunately, it gives very little indications on the dynamics of wood fuel demand and supply.

Discussions with local knowledgeable sources of information may give a better insight in the variations and influencing factors on the demand as well as supply side for the wood fuel situation over a period of time. Even though such discussions may turn up clues on why and how changes occurred this is only valid for a certain area and can never be taken as generally valid for the whole country. Besides, recollection by people of information often is biased towards own perceptions and own situations and may not reflect the actual situation nor the situation other people faced in the same area.

Besides the more longer term fluctuations there are also short term fluctuations, mainly caused by climatic seasons as well as agricultural seasons. Wet, dry, hot, cold seasons normally result in distinct changes in fuel use, not only in the amount which is used but also in the type used. Cultural influences such as celebrations, certain types of food require special types of fuels, etc. also may play a role in the choice of fuel.

During harvest periods people may not have time to collect fuels and this may force them to rely during such periods on commercial sources of energy (including wood fuel). During slack agricultural seasons people may go out and collect wood fuels even though this may be time consuming.

2.1.2 Sources of Information on the Supply Side of Wood Fuels

The supply of wood fuels is an important parameter in studies on the supply and demand balance of wood fuels. Unfortunately, in most cases the supplies have to be estimated based on the demand for several reasons. Actual or potential supplies are almost never recorded in wood fuel studies nor household consumption surveys. The same is true, but to a lesser extent for commercial fuels like kerosene and LPG. Some data on supplies may be available for these fuels but these are normally reported on a country wide basis without any information about end users. In the case of metered fuels like electricity or gas the situation is more easy as dis-aggregated data normally are available.

Information on wood fuel supplies normally have to be derived from data on land use and tree resources. The latter not only include forests and wood land but, as experience has shown that a large part of the wood fuel supplies is derived from non-forest sources, also scattered trees on agricultural land, grass and bush land, small wood lots, common village lands, trees along roads and canals, hedgerows, orchards, etc.

For forest resources an estimate can be made on the amount of wood fuels which could be available from such areas if the following information is available: area covered, the standing stock, the annual increment (growth rate), the accessibility, competing uses (logs, timber, poles) as well as the cost of cutting, transporting and selling of the wood fuels. Estimates of the standing stock are normally based on remote sensing techniques and for that reason can only be approximates. Besides, most of such data, available from forest departments, concerns commercial timber volumes which often are only a small part of the total standing stock.

Survey departments, planning departments as well as universities, in particular those which teach forestry and geography subjects are often also a good source for information on land use and tree cover. A major wood fuel supply source is often the clearance of forest and wood lands for use as agricultural land, for road construction, etc. so it is obvious that data on changes in land use may give some indications on wood fuel supplies.

Comparisons between countries as well as of areas within countries or even districts are difficult to make. This is caused by large variations in the type of forests (age, species), soil and climatic conditions, accessibility, etc. Seen these widely varying conditions as well as diversified needs for forest products it is clear that calculating the amount of wood fuels from forest and wood lands can only provide a rough estimate of the sustainable supplies.

Information on the other tree resources such as scattered trees is almost non-existent. Unless surveys are made, estimates on possible supplies will have to be made for such areas and these again can only provide a very rough estimate.

Residues, another source of biomass energy and a substitute for wood fuels, consist of crop residues, animal waste but also wood waste from saw milling, furniture factories as well as discarded construction timber, torn down buildings, wood derived from land clearings, etc. For crop residues and animal wastes the main sources of information are agricultural statistics. Data on cropped areas, crop yields and the locations can be combined with appropriate residue yield factors to estimate the total residue production. The same method can be used for animal wastes. However, estimating the amount of these materials that are or could be made available as a source of energy, allowing for alternative uses, is much more difficult.

It is clear from the above that reliable information on the wood fuel supply side is hard to come by due to that little is known about the resources. It appears also that, unless detailed studies on the wood fuel supply base as well as the supply mechanism are made, the supply side will remain a grey area. However, it should also be noted that, even though such information on the supply side would be available, part of the grey area will remain. This basically concerns the access to supplies. Trees on agricultural land may be abundant but this does not imply that everyone has access to it.

Community participation in forest management may exclude certain parts of the community as is evident from Nepal where lower castes are kept out of the forests (FAO, 1991b).

Social factors such as access to as well as seasonal and cultural influences discussed in the previous sections can never be detected in short term surveys. In order to account for such social as well as seasonal influenced differences a multi-disciplinary team may have to be fielded over a long period.

3. REVIEW OF THE VIETNAM TFAP WOOD FUEL ENERGY STUDY

As mentioned earlier, in most of the countries where separate studies on wood fuel energy have formed part of the Tropical Forestry Action programme, the studies have been based on existing and available information on wood fuel use and Vietnam was no exception. The TFAP guidelines on the wood fuel energy sector and its accompanying checklist (see Annex 1) have formed an overall guiding factor with regard to data collection and analysis. However, as wood fuels are used side by side with other biomass fuels as well as commercial fuels these types of energy sources had to be covered as well.

3.1 Literature Review

The wood fuel energy study started with a review of available information on energy use as well as wood energy both inside and outside the country. Regional offices of international organizations like UNDP, FAO, ADB, WB, ESCAP, UNIDO, etc. often can provide copies of country papers and/or reports presented at national or international seminars, workshops, etc. Even though these papers may not cover the subject directly they often can be helpful in analyzing and understanding bits and pieces of information. For instance a paper on fertilizer use in Vietnam gave information on the use of organic fertilizer and the role of agricultural residues in it. Besides, references cited in such papers can be a starting point for further searches for more specific information.

However, even though the literature survey turned up quite a bit of useful information, it became soon clear that many estimates would have to be made, simply because for some parts no or not sufficient data were available. A main problem directly identified also was that only "static" information was available e.g. information for only one period but that very little if anything was known about the "dynamics" of wood fuel use. Large variations in consumption, but in supplies as well, do occur due to seasonal variations, changes in cropping patterns, migration of people (a large migration programme from urban to rural areas exist in Vietnam), availability and reliability of alternative sources of energy etc. The study therefore could only be based on the available information and would never be able to account for the "dynamics" involved.

Therefore, in order to make checking and updating possible and more easy, it was decided from the start to record and report dis-aggregated data for as far as would be practical. After a careful examination of the available data, the province level was chosen as being the smallest level for which in almost all cases data would be relatively easy to obtain. Besides, in this way it was expected that regional variations in the demand and supply could be identified in a better way which in its turn would facilitate drawing up solutions for such local or regional problems rather than only national problems.

3.2 Energy use

3.2.1 Setting up of Database on Domestic Wood Fuel Energy Use

By using the existing information a spreadsheet like database on domestic energy consumption including wood fuels was set up. By using such a database in a systematic way anomalies, problem areas and lack of some data can be more easily detected. In this case a main problem with charcoal and coal consumption was identified. Most of the information available was in Vietnamese and this, mainly in the form of the tables, was translated. In the Vietnamese language the word for charcoal and coal is the same and as translation was handled by different persons this resulted also in different interpretations. Long sessions with translators were needed to try to sort out the problems. For the northern part of the country this was relatively easy to solve as coal is widely available and very little charcoal is available. However, in the central and southern part of the country both fuels are available and this presented a problem. Only through discussions and field visits some light could be shed on the actual situation. It was found that very little coal was available in the Mekong River Delta while charcoal was available in shops and market places. It was therefore assumed that the use of coal would also be low and would be negligible in this area.

The available information indicated that in mountainous areas as well as in urban areas the amount of energy was different from those of the surrounding areas. Unfortunately these areas were not specified as to location other than that there were 80 mountainous districts as well as 80 cities in addition to Hanoi, Haiphong and Ho Chi Minh city. Verification as to the location of most of these areas was not possible even after consultation with some of the authors of the reports. This resulted, in cooperation with the authors, that assumptions as to the locations of these areas had to be made, based on maps and population densities of provinces rather than districts.

After the initial database had been established, refinements were made. This consisted for a part out of using other and more recent data obtained through personnel involved with stove programs as well as by updating consumption data of the commercial sources of energy, mainly in the form of kerosene and electricity. Although no doubt information on consumption on a provincial basis exist, no access could be gained due to various reasons. Only some general information on increases in supply on a country wide basis were obtained. By correlating these supply changes with overall population size as well as changes in population sizes of the provinces the per capita consumption data were adjusted

From the foregoing it is clear, even though changes in the use of energy had taken place, that these changes only could be reflected in the per capita use by using estimates, often arbitrarily applied. In the late eighties the economy has been opened up and this no doubt has resulted in more cash income for many people and this normally is also reflected in changing consumption habits, including energy. At the same time quite drastic changes in the prices of commercial sources of energy took place and this resulted in a reduction in the use of these sources of energy. However, both phenomena could not be accounted for, simply because this would have entailed surveys which in the short time was out of the question. Therefore the database most probably merely reflects an approximate of the actual situation and further investigations will be required on how changes, which have taken place, have affected the overall energy consumption.

3.2.2 Setting up of Database on Non-Domestic Wood Fuel Energy Use

Besides the domestic sector, other activities also consume considerable amounts of energy. For this reason a second database was set up on these other consumers like industries, food processing, textiles, restaurants, etc. Based on information obtained from country studies carried out for the Regional Wood Energy Development Programme a list of 40-50 different types of industries, activities was compiled, complete with specific energy consumption data where these were available. The list was given to several knowledgeable persons with the request to comment on it with regard to completeness, activities/industries not found in Vietnam, specific energy consumption, types of energy used, energy mix, etc. This resulted in an updating of the list by omitting some, adding others and updating of specific energy consumption data to reflect the conditions as found in Vietnam. For some activities such as the number of restaurants and bakeries as well as their overall production, estimates had to be made because no information was available. During field visits attempts were made to verify and, where necessary, update the data. However, updating through a few field visits to industries in a country which measures 1,600 km. in length can only result in some vague ideas on the actual situation. Therefore existing statistical information which, in the case of rural based industries and other village activities often is a far cry of the actual situation, formed the basis of determining the amount of biomass energy sources (fuelwood as well as residues) used by these non-domestic sectors.

3.3 Energy Supplies

3.3.1 Residues

In the case of Vietnam it soon became clear from the literature that the term of "residues" covered besides agricultural residues also wood residues such as from saw milling activities (saw dust, off cuts, slabs, etc.), scattered trees on home steads, along roads, etc. wood and other biomass from perennial crops like rubber trees, coconut trees, etc., other wood waste such as from torn down buildings, etc. Therefore the database set up was in the form of two different parts: one dealing with agricultural residues, the other with wood like residues with the exception of wood from scattered trees, wood processing waste and other discarded wood which were covered in the wood fuel database.

Using standard residue factors for different types of crops and statistical information on crop production and cropping patterns, the amounts of agricultural residues generated on an annual basis as well as woody biomass from perennial crops was determined. An additional database on alternative uses of agricultural residues was made. This was done in order to have an indication on how much of the residues could be available as a source of energy and what part would be used for other purposes.

By combining the database information, the amounts of residues generated in each province, their use for other purposes as well as the amount of residues which potentially would be available as fuel was calculated.

3.3.2 Fuelwood

Statistical information published by the Ministry of Forestry showed that in 1988 about 30 million stere had been produced with the state sector accounting for less than 1 million stere. Attempts to verify the fuelwood production figure with the statistics department of the Ministry of Forestry as well as with the National Bureau of Statistics unfortunately resulted in a big question mark hanging over the reliability of the official figures on fuelwood production. No raw data could be located and in fact it appeared that no one knew the origin of the data. The general consensus at the end was that the statistical data most probably were estimates based on what was deemed to have been consumed. Checking the production data with the data derived through the wood fuel energy study indeed showed in many, but not all, cases quite a good correlation between the data.

Because no other sources of information could be located, the almost classical approach was taken to look at forest areas covered, the standing stock, growth rates, areas accessible, protected areas, etc. By combining all these factors the amount of fuelwood which can be removed on a sustainable basis from the forest was calculated. The same was done for tree plantations, planting of scattered trees and bare forest lands, etc. The end result was an amount of wood fuels for each province which could be used without endangering the sustainability of the supply base.

3.4 Interpretation and Analysis of Biomass Energy Consumption and Supplies

After entering all the data in the databases, several calculations were made with regard to consumption and supply. First of all the total consumption was calculated whereby the total amount of residues was divided into a woody biomass part and the agricultural residues part.

In order to have some sort of a check on the general validity of the total consumption of wood fuels consumed by the household sector, as derived from the calculations, a comparison with the standard FAO date (FAO, 1983) for similar areas was made. These calculations showed that using the FAO data the consumption would have been about 29 million tons while the calculation showed an amount of 28.2 million tons. It should be noted that even though the results were reasonably close that this is not a guarantee that the method used has been correct. It merely shows that conditions in Vietnam are more or less comparable to other areas with similar climatic and other conditions.

The sustainable supplies from forests, plantations, scattered trees, waste wood from forest industries, etc. were found to amount to about 20 million tons while the total consumption of wood fuels, including the other non-domestic sectors, was found to be close to 33 million tons, leaving a gap of about 13 million tons. With regard to residues the supplies were estimated as about 35 million tons. Out of this amount 15 million tons were used for other purposes like organic fertilizer, animal feed, etc., over 13 million tons as fuel which leaves a surplus of over 6 millions tons, all on an annual basis.

The calculations also showed that most of the provinces had deficits for both wood fuels as well as residues, others had only a deficit in wood fuels, other only for residues while only a few had surpluses of both wood fuels and residues.

However, in all calculations supplies from other lands like grass lands, non forest lands, etc. were not taken into account because no information at all was available on their tree resources. Evidence from other countries suggest that such lands can supply considerable amounts of wood fuels as well.

No information was available on how the overall gap between consumption and supplies was covered. Part of the gap no doubt is made up by over-cutting of tree resources on forest lands such as wood derived from forest clearing for agricultural purposes, etc. Another part is probably covered by trees from the non-forest lands while also more residues may have been burnt than calculated. However in some provinces, notably along the coastline, it was found that people used everything which was combustible as fuel. This included grass, roots of grasses, leaf litter from trees including from casuarina plantations established for coastal protection and probably, in some isolated cases, also dung. Casual observation showed that the hardest hit were those without land e.g. labourers, fishermen, etc. In some cases they were allowed to take agricultural residues from land owned by relatives or neighbours. However, the practice of buying residues like rice straw, etc. was also quite common.

Based on the gap between the consumption and supplies of wood fuels some options for decreasing the gap were worked out. Two main options were identified: Reducing the demand through improving the efficiency of existing conversion equipment, fuel substitution through improving supplies of other sources of energy as well as increasing the wood fuel supplies.

The latter basically consisted of calculating the amount of wood plantations as well as scattered tree planting required to close the gap. Based on the available information it was realized that in particular the supplies from scattered tree planting supplied a large part of the wood fuels in the country. Improving the supplies through popular participation in tree growing was identified as being a corner stone in efforts to increase the supplies. However, a main problem identified was that pure fuelwood plantations were economically not feasible as existing fuelwood sources by many were considered a "free" good. Only where fuelwood could be obtained as a by-product from tree growing e.g. for pulp wood, poles, timber, etc. could fuelwood be supplied at competitive prices when compared to other wood fuel supply sources.

Besides, little information was available on how existing wood plantations and scattered tree growing fared in terms of survival, growth rates, etc. the socio-economics of tree growing as well as the suitability of available land for such tree growing activities and this would have to be looked into also. However, a question mark was placed whether a market for plantation grown wood existed at present as well as if such a market would be available in the future. This would result in that a larger amount of the wood grown would be destined for the wood fuel market. This in its turn would require a higher wood fuel price than the current market price of wood fuels. Seen the uncertain economic conditions the country was facing, this could not be ascertained.

3.5 Review of Conversion and Processing Technologies

An extensive review of existing technologies both at the domestic level as well as at the non-domestic level was carried out based on the database built up as mentioned in section 3.2. Even though not sufficient information was found to be available, several possible options for improvements were identified. This not only concerned decreasing the wood fuel consumption but also improvements in product quality, working environment, etc. However, with regard to the socio-economic aspects of non-domestic applications in terms of employment and income generation, support to agricultural production and household and community food security, etc. very little information could be gathered. This made analyzing and the identification of options for intervention more difficult.

3.6 Institutional Framework

Within the TFAP normally an extensive review of the institutional framework in the forestry sector is carried out. Unfortunately this normally does not cover the use of wood as a source of energy and consequently no institutions concerned with this topic are covered.

Considering, according to the results of the study carried out, that over 70% of all energy consumed within the country probably is derived from biomass, it appeared from the cursory review that this was not reflected in energy policies nor in institutional support to this sector. The cursory review showed that the institutions which were identified in the short time in general were well staffed but that at the same time they were ill equipped to handle and assist the non-domestic as well as the domestic sector with energy conservation measures, etc.

3.7 Overall Review

Based on the findings conclusions and recommendations were drawn up. These basically pointed out that wood fuels and other sources of biomass energy accounted for a large share of the total amount of energy consumed but that this was not reflected in planning nor in policies for the forestry as well as the energy sector.

Energy planning and policy covered only commercial sources of energy like oil, coal, gas, etc. as was also evident from energy balances which only gave data for these sources of energy. The main reason for the non-inclusion was that very little information existed on which wood fuel and biomass energy planning and policies could be based. For this reason proposals were drawn up to improve the situations by a two pronged approach.

One was to improve supplies by encouraging tree planting activities by developing a planning system for a rational technical and socio-economic viable basis for participatory forestry through land allocation and settlement programs on bare forest lands e.g. forest land without tree cover. For this purpose a vegetation mapping and land capability survey was advocated coupled with a socio-economic study of existing participants in land allocation programs.

The second prong consisted of strengthening the role of biomass energy in a sustainable national energy and economic develop plan. This was proposed to be carried out through improved wood energy information systems, manpower development in the field of biomass energy, strengthening of institutional capabilities, promoting of more efficient use of wood and biomass based sources of energy, etc.

4. CONCLUDING REMARKS

From the foregoing several conclusions can be drawn. One, and maybe the most important one is that the results of such short term studies can never be better than the underlying data resources. Where little data exists many estimates will have to be made while in the case where a lot of data is available the results can be based more on facts. This has a direct bearing on the outcome of the study and consequently on its usefulness. Direct field observations can improve the understanding of the data but it should be realized, seen the size and diversity of the countries involved, that this can only have a superficial bearing on the scope of the data.

However, even though a lot of data may exist on the consumption of fuelwood, often very little knowledge exists on the dynamics involved e.g. fluctuations over time in the demand and probably in the supply as well. Such fluctuations can be in both directions e.g. increases in demand as well as decreasing demand. At the same time even less is known about the supplies.

This phenomenon appears not to be limited to Vietnam alone. In most, if not all studies covered, the same remark of having only a one time estimate of the consumption available is made. In all cases supplies are calculated based on sustainable supplies and the difference between the demand and supply, normally negative (deficit) has to be made up from somewhere and in general this amount is assumed to be obtained by over-cutting forest and tree resources.

However, it should be considered that the wood fuel studies were carried out within a review of forest resources of which wood fuel is only a (small) part and not for the purpose of energy planning. It has to be stressed that within the forestry sector the overall information on forest resources it self in terms of standing stock, growth rates, removal rates other than commercial timber, etc. appears in general also to be limited. Considering this, one can question whether a more exact knowledge on the wood fuel energy demand system without having much information on the supply side would make much of a difference to planners and policy makers for the forestry sector. However, it should also be acknowledged that with a limited insight in the mechanisms of wood fuel demand and supply, planning and policy options which will have to be drawn up for it will have also a shaky base.

Probably the same remark could be made for the much more detailed household energy studies carried in the Philippines and Pakistan. Detailed information is available on the wood fuel and biomass energy demand side but little, probably with the exception of Pakistan, about the supply side. In the case of Pakistan apparently a lot of information has been collected on the role of trees on non-forest lands in the overall wood fuel supplies. However, also here the data on the demand for biomass fuels are "static" e.g. they do not take into account the seasonal, social and cultural influences.

However, more thorough studies can and do give much more information on the shares on the different types of fuel used, availability and use of substitute sources of energy, the source of the supplies, elasticity in demand, energy conservation measures, etc. but still little, if any, information on access to it.

In order to have a better understanding of the wood fuel energy system much more thorough studies would be required. These would be time consuming and costly. Such studies should cover a period of at least a few seasons and besides pure demand and supply should cover also the social and cultural aspects in order that a better understanding can be ensured of the factors which influence wood fuel use and substitution issues. Unless we know how people cope with energy in a complex system of securing food, water, cash, land, health care, markets, credit, etc. and how these factors inter-relate with each other can we suggest solutions to wood energy problems.

A preliminary conclusion may therefore be drawn that wood fuel energy studies as they have been carried out within the TFAP, by making use of existing sources of information, updated through field observations and discussions with local knowledgeable sources of information, can be a cost-effective way of getting some but at the same time a limited insight in the very complex system of wood fuel energy consumption and supply.

It appears that such quick methods often are sufficient to identify bottlenecks and constraints. They may be used to pinpoint to areas which face more problems than others. The time and money saved by using a "quick method" could then be used to carry out more in-depth studies in such areas. These could be either formal surveys or apply rapid appraisal techniques. However, this presupposes that results of these short "quick method" studies are presented in a dis-aggregated manner. By over-aggregating data, much information which may assist decision makers in drawing up action plans, is being lost

On the other hand, savings in time and money could also be used to direct more inputs towards building up an in-country capability of wood fuel and other biomass energy data collection and analysis. The need for this is recognized in all studies carried out. Unfortunately, in most countries the final recommendations for follow up for the forestry sector apparently pay only lip service to this identified need.

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Annex 1

Checklist

It is recommended that the factors outlined under the guidelines should, as much as possible, encompass the points which are listed below under the checklist.

In addition, it is suggested that the missions pay particular attention to the following:

- efforts should be made to use the most u-to-date and reliable information and, whenever possible, organize spot-visits to increase existing information;

- there must be uniformity in the units of measurement used;

- description of the main factors and sub-factors should, whenever possible, be supplemented by tables, charts, graphs and maps;

- in carrying out wood energy sectoral analysis, it is essential that the missions have work contacts not only with the forestry officials, but also with the energy sector and other institutions which have related activities;

- detailed energy balances should be annexed to the reports of missions (which will be part of the fuelwood and energy documents of the TFAP).

Checklist

1. Country Profile

(a) *Geoclimatic Conditions:*

- location, physiography;
- total area, extent of forest and woodland cover, cultivated area (rainfed, irrigated) and other land uses;
- major changes in land use in the last period, also by areas converted from one to another;
- potential resources of coal, oil, gas, etc.;
- type of climate (in terms of temperature and rainfall, etc.).

(b) *Population:*

- size, annual growth rate, projected size;
- distribution by rural and urban sectors;
- highlights on the area of high demographic density;
- occupation or means of livelihood, particularly of the rural population.

(c) *National Economy:*

- natural resources endowment;
- gross domestic product (GDP), present and projected economic growth rates;
- structure of the economy and contribution of each sector to the GDP;
- present and projected per capita income;
- the performance of the economy and future trends.

(d) *Current Energy Situation and Future Prospects:*

- current and foreseen future demand and supply of energy;
- energy balance by source (type of energy) and user sectors differentiated by rural and urban areas;
- per capita energy consumption;
- current energy policies and strategies;
- actions undertaken to narrow the gap between demand and supply and results achieved;
- identification of shortcomings/problems and prospects for overcoming the problems.

2. Wood Fuel Situation

- the importance of the role played by wood fuels in meeting energy needs (rural/urban);
- wood fuel demand and projections (fuelwood, charcoal, wood residues and other processed fuels) by household, agro-industries and non-agro industries, making a clear differentiation between urban and rural users;
- wood fuel supplies and projections (natural forests, woodlots, farm trees, and other plantations);
- accessibility, sustainability of production, volume and yield of wood resources for energy purposes;

- show a geographical distribution of users and suppliers of wood fuels according with the level of demand;
- organization of wood fuel production (individual farmers - gender analysis included - cooperatives, private enterprises, etc.);
- costs of production and income of producers;
- current policies, strategies and objectives of the wood energy sector and the importance placed on wood-based energy in the national plans;
- actions undertaken to correct the supply-demand relationship and results achieved;
- identification of problem/obstacles encountered and prospects for tackling the problems.

3. Wood Energy Conversion/Processing Technologies

- current wood fuel production systems;
- currently used methods and technologies for:
  (a) charcoal production,
  (b) cooking at household lelvel,
  (c) commercial and public services,
  (d) conversion technologies for rural industry;
- present status of wood/charcoal gasification systems for mechanical power and electricity generation;
- prospects for the promotion of more efficient technologies of wood energy uses (kilns, stoves, furnaces, gasification systems, etc.);
- comparative analysis of prospective technologies in terms of economic and technical viability and social acceptability;
- selection of technology and/or improvement of current production methods;
- economic, social and environmental impacts expected from the use of more efficient conversion systems;
- skilled manpower situation and the training activities for the manufacture of equipment and the training activities for the manufacture of equipment (which can be produced locally), equipment installation, operation and maintenance.

4. Marketing of Wood-Based Energy

(a) *Wood Energy Products:*
- Description of wood energy products (fuelwood, charcoal, wood-based electricity, steam) and their quality requirements;
- comparison with other energy products.

(b) *Distribution Systems:*

- Movement of wood fuels from production to consumer centres (direct transaction between producer and consumers, middlemen, etc.) and the various storage stages and systems in the process, marketing practices;
- means of transportation from production site to consumer centres;
- average distance covered by type of wood fuel and cost of transportation;
- the effect of the present distribution systems on consumer prices;
- regulation of the distribution system;

- prospects for improving the present distribution system and expected benefits;
- conclusions.

(c) *Pricing*

- price structure (the cost elements generally included in the structure are: production cost, producer margin, transportation charges, wholesale margin, retail margin and government taxes);
- price trends (price increases/decreases in relation tot he prices of alternative fuels) and the causes for such changes, giving consideration to specific cases of rural areas where fuelwood for households and rural industries and village applications are of free appropriate;
- the effect of price changes on the demand for wood fuel and other alternative fuels;
- supply and demand interaction;
- interfuel substitution (possibilities of substituting wood energy by other competitive fuels);
- government regulations (control systems and their effects on the income of producers and consumer prices).

5. Financial, Economic and Social Aspects

- financial, economic and social costs of wood fuel and other alternative fuels;
- financial, economic and social benefits of using wood fuel considering different beneficiaries, wood fuel producers, industries, householders, etc.;
- national benefits;
- comparative analysis of locally-produced fuels and imported ones;
- examine the social aspects of wood energy activities in terms of employment and income generation;
- role of gender aspects involved in the wood energy systems;
- conclusions.

6. Environmental Aspects

- environmental degradation caused by the overwhelming dependence on forest resources as a source of energy and future trends, also environmental degradation caused by the dependence on alternative organic fuels (agricultural residues, etc.);
- impacts on the environment resulting from improved forest management, creation of new resources (woodlots, farm trees, other plantations);
- impacts resulting from the adoption of more efficient wood conversion technologies;
- possibilities for substitution of wood fuel by other competitive fuels, where possible.

7. Institutional Aspects

(a) *Wood Fuel in the National Energy Policy, Strategy and Planning*

(b) *Planning Process*

- planning techniques (top-down, bottom-up or balanced approach);
- the place of wood-based energy in the national energy plans;
- integration of the wood energy sector in the national economic development plans.

(c) *Organizations*

- the organizations which are directly responsible for wood-based fuels and energy and other concerned organizations;
- institutional strength of the main organizations in terms of staffing, capability and financial resources;
- clarity of organizational responsibility and inter-organizational coordination;
- review and assessment of past and present wood energy activities.

(d) *Training, Research and Extension*

- training activities and the institutional strength and capability to meet the training needs;
- research institutions (their activities and contribution to energy development programs), institutional strength to meet research requirements, level of cooperation with other national, regional and international research institutions;
- extension/extent and intensity of services, institutional strength in terms of qualified manpower, equipment and materials.

(e) *Legislation*

- existing legislation on forestry, energy, land use and tenure and environment;
- general evaluation of the effects of these legislation on energy development programs.

(f) *Energy Policies and Strategies*

- relationship of policies and strategies with the legislation;
- present energy policies and strategies and their effect on the formulation and implementation of energy programs/projects.

(g) *Participation*

- the level of participation of target groups (rural population, communities, particularly women, non-governmental enterprises), other concerned government organizations and external assistance agencies in the formulation and implementation of energy development programs/projects.

(h) *Incentives*

- types of incentives currently used to encourage the adoption of improved energy production methods and technologies;
- effectiveness of these incentive systems.

9. Conclusions and Recommendations

- Conclusions.
- Recommendations on the basis of the conclusions reached.

10. Proposals

- Fuelwood and energy programs.

The Use of Formal Structured Surveys in Wood Energy Consumption and Woodfuel Flow Studies

by

A.C. Pujanes[1]

1. TRADITIONAL ENERGY SOURCES

1.1 Introduction

Data on Traditional Energy Sources (TES) is of critical importance to developing countries in the region as it is a major energy source for them. TES can be classified into two broad categories: (1) biomass and related sources, and (2) animate energy sources. Biomass and related sources include firewood, woodfuels (branches, shrubs, etc.) charcoal, sawdust, crop residues (straw, rice husk, jute sticks, cotton sticks) and animal residues (animal dung, swine wastes). Animal draft power and human labor which are important sources of energy in the Third World traditional agricultural systems form part of the animate energy sources.

Despite the numerous problems encountered in measuring these forms of energy, the collection and analysis of data is very important due to the following reasons:

a) In some cases it provides 80-90% of the total energy consumed in many developing countries.

b) They are used not only in cooking but also for farm operations and transport in most households in the rural areas of developing countries.

c) Significant amounts of labour time is spent in collecting fuels in meeting their "basic needs" which has implications for their income/welfare levels.

d) It has important implications for ecological balance in some regions and requires very careful consideration.

e) Most of the traditional sources are renewable in nature and there are possibilities of significantly improving their efficiency of utilization from current levels.

1.2 Need for TES Surveys

Some statistics on the supply and demand of traditional energy sources coming from agricultural and livestock censuses, farm management surveys and consumer surveys are generally inadequate for planning purposes. Specially designed surveys are required in collecting data on TES due to some of its special characteristics which are as follows:

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a) Most of the biomass resources are obtained as by-products of the overall activities relating to agricultural production, crop processing and livestock maintenance. It is necessary to understand the complex interactions in the production, availability and use of these resources for fodder, fuel, fertilizers, and construction materials.

b) There is no record of supplies of traditional fuels from different sources since majority of poor households in rural areas depend on collected fuels obtained from farms, plantation forests, community land and roadside.

c) Traditional fuels are collected and measured in non-standard units such as bundles, bags, headloads, backloads, baskets, buckets, etc. It is very difficult to get precise measurement from ad hoc surveys since these units are from person to person, region to region and season to season.

d) Consumers do not usually keep records of consumption of these fuels because these are collected, stored and used by various family members over different seasons, primarily for domestic purposes.

e) Contribution of animal power to various agricultural and other activities is difficult to measure due to variety of tasks performed by various animals over different seasons.

f) Due to moisture content, the gross energy content of each category of fuel is different and it varies from one season to another. Thus, "norms" of energy content of these fuels cannot be used as basis for estimating energy consumption.

g) The efficiency of different devices used varies and hence, the useful energy available from various levels varies with end-use devices such as different types of stoves. Again, "norms" based on laboratory tests or ad hoc surveys will be very useful.

It is important to discuss the methodological aspects of collection and analysis of data on these sources in view of the special characteristics of TES data.

1.3 Data for Energy Planning and Policy

TES data needed for energy planning, may be classified according to the following grouping:

a) Energy-use pattern for various agricultural, domestic and industrial activities in different seasons together with the methods of acquisition (ownership, collection, exchange, purchase, leasing, etc.)

b) Relationship of the pattern of energy-use with family size, land holding, cattle population, income, education, organization, etc. so as to predict changes over time.

c) Possibilities of conservation (improved efficiency) and interfuel substitution under different ecological and fuel price scenarios.

d) Assessment of the resource position, i.e. livestock population, forest land, uncultivated waste land, pastures, crop production pattern, pattern of processing agro-products, etc.

e) Possible changes in supply position, i.e. changes in forest area, grazing land, crop pattern, straw-grain ratios, livestock population (size, age), dung production per animal, efficiencies of collection of crop/animal residues, etc.

1.4 Relevance of Survey Data

The data collected from specialized surveys are important because:

a) It can help the policy maker in defining the scope of various projects and programs under the Integrated Energy Planning (IEP).

b) It can be used to evaluate energy strategies, such as (1) improvements in end-use devices such as cooking stoves lamps, pumpsets, etc.; (2) fuelwood plantations on non-agricultural land; and (3) introduction of new technologies such as biogas plants, solar systems, gasifiers and windmills.

c) The data on the type of biomass used for cooking, the efficiency of existing stoves, the time spent in collecting cooking fuels and their alternative uses, the prices of end-use devices and commercial fuels can be used in instituting programs for the improvement of stoves and other devices.

d) The information on availability of biomass sources at the barangay/village and household levels and the demand pattern of energy for various end-uses can be used in defining the size and scope of projects such as biogas plants, gasifiers and solar systems.

e) It would be helpful in assessing the impact of different projects on the households since the surveys would also provide information on the pattern of energy generation and use by individual households.

f) Since the financial viability as well as social profitability of renewable energy projects depends on the pattern of utilization of its output, it is necessary to assess the requirements properly.

1.5 TES Data at the Macro Level

Macro level data on traditional energy sources may be needed to estimate the consumption of these sources at national/regional levels. At the same time, there is also a need to gather information at the micro level, i.e. at the barangay and household levels in order to understand the processes of generation and use of traditional energy sources in the rural areas.

Assessing the demand-supply situation of TES is an important input to energy planning. It is necessary to know that the demand for these sources varies with growth in population, changes in household size, income levels, organization and education. It is also necessary to make supply projections based on agricultural growth, cropping patterns, livestock situations, mechanization, afforestation schemes, etc. These supply estimates will serve as basis for planning supplies of kerosene and LPG as well as determining prices (or taxes/subsidies) for substitute fuels such as kerosene, soft coke, diesel and electricity.

Consumption data of traditional energy sources are usually available from special-purpose surveys. These surveys are sometimes conducted to estimate the quantities and costs of different fuels used by various categories of consumers. Using appropriate population figures, the aggregate national/regional consumption are estimated from the household and per capita level.

The first step for a macro level energy-use survey would be to do a thorough evaluation of existing information. Existing information may also available on either the economic, social, or physical aspects of rural systems and urban areas. It may be useful to coordinate energy surveys with other socio-economic surveys so that a large amount of data on these variables is simultaneously available at the target groups.

The next step would be to define concisely the objectives and the scope of the survey being undertaken as follows:

a) To assess the role of traditional energy sources in meeting the current energy needs of households, industries and commercial establishments.

b) To correlate the existing pattern of fuel-use with the regional distribution of biomass and other resources in the country in order to identify which regions and population are likely to face shortages over time.

c) To relate energy consumption patterns with socio-economic variables such as household size, farm size, income and educational levels, etc. in order to predict changes in energy-use levels and composition.

d) To design energy augmentation and pricing policies so that adverse environmental consequences of energy-use are minimized.

1.6 Scope and Coverage of TES Survey

The scope and coverage would be determined as follows:

a) The target population would be rural and urban households, industries and establishments relying primarily on traditional fuels. This would require a sufficiently large sample to include consumers in different regions, different income levels and size classes.

b) Data would be collected on all the energy sources used for various activities. Both animate and biomass resources would be included along with commercial sources such as coal, electricity and petroleum products. Biomass resources would have to be properly defined and desegregated.

c) Information on the quantities of different fuels which are purchased, collected, home-grown or obtained in exchange would be collected. In the case of purchased fuels, data on prices paid will have to be obtained.

   For collected fuels, it would be necessary to know if these have been collected from own farms/orchards, other person's farms/orchards, forests, road-side trees, etc.

d) The measurements of biomass fuel consumption would require actual weighing and observations since records of traditional fuel usage are generally not kept. Measurements may be required to reflect variations in moisture content, availability of biomass fuels and consumption norms.

1.7 Sampling

The target population of a large-scale survey like this is generally very large, thus, a multi-stage stratified random sampling approach would need to be used. It is also advisable to study the sampling designs and procedures of socio-economic and industrial surveys that have been previously conducted. The Primary Sampling Unit (PSU) could be a barangay, district or a province.

In the Philippines Rural Energy Needs Survey in 1982, the PSU is the barangay. The barangays are chosen with probability to the number of households in the barangays. The National Census and Statistics Office (NCSO) stratifies all barangays in a province into six economic activity strata, namely, palay, corn, other agricultural products, fishing, manufacturing and other economic activities. The allocation of sample households to the six strata was first made at the national level. Then, using the resulting national allocation levels as controls, these were allocated to different provinces. Finally, a total of 30,000 households were selected as samples.

There is no standard procedure for selecting villages/towns and households/establishments. The actual strata and procedure for selection would have to be decided on the basis of available information on different strata and households. Similarly, there is no standard size of the number of households to be surveyed. This may vary depending upon the available resources and the level of uniformity in energy consumption across households, villages and regions. It may be useful to keep the following criteria in mind at the time of selection of villages, farms and households: rural/urban, hill/plains/desert, electrified/non-electrified, irrigated/non-irrigated, high/medium/low income and educational levels, predominantly agricultural/industrial, etc. In any case, before a sampling design is implemented, expert advice from statisticians should be sought.

1.8 Type of Data to be Collected

In general, the major users of TES are households, industries and commercial establishments. Energy may be required in various forms for cooking, heating, lighting, transportation, crop production, crop processing and industrial units.

In collecting data, emphasis should be given on:

a) Consistent measurements of quantities when fuel is used in non-standard units.

b) Careful distinction among the different variety of fuels such as logs, twigs, branches, fallen/dead trees, self-grown firewood, etc. which are usually classified under "fuelwood".

c) The methods of obtaining various fuels, e.g. purchase, collection and exchange along with necessary data on prices, sources of collected fuel, time spent on collection, terms of exchange, etc.

1.9 Methods of Data Collection

The data collection may be made through personal interviews using two sets of structured questionnaire: (1) The Barangay or Village Questionnaire which covers the following: identification, location of the barangay or village in the context of distance from rail/road head, production resources such as land, livestock, infrastructure, etc., energy resources and their ownership, cropping pattern, manpower utilization and occupation and education levels. (2) The Household Questionnaire which has items relating to household size, occupation, income, pattern of fuel collection and use, ownership of energy-using devices, modes of transportation, industrial activity, etc. the village questionnaire may be filled up by individual village leaders and may have to b handled by the supervisor of the interviewing team. Respondents for household questionnaire may be heads of households for general questions and housewives for questions relating to cooking, fuel collection time, fuel processing, smoke-missions, etc. It may also be necessary to include women interviewers in the team. A man-women team working under the overall guidance of a supervisor is expected to give good results since this requires proper training and coordination.

Questionnaire should be tested and revised through panel discussions and mock interviews. The format, design and content of questionnaire may have to be revised after field discussions with statistical agencies, feedback from workers and comments from energy experts. a thorough analysis may be required regarding the number of questions, length of interview, understanding of technical terms, etc. before a questionnaire form may be finalized. If computers are to used for consistency checks on data as well as for tabulation and statistical analysis, it is important that computer programmers are associated with the designing and testing of questionnaires, etc. A clear specification should be drawn up, in close consultation with data users, of the tabulations required.

Actual measurement/weighing may be necessary for certain fuels where non-standard units are used although most of the answers will be obtained through recall method. The seasonal variations in fuel availability, moisture content, consumption norms, etc. may be handled through one or two repeated visits for this specific purpose. This may also be handled by recall methods if more than one visit is not possible.

1.10 Analysis of Data

One of the important components of the study is the analysis of survey results. The full benefits from the study are not obtained when sometimes a detailed analysis of data is not carried out.

We can group into two the methods of analyzing survey data:

a) Tabular and graphical presentation of data to present an energy profile of the region/village.

b) Statistical and econometric analysis of data to present inter-relationships between energy profile and socio-economic variables.

2. HOUSEHOLD ENERGY CONSUMPTION SURVEY IN THE PHILIPPINES

2.1 Overview of the Household Sector

The Philippines had some 10.8 million households in 1989. Majority of the population are living in the countryside because of the climatic condition conducive to crop raising and availability of aquatic resources. This was reflected in the 1989 Survey where the rural folks comprised almost three-fifths of the population. Their reported source of livelihood were farming and fishing. Rural households from the 1977 level of 29.0 million grew to 34.8 million in 1989 or a 1.5% annual average growth rate. On the other hand, urban households posted a higher annual average increase of 4.1% for the twelve year period.

Electrification also plays a vital role in the household sector. Accessibility to power supply was very beneficial to the Filipino families as it improved their way of living. Likewise, household activities became easier because of the amenities available.

A review of the country's residential energy demand patterns usually delved across urban and rural areas with emphasis on the end-use of the various types of fuel. The four household energy surveys conducted in the past were very useful because they were able to focus on the energy usage by type of end-uses i.e. cooking, lighting, refrigeration, space cooling, and ironing as well as the uses of electrical appliances. The conventional fuels used by the households were electricity, LPG, and kerosene while the traditional fuels were fuelwood, charcoal and crop residues (e.g. coconut shell, rice husk, sawdust).

2.2 Completed Household Energy Demand Surveys

Baseline information on the energy consumption of the residential sector was compiled from the documented statistical surveys of the former Ministry of Energy and Office of Energy Affairs. They were used to determine and analyze the demand trends of the sector from 1977 to 1989. Following are the surveys used in drawing up the historical household energy consumption pattern.

a) 1977 Urban/Rural Household Energy Demand Survey
b) 1979 Urban Energy Consumption Survey
c) 1982 Rural Energy Needs Survey
d) 1989 Household Energy Consumption Survey (HECS)

The initial study in residential energy demand was undertaken by the former Ministry of Energy in 1977. The survey covered 14,600 respondents in both urban and rural areas throughout the 12 regions in the Philippines. Primarily, the database includes information on the quantitative approximation of commercial and traditional energy forms used nationwide by the households. Consumption patterns relating to socio-economic variables are likewise objectively given emphasis.

The second study was the 1979 Urban Households Energy Consumption Survey which was also conducted by the Ministry of Energy. This survey focussed on the energy consumption patterns, conservation practices and attitudes toward fuel substitution by households in Metro Manila and in 12 key metropolitan areas. A multi-stage probability sample size of 1,999 was used. Mobility patterns vis-a-vis road motorfuel consumption was included in the reported total

urban energy demand for 1979. Since this study classified motive power as part of the transport sectoral account, the only end uses considered were household cooking, lighting, ironing refrigeration, space cooling and other uses of appliances.

The next study was a profile on the energy usage of rural households. This was undertaken in 1982 by the Ministry of Energy. It was designed to determine the consumption and saving patterns for the different type of fuels and different household energy consuming activities in the countryside. Household size, income, fuel prices and energy expenditures were cited as economic indicators of energy demand patterns.

The most recent was the 1989 Household Energy Consumption Survey (HECS) funded by the Joint World Bank/UNDP/Bilateral Energy Sector Management Assistance Program. The National Statistics Office (NSO) adopted a stratified two-stage cluster sampling design wherein the barangays classified either as urban or rural were the primary sampling unit (PSU) and the households within each sample barangay comprised the secondary sampling unit (SSU). The details of this survey is discussed in the next part of this paper.

2.3 Household Energy Consumption Survey (HECS)

2.3.1 Objectives

This study was designed to:

a) Assist the government in defining important issues in household fuel supply and demand growth by developing a national database on current fuel consumption patterns that will remain on-line at the Office of Energy Affairs (OEA).

b) Assist the government in analyzing this information to develop appropriate policies and specific programs to improve access to energy supplies, promote efficient use of wood, LPG, electricity and other fuels and stimulate interfuel substitution where appropriate.

c) Strengthen analytic capabilities of OEA in the household energy sector through joint work of ESMAP and OEA staff on data analysis and project evaluation.

d) Complement an on-going World Bank rural electrification study by providing a more view of household energy supply and demand in rural areas, thereby setting electricity use in context.

2.3.2 Methodology of the study

A. Sample Frame

The HECS sample included 5,082 households, roughly half urban and half rural, comprising one panel of the NSO Integrated Survey of Households sample frame. As such, the HECS sample frame adopted NSO's two-stage cluster sampling design that treats urban and rural areas of each province as principal domains, draws barangays within each domain in the first stage and households within each selected barangay in the second stage. On the average, each urban household in the sample represents about 1,600 actual rural households while each rural household surveyed represents approximately 2,400 rural households. NSO provided exact weights (raising factors) for each sample barangay to reflect 1989 demographics as projected from 1980 census figures. The World Bank study team revised these weights in light of the more accurate distribution of urban and rural households contained in preliminary figures from the 1990 census that were made available during the main mission. All summary tables and data used in the analysis have been weighted to reflect the number and distribution of households in 1990 and have been discounted to 1989 by 2% to allow for growth in household formation.

B. Survey Instrument and Survey Execution

The HECS questionnaire was jointly prepared by the study team members of NSO and OEA and was designed into parts. The main section, enumerated to the household head or other family member chiefly responsible for fuel purchasing and use, collected information on choice of fuel, source of fuel, mode of acquisition, stove and appliance ownership, and fuel consumption for different end uses. A supplementary survey form was filled out at the barangay level to determine access, availability, and prices of fuels in the market. The field survey team was composed of NSO field personnel, namely: Regional and Provincial Census Officers, Statisticians who supervised survey teams, and Census Field Workers who were principally responsible for collecting data from the respondent households.

The enumerators were instructed to validate reported household consumption by referring to electricity bills, directly measuring the weight of woodfuels the household reported using daily, and verifying the size and nameplate wattages of major appliances. Separate manuals of instructions were developed for enumerators and data processing staff to guide field data collection and data entry of completed questionnaires.

C. Data Validation

The data set was first subjected to a number of data validation procedures that were designed to identify inconsistencies, keypunching errors, miscoded entries, and otherwise unreasonable responses to ensure that the data set was suitable for statistical analysis. This was followed by a set of screens through which households that had missing, incomplete or inconsistent data for key variables were eliminated from the analysis. A household was omitted from the analysis if they: 1) used a fuel but reported no quantity figures; 2) did not cook; 3) did not light; or 4) did not report income.

Of the 5,082 households in the original sample, 610 or about 12% of the sample were excluded from the analysis as a result of this cleaning procedure. Raising factors were revised to compensate for households excluded from the original sample.

D. Modification of HECS Demand Estimates to Fit Known Supply Figures

National fuel consumption estimates were compared to known supply figures as a check on consistency of the HECS results after the data was cleaned and weighted to represent the 1989 household distribution. Also, per capita woodfuel use by households that use fuelwood or charcoal as a primary cooking fuel were checked for consistency by comparing HECS estimates with similar estimates from other Asian countries with moist tropical climates.

2.3.3 Problems encountered

Some of the problems encountered during the processing of data are as follows:

a) Estimates of fuel consumption cannot be ascertained by some respondents which likewise affected the outcome of data tabulation.

b) Conversion of various local units (variation in the size and types of bottles used, different sizes of wood bundles) to a common unit were not clearly defined.

c) Key-punching errors of data encoded resulted to longer data cleaning.

d) Some of the instructions in the enumerator and processing manual were not very clear.

Likewise, the disparities in the sampling framework, survey methodology and the formulated questionnaires of the past three surveys and HECS led to some constraint in reconciling the available information. There were instances when the data available did not conform to the desired format, thus resulting in some data gaps. In addition, the variation in the sampling design of the 1979 and 1982 surveys for urban and rural households resulted in some discrepancy with the percentage of households using electricity.

In spite of the constraints, the overall statistics obtained from the reference materials were very useful in depicting the energy share of the household sector.

2.3.4 Survey limitations

One of the possible criticisms against the study might be its disregard for the accounting of human and animal energy for domestic chores. Additionally, as inherent in all sample surveys some room must be allowed for the possible sampling errors and memory lapses of the respondents. Thus, interviewers were advised to probe other details relating to a particular item and based on such details relating to a particular item, come up with an estimate of the items value. Also, sometimes, respondents deliberately under reported or over reported, depending on motivational factors such as indifference, need to impress, etc. Also, the length of the questionnaire may have taxed the respondent thus affecting the quality of his responses. Finally, the season in which the survey was undertaken may also biased the aggregated results.

2.3.5 Survey cost

The Household Energy Consumption Survey which was supervised and administered by the Philippine Office of Energy Affairs was funded by the World Bank through its Energy Sector Management Assistance Program (ESMAP). The total budget of the data preparation and analysis phase including the Woodfuel Supply Systems Study was US$ 53,000. The fund was released by the International Bank for Reconstruction and Development (IBRD).

To carry out the Survey work, the services of the National Statistics Office (NSO) was contracted. The NSO was responsible for all aspects of Household Energy Consumption Survey (HECS) up to and including the provision of validated data in a form suitable for statistical analysis. The budget allocated for its services as a rider survey totalled US$ 37,800. This amount is relatively lower compared to an independent survey. This arrangement likewise prove to be a good step in establishing a good linkage with NSO. As an offshoot of this undertaking, the NSO has included the HECS in their regular survey program. To date, they plan to undertake this kind of survey every four years.

2.3.6 Survey results

Household Energy Consumption Trend

A. <u>Fuel Mix in the Country</u>

As population is rising, the fuel consumption is also increasing. Table 1 shows the total energy demand of households in 1977 and 1979. The country's residential consumption increased by an annual average growth of 1.5%.

The recorded total household consumption for conventional fuels increased by 1.2% from 1,016 KTOE to 1,028 KTOE for 1977 and 1989 respectively. Among the conventional fuels, kerosene usage was substantially reduced by 54.4% from 1977 to 1989 while demand for electricity reflected a two-fold increase in 1989 compared to the level twelve years ago. Likewise, LPG consumption in 1989 more than doubled. Interfuel substitution among the three conventional fuels was very prominent during the twelve year span. Kerosene was initially the most widely sued fuel because of its accessibility, but with the improvement in power supply and LPG distribution network in the provinces, consumption for both electricity and LPG also increased.

When the oil equivalent value was calculated, it shows that there is still continued reliance on traditional fuels in the country. It accounted for 73.5% and 77.7% of the aggregate demand in 1977 and 1989, respectively. Fuelwood was the most predominant household fuel providing 62.2% of the total demand in 1989. Charcoal and crop residues contributed 4.5% and 11% each. Traditional fuels were intensively used because of its accessibility, low cost and customary usage.

Notably when the oil replacement value for the traditional fuels was obtained, the energy consumption of households in 1989 totaled 1,921 KTOR which was 10.4% higher from 1,721 KTOR in 1977. this implies that the energy demand in the residential sector continued to row as population increases gradually by 2.5%

Table 1: Total Household Energy Consumption
(By Type of Fuels in the Philippines)

	1977				1989			
	KTOE		KTOR		KTOE		KTOR	
	Volume	% Share	Volume	% Share	Volume	% Share	Volume	% Share
Conventional Fuels	1016	26.5	1016	59.0	1028	23.3	1028	53.5
Electricity	131	3.4	131	7.6	444	9.7	444	23.1
LPG	111	2.9	111	6.4	231	5.0	231	12.0
Kerosene	774	20.2	774	45.0	353	7.6	353	18.4
Traditional Fuels	2818	73.5	705	41.0	3572	77.7	893	46.5
Fuelwood	1699	44.3	425	24.7	2859	62.2	715	37.2
Charcoal	727	19.0	182	10.6	207	4.5	52	2.7
Crop Residues	392	10.2	98	6.7	506	11.0	126	6.6
Total Energy	3834	100.0	1721	100.0	4600	100.0	1921	100.0

Sources: 1977 Urban/Rural Household Energy Demand Survey
1989 Household Energy Consumption Survey

B. Fuel Mix in Urban and Rural Areas

The total energy in the metropolis for the twelve year period (1977-1989) declined by 5.6% to 1,369 KTOE due to the reduction in consumption of traditional fuels. The energy requirements in the countryside, however, increased to 5,229 KTOE in 1982 but was trimmed down to 3,230 KTOE in 1989.

On the other hand, when the oil replacement value expressed in KTOR was calculated on a sub-sectoral basis, the energy demand in the urban areas increased by 17.1% to 842 KTOR while 1,078 KTOR was obtained in the rural areas. this can be attributed from the variation in consumption of conventional and traditional fuels for the two sub-sectors.

Urban consumption for conventional fuels in 1989 significantly increased by 48.6% to 667 KTOE compared to 449 KTOE in 1977. Electricity dominated at 341 KTOE while LPG was recorded at 176 KTOE. After twelve years, a downtrend in kerosene demand (150 KTOE) was noted in the metropolis. It declined by almost one-half due to interfuel substitution and progress in electrification. Moreover, respondents from the recent survey claimed that conservation measures were undertaken to save expenditure on their household fuel consumption.

On the other hand, urban consumption for traditional fuels namely fuelwood and charcoal have respectively declined to 508 KTOE (25.9%) and 94 KTOE (65.4%) while demand for crop residues (e.g. coconut shell, rice husk, woodwaste) reached 100 KTOE in 1989.

The rural consumption for conventional fuels went down by 24.7% to 381 KTOE in 1982. The drop was due to the notable decrease in kerosene from 482 KTOE in 1977 to 108 KTOE in 1982. In addition, LPG share from the aggregate demand comprised only less than 2% in the countryside. But electricity usage recorded an increase of 159 KTOE for a span of five years (1977-

1982). The 1989 survey results however, showed that electricity went down by 50.5% to 103 KTOE from the 1982 figure of 208 KTOE while kerosene level of 203 KTOE grew by 87.9%. It should also be noted that the variation in the sampling design and methodology of the surveys have possibly affected the comparative electricity consumption figures. Sales report from the power utilities, however, showed that electricity consumption in the residential sector continue to rise by 9.3%.

Table 2: Total Household Energy Consumption
(By Type of Fuels in the Urban and Rural Areas

KTOE

	URBAN		**RURAL**			**PHIL**	
	77	89	77	82	89	77	89
Conventional Fuels	449	667	506	381	361	1016	1028
Electricity	81	341	49	208	103	131	444
LPG	76	176	35	65	55	111	231
Kerosene	292	150	482	108	203	774	353
Traditional Fuels	996	702	1824	4848	3869	2818	3571
Fuelwood	686	508	1014	3045	2350	1699	2858
Charcoal	272	94	456	1264	113	727	207
Crop Residues	38	100	354	534	406	392	506
Total Energy	1445	1369	2390	5229	4230	2834	4599

Sources: 1977 Urban/Rural Household Energy Demand Survey
1982 Rural Energy Needs Survey
1989 Household Energy Consumption Survey

The share of traditional fuels in the rural household energy use have been reduced. In 1989, it contributed 88.8% while it was 92.7% in 1982. Fuelwood consumption of 2,350 KTOE in 1989 was 22.8% lower from 3,045 KTOE in 1982. but it still remained the most predominantly used fuel by the rural households, Usage of charcoal and crop residues in 1982 grew to 1,264 and 534 KTOE respectively. But households have reduced their consumption of charcoal by 91.1% and crop residues by 24% in 1989.

C. Fuel Mix in Electrified and Non-Electrified Urban/Rural Areas

The households in the electrified area consumed 2,937 KTOE, 43.4% higher than in the non-electrified area. This signifies that as development proceeds, there is also a boost on the household energy requirements. Fuelwood is still predominantly used in both zones which accounted for almost 54.4% to 75.9% share in the aggregate demand. charcoal and crop residues were also used in substantial proportion at 161 and 303 KTOE, respectively, in the electrified area. The food habits and customary cooking practice of suing fuelwood, charcoal and crop residues accounted household consumption of traditional fuels to be significantly higher. On the other hand, the total conventional fuel demand in the energized area was 876 KTOE, 82.6% more than in the non-energized area. It can be attributed to the better distribution network and accessibility of electricity, LPG and kerosene to the households.

Moreover, the demand for LPG and kerosene in the urban electrified area registered a greater proportion at 174 and 120 KTOE respectively. Usage of kerosene was significant in the rural non-electrified area because it was basically used for lighting.

Table 3: 1989 Total Energy Consumption of Households By Electrified and Non-Electrified Areas

(KTOE)

	Electrified Area			Non-Electrified Area			Phil.
	Urban	Rural	Sub-total	Urban	Rural	Sub-total	Total
Conventional Fuels	635	241	876	32	120	152	1028
Electricity	341	102	444				444
LPG	174	53	227	2	2	4	231
Kerosene	120	85	205	30	118	148	353
Traditional Fuels	535	1526	2061	168	1343	1511	3572
Fuelwood	374	1223	1597	135	1127	1262	2859
Charcoal	87	74	161	7	39	46	207
Crop Residues	74	229	303	26	177	203	506
Total Energy	1171	1766	2937	200	1463	1663	4600

Source: 1989 Household Energy Consumption Survey

D. Components of a Household Energy Strategy for the Philippines

Several important issues have been identified which are critical to the development of a meaningful country's household energy strategy:

* Electricity generation requires large capital investments and saving electricity through investments in end use efficiency can be much more cost effective. government can play a critical role in obtaining this economic potential by promoting electricity conservation through appropriate pricing, information provision and setting performance standards for key appliances.

* LPG and kerosene distribution is hampered by a strict price control system. Easing these restrictions on retailers could serve to increase competition and enhance the extent of the distribution system and increase the reliability or service.

* The urban poor and rural households rely on biomass fuels, the dominant household cooking fuel in the philippines. Though the country is well endowed with an abundant biomass resource base, some local areas are showing signs of resources tree. Therefore the government should act to support management practices in these areas that will ensure that woodfuels will continue to be supplied in an environmentally sustainable way.

*	The efficiency of charcoal production in the Philippines is variable, but appears to be low on average, thereby wasting fuelwood and agricultural residues as feedstocks. there is scope for expanding charcoal production in areas where biomass is going to waste. Therefore, efforts should be made to improve the efficiency of transformation and to include logging waste materials as additional feedstock.

In order to fulfill the principal objectives of this study, it is therefore recommended that initiatives be taken in four key areas namely: 1) residential/ commercial electricity conservation; 2) simplification of the LPG and kerosene pricing system; 3) woodfuel management and price monitoring; and 4) institutional strengthening.

3. STUDY OF FUELWOOD SUPPLY SYSTEMS FOR SIX MAJOR URBAN AREAS

3.1 Background

In November 1989, the Philippines, through the then Office of Energy Affairs (now known as the Department of Energy, DOE), undertook a **Household Energy Strategy Study** under the auspices of the joint World Bank/United Nations Development Programme/Bilateral Aid energy Sector Management Assistance Programme (WB/UNDP/ESMAP). The first part of the Study is the HECS which was discussed fully in the second part of this paper. the other major component is the study of wood fuels supply systems in five pre-selected urban areas and Metro Manila. In general, the survey should work backwards from retailers to transporters to wholesalers and woodcutters/charcoal makers in an effort to define the market structure. In essence, this is a pioneering and exploratory investigation of the fuelwood supply systems for the following six major urban centers in the Philippines: (1) Metro Manila, (2) Metro Cebu, (3) San Fernando, La Union, (4) Santiago and Alicia, Isabela, (5) Cagayan de Oro, Misamis Oriental, and (6) Tacloban, Leyte.

3.2 Objectives of the Study

The objectives of this study are as follows:

a)	To characterize the marketing channels, intermediaries and other actors involved in the marketing process.

b)	To describe the pattern and practices of fuelwood and charcoal distribution.

c)	To evaluate the present marketing and distribution pattern in terms of efficiency.

d)	To determine the sources and destination of fuelwood and charcoal traded.

3.3 Methodology

The study was undertaken under the supervision of the Non-Conventional Resources Division (NCRD) of the OEA while the actual implementation was contracted to the following parties:

a) University of the Philippines in Los Banos-Forestry Development Center (UPLB- FDC) for the Metro Manila Study.

b) University of San carlos-Affiliated Noncon energy Center (USC-ANEC) for the Metro Cebu Study

c) Don Mariano Marcos Memorial State University-Affiliated Noncon Energy Center (DMMMSU-ANEC) for the San Fernando, La Union Study.

d) Isabela State University-Affiliated Noncon Energy Center (ISU-ANEC) for the Santiago, Alicia and Isabela Study.

e) Visayas State College of Agriculture-Affiliated Noncon Energy Center (VISCA- ANEC) for Tacloban, Leyte Study.

f) Xavier University-Affiliated Noncon Energy Center (XU-ANEC) for the Cagayan de Oro City, Misamis Oriental Study.

The Memorandum of Agreement (MOA) entered into between the OED and the UPLB-FDC stipulated that the latter will have over-all responsibility for the analyses of the data generated from the study. The other five sub-contractors, on the other hand, will undertake the data analysis for their specific area of coverage only.

The criterion used for the identification of the study sites was based on a provincial categorization relative to the area's fuelwood situation. The provincial categorization is a typology based on the relationship between the woody biomass resource-base and the population density of the province. The criteria used in the categorization are the population density of each province taken from the data provided by the National Statistics Office. On the other hand, the data for the woody biomass resource-base was derived from the secondary data taken from the Forestry Statistics, a regular publication of the Forestry Management Bureau of the Department of Environment and Natural Resources (DENR-FMB). The total land area, forest land, land covered by coconut trees and land under other forms of cultivation of each province were also assessed. Consequently, four categories were identified to typify the various fuelwood situations in the country. The four categories are:

a) **Low Population Density/High Woody Biomass Areas.** These are provinces in when balance of population density and woody biomass areas are unlikely to have any significant fuelwood shortage in the foreseeable future. The Isabela Study will attempt to characterize this situation.

b) **Medium Population Density/Medium to High Woody Biomass Areas.** These areas generally consist of provinces which are predominantly agricultural areas which have lower population densities, some significant remaining forests and abundant coconut tree resources.

It can also be predicted that in general, fuelwood shortage is unlikely to occur although localized stress may be experienced. This may be associated with pockets of higher population density. The Tacloban, Leyte Study was selected to represent this scenario.

c) **Medium to High Population Density/Medium to Low Woody Biomass Areas.** These are areas where there are no widespread fuelwood supply problem at present but are expected to contain pockets of stress which could give cause for concern in the future. Coconuts are crucial fuel resource in most provinces under this category. The Cagayan de Oro City Study is expected to shed light on the characteristics of this category.

d) **High Population Density/Low Woody Biomass Resource Areas.** These are densely-settled agricultural lowlands which apparently are areas of potential fuelwood stress and which merits investigation. The San Fernando, La Union province exemplifies this scenario.

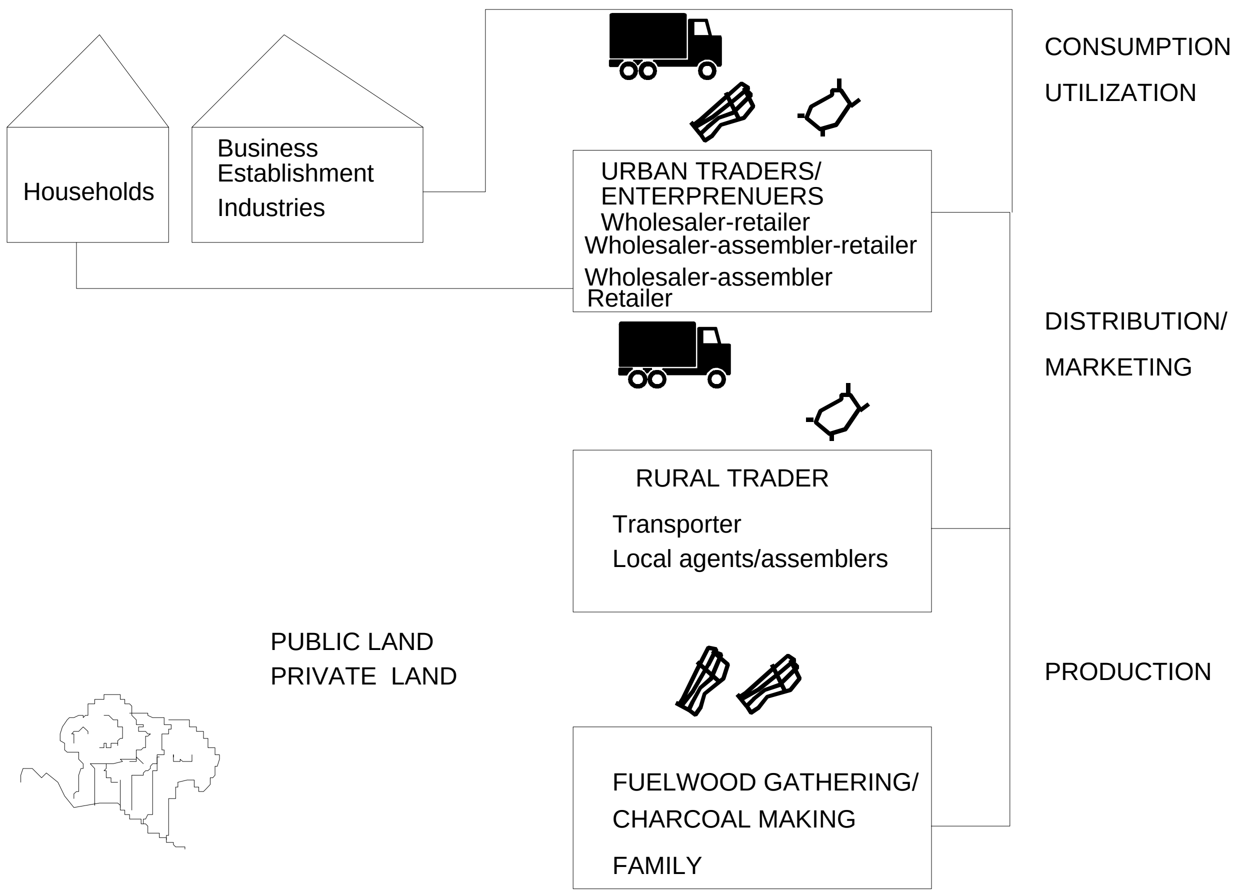
The Metro Manila for Luzon and the Metro Cebu for the Visayas were specifically chosen as the other two study areas due to the high complexity of their urbanization.

The conceptual framework used in formulating the study has three major components as shown in Figure 1:

1) production wherein the actors involved are fuelwood gatherers and charcoal makers;
2) distribution and marketing represented by the urban and rural traders (wholesalers and retailers), and transporters; and
3) consumption/utilization wherein the main respondents are the households, commercial and industrial establishments.

Pioneering and exploratory in nature, the study was faced with the problem of paucity of secondary data. A **reconnaissance survey** was initially undertaken for each of the six study sites. Interviewers were designated at the ports/piers, roadsides, public markets, business establishments consuming fuelwood and/or charcoal to conduct a **rapid rural appraisal (RRA)** of the various actors. this was aimed at getting basic information such as sources and destination of fuelwood and charcoal transported, frequency of transporting, volume of product transported, fees and dues collected in the process of transporting and marketing, species of wood and charcoal frequently traded, and practices and negotiations made in the process of trading and distribution, etc. The results of the reconnaissance survey were complemented by secondary data taken from data bases of relevant agencies such as the Department of Trade and Industry (DTI), Department of Agriculture (DA), DENR, Bureau of Agricultural Statistics (BAS), Philippine Coconut Authority (PCA), National Mapping and Resource Information authority (NAMRIA), Philippine Ports Authority (PPA), and the Provincial Department Offices (PDOs).

Figure 1: Conceptual Framework Used in the Analysis of the Supply System of Fuelwood and Charcoal.



After the conduct of a reconnaissance survey for the six urban areas, a consultation meeting was held among the leaders of each of the sub-studies. There was a sharing of salient information gathered and individual experiences which gave insights to the formulation of the formal structured survey instruments. The formal structured survey was chosen as the primary medium for the generation of data for the following reasons:

a) There is an absence of an organized and systematically managed database in the fuelwood/charcoal sector as it is a highly informal sector. Cognizant of the fact that fuelwood would remain to be a valuable traditional energy source necessary to fuel economic growth, a wood energy program must be formulated and managed to ensure its sustainable contribution in the economy. This proposition, however, initially requires the establishment of wood energy database.

b) The use of a formal structured questionnaire will result in the generation of a comprehensive picture of the current situation of the sector.

c) The existence of wide spatial variations in practices in production, distribution and consumption of fuelwood and charcoal also necessitates a procedure which will have provision for easy reference, manipulation and editing of information.

Afterwards, sets fo questionnaires were drafted for the following actors:

a) Fuelwood Gatherer
b) Charcoal Maker
c) Rural Traders
d) Urban Traders
e) Urban Industries
f) Rural Industries
g) Transporters/Wholesalers/Retailers

These questionnaires were pre-tested in each of the study sites and were finalized later.

3.4 Sampling

The inavailability fo sufficient secondary data, i.e., knowledge of population of each actor identified, justifies the use of purposive sampling. However, the statistical rule of thumb in estimating the sample frame of at least 30 sample population was strictly observed.

The actual data gathering started with the consuming actors like the fuelwood and charcoal-based industries. Based on the list of industry category taken from the available censuses, a stratified sampling was made to ensure a good representation of the various fuelwood and charcoal-based industries. Moreover, the level of consumption (i.e., high, medium and low wood/charcoal consuming industries) was one of the variables used in the selection of establishments to be sampled. The interview schedule included questions such as: business profile, pattern of consumption, volume consumed, seasonality of consumption, sources of supply of fuelwood and charcoal, mode of acquisition of fuel used, preferences for certain species, perceptions and attitudes towards fuelwood and issues/concerns in charcoal-making.

The distribution and marketing of fuelwood and charcoal are largely unrecorded. In addition, many conduits and persons are usually involved in the process. Hence, the initial problem is the identification of the persons and channels of the supply systems. Information on sources and mode of acquisition of fuels used which were gathered from the fuelwood and charcoal-based industry survey served as guide inputs in the identification of population and the sample frame. The inspection and ocular survey of the different market places also proved to be very helpful in pinpointing the fuelwood and charcoal depots.

In general, the key players in the woodfuel distribution can be classified as urban and rural traders:

a) The urban traders are the sellers of fuelwood and charcoal operating in the city. Included in this category are the wholesaler-assembler, wholesaler-assembler-retailer, wholesaler-retailer, and retailer. A wholesaler is one who sells fuelwood and charcoal in large volume at any given time. Several involved in gathering or bringing together fuelwood and charcoal from different sources to accumulate a large volume are called assemblers. A retailer, on the other hand, is one who sells in small quantity directly to the consumers.

The sampling technique used is purposive sampling with random selection. the traders were personally interviewed and requested to show samples of fuelwood in different sizes and shapes. These samples were then placed in bags of different packaging sizes and were later measured using a pocket weighing scale. The specific part of the tree being used as fuelwood was also properly noted.

The information gathered include the following: household information, socio-economic profile, basic information pertaining to the trading business of the actor, sources of wood and charcoal traded, mode of transport, pattern of fuelwood and charcoal distribution, marketing and disposal as well as perceptions on important issues regarding fuelwood and charcoal trading.

b) The rural traders are the persons responsible for bringing in fuelwood and charcoal from the rural areas to the urban areas. They are composed of the transporters and dealers of the fuelwood and charcoal. These group of traders usually procure fuelwood and charcoal directly from the source, i.e. form gatherers and charcoal makers, from sawmill operators, from local agents, and from assemblers of fuelwood and charcoal in a particular area.

The sample provinces were purposively selected based on any or a combination of the following criteria: (1) most frequently mentioned source of fuelwood and charcoal; (2) location or proximity of the province in the case of Metro Manila; (3) presence of some unique characteristics based on the area's geographical location and approximate forest cover.

The sample manipulates and barangays were identified through the assistance of the Provincial Offices and community offices of the DENR know as the PENROs and CENROs respectively. All traders or transporters of fuelwood and charcoal are required by the DENR to secure a permit to transport and certificate of origin before they can transport their fuelwood to the areas.

Very few respondents were interviewed to represent this group of traders. Firstly, they were very hard to locate as they were frequently on the road. Secondly, it was very easy for them to deny that they were traders transporting fuelwood and charcoal.

In the supply chain, the most important actors are the fuelwood gatherers and the charcoal makers. Fuelwood are usually collected while charcoal are produced by farmers not only for their own use but also as a source of income.

The sample barangays were selected based on the following criteria: (1) concentration or proliferation fo fuelwood gathering and charcoal making activities; and (2) relative peace and order situations of the area.

The accumulated information gathered from the rural traders, urban traders, industries operating in the urban area and secondary data provided by the CENROs were all useful in the final identification of sample barangays and ultimately the gatherers and the charcoal makers.

The interview schedule included questions on the following items: household information regarding the respondent, duration of involvement in the gathering and/or charcoal making activities, seasonality of the activity, sources fo woody biomass, storage and marketing practices, fees or taxes paid and attitudes, perceptions and awareness of issues regarding fuelwood gathering and charcoal making.

The widely and thinly dispersed nature of production and consumption systems and the lack of organized markets were the major difficulties encountered in the conceptualization of the study. It was, however, made easier with the diagram shown in Figure 1. the framework was very useful in weaving the story of the flow of supply from the rural to the urban areas.

A number of statistical tools were used in describing and analyzing the data gathered. These included frequency counts, percentages, means and ranges.

3.5 Survey Cost

The Fuelwood Supply Survey costs about $19,000. Of this amount, 40% or $7,500 went to the Metro Manila sub-study while the remaining 60% was equally distributed to the five other sub-studies undertaken in La Union, Isabela, Leyte, Cebu and Cagayan de Oro.

As stipulated in the MOAs entered into with the five ANEC implemented sub-studies, their activities include conduct of the survey and analysis of the data. It should be noted that the funding received by each ANEC for the sub-studies were optimized and the joint undertaking between the NCRD-OEA and the ANEC in the implementation of this project came out to be a very cost-effective scheme. The funding received were mostly utilized to cover administrative cost while manpower requirement was augmented by the ANEC staff. Post evaluation of the study, however, showed that the Cebu sub-study should have received a bigger amount due to the level of its urbanization. The situation in Metro Cebu is almost parallel to that of the Metro Manila.

The Metro Manila Sub-Study received a bigger chunk of the project cost because it served as a focal point of the activity. The functions of the Metro Manila Sub-Study proponent includes the following:

a) Conduct of the Metro Manila Sub-Study which impinges on many provinces neighboring to the study site;

b) Overall management of the conduct of two consultation meetings among the leaders of the various sub-studies. Expenses include meeting paraphernalia, and accommodation of the participants. Each meeting lasted for about three to four days each;

c) Formulation of the general interview schedule;

d) Overall analyses of results of the six sub-studies;

e) Packaging of the report.

3.6 Problems Encountered

Following are the problems encountered in the course of the project implementation:

a) **Inadequacy of Secondary Data**. The wood energy is largely an informal sector and this is the reason for the existence of wide data gaps. This resulted to the inability to determine the population set and consequently the sample frame for the study. Therefore, date on volume of fuelwood gathered and traded, charcoal produced and traded should not be seriously considered but rather observations on patterns and practices which are less sensitive to sample size should be properly noted.

b) **Time constraints**. The activity was undertaken for a period of six months, i.e. from November 1989 to May 1990. Due to the paucity of secondary data available and lack of knowledge of sources of relevant information, substantial time was utilized in the collection of these information. This greatly affected the overall time table of the study.

In the course of the project implementation, it was noted that there are certain information which will have differing answers at a various seasons fo the year. It was therefore recognized during the latter part of the survey that it would have been ideal if the study was conducted continuously for a year to account for the different situation at different seasons of the year. This however, was remedied by asking the enumerators to return to their original respondents if they are easy to locate. In this case, a new set of questions were asked in order to get additional insights in this different scenario. However, the answers were largely based on the respondents capacity to recall.

c) **Financial Constraints.** The tight financial schedule of the project harshly affected the analysis portion of the study. It was noted that a statistician could have been tapped to package a comprehensive analysis of the study showing correlation analyses of relevant variables.

d) Spatial variations on physical measurements of wood. On recurring problem revolved around the difficulty in arriving at an accurate measurement of quantities sold and consumed since each supplier and region have varying sizes of their wood.

3.7 Survey Results

Below are the major findings of the detailed market studies undertaken by the six contracting parties:

A. Biomass Resources

Fuelwood and charcoal sources vary from region to region and demand on government forest is much less than expected at the start of the study.

Residues from logging and sawmill are important sources of fuel in certain areas. There is undoubtedly a scope for increasing these flows if production continues at current levels.

Village woodlands in agricultural areas are an important source of fuel in most regions. This provides a source of income for farming families and is intensively managed in some cases. Little is known, however, of village or farm wood fuel management practices in upland areas.

B. Economic Significance

The fuelwood and charcoal supply industries are important sources of income for many rural households. Close to 10% of all rural households receive income from selling wood or charcoal. On the other hand, the urban fuel markets provide an average of 40% of the cash income for these households.

C. Pricing and Market Efficiency

The wood and charcoal markets are classic examples of informal sector activities as they operate totally outside the formal regulatory mechanisms of the state. The study indicates that they operate efficiently to link fuelwood resources with urban markets, and do so without utilizing significant quantities of capital. The supply systems appear to be flexible and responsive to consumer demand.

D. Management of the Resource Base

The analysis of the biomass situation indicates that the overall national picture for these fuels is extremely favorable and that there is no immediate cause for concern widespread woodfuel shortage in the household sector.

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Methodologies For Wood Energy Supply Studies in Pakistan

by

Gary Archer[1]

1. INTRODUCTION

The Pakistan Household Energy Strategy Study was designed to provide information on household energy supply and demand in Pakistan, including both commercial and traditional fuels. Development of effective energy planning for the household sector in Pakistan required information on the available supply of traditional household fuels, including fuelwood and burnable crop residues. Although some fuelwood information was available for areas of forest under Government control, there was evidence that a considerable amount of fuel was being supplied from trees grown on farms, from collection on rangelands and from crop residues such as cotton sticks. It was therefore necessary to collect data on woody vegetation elsewhere throughout the country and on crop residue yields.

The survey of traditional fuel supply was to be completed within one year, to coordinate with the parallel survey of household energy demand. There was a need for a national sampling frame, both for the vegetation inventory itself and also to enable the results to be spatially linked with the demand survey.

2. METHOD

2.1 Sampling Frame

The distribution of biomass resources in Pakistan is a complex of natural and cultivated vegetation. Natural vegetation types range from high-altitude conifer forests (Cedrus deodara, Abies pindrow, Pinus wallichiana) through tropical thorn forest (Acacia modesta) to arid desert where almost the only vegetation is dwarf palm (Nannorrhops ritchieana) in watercourses. Over this is imposed the effect of human cultivation, mainly in the form of irrigated and rain-fed agriculture, with a major part of the wood resource occurring as planted trees on farmlands.

Satellite imagery was used to provide accurate and up-to-date information on the type and extent of natural and cultivated vegetation throughout Pakistan. Multi-stage sampling (Langley, 1969; Titus et al., 1975) was used to maximise efficiency. A national sampling frame for the first stage was created from the multi-temporal analysis of NOAA AVHRR data, which was in the form

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of monthly images of vegetation activity covering six annual growing seasons; this was combined in a geographic information system (GIS) with ancillary geographic data including topography, climate and the extent of irrigated farmland. Availability of six years of satellite data allowed the development of the concept of "core" and "non-core" areas, to discriminate between areas where the zonation was relatively constant from year to year and areas where it varied with time; details are given by Millington et al. (1993).

The resulting agro-ecological zonation at a resolution of approximately 4 km provided a basis for selection of Landsat TM scenes for the second stage of sampling. Table 1 lists the 14 zones and their frequencies within Pakistan. Sampling units were then selected within each Landsat scene for field measurement of woody biomass and crop residues.

Table 1. Agro-ecological zonation of Pakistan (after Millington et al., 1993).

Zone	Description	Area (km^2)	Percent
1	Hyperarid desert	58,738	6.7
2	Arid desert	193,604	22.1
3	Transitional arid/semi-arid rangelands	117,833	13.4
4	Moderate productivity semi-arid	74,819	8.5
5	High productivity semi-arid	61,180	7.0
6	Sub-tropical rain-fed agriculture	27,878	3.2
7	Permanent snow	25,019	2.9
8	High mountain valleys	18,964	2.2
9	Alpine and temperate scrub and forest	94,747	10.8
10	Temperate and sub-tropical Himalayan foothills	10,637	1.2
11	Marginal irrigated	1,940	0.2
12	Moderate productivity irrigated	74,533	8.5
13	High productivity irrigated	111,717	12.7
14	Indus delta swamps	5,619	0.6
TOTAL		*877,227	100.0

* includes the area of Jammu and Kashmir on the Pakistan side of the Line of Control.

2.2 Selection of Landsat Imagery

Twelve Landsat scene locations were selected, to cover the full range of agro-ecological zones, including "core" and "non-core" areas as explained above, population distribution, growing areas for crops with useful residues, and adequate representation of each of Pakistan's four main provinces. Figure 1 indicates the locations of 120 km x 120 km squares from within each of the twelve Landsat scenes, within which sampling units were selected for field work.

All Landsat TM imagery was acquired and supplied by the Satellite Ground Station of the Pakistan Space and Upper Atmosphere Research Commission (SUPARCO). Acquisition dates were chosen from SUPARCO archives to maximise the value of the Landsat imagery for both woody vegetation and crop sampling. This required a trade off between the optimal season for classifying woody vegetation (June-July) and for classifying crops at their stage of maximum greenness (March-April for the spring or *rabi* harvest and September for the autumn or *kharif* harvest). Because most of the wood supply was known to come from cultivated farmlands, imagery selected primarily for crop detection could also provide a sample frame for sampling trees on farms. The relative scarcity of areas of closed forest in Pakistan together with crop ephemerality made it more cost effective to time the imagery primarily to capture crops.

Of the two harvest seasons, the *rabi* is almost entirely wheat, whereas the *kharif* includes a wide range of different crops; *rabi* imagery was therefore selected for all twelve locations so as to achieve as uniform a spectral signature as possible for cultivated farmland, with backup *kharif* coverage of six scenes from the most important agricultural areas for cross checking purposes. Largely cloud free imagery was selected with dates as close as possible to the *rabi* optimum: February for arid areas with early maturing rain-fed crops, March for irrigated farmlands on the plains and April-May for highland agriculture. Dates selected for the six *kharif* images were as close to September as possible. Table 2 lists the imagery used.

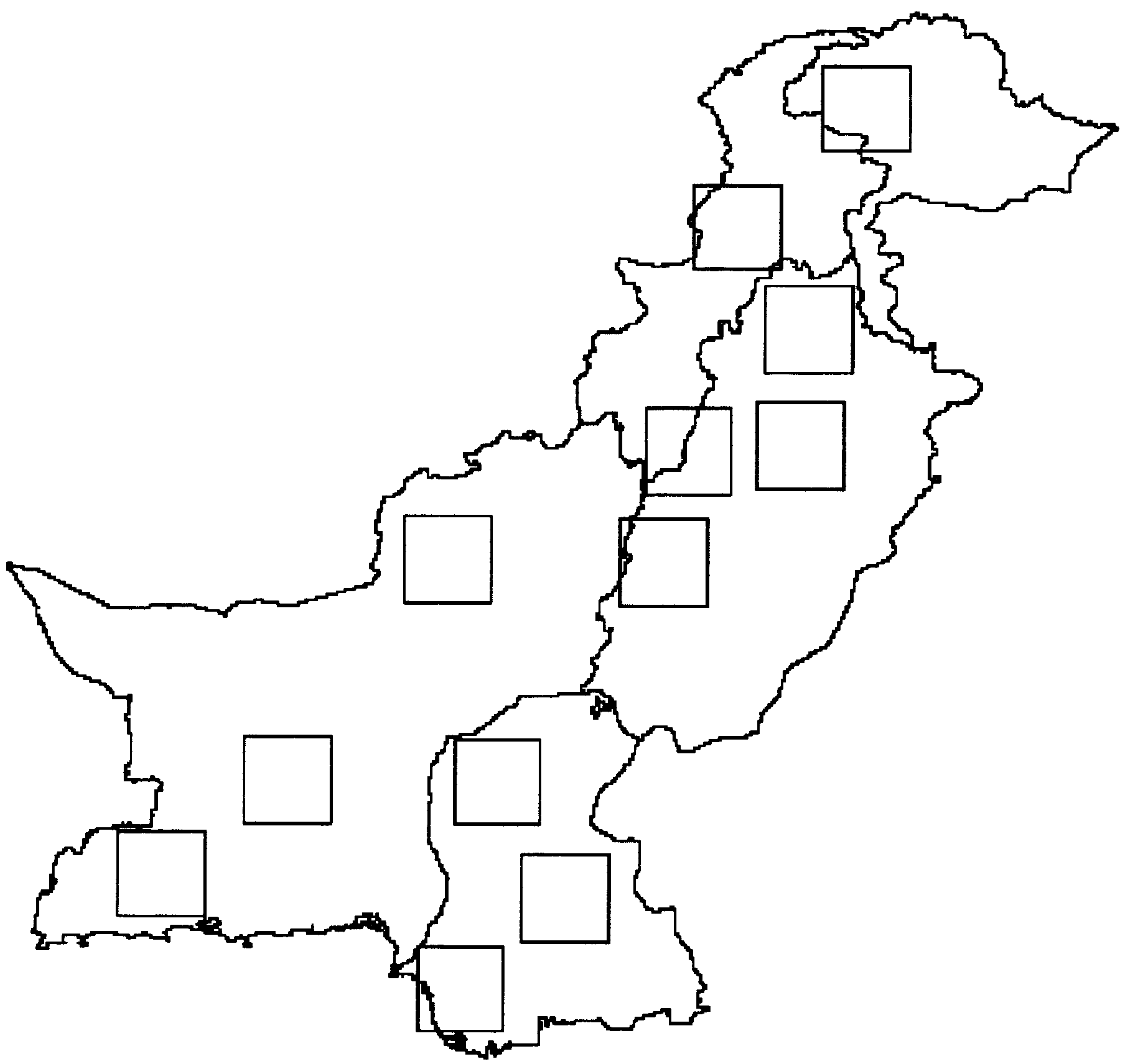

Figure 1:
Locations of 120 km x 120 km squares from within each of the twelve Landsat TM scenes, within which sampling units were selected for field work.

Table 2. Landsat TM imagery used.

Scene No.	Path	Row	Acquisition date (for *rabi* harvest)	Acquisition date (for *kharif* harvest)
1	150	35	24-Apr-90	
2	150	37	07-Mar-90	28-Sep-89
3	150	38	08-Apr-90	12-Sep-89
4	151	36	14-Mar-90	
5	151	38	14-Mar-90	
6	151	39	14-Mar-90	19-Sep-89
7	151	42	14-Mar-90	19-Sep-89
8	152	41	05-Mar-90	26-Sep-89
9	152	43	05-Mar-90	
10	153	39	12-Mar-90	04-Sep-90
11	154	41	15-Feb-90	
12	155	42	21-Jan-90	

2.3 Ground Truthing and Ground Control

Topographic maps at a scale of 1:50,000 were available for most of the areas covered by the selected Landsat imagery. The maps were based recent surveys in more developed areas, but were sometimes based on old British reconnaissance surveys in more isolated areas. To overcome some limitations in map accuracy, position fixes were taken at up to sixteen ground control points within each landsat TM scene using global positioning system equipment.

Ground truthing was carried out in conjunction with field work for ground control. Because of time constraints, no more than four days could be spent within each image. Travel between ground control points provided useful transects over large parts of each image and further land cover details were recorded at most control points while position fixes were in progress.

2.4 Image Classification and Sample Selection

Image classification was designed to provide sampling frames for both the woody biomass and crop residue surveys. Field work for the woody biomass component of the survey was not highly time-critical, but field measurement of crop residues such as cotton sticks and maize stalks had to be carried out within a week before harvest. The time schedule for the project made it necessary to consider alternatives to the lengthy procedures involved in conventional digital image classification, especially for twelve Landsat TM scenes involving more than two gigabytes of digital image data. The approach used was as follows:

(i) The NOAA AVHRR agro-ecological zonation had been shown to provide a sound sampling frame at the national level (Millington et al., 1993); this was confirmed during ground truthing for the twelve Landsat scenes and from overlay comparisons. The zonation provided a basis for introducing consistency between scenes, in that the proportion of vegetation cover classes falling with each zone would be typical of that zone.

(ii) For the woody biomass survey, ground truthing confirmed that all vegetation cover classes derivable from the Landsat imagery contained significant woody biomass resources. This included cultivated farmland which, although having spectral signatures overwhelming characteristic of crops, included an important tree component. Because no reliable information was available on sampling variances within each class, and there was no time to collect adequate data, the only feasible sampling allocation was area proportional for each class.

(iii) For the crop residue survey, Government agricultural statistics for crop areas and yields provided more reliable data than could feasibly be collected during the time available for the survey. The most efficient objective for the field survey was therefore to establish residue yields per unit area of crop, and crop residue:yield ratios. Landsat imagery was used for the crop residue survey to ensure that field sampling covered the full range of cropped sites and to estimate the proportion of cropped land per agro-ecological zone; with imagery timed to match maximum crop greenness it was found possible to develop satisfactory crop classifications quickly.

Variable probability sampling was used for selection of primary sampling units (PSUs) for field work, to ensure robustness with respect to any variation in classification accuracy between images. Software was developed to select primary sampling units (PSUs) directly from the precision-corrected classification for each image, with probability proportional to the number of vegetated pixels within each PSU. The same classification was then overlain on the AVHRR agro-ecological zonational within the GIS. Sampling expansion factors could then be developed from (i) the proportion of vegetated image pixels within each PSU and (ii) the vegetated area falling in a given agro-ecological zone within each Landsat scene. This approach automatically compensated for any remaining under- or over-classification within each scene. If, for example, the vegetation in a given scene was under-classified the expansion factors for individual PSUs would be inflated, but the vegetated area falling within each agro-ecological zone in the scene would be correspondingly reduced; if the vegetation was over-classified the effects would compensate in reverse.

A total of 1100 PSUs were required for field sampling for the woody biomass and crop residue surveys. To enable the work to be completed on time, computer software was developed to automate the printing of precision-corrected satellite images at 1:50,000 scale centered on each PSU, and to specify PSU locations on matching topographic maps at the same scale. The printed subscenes were used by the field teams together with the topographic maps to locate each PSU in the field.

2.5 Field Sampling and Measurement

Efficient field sampling designs were essential to permit the woody biomass and crop residue surveys to be completed in parallel, within a time frame of not more than 10 months. Two-stage field sampling was used, with secondary sampling units (SSUs) selected from within each PSU to measure biomass resources in the field. No reliable information was available on sampling variances for woody biomass and crop residues for different sizes of primary and secondary sampling units, and there was no time to carry out adequate pilot studies. Sampling unit sizes were determined on the basis of past experience, to provide a balanced two-stage design which could be applied efficiently in the field.

For the woody biomass survey, a PSU size of 400 x 400 metres was used. Four SSUs were selected by systematic sampling within each PSU, spaced 200 metres apart. 3P sampling (Grosenbaugh, 1964) with variable radius field plots was used for maximum efficiency; this provided a flexible sampling scheme which worked well in almost all field situations and ensured that field team time was well targeted towards the tree sizes which contributed most of the standing biomass. As well as measurements of tree size, all trees were assessed for other factors relevant to their use for fuel, such as extent of crown damage caused by lopping for fuel, and for amenity value such as household shade, occurrence in graveyards and roadside plantings. Productivity estimates were obtained where possible, either by taking increment cores from tree species with visible annual rings or by questioning landowners about the ages of planted trees.

Methods for measuring crop residues used for fuel not been previously developed for large scale work on a national basis. A methodology was adopted which allowed estimates of crop residues to be generated on both an area basis (tonnes per hectare of cropped land) and a ratio basis (tonnes of residue per tonne of crop yield); this provided the flexibility of two methods of estimation. The main target crops were, in decreasing order of importance of their residues as fuel: cotton, sugar cane, maize, rice and wheat.

For the crop residue survey, agricultural Area Sampling Frame methodology developed in Pakistan (USAID, 1988) was used as a guide. A PSU size of 300 x 300 metres was used, with SSUs located randomly in randomly selected fields of target crops within each PSU. Field sampling and measurement methodology were closely modelled on the Area Sampling Frame approach, to create consistency with any future surveys carried out after the Area Sampling Frame methodology is employed for future surveys of crop yields in Pakistan.

3. RESULTS

By the end of both the woody biomass and crop residue surveys it was clear that the sampling and field methodology had proved effective. Validation checks of approximately 10 percent of the field sample sites showed that PSUs had been accurately located on the ground. For the woody biomass survey, more than 93 percent of the PSUs contained measurable woody vegetation, indicating that the sampling frame was efficient. For the crop residue survey, although the sampling frame derived from the Landsat imagery was no more specific than cropped land regardless of type of crop, target crops with measurable residues were still found in more than 84 percent of the crop residue PSUs.

When the Landsat classifications were imported into the GIS and overlain on the agro-ecological zonation the vegetation distribution matched well with the zones. Overlaying the vegetation stratum derived from the Landsat imagery on the agro-ecological zonation provides a robust and effective second stage sampling frame, in that zonal differences are also reflected in both the proportions of vegetation types and in the quantities of vegetation biomass per hectare.

The thirteen zones (excluding permanent snow) from the agro-ecological zonation were both collapsed and split into eight zones for sampling stratification, as shown in Table 3.

Table 3. Modified agro-ecological zonation for sampling stratification.

Zone	Description	Modified Zone	Description
13	High productivity irrigated	1	High productivity irrigated (North)
		2	High productivity irrigated (South)
11	Marginal irrigated	3	Low productivity irrigated (North)
12	Moderate productivity irrigated	4	Low productivity irrigated (South)
6	Sub-tropical rain-fed agriculture	5	Rain-fed agriculture
8	High mountain valleys	6	Forested, scrub and high-lands
9	Alpine and temperate scrub and forest		
10	Temperate and sub-tropical Himalayan foothills		
14	Indus delta swamps		
3	Transitional arid/semi-arid rangelands	7	Semi-arid
4	Moderate productivity semi-arid		
5	High productivity semi-arid		
1	Hyperarid desert	8	Desert
2	Arid desert		

Summary results for the woody biomass and crop residue surveys by modified zone are given in Tables 4 to 8.

Table 4. Biomass standing stock and productivity

Zone	Total PAK	Irr high north	Irr high south	Irr low north	Irr low south	Barani	Forested/ Highland	Semi-arid	Desert
Zone area (km2)	877,227	91,848	19,870	31,864	44,609	27,878	129,966	253,832	252,342
	mil tonnes	tonne/ha	tonne/ha	tonne/ha	tonne/ha	tonne/ha	tonne/ha	tonne/ha	tonne/ha
Twigs	31.39	1.41	0.98	1.28	0.13	0.46	0.63	0.04	0.05
Growth	4.36	0.26	0.09	0.20	0.02	0.07	0.05	0.00	0.00
Roundwood	96.41	2.52	3.00	3.63	0.70	1.01	3.09	0.22	0.16
Growth	7.46	0.27	0.19	0.47	0.07	0.06	0.15	0.02	0.01
Timber	73.19	2.51	1.47	3.14	0.52	0.11	2.32	0.17	0.01
Growth	5.13	0.24	0.08	0.29	0.05	0.00	0.10	0.01	0.00
Shrubs	9.78	0.01	0.10	0.35	0.59	0.03	0.23	0.01	0.09
Growth	5.74	0.01	0.09	0.29	0.46	0.01	0.10	0.01	0.04
(million tonnes)									
Total standing	210.78	59.19	11.02	26.78	8.66	4.46	81.66	11.16	7.85
Total wood growth	22.70	7.08	0.91	3.98	2.66	0.42	5.22	0.94	1.48
Total fuel growth	20.13	5.98	0.82	3.51	2.55	0.42	4.56	0.80	1.48
Twigs fuel growth	10.10	2.44	0.35	1.56	2.14	0.24	2.01	0.20	1.16
Round fuel growth	10.03	3.55	0.47	1.96	0.41	0.18	2.55	0.59	0.32

Table 5. Diameter distribution (trees with visible dbh only).

	Total PAK	Irr high north	Irr high south	Irr low north	Irr low south	Barani	Forested/ Highland	Semi-arid	Desert
Area (km2)	877,227	91,845	19,872	31,863	44,609	27,878	129,967	253,832	252,342
<5 cm	3.26	6.62	0.16	18.89	0.49	0.75	7.66	2.40	0.00
10 cm	6.64	16.33	4.78	29.75	4.57	6.29	18.82	1.72	0.08
20 cm	2.67	8.36	2.61	4.77	1.77	2.11	7.54	0.95	0.04
30 cm	0.88	2.74	1.46	3.44	0.64	0.58	2.28	0.14	0.02
40 cm	0.34	0.79	0.79	1.35	0.23	0.11	1.04	0.06	0.03
50 cm	0.17	0.23	1.30	0.45	0.09	0.06	0.46	0.03	0.07
60 cm	0.07	0.06	0.54	0.22	0.03	0.01	0.22	0.01	0.03
70 cm	0.02	0.02	0.06	0.04	0.01	0.00	0.09	0.00	0.01
80 cm	0.01	0.00	0.02	0.02	0.00	0.00	0.05	0.00	0.00
90 cm	0.00	0.00	0.01	0.01	0.00	0.00	0.02	0.00	0.00
100 cm	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
105+ cm	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00
Total/ha	14.08	35.14	11.74	58.93	7.83	9.91	38.20	5.31	0.27

Table 6. Crown condition due to lopping (trees with visible dbh only)

	Total PAK	Irr high north	Irr high south	Irr low north	Irr low south	Barani	Forested/ Highland	Semi-arid	Desert
Area (km2)	877,227	91,845	19,872	31,863	44,609	27,878	129,967	253,832	252,342
0% removed	8.99	18.65	7.08	39.79	4.91	4.54	24.69	4.56	0.19
25% removed	2.33	8.65	0.99	7.22	1.09	2.07	6.10	0.37	0.00
50% removed	1.64	5.92	1.17	6.53	0.54	2.81	4.01	0.13	0.01
75% removed	0.68	1.15	0.81	3.50	0.66	0.28	2.24	0.11	0.02
All removed	0.45	0.77	1.70	1.89	0.62	0.21	1.17	0.13	0.05
Total/ha	14.08	35.14	11.74	58.93	7.83	9.91	38.20	5.31	0.27

Table 7. Amenity value (trees with and without visible dbh)

	Total PAK	Irr high north	Irr high south	Irr low north	Irr low south	Barani	Forested/ Highland	Semi-arid	Desert
Area (km2)	877,227	91,845	19,872	31,863	44,609	27,878	129,967	253,832	252,342
None	13.13	37.50	11.53	33.72	8.03	19.85	38.20	3.31	0.21
Roadside	0.82	1.73	0.55	4.30	0.04	0.15	1.66	0.77	0.00
Household	1.75	2.42	1.11	23.85	0.22	0.02	1.27	1.23	0.18
Hedges	0.53	3.05	0.00	0.06	0.00	0.00	1.38	0.00	0.00
Graveyards	0.12	0.06	0.12	0.00	0.00	0.16	0.73	0.00	0.00
Total/ha	16.36	44.75	13.30	61.93	8.29	20.17	43.25	5.31	0.39

Table 8. Production of crop residues by zone ('000 tonnes)

	Total PAK	Irr high north	Irr high south	Irr low north	Irr low south	Barani	Forested/ Highland	Semi-arid	Desert
cotton	8,243	1,383	1,704	1,129	0	0	0	0	12,459
sugarcane	7,777	1,831	831	2,407	4	17	0	0	12,884
maize	1,834	32	189	54	55	1,272	31	1	3,468
rice	4,806	1,087	305	1,957	0	0	0	0	8,155
wheat	11,360	1,648	2,310	1,210	1.002	1,793	1.261	69	20.654

4. DISCUSSION

It is a relatively straight forward exercise to obtain good estimates of standing stock for the woody biomass resource. Reliable estimation of woody biomass productivity for a resource ranging from slow-growing junipers to fast-growing poplars and eucalypts on irrigated land is not so simple. Productivity estimates were obtained for proportion of the resource from increment corings or reliable age estimates from landowners, augmented with data from yield tables for Pakistan species. To deal with the problem that the age of much of the wood resource is not known, which limits the application of conventional forestry yield tables based on age, growth models were developed based on relative growth rate dependent on tree size. The growth of each tree in the sample was separately modelled, using models of relative growth rate which varied with total tree biomass, species, extent of crown damage due to lopping and agro-ecological zone.

The preceding tables show some interesting patterns, which are directly relevant to the problem of assessing and modelling supply and demand of biomass fuels. Fifty percent of the woody biomass standing stock is found in the irrigated zones, but the estimated wood productivity for these same zones is 64 percent of the national total. This confirms the importance of irrigated farmlands as sources of wood. The higher relative growth rates are a direct consequence of the tree size distributions in the irrigated zones; as can be seen from Table 5 there are large numbers of small trees in these zones, which implies that trees are generally managed by farmers on short rotations of about five to ten years.

The extent of crown lopping is a strong indicator of fuelwood scarcity. This is shown in Table 6. In the irrigated zones the weighted average proportion of trees with severe lopping (75 percent or more of the crown removed) is 8 percent of the total; in the desert zone the proportion is 26 percent. This reflects the wood scarcity in desert areas. An interesting statistic is the very low proportion of severe crown damage in the semi-arid zone - only 4 percent. This contrasts greatly with the desert zone and may reflect the fact that desert vegetation is generally concentrated in very limited areas where water is available and human pressure is greatest, whereas the semi-arid vegetation tends to be somewhat more dispersed.

Table 7 shows tree distribution by amenity value. Only a very small proportion of trees - those occurring in graveyards - could be considered excluded from normal patterns of wood harvesting. Overall, this percentage is only 0.7 percent.

Annual production of crop residues is shown in Table 8. Of the residues shown, only cotton sticks make a significant contribution to the national biomass fuel budget, with approximately 50 percent of the total being consumed. Other crop residues have predominant end uses other than household fuel: bagasse from sugar cane is almost all used for fuel during sugar production and other crop residues are used almost entirely for fodder.

Results from the HESS biomass supply survey are integrated with results from the demand survey to produce a database for household energy planning. Projections of future supply and consumption can be combined with other data such as responses from farmers on numbers of trees planted. Table 9 shows two scenarios from an analysis which combines these data with two different assumptions on future tree planting. This can provide very useful input to policy makers to intelligently monitor the national management of woody biomass resources and so ensure sustainability of supply in the long term.

5. CONCLUSIONS

Use of satellite imagery at two scales together with GIS data and efficient multi-stage sampling designs allowed a national inventory of woody vegetation and crop residues in Pakistan to be carried out quickly and efficiently. An effective agro-ecologicl zonation enabled the results of woodfuel supply and demand surveys to be well integrated. The work was completed within severe time constraints and is contributing to the successful development of a household energy planning database for Pakistan.

Table 9. Combination of supply and demand with different assumptions on future tree planting.

(a) Assumption 1: current levels of tree planting (125 million trees per year) have developed over the past five years and will be sustained at current levels. The long term outcome is that levels of standing stock are maintained.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total Stock Incl Planted		209.2	202.4	194.9	186.9	178.3	172.3	168.8	168.0	170.2	176.0	182.4	189.6	197.6	206.1	211.3	211.7	206.2
Initial Stock	210.8	200.9	188.3	172.7	154.3	136.4	122.5	113.1	108.7	109.6	113.0	115.5	116.9	117.1	116.1	113.7	109.8	104.1
Productivity	22.7	21.6	20.3	18.6	16.6	14.7	13.2	12.2	11.7	11.8	12.2	12.4	12.6	12.6	12.5	12.2	11.8	11.2
Consumption	32.6	34.2	35.9	37.0	38.1	39.3	40.5	41.7	42.9	44.2	45.5	46.8	48.2	49.4	50.7	52.0	53.3	54.7
Surplus/Deficit on Initial Stock	(9.9)	(12.6)	(15.6)	(18.4)	(21.5)	(21.0)	(20.1)	(18.8)	(16.9)	(14.5)	(15.4)	(16.5)	(17.7)	(18.9)	(20.3)	(21.8)	(23.6)	(25.5)

(b) Assumption 2: current levels of tree planting (125 million trees per year) have developed over the past five years and will decline to 100 million per year. The long term outcome is that levels of standing will slowly decline.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total Stock Incl Planted		209.2	202.2	194.3	185.6	176.0	168.4	162.8	159.4	158.5	160.7	159.5	158.1	156.6	154.4	147.4	134.4	114.0
Initial Stock	210.8	200.9	188.3	172.7	154.3	136.4	122.5	113.1	108.7	109.6	109.5	104.4	97.4	88.4	77.1	63.4	46.9	27.2
Productivity	22.7	21.6	20.3	18.6	16.6	14.7	13.2	12.2	11.7	11.8	11.8	11.2	10.5	9.5	8.3	6.8	5.0	2.9
Consumption	32.6	34.2	35.9	37.0	38.1	39.3	40.5	41.7	42.9	44.2	45.5	46.8	48.2	49.4	50.7	52.0	53.3	54.7
Surplus/Deficit on Initial Stock	(9.9)	(12.6)	(15.6)	(18.4)	(21.5)	(21.0)	(20.1)	(18.8)	(16.9)	(14.5)	(19.4)	(21.3)	(23.4)	(25.6)	(28.1)	(30.8)	(33.9)	(37.4)

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Methodologies for the Study of the Wood Energy Situation in a Rapidly Urbanizing Area: Case Study of Cebu City, Philippines

by

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OVERVIEW

The energy crises experienced by the world in the 1970's made energy a very important area of study. Various disciplines, from the basic sciences to engineering, from economics to the various social sciences, got involved in the study of energy as related to their respective fields. And through the years, an increasing number of students and professionals have immersed themselves in the study of energy.

In itself, energy is a complex system. Compounding the situation is the fact that it is within the more complex human activities related to production, transformation, conversion and consumption of energy whose interaction results to an energy system subject to continuous change. This process of change is normally brought about by market adjustments and technological change. Thus, it is recognized that energy issues involve not only physical and technological issues but also economic, social, cultural, political and environmental which may not be quantifiable (Heruela, 1988).

Thus, if energy is an important component of economic development, then, it is necessary to assess systematically the supply and demand of different types of fuels in formulating energy policies and in planning for strategies of the development of such fuels. This is especially true if one recognizes the notion that the choice of a particular fuel depend upon various factors like availability, reliability, costs, etc. (Balamiento, 1988).

Woodfuel is a vital source of energy in two-thirds of the developing countries in Asia. Its uses are numerous ranging from traditional cooking, to food processing industries, to small-scale village industrial activities and applications. Studies have shown that rural households and industries depend on fuelwood for their daily energy needs. Over the years however, wood resources have become scarce, and in some developing countries of the region, supply is facing acute scarcity. The situation is compounded by the fact that these countries have very little, or in some cases, no oil reserves to depend upon for their energy needs. Failure to address this problem, and provide measures to improve existing condition, will make the future of these countries a bleak one (Silva, 1989).

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In the Philippines, woodfuels (including charcoal and other biomass residues) account for 90% of energy for cooking in rural areas, and close to 70% of that in urban areas outside Manila (Soussan, 1991). Despite this importance, little is understood of the ways in which these fuels are harvested, traded and consumed. Such a lack of understanding typically stems from the complexity of most woodfuel systems (involving a multitude of small-scale agents who rarely keep any record of production and use) and the low priority given to this sector by most LDC governments (Bensel and Remedio, 1991).

It is in this context of trying to understand better the nature and scope of the wood energy situation that the Office of Energy Affairs Non-Conventional Resources Division (OEA-NCRD) through its established Affiliated Non-Conventional Energy Centers (ANECs) throughout the country have vigorously undertaken studies investigating the seemingly complex system of woodfuel production and markets.

The ANEC is a Program conceived and created by OEA (now Department of Energy) aimed at establishing linkages between OEA-NCRD and strategically- located universities and agricultural colleges which will act as the agency's local partners in the implementation and promotion of the use of non-conven tional energy systems. Since its inception in 1987, 15 ANECs have already been established in 11 regions of the country. Over the last 5 years the ANEC network have served as research and extension arms of the OEA. A typical ANEC activity would include the conducting of surveys on non-conventional energy use, research into the potentials of non-conventional energy such as biomass/wood, solar, mini-hydro energies (OEA-NCRD, 1989) (Bensel and Remedio, 1991).

In the province of Cebu, the University of San Carlos (USC) serves as the Affiliated Non-Conventional Energy Center for the Office of Energy Affairs. Among the earlier fuelwood-related studies done by USC-ANEC are: Fuelwood Price Survey in 1989, Province-wide Fuelwood Survey in 1989, Fuelwood in Olango Island, also in 1989, and the World Bank-assisted, University of the Philippines Forestry Development Center at Los Banos - collaborated Fuelwood Supply Systems Study done in 1990.

These efforts continue to bear progress as USC-ANEC once more delve into another research undertaking, this time in collaboration with a Ph. D. candidate in Natural Resources from the University of New Hampshire - Complex Systems Research Center, U.S.A. Mr. Bensel is presently in the Philippines serving as a Fullbright scholar and working closely with me through the ANEC program in the university. Through the recommendation of Atty. Wenceslao de la Paz, former Director of the Office of Energy Affairs way back in 1991, I was introduced by Mr. Conrad Heruela, then the Chief of NCRD, as a researcher interested in biomass, particularly, woody-biomass systems.

The 15-months study (September, 1991 - January, 1993) obtained funding assistance from the United Nations- Food and Agriculture Organization - Regional Wood Energy Development Programme (FAO-RWEDP) and Winrock Foundation's F/FRED. Institutional support also came from the University of San Carlos, Cebu City, the Affiliated Non-Conventional Energy Center of the Office of Energy Affairs and the University of New Hampshire's - Complex Systems Research Center, U.S.A.

The study was originally conceived to consist of three phases best described as: Phase I - an urban households woodfuels consumption survey; phase II - a woodfuel transporters/ traders survey, and, phase III - a woodfuel source of supply study. The study made use of different research methodologies in order to purposely meet the objectives of each phase. These methods include the use of formal-strucutred personal interviews, semi-structured interviews, collection of secondary data, oral history, telephone interview, team interview and triangulation and observation and ocular inspection trips. These strategies meant flexibility and adaptability to real-life situations. Moreover, these approaches were necessary given the time, resources and database limitations.

On the whole, the study accomplished what it had set out to do from the start. It has extensively added to the existing body of knowledge regarding the wood energy situation of the province and city of Cebu. These information will largely contribute to a better understanding of wood energy development, in general, and woodfuel use, production and marketing network, in particular.

Future research efforts can do much to improve and expand the scope and coverage of the industrial/commercial/institution study to account for its complexity, variability and diversity. Also, a wider understanding of the woodfuel sources of supply may lead to the development of wood energy itself, and the development of policy measures that could influence the critical issues of wood and energy in an industrializing/urbanizing country, like the Philippines.

PHASE I

1. INTRODUCTION

Phase I of the research is an Urban Woodfuels Consumption Study. The primary goal of this phase is to be able to quantify the fuelwood consumption of the various sectors of the city. To begin with, we assumed a two-woodfuel consuming sectors, namely: The household sector and the industrial/commercial/institution sector.

Given this consideration, Phase I was further divided into 1.1, the household consumption study, and, 1.2, the industrial/commercial/institution consumption study.

The decision as to when to conduct 1.1 and 1.2, the choice of data collection techniques, and the type of research design, have been influenced by a variety of factors:

* access to official documents/listings
* variability in size and type of woodfuel users
* previous experiences in woodfuel-related type of studies
* distance and geographical areas to be covered
* cooperation and willingness of respondents to be interviewed and disclose information
* availability of manpower, time and funding resources

1.1 Background and Rationale

1.1 may be referred to as the Urban Household Woodfuel Consumption Survey. The need to conduct the household study was first given highest priority and emphasis for a number of reasons. One is that, a recent and confirmed (by the USC-Post Evaluation Survey) to be fairly accurate 1990 Census of Population and Housing conducted by the Philippine National Statistics Office provided complete listings of names and figures (upon official request) needed to construct a good sampling frame.

With the available household listings, the household sector become a well-defined, well-enumerated sector for study and starting with the survey was fairly easy as compared to the not-well-defined, not fully enumerated, very varied industrial/commercial/institutional sector.

Another reason is the lack of available comprehensive, detailed previous urban household energy studies. While we have come to know about the existence of two earlier secondary sources namely,: "The 1989 Household Energy Consumption Survey" conducted by National Statistics Office, and, "The Urban Energy Consumption and Air Pollution Study" done by Garcia of the University of the Philippines, College of Engineering, 1990, findings both studies were not available to us at the start of our survey.

Lastly, we hypothesized that this is a major consuming sector.

1.1.1 Objectives

The objectives of the Urban Households Woodfuel Consumption Survey are three-fold. Primarily, it seeks to quantify the consumption of woodfuels including other biomass residues such as charcoal and coconut shells/husks. Secondly, it is an attempt to analyze fuel use patterns as a function of socio-economic status, family-size, tastes/preferences, cooking patterns, cooking habits and other factors. Thirdly, it ventures to determine the extent to which a fuel-switching transition from traditional to modern fuels has or is already taking place.

1.1.2 Methodological design

Based on the objectives enumerated above, and given access to reliable census figures, we decided to conduct a survey of woodfuel use for the households of the city of Cebu using the personal interview technique as the primary source of data.

1.1.3 Sampling procedures

The study employed the simple random sampling procedure/method. Sample households were drawn from each of the 49 city barangays to ensure representativeness. A barangay is the smallest political unit and the 49 city barangays serve as the sampling population. A total of 603 sampling units were picked from complete masterlists of households produced during the 1990 Census, on a per barangay level. The number of samples ensured a significant confidence level of .05 and a standard deviation of .08, which is acceptable (de Jesus, 1990). Consultations with statisticians were done regularly during this stage.

Although it took 5 days for 4 research assistants (including study leaders) to locate, arrange and fully enumerate all the households, the masterlists once drawn, was a great achievement, as it served as the sampling frame, a major requirement of the simple random sampling technique.

Selecting other modes of sampling designs was not impossible, but in this case, because of the full enumeration at hand, the attraction for a simple random sampling was rather strong. Per literature, and per experience, however, a weakness of this method is in data collection. Due to the geo graphical dispersion and spread of the different barangays, many times it was difficult to locate a particular household respondent, especially in cases where the address obtained from the census list seemed vague. This situation according to Parel et al (1978), and supported by our own experience, increases transportation and labor costs and lost of time. The total number of sampling units in fact decreased because of this difficulty given time and funding limitations.

1.1.4 Developing the questionnaire

54-paged, double-spaced, interview schedule, more commonly known as the questionnaire was developed to serve as the research instrument. Data gathering would then be done through personal interviews of respondents from each household drawn as samples using this closed-type, standardized, pre-coded, structured questionnaires. The questionnaire consists of three main parts: Basic household data, energy use patterns and cooking practices information:

The section basic household data contains: (for the respondent and all household members)

* name
* age
* sex
* educational attainment
* address
* primary/secondary work
* monthly incomes
* housing information
* ownership of dwelling units
* amount of rent (if not owned)
* use of residence as work area (type of work)
* no. of rooms in the dwelling

The section on energy use patterns included questions re:

* use of woodfuel
* reasons for use/non-use
* source of fuelwood, price, amount consumed
* other questions related to fuelwood
* use of coconut fronds/scrap wood
* use of coconut shell/husks
* reasons for usage
* source, price, amount consumed per day
* other coconut shell/husks related questions
* usage of charcoal
* reasons for usage

* source, price, amount consumed per day
* other charcoal related questions
* use of electricity
* reasons for using electricity
* monthly bill, no. & type of electric appliances
* other electricity related questions
* use of kerosene and LPG
* reasons for use
* other questions related to kerosene and LPG use

The section on Household cooking consists of questions about:

* type of stove/s used by the household
* cost of stove/s
* frequency of stove use
* changes in main cooking fuel over time
* fuel switching questions
* reasons for fuel switching
* other related questions

The general design and presentation of the questionnaire is one which is pre-coded and closed type. The reasons for this are:

* previous experience in conducting similar surveys
* the study included many variables
* the study was meant to be large-scale
* data processing will be done in computers

In drafting the questionnaires, the general strategy was to break the questions down into their smallest components (Hyman's draft). Simple words and common concepts were used.

The way the questions were typed and printed out projected an impression of spaciousness to assist the interviewers read the right questions and record the right answers with the ample spaces provided. While it is surely not a 100% guarantee of precision, experience tells us that this matters.

In other words, while the goals of the study served as its guiding principle in "handcrafting" the questions to be asked, the actual wording and appearance of the questionnaires was tailored to allow maximum information gathering by providing ease and comfort to both interviewers and respondents. Easy to follow, briefly stated skip instructions also worked well.

In addition, although the drafting of the questionnaire was done in the English, this was translated into the local Cebuano dialect with the help of people who were considered experts in the translation field.

1.1.4 Data gathering

Actual field work for 1.1 took a total of 4 months starting from recruitment, selection and training of field staff up to preliminary data processing.

Getting ready for field work involved the following activities:

* recruitment, selection, training and organizing of field interviewers and field supervisor
* preparing logistics of survey
* pretesting the survey instrument
* revision and final reproduction of questionnaire

1.1.5 Fielding of survey teams

With one field supervisor to oversee data gathering and arrange courtesy calls to each barangay captains/councilmen, the entire survey force was divided into 5 field teams with 2 members for each team.

The use of flash cards and weighing scales made it convenient if there were 2 people in each team. Also, one could concentrate in directing the flow and spontaneity of the interview and at the same time establish rapport with respondent, while the other interview focuses in recording the answers and jotting down notes and observations.

Letters of introduction and endorsement and identification cards, interviewers manual, weighing scales, flash cards and tokens were important field paraphernalia each field staff must never forget to bring along.

On the average, the interview lasted 20-30 minutes each. Despite the short interview time, only 4-5 interview could be accomplished per day. This was due to the problem of travel time and specifically, time spent in trying to locate the respondents. Although the Census masterlist was correct, sometimes it provided vague addresses. One would think that if for example, cluster sampling was employed instead, perhaps more interviews would have been completed at a much lesser time, but at the expense of representativeness. This is true especially since not all barangays will be covered and some types of households may be missed out.

1.1.6 Editing

Time and again we see nicely written questionnaires and crisply packaged study results. But have we ever wondered how much editing must have been done to produce such results? Indeed, we do not see the field-used-crumpled questionnaires. In those used-filled-up questionnaires the act of editing is very much crucial. Editing, in fast is already part of data processing.

Experience have led us to differentiate 4 types of editing that normally takes place in a computer-aided data processing of administered question naires. The field-on-the-spot editing, the office editing, the computer editing and the print-out editing. Perhaps, by far, the most important of which is the field editing where the interviewer who has freshly came out of the interviewing scene cleans up her/his data according to his/her interpretation of the entire situation that has recently taken place. As a rule then, field editing should be done right after the interview, or at least, within the day of the interview. The rest of the editing process is merely cleaning up data to make computerization fast and easy. Inconsisten cies, blanks, miscalculations, and other minor as well as major errors can easily be detected if there is a serious effort towards the editing phase.

1.2 Background and Rationale

It is a well known fact that aside from the households, there are industries, and other institutions who are also users of woodfuel. Further, it is also known that their usage is not only for cooking, but for other purposes, as well. It is in this light that a 1.2, or a commercial/ industrial/institutional woodfuel consumption study was undertaken much later than the household survey or 1.1.

Unlike the well-defined, fully enumerated household sector, this sector is just the opposite. This sector is so varied in size, in type, in usage of woodfuel, in the amounts used, in technologies and processes employed, in short - in their reasons for using fuelwood. Nonetheless, its overall importance in the area of wood energy simply cannot be denied and taken for granted.

1.2.1 Key objectives

The aims of this phase are also three-fold. First, it seeks to quantify consumption of woodfuel by selected types of establishments. Second, it endeavors to analyze commercial fuelwood use patterns as a function of size of establishment, age of establishment, type (formal/non-formal), taste and preference, availability of fuels (including internally generated waste-biomass), type of products being produced and type of technology employed. Lastly, it wants to assess woodfuel users' satisfaction with supply and price and other factors of woodfuel with the intention of determining likely future patterns/trends in woodfuel uses by these establishments.

1.2.2 Methodological design and sampling techniques used

The choice of research design and data collection technique in surveying these types of establishments are limited and subject to the following constraints:

1. Many of the establishments belong to the formal sector and are officially registered. Thus official listings can be obtained. A number of establishments, however, are informal and are not registered. In this case, no official listings are available.

2. These establishments vary in many ways. For instance, they differ in types of establishment, in size of establishment, in their usage of fuelwood and even in the technologies used to procedure their products.

3. Respondents for interview in the business environment, or commercial sector, unlike the household sector, may not be as available, and as willing to cooperate with the interview.

These factors inherent to industries and institutions make it difficult to fully define and fully enumerate these groupings. Information gathered from several government officials and other key informants convinced us that where there are lists available, these lists were not complete. As previously cited, neighborhood eateries, small food processors, various cottage industries and other small scale manufacturing firms, are not covered in the official listings of the formal, registered, tax paying sector.

How then should the study proceed? What research design is best? What sampling technique is suitable?

Eric Hyman in a study done in Nigeria described this situation perfectly when he wrote "In the institutional and industrial sector as a whole, fuelwood users... in certain sectors form a majority. The variability in size and nature of user is far greater than amongst households. A sampling design that includes all energy users either would have to be very comprehensive and costly in time and money, or would not adequately represent users of fuelwood."

Further he argued that his surveys simply deliberately selected categories of industries and institution known to include fuelwood users and in some categories, restricted sampling to actual fuelwood users. Such a focus, according to him, as opposed to overall energy use, is consistent with the objectives of the study.

Thus, for 1.2, methods of study and steps undertaken were as follows:

First, a decision was made to survey only those types of industries and institutions we knew from a previous ANEC study (Remedio and Bensel, 1992) or we believed were significant users of woodfuel based on information already collected during Phases 2 and 3 of the study.

Second, based on such a narrowing down, we obtained listings from government officials on these establishments and from these lists selection of sampling units was done at random (See Table 1). In addition these lists were supplemented by other establishments found in the phone book. Sample size decisions depended much upon time and resource constraints. For those establishments with a small population size, the decision was to get as much as possible a complete enumeration. We also expected some of these types of industries (such as food processors) to exhibit for greater variability in energy use.

Third, cluster sampling was resorted to for those unlisted users of woodfuel such as small eateries, bar-b-q vendors, lechon makers and other food processors in the areas or locations where they tended to concentrate. The field interviewers were instructed to roam these neighborhoods and interview certain types of business establishments that did not appear in the official city government list. Types of business establishments encountered and interviewed included may be found in the Table 1.

1.2 was still carried out using the personal interview method.

1.2.3 Questionnaire design

Compared to the household survey, the researchers found it difficult to develop a highly structured, pre-coded type of survey instrument. Instead, a semi-structured, open-ended type of questionnaire was developed for administration. This flexibility was necessary in order to conform with the type of respondents, majority of which are busy business people, and also, the establishments in themselves varied from one another in many different ways. The only way to tell the difference and capture important information was to have a more-or-less semi-structured, open type research instrument.

The guide questions consists of 3 main parts: Basic business information like - items produced, usual customers, ownership, number of years in business, numbers of employees, their salaries and their work status, and seasonality in production and sales.

Second part is on energy use. Questions regarding the use of fuelwood, charcoal, LPG, kerosene, electricity and other biomass residues were asked. Their sources, prices and frequency of purchase and other information regarding the technology of process were also inquired from them.

Lastly, information regarding fuel choice decision and preferences were also asked, as well as, their intention to continue using the same fuels.

Table 1: Sampling Details 1.2

Type of Business Establishment/ Institution	Total Assumed Population (*) (N)	Number of Samples Drawn (n)	Sampling Techniques Used	Data Gathering Method Used
Bakeries	340	70	random and purposive	personal interview
Listed Eateries/ Restaurants	757	64	random	personal interview
Unlisted Eateries/ Restaurants	1,500	57	purposive	personal interview
Lechon Vendors	25	10	purposive	personal interview
Barbecue Stand	3,500	161	purposive	personal interview
Poso Makers	100	19	purposive	personal interview
Chicharon Makers	30	5	purposive	personal interview
Noodles/Bijon Manufacturing	13	7	random	personal/ telephone interview
Rattan Factories	69	12	random	personal/ telephone interview
Feeds Manufacturing	7	4	random	personal/ telephone interview
Seaweed/Carageenan Processors	2	2	census	personal/ telephone interview
Dried Mangoes	11	4	random	personal/ telephone interview
Schools	-	39	purposive	telephone interview
Hospitals	-	15	purposive	telephone interview
Prisons	-	2	census	telephone interview

* Estimated total population

1.2.4 Actual field work

Social research is a matter of flexibility with the primary intention of gathering data to meet the goals of a study. Given the conditions and limitations in the collection of woodfuel-related information among respond ents in an industry - institution setting, three types of approaches were used:

One, is direct interview. Smaller business such as eateries, bakeries, cottage industries were approached by the surveying team for personal interviews using the questionnaires described above. Generally, these respondents were willing to take 10-20 minutes necessary to complete the interviews.

Two, is leaving the questionnaire and picked up at a later time. Sometimes, when respondents are really simply too busy to entertain the interviewer and answer questions, the survey team simply leaves the questionnaire behind after explaining what the study is all about. Retrieval of questionnaire has been rather successful.

Three, phone interview. Medium to large scale industries and institutions are better phoned first than directly approached. For a number of reasons, this approach has proven to be effective not only in this particular study, but also in past studies conducted by the researchers (Remedio and Bensel, 1992).

Persons in authority, such as the owners or managers in medium-sized to large-sized establishments usually would require the setting up of appointments first before one is able to talk to them. Getting an appointment is never easy. Depending on the purpose of your visit (business or personal), either the security guard will give you chance to speak with the secretary or the secretary herself over the phone will give you a dozen of reasons why your interview "may" be done a week or two later. The boss can be out-of-town, having a conference, entertaining visitors, etc.

If one is lucky enough to make it up to the desk of the secretary, the questionnaires are usually asked to be left behind and picked up at a later date. Retrieval on these cases are low.

The attitude towards woodfuel-research is suspicious, illegal and uncertain. Unclear policies towards wood collection and preservation tend to make would - be respondents take a distant - safe. "I-dont-want-to-be-in volved" stance. Especially when one is dealing with the business sector where company image is a matter of utmost importance.

PHASE II

1. BACKGROUND AND RATIONALE

This phase is concerned with the urban network for woodfuel market/trader study. An appraisal of the transport and distribution network was done through primary interviews with fuelwood wholesalers, retailers and other key informants within the city. This phase benefited much from a previous Fuelwood Price Study (Remedio, 1989) and the WB - assisted Fuelwood Supply Systems Study for Urban Areas of the Philippines (Remedio and Bensel, 1992).

A better understanding of the situation and environment of the woodfuel industry can be achieved by gathering sufficient information on how and where these fuels are produced, how competitive the industry is and how important this network is as a source of rural and urban livelihood and employment.

This phase which inquires into the general distribution and trading patterns of woodfuel, will not only be an additional source of information to complement data generated from Phase I, the household consumption study, but also serve as guide in preparing for Phase III, the supply and production source phase. The researchers feel that a better way of looking into the overall wood energy situation in the city of Cebu is by giving enough emphasis at the consumption, distribution and production of woodfuels.

2. KEY OBJECTIVES

As mentioned earlier, one of the reasons for studying this sector is to provide us with information to complement Phases I and III, specifically with regards the supply situation, i.e. species, location of fuelwood producing areas, volumes, etc. Also, knowledge leading to the final users and end uses of woodfuel would be significant.

In addition, the study would like to understand how the local urban woodfuel market functions with regards to pricing, cost, break-of-bulk, inter-urban trade, forms of transportation used, seasonality of sales, species-preference and fuel characteristics.

Finally, with this phase, the research would like to better understand the socio-economic and personal background of urban woodfuel traders and the extent to which this trade provides a source of income, livelihood and employment.

3. METHODOLOGICAL DESIGN AND SAMPLING TECHNIQUES USED

First of all, we wanted to identify the actual members of this sector. To begin with, a real and official list of fuelwood traders does not exist. However, we do have prior knowledge of 40-50 medium to large urban traders from two previous ANEC studies (Remedio and Bensel, 1992), as cited earlier. We felt that these lists are incomplete, so an ocular inspection of as many parts of the city as possible, was undertaken.

Results of ocular inspection recorded a total of 81 traders who were subsequently interviewed. Again, here is a situation where attempts at any sampling technique was not a question. There is an absence of masterlist, moreso, owing to the difficulty of constructing [2]and defining one, two conditions have to be met in order to proceed with the study. First, for as long as a trader can be classified as either a medium-scale or large-scale woodfuel trader[3], he/she is a prospective respondent. And second, if after identifying one as a respondent, he/she is willing to cooperate with the interview, he/she automatically becomes an urban woodfuel trader respondent for Phase II.

4. SURVEY INSTRUMENT

Instead of a pre-coded, structured questionnaire, this time the researchers prepared a set of open-ended guide questions. Why so? Primarily, the researchers felt that the types of issues needed to be addressed are better answered through open-ended questions. That, together with the fact that

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2 Some traders sell only fuelwood, others sell fuelwood in equal combination with charcoal, coconut fronds and other biomass residue. Still others, sell fuelwood only in small quantities as compared to the other dry goods being sold, like staple, laundry soap, softdrinks, etc.

3 Medium to large scale trader here is defined as traders who are directly supplied by rural sources. Also, the physical appearance of their stalls indicate that are medium to large scale sellers of woodfuel.

little is known about answers to such issues, which are very important issues, made it difficult to anticipate responses needed for a pre-coded questionnaire. Thus, in order to capture as much information as possible without missing key points or key pieces of information, the use of open-ended guide questions was finally resorted to.

The main issues addressed are found in Table 2. (text follows).

Table 2: Phase II: Netowrk for Woodfuel Markets/Traders Study
Summary of Issues Included in Semi-Structured Questionnaire

Description of Section	Issues
1. Physical Description of Business Establishment	* Address/location of proprietorship * Physical description of establishment * Nature of business
2. Socio-Economic Background of Traders	* Name, age, sex, educational attainment, primary occupation * Type of ownership * No. and type of involvement of family members in business * Length of time resident of Cebu City * Length of time engaged in fuelwood/charcoal/business * Intention to stay in business
3. Sales Patterns	* Seasonality of sales/average sales per day, month, year * Amount of stock on hand/normal level of stock * Regular customers (names, address, uses) * Main buyers and users of charcoal * Sales, prices, characteristics of stoves for sale
4. Supply Patterns	* Location/distance of source of wood and charcoal * Amount obtain from each source and mode of transport * Wood collection/charcoal production * Names and addresses of major suppliers * Trader-supplier arrangements * Supplier production information * Trends in supply (past, present, future perceptions) * Type of land wood/charcoal are sourced from * Perception of environmental impact of woodfuel & charcoal use
5. Transportation Patterns	* Transport made of fuelwood/charcoal deliveries * Type, size, condition & maximum load of vehicle * Frequency, quantily of deliveries * Transportation Expense * Other deliveries made by supplier
6. Fuel Characteristics	* Sales per wood, type sold/sopecies identification * Sales/preference of special type of woodfuel * Local terms/names * Respondent perception of changes of quality of woodfuel/charcoal * Amount of charcoal fines
7. Pricing Patterns	* Historical? Price and quantity recall * Current buying/selling price * System of price mark-ups (factors influencing) * Discounts, repacking, rebundling practices
8. Operating Costs/Patterns	* No. of people working, amount of paid, permits required, storage areas, days/hours of work/other cost * Source of start-up capital
9. Miscellaneous Questions	* Other outletsknown/competition among traders * Average monthly income * Possibility of price monitoring by USC students

5. ACTUAL FIELD WORK

Members of the survey team were asked to be familiar with the guide questions by heart. In this way, a more spontaneous conversation - interview situation can productively take place. Interviewing time lasted as much as two hours per respondent-trader, or as short as thirty minutes, depending upon how loquacious a respondent can get, or how long a particular trader has been in the business itself. The greater the number of years spent as a woodfuel trader, the longer the duration of the interview became, and vice-versa.

Data gathering, in general, has been characterized by the promise and assurance of confidentiality, not only in this phase, but very particularly, in this case. The reason for this is obvious, fuelwood trading, medium or large scale is a source of income, but since woodfuel production and distribution practices as a whole is clouded with uncertainty and ambiguity, respondent-traders are oftentimes reluctant to provide information. Rapport and confidence, however, once established can work positively.

Aside from inquiries, descriptions and explanations, samples of stocks were also weighed and measured. In addition, other characteristics of the woodfuel merchandise for sale such as: Diameter of pieces of wood in a bundle, visual appearance of the moisture of wood during weighing were also taken.

Selling price was also recorded.

PHASE III

1. INTRODUCTION AND RATIONALE

This phase of the study deals with perhaps the most complicated and least understood aspect of woodfuel energy systems - the sources of supply. From the start, several considerations have driven the researchers to realize that it would be impossible to do a comprehensive and highly quantitative assessment of the woodfuel supply situation. Evidently, the scope is too large. There are so many barangays within each of the municipalities of the province supplying woodfuels to urban Cebu that to be able to cover such a scope is simply beyond the capability of this entire research study.

Another consideration had to do with the overall objective of the study. To recall, the aim is to understand the commercial flow of woodfuels from rural suppliers to urban users and less in understanding the physical/ ecological nature of the supply areas. Thus, the main focus is on issues of land-use, land tenure and fuelwood supply.

Then too, to be considered, are the qualifications of the researchers. The fact that the researcher's orientation are basically more on markets and economics, and less on forestry, agriculture and related-fields, already limits the areas of study to be more on the socio-economics aspect, and less resource-base inclined.

Lastly, given the dearth of information, it was deemed more important to look into qualitative factors such as land use patterns, land tenure arrangements, socio-economic situation, fuelwood preparation-harvesting practices, as well as, local oral history of the woodfuel trade in the area.

2. KEY OBJECTIVES

The following are the key objectives of this phase:

1. To have a qualitative assessment of woodfuel production patterns with respect to land use practices, species preference, sources of supply (agricultural vs. timberland), land tenure and other cropping arrangements.

2. To investigate the nature and extent of marketing and distribution network of landowners, fuelwood cutters/charcoal makers, rural traders and transporters.

3. To analyze the role of woodfuel industry in providing either seasonal (part time) or year-round (fulltime) employment.

4. To look into the historical patterns of woodfuel production in a number of sites, especially in relation to changes in species, production,marketing arrangements and land-use patterns.

3. METHODS AND TECHNIQUES USED SITE SELECTION

Initially, sites for investigation were chosen based on information provided to us by the Urban Woodfuel Traders Survey, or during Phase II. This information included names and locations of rural traders supplying the urban market. This information was later supplemented with data from DENR (Department of Environment and Natural Resources) records on permits granted for the transport of woodfuels. A total of eight visits/sites covering barangays were conducted. Each visit lasted from 1-4 days depending on the scope and area covered, and also, the barangay's distance from Cebu City proper.

As a standard procedures, introduction and endorsement letters were sent and courtesy calls were made introducing to the parties concerned (town mayors, barangay captains/ councilmen, influentials) the goals nature and scope of the study. Especially in cases when the survey team had to stay overnight, we made sure to inform local government authorities of our presence and our purpose in conducting research.

The distance of the chosen sites from Cebu City ranged from as close as 10-20 kms. in the case of mountain barangays of Cebu City as far as 66 kms. to the south for Argao and 60 kms. to the north for Sogod. The sites also differed in topography /slope, with field work being done in some coastal/lowland barangays of Catmon and Compostela, as well as, mountain barangays of Sogod and Argao. (See Table 3)

4. DATA GATHERING

The instrument used was a semi-structured guide questions with a slightly different set of questions prepared for three groups of respondents:

1. Fuelwood cutters/charcoal makers
2. Rural fuelwood/charcoal traders
3. Local officials, forestry personnel and local influentials or key informants.

Table 3: Description of Study Sites for Woodfuel Supply Surveys

Site	Barangays Covered	Distance from Downtown Cebu City	General Description	Woodfuel Production Pattern
Argao	Sua, Mabasa, Jampang	66 km.	All upland barangays, only major crops are corn and coconuts. Area is generally depressed, high out-migration to urban areas.	Supplying only a little charcoal mostly fuelwood and coconut fronds. Fuelwood comes mainly from naturally growing native shrub species.
Cebu City	Sapangdaku, Kalunasan	10 km.	Two hillyland barangays of Cebu City. Major crops include banana, mango and jackfruit with some corn grown for own consumption.	Supplying mainly fuelwood from fast growing species planted over large areas for sometime as a form of tree fallow. These trees are coppiced for fuelwood every 2 years. In any hillyland barangays of Cebu City wood from fruit trees is also an important source of woodfuel.
Cebu City	Busay, Budla-an Pulangbato	12 km.	Hillyland barangays of the city. Busay and part of Budla-an are producing out pulangbato is dominated by steep hills covered mainly with *Gliricidia sepium*. Land speculation is rampant in Busay due to spectacular views of the city.	A combination of fuelwood and charcoal. In Busay & Budla-an trees are grown in small plots & as hedgerows, live fencing & property boundary. In pulangbato the whole watershed area above the barangay allows for regular harvesting of fast growing trees.
Cebu City	Sirao, Guba Binaliw	15 km.	Hillyland barangays of the city. All produce fairly large amounts of vegetables, fruits, and in Sirao, cut flowers. Land speculation is becoming a problem in Sirao due to its proximity area being developed.	Producing both fuelwood and charcoal from trees grown mainly in idle areas of farms or as hedgerows, live fences, etc.
Consolacion	Saosao	15 km.	Interior barangay of Consolacion only 100 m above sea level. Increasingly part of developed Metro Cebu with recent development of poultry farms, housing subdivisions with a golf course planned for the near future.	Sacsao and neighboring barangays used to produce fairly large amounts of fuelwood and charcoal for Cebu and Manduae cities from large areas of native shrub forest. These areas, however, are now being cleared for other development providing for a final pulse in woodfuel supplies from these areas.

(continued)

Site	Barangays Covered	Distance from Downtown Cebu City	General Description	Woodfuel Production Pattern
Compostela	Cabadiangan, Cambayog, Bagalnga, Basak, Lupa, Mulao, Dap-dap, Tag-ube	30 km	These 8 barangays vary greatly in elevation, slope and land-use patterns. Cabadiangan, Cambayog, and Bagalnga are low lying barangays producing a variety of vegetables and rice on irrigated fields. The other five are at higher elevations and support more subsistence crops (corn) coconuts and some woodfuel "plantations".	Compostela is one of the biggest suppliers of fast growing species are grown on idle lands and as line-fencing and property markers, Basak is home to a 5-hectare ipil-ipil plantation. Other barangays make use of fast-growing species planted in woodlots as well as native shrub forests.
Catmon	Panali, Basak, Cabungaan, Bactas Catmondaan	57 km	Panalipan and Catmondaan are coastal barangays, the other three medium elevation interior barangays with large areas planted to coconut.	Catmon appears to supply larger volume of coconut fronds to urban woodfuel markets, however, there is also an ipil-ipil planters association made up of close to 100 livestock owners. Ipil-ipil and *Gliricidia sepium* are grown in small plots for woodfuel and fodder purposes.
Sogod	Mohon, Bagakay, Cabangahan	68 km	All three are high-elevation interior barangays characterized by a gently rolling terrain. Corn is the most widely cultivated crops, and livestock ownership is widespread. Many residents work as seasonal laborers in sugar plantations in the adjacent town of Borbon.	Relatively small amounts of charcoal are produced in Sogod mainly from native shrub species. However, these three barangays are home to a number of very large charcoal dealers who obtain their supplier from more thickly vegetated barangays in the adjacent town of Tabuelan. This charcoal is carried manually and on horseback from Tabuelan into Sogod. This area is the third largest supplier of charcoal to Metro Cebu.

Table 3 provides some background information on the sites visited including distance from Cebu City. A general description of the site and woodfuel situation in each place. As can be seen, the sites vary greatly in a number of ways. The idea was to get a cross section of woodfuel-producing areas with differences in topography, agro-climatic features, woodfuel species, propagation techniques and whether or not the area produces mainly fuelwood, mainly charcoal, or a combination of the two.

The guide questions were divided among the three members of the survey team which included one of the study leaders and two research assistants. using a semi-structured interview format, each member of the survey team asked questions as needed, not following any specific protocol. Feverish note taking was found to intimidate respondents, so only key points were jotted down and as soon after the interview, as possible, the survey team went over the notes and clarified the details.

During the site visits, the survey team did not have access to, and sometimes avoided the use of any type of motorized transport due to cost factors and road condition. In hindsight, the benefits of walking into and around the survey sites are numerous. For one, it enabled us to get a first hand feel for the topography, cropping systems and general land use patterns of the area. Secondly, we could not help but notice the difference in the reception we got from respondents, as compared to earlier experiences where motorized transport was used. Perhaps it was a combination of sympathy, or admiration for us having covered such long distances on foot. Moreso, it appeared that many of the local people were for more willing to entertain our inquiries because we shared their daily experience of walking.

Also, during all of these site visits, an attempt was made to record as many features as possible on slides both for documentation, as well as, for future presentation purposes. In addition, we found that offering monetary compensation to providers of meals and lodging created an awkward situation. Therefore, the survey team generally brought along a few small tokens such as jars of coffee, bars of soap, etc. as a form of "payment" or gratitude and appreciation.

5. DATA ANALYSIS

The bulk of the data collected during this phase of the study consisted of field notes. In an effort to "round-out" the picture, this information was integrated with information collected from a number of secondary sources. For example, DENR requires that woodfuel traders secure a permit before transporting fuelwood or charcoal to a market. The purpose of such a permit is to verify that the woodfuels being transported originated from private lands and consists of planted species. These permits contain information on the source of woodfuel, volume being transported and the species. Although not always a hundred percent accurate (see Bensel, p. 33-34), we believe that information contained in these permits would be a valuable supplement to data collected in the field. Therefore, all of the permits granted for twelve months period from August, 1991 to July, 1992 were scanned and relevant information recorded and later tabulated and analyzed.

In addition, extensive use is also made of other forms of secondary data such as maps (including land use, topography, rainfall, etc.), government documents and reports, academic papers were made.

6. DISCUSSION

Parts 2.0 to 4.0 of this report elucidated the details of the different methodologies employed in conducting the research from formal surveys, to purposive interviews, to ocular inspection and observation trips, to local history collection. All these show the variety of strategies and techniques used to obtain a good and better understanding of the woodfuel situation of the city and province of Cebu.

This section of the paper deals with a brief discussion of the considerations given before and during the course of the study, to the methodological approaches for data collection of wood energy. What issues are to be addressed? How does the local woodfuel system operate? What financial, technical and manpower resources are needed and are available to carry out the investigation? Who is interested in the results of the study? These and a host of other questions had to be considered at teach phase of the research.

7. COMPREHENSIVENESS AND COST EFFECTIVENESS

To recall, the study was undertaken essentially to fill existing gaps in the knowledge of the subject matter of wood energy. On the one hand, a more comprehensive study was necessary due to insufficiency of prior efforts. Earlier efforts were an attempt tot trace the network of distributors and users, and to monitor prices. These efforts form an important source of secondary data for this present endeavor, but they are not comprehensive enough on their own to answer the questions we have sent out for this study.

On the other hand, the comprehensiveness of this present investigation is aimed to form a critical baseline for future, more specific studies. To achieve such comprehensiveness, however, depth had to be sacrificed in many areas. Further, not only can the study serve as a baseline, but in addition, would fill critical gaps in policy debate and confirm or refute common beliefs and perceptions of sustainability of the woodfuel system. For instance, it is premised by several existing literature and research reports that Cebu is suffering from serious environmental problems. As we have learned in the course of our study, while there are certainly parts of the province that have undergone massive soils erosion and environmental degradation, there are also many areas enjoying the county of lush vegetation and well-managed agricultural patches of land. Trees, crops and secondary growth may be lacking in some areas, but they certainly continue to flourish and provide food and income in still many parts of the city and province.

Every researcher has to overcome the desire and temptation of wanting to study everything that seems to be associated with the subject of interest. Reality and practicability dictate otherwise. Although we wanted to cover as many details as possible, time and resources did not permit us to do so. The approach of dividing the study into three different, almost distinct, yet interelated phases, in itself is a representation of comprehensiveness. It shows that while we cannot study everything at one period in time, yet it is possible to have a "systems" approach by covering the three major areas needed to understand how the woodfuel system operates. Definitely, future studies could do much to improve details of site specific and situation specific issues.

What has helped make this study cost-effective? First, we have benefitted from past experiences and surveys, and made as much use as possible of secondary data. Second, the study was conceptualized and carried out in a comprehensive fashion, even if the three phases covering production, distribution and consumption of woodfuels had different sub-objectives. As a result, overhead and operating costs were reduced compared to a case where three different studies were to be undertaken. In addition, this comprehensive approach ensured that we would not lose the significance of the interconnections and interrelatedness of different aspects of the web of the woodfuel system.

The deliberate effort at searching for and using secondary data, especially at the design and pre-implementation stage, all combined to make the whole study cost lesser than if everything had to come from primary sources. In the final analysis, it was the conscious move to look at the macro situation in its generality and to try to understand the major areas of the how the system works and look for possible research methods to address them, that makes this woodfuel study cost effective.

8. TYPES AND EXTENT OF DATA

With comprehensiveness and totality in mind making choices and decisions always became a painful exercise whenever constraints presented itself. Take for example the time when we had to decide what types (and extent) of data were needed to be collected, we were constrained by the following:

First, we wanted the study to be comprehensive given the time, financial and manpower resources;

Second, there is not much available consumption data, specifically urban household consumption data for Cebu to start with;

Third, as study leaders our orientation is more in economics and markets, and less in forestry, or agriculture;

Fourth, we had a tight budget. While we did get financial and institutional support, to which we are very grateful for, these had to be efficiently allocated throughout the different phases of the study;

Lastly, we had to temper our purely academic appetites as we always had to keep in mind that we wanted to be able to make a contribution to policy debase and shed more light regarding the importance of woodfuels in energy systems and environmental impact.

9. CONSIDERATIONS IN DESIGN AND METHODOLOGICAL APPROACHES OF DATA COLLECTION

Given scope, complexity and variation of the woodfuel supply areas, it was decided to gain only rapid knowledge of a larger number of sites and then use these information to design more focused future inquiries (rather than start specific with few sites and then not know if these are the exception or the rule).

Meanwhile, since woodfuel systems change, the design of the study is such that future follow-up studies is kept in mind. For instance, the household survey is replicable and allows for post-stratification. Phases 2 and 3 provide good information in designing a more structured future investigation.

Moreover, the goals of the study, the kinds of information needed and the resources available, dictated the methodological approaches employed. For instance, in the household survey, what we needed was a highly quantitative estimate of consumption, so a structured interview using random sampling was employed for ease in extrapolation. Also in the case of supply, we needed information more baseline in scope and nature in order to have better understanding of the prevailing situations, so a less structured, less systematic and a less quantitative approach was appropriate. At this stage highly quantitative estimates of resource base (tree census, land use, hectares planted) might be expensive luxuries, since we do not know much about how the resource based is used, or how to capture information of other social factors at work. Where "sector" was well-defined/understood, more structured survey techniques could be used, as compared to instances when "sector" was less defined, a less structured method was correspondingly employed.

In the end, we have come to the salient conclusion that there really is no clear package research approach to doing woodfuel studies since situations vary so much from one place to another. It is however always important not to lose tract of on's objectives and be creative enough to meet them in the midst of difficulties and constraints without sacrificing quality and scientific methodologies.

Below is a list which summarizes in detail the steps necessary in conducting a good woodfuel study based on experiences from this study:

* Establish clear overall objectives and sub-objectives for each aspect of study
* Develop a list of possible ways to achieve such objectives
* Make use of secondary data
* Triangulate between all types of information available
* Consult proper authorities
* Empathize with respondents (i.e. problems of recall, languages, etc.)
* Tailor research instruments to:

    (a) type of data being collected
    (b) type of data needed
    (c) mode of collating/tabulation/processing
    (d) interviewing ability of enumerators and recall ability of respondents

* Tailor survey design to:

    (a) local conditions (N is known, or N is unknown)
    (b) financial resources
    (c) manpower availability
    (d) time limitations

* Consult other studies from outside the region for comparison and information on methodology
* Drop biases
* Remember that conceptualization and project preparation is as important as data gathering, as well as, the analysis and interpretation of data. The degree and level of important and commitment to each should be equal as each one is inevitably related to the other.

CONCLUSION

In sum, the study which is not only descriptive and explanatory, but also exploratory, covered 18 months of work, from September of 1991 to February of 1993. Conceptualization and project preparation phase took about 6 months in duration (including search for funding sources). Phases 1-3 averaged three to four months each (sometimes overlapping in implementation), and data analysis, interpretation, including the writing of preliminary report - consumed four to five months total. Funding was for a 12-month study.

The overall objective of the study is to understand the production, distribution and consumption patterns of woodfuel systems in the city and province of Cebu. To do this, a three-phased research was conducted with Phase I aimed at quantifying the fuelwood consumption of the various sectors of the city: household (1.1), and, commercial, industrial and institutional establishments (1.2). Probability sampling using simple random sampling was employed during the urban household study because of the availability of good quality census figures. Data gathering through personal interview used structured, pre-coded questionnaires. field supervisors and field enumerators were hired and trained to administer the instruments. The giving of tokens (bars of soap) was also practiced and found to be effective in that the respondents were very appreciative of the gesture. Weighing scales, flash cards, enumerator's manual, ID cards, letters of endorsement and introduction were important field paraphernalia. The industrial/commercial/institutional survey employed simple random sampling where official lists existed and non-probability sampling (purposive and convenience sampling) for those where lists did not exist. Using semi-structured questionnaires, personal interviews, phone interviews, photo documentation and inspection trips were employed whenever feasible.

The second phase of the study was meant to understand better how the local urban woodfuel market functions in terms of price, cost, forms of transportation used, seasonality of sales, species preference, fuel characteristics and other aspects of the trading system. For various reasons no sampling frame can be developed for local urban woodfuel traders due to diversity and variations of the nature of the trading characteristics. There is not list available, thus non-probability sampling with features of judgmental sampling was employed. Aided with semi-structured questionnaires, interviews were conducted to willing respondents. Information gathered during this phase supplemented Phase 1 and 3 findings.

Phase 3, the last phase of the study, was aimed at understanding the commercial flow of woodfuel from rural suppliers to urban users including issues of woodfuel marketing, woodfuel as a source of income, land use patterns, land tenure arrangements and impact of future supplies. The need was not so much understanding the physical/ecological nature of the supply areas. but because of the broadness of the area and scope of coverage, an "RRA - inspired" research method was employed. This meant the use of information obtained from the woodfuel traders study such as the names and locations of rural traders supplying urban markets. In addition, DENR records of permits granted supplemented the former list of woodfuel rural traders. Semi-structured guide questions were prepared for fuelwood cutters, charcoal makers, rural fuelwood traders, rural charcoal traders, local officials, forestry personnel, and key influential. Personal interviews were conducted with them, and at times where local oral history recollection could obtained, it was properly documented. Techniques/approaches employed included the recording of field notes, triangulation techniques, walking (instead of using motorized vehicles), observations, recording of features and, taking of photo-documentation (slides). This phase is highly descriptive and exploratory in nature and in scope.

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Considerations in Energy Planning Models For Wood Energy Planning

by

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1. INTRODUCTION

The debate over the woodfuel crisis has progressed since the early days in the late 1970s and early 1980s when a "woodfuel gap" was believed to be leading to large-scale deforestation. Since that time, through advances in the understanding of the complexities of woodfuel issues, analysts have come to recognize that, in most instances, woodfuel use is not the major cause of deforestation and that people can adapt in numerous ways to a declining availability of woodfuel.

But if woodfuel use is not a major cause of deforestation and if people are able to adapt then just what is the value of studying woodfuel issues?

First, the issues are important both in human, and in ecological terms. Just because physical "gaps" do not exist, that does not mean that people are not suffering through woodfuel supply problems, nor conversely that their lives could not be improved if better quality fuels became affordable and available. While some of their responses to woodfuel scarcity represent improved standards of living, others represent a decline. The transition away from reliance on collected wood as a fuel and toward increased purchases of commercial (often fossil) fuels tends to occur as people's standards of living improve. Conversely, switching to lower quality fuels, changing cooking habits (possibly resulting in lower nutritional standards) or increasing the time spent in collecting woodfuel are all related to decreases in the standard of living. In terms of the ecological consequences, widespread land-use changes may be leading to varying degrees of deforestation, soil erosion, desertification, loss of habitats and even global environmental impacts (i.e. global climate change).

Second, despite rapid urbanization and a trend toward switching to fossil fuels, continuing poverty and rapid population growth in the developing world, make it evident that large numbers of people will continue to depend on biofuels for the foreseeable future. Rapid urbanization, unless carefully managed, could in fact place increasing pressures on biomass resources in some countries.

Third, different development policies whether politically interventionist or in the form of encouraging market-based transitions will have markedly different effects on woodfuel supply problems. It is important to try and assess what these effects may be.

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Finally, woodfuel and other biomass resources are not only traditional fuels, but are also important locally available resources. As concerns about global environmental issues such as climate change increase, modern sustainably harvested biomass will become an increasingly attractive energy option, both for industrialized and also for developing nations. Biomass offers a potentially low cost energy source that, in more convenient forms, could substitute for more costly, imported or environmentally problematic fuels and could also act as a useful source of rural employment. If properly planned and implemented, modern biomass energy systems may prove to be an attractive option for some developing countries. The 1970s and 80s witnessed several attempts at tapping these resources including the Brazilian and Zimbabwean ethanol programs, the Philippines dendrothermal program (in which wood is grown and harvested for combustion in power plants), and current efforts to promote new efficient biomass energy technologies such as integrated gasifier systems (BIG-STIGS) - an efficient technology for generating electricity and heat from biomass.

Thus, woodfuel and biomass energy systems must be viewed as presenting opportunities as well as problems. This paper concentrates on how we can improve our understanding of the most pressing current problems associated with woodfuel supplies and demands. Important and closely related issues concerning the social costs and benefits and the land-use and environmental implications of modern biomass options also need to be fully assessed, but are touched on only briefly here.

The importance of studying these issues is made more complicated by the dearth of detailed information. For example, where biofuels consumption is concerned, Meyers and Leach (1989) state that "it is not possible to state with much certainty whether overall biofuels consumption is growing or declining in most developing countries".

Section 2 of this paper briefly outlines some of the principal issues concerning woodfuel and bioenergy systems. Section 3 goes on to look at early attempts to analyze the woodfuel crisis using what has come to be known as "gap theory". Using the lessons learned from these early exercises, section 4 outlines the areas where earlier gap theory models need to be changed or improved upon to provide a better model of bioenergy supplies and demands. Section 5 briefly describes some desirable characteristics which can help to make energy planning software tools useful to planners in developing countries. It then goes on to introduce the LEAP (Long-range Energy Alternatives Planning) system for energy and environmental analysis - in particular its Biomass program - and shows how it improves upon earlier attempts to model woodfuel and biomass energy systems. Section 6 briefly describes some experiences of the use of the LEAP system. Section 7 outlines some of the constraints which currently limit the effectiveness of energy planning models. Section 8 presents some conclusions about the role of models in biomass energy planning.

2. WOODFUEL ISSUES

Before proceeding to model woodfuel and biomass energy systems, it is necessary to look at some of the basic questions concerning the current structure and dynamics of those systems in developing countries:

* Who uses biofuels and what factors affect their choice of fuels?
* How do people obtain woodfuel?
* How do people react to woodfuel scarcity?
* Is deforestation occurring, and to what extent is it caused by woodfuel use?
* What are the constraints on woodfuel policy interventions?

Each of these questions is addressed in more detail in the sections that follow.

2.1 Who Uses Biomass Energy?

The term "biofuels" encompasses numerous different forms of processed and unprocessed biomass. These include firewood, charcoal, crop residues, bagasse (sugar cane residue), dung, coconut husks and shells, coco-charcoal, ethanol, methanol and producer gas. Their use varies widely both between and within individual countries. Biomass energy is used both in households for cooking, heating and lighting, and in industries and commercial establishments for end-uses such as tea, coffee and tobacco drying; brick and lime making; sugar refining and a host of other small-scale end-uses.

In households, the level of biomass consumption and the mix of fuels used in urban and rural areas are dependent on a range of interrelated factors. These include:

* the availability of wood and other biofuels
* the availability of modern fuels
* household income levels
* household size
* fuel prices
* costs and availability of end-use technologies (e.g. stoves)
* climate (which affects space heating/drying needs)
* cultural issues (e.g. cooking habits, social use of fires for pest control, ceremonies).

There is a dearth of statistics on biofuel consumption and it appears that the overall level of consumption and mix of fuels varies widely both between and within countries. Table 1 presents estimates of biomass fuels consumption in Asian Countries. As with most aggregate biomass data, these figures are incomplete and inaccurate. For example: residue use is known to be significant in the Philippines. Even without these data, It can be seen that dung and crop residues are an important form of energy in Asia.

Table 1: Estimated National Biofuels Consumption for Asia, 1986 (Petajoules)

	Firewood	Wood for Charcoal	Agricult. Residue	Dung	Bagasse	Comm. Energy [2]	Biomass % of Tot.
China	4,930		3,600	100	120	25,930	25%
India	2,365	160	430	860	190	6,114	40%
Indonesia	1,420	15		0	54	3,863	28%
Thailand[1]	125	250	49	0	53	343	58%
Bangladesh	54	X	300	78	18	144	76%
Pakistan	220	X	34	87	29	542	41%
Philippines	330	X	X	0	32	70	83%
Vietnam	245	X	X	?	5	171	59%
Others	1,055	60	x	0	27		
Total	10,764	520	4,413	1125	528		

Source: Meyers and Leach, 1989

1 includes industrial and commercial energy. Inclusion in other cases is uncertain.
X indicates that value is very uncertain but probably small.
? indicates that no estimate was available
2 Commercial energy data is for 1987, source: World Resources 1990-1991 (WRI, 1991)

Patterns of biomass fuel use are not static. The transition from traditional biomass fuels to fossil fuels has been fairly rapid in Latin America and many Asian cities (Sathaye and Tyler, 1991), but has been slow or non-existent in many rural areas and some cities. Income levels and the physical availability of wood and charcoal in cities and the use of other biomass fuels in rural areas remain major determinants of energy transitions. Among high income households in many developing countries, biomass consumption can still be significant. With smaller households, fuller entry of women into the (out-of-the-home) work force, and changing eating habits, clean and convenient fuels such as electricity, LPG, and natural gas become essential.

Whether rapid transitions will occur elsewhere in developing regions, particularly in rural areas, and what form this transition will take has been a subject of great debate in the literature (see for example: Leach and Gowen, 1987 or Leach and Mearns, 1988). Such changes in energy use patterns will ultimately depend on the speed and shape of economic transformations that occur. Korea provides an example of an extremely rapid transition: as recently as 1962, firewood accounted for 55 percent of total energy demand and, by implication, a large majority of household energy use (Asian Development Bank, 1991). By 1988, firewood accounted for less than 2 percent of Korea's energy demand, while oil and electricity use accounted for 64 percent, up from 10 percent in 1962.

A different story however has taken place in the Southern African region, where biomass fuels account for 80 percent of the regional energy mix (Raskin and Lazarus, 1991): "Imprecise biomass demand data, the lack of time-series data, and the highly localized nature of surveys make it difficult to track trends in biomass use. However, it is clear that a significant substitution of modern for biomass fuels - the so-called energy transition - has not occurred in Southern Africa in the 1980s. As per capita modern fuel consumption declined, there even are indications of "backward fuel switching" in recent years from modern fuels to woodfuels in urban areas and from woodfuel to agricultural residues in rural areas."

2.2 How Do People Obtain Biomass Energy?

Biomass energy may be purchased or collected as a "free" good. In urban households, industries and commercial establishments purchasing is common. In rural households, biomass fuels are normally collected. Again, there is little quantitative data about the scale of these activities. Biomass fuels, because they tend to be of a lower quality and are generally more abundant than woodfuels tend to be collected, more often than being commercially traded.

BOX 1. Sources of Woodfuel

Collection of Dead Wood

Bushes & Shrubs

Lopping, Pruning of Trees

Whole Tree Harvesting

Surplus Wood From Land Clearances

Surplus Wood From Commercial Wood harvesting & Milling

Re-growth From Fallow Lands

Woodfuel may be collected from a variety of sources. It may simply be collected from dead wood lying on the ground: branches and twigs, or it may be cut from bushes, shrubs, or trees. Another source of wood is the surpluses that arise when land is cleared for agriculture, or the wastes that arise from commercial logging of wood for non-energy purposes (e.g. lumber, pulp). Informal tree cutting practices often involve cutting live wood from trees in a sustainable way by lopping branches, pollarding or coppicing trees[2]).

Proper pruning practices can actually increase tree growth rates (Kaale, 1990). Unfortunately, there is little systematic data about the growth rates of different tree species under these informal but nevertheless highly skilled management practices.

Estimates of tree stocks are often based on forestry department data for commercial forests or on satellite imagery. These data may only provide estimates of the biomass content of trees. They will not include the resources available from dead wood, bushes and shrubs, and often will not include trees outside of managed forest areas. Thus they may tend to severely underestimate the total biomass resources actually available.

Even in cases where whole trees are cut or land areas are cleared it is possible, depending on the presence of grazing animals, that trees will begin to re-grow. For example, charcoal cutters in Africa will often clear-fell an area of land to produce charcoal, but then will not return to the same area until the trees have grown back. Agricultural land left fallow may also be a significant source of woodfuel. It is important not to neglect

[2] Pollarding is the practice of cutting branches near the trunk to stimulate a dense growth of new shoots. Coppicing referes to the ability of some species of trees to grow back from a cut stump. Copping trees typically produces a number of smaller shoots when the main trunk is cut.

the effect of tree re-growth when estimating woodfuel supplies. Note however, that grazing animals may prevent the re-growth of woody biomass.

2.3 Responses to Woodfuel Scarcity

Responses to woodfuel scarcity can be divided into two categories: the spontaneous adaptations in the behavior of woodfuel users, and planned policy interventions.

Users and collectors of woodfuel, when faced with scarcity, may change the ways they use and procure fuels in a number of possible ways. Their options include: better management of existing resources (by shielding fires or quenching partly used firewood, for example); reducing less essential end-uses (heating water for bathing or washing clothes, for example); spending longer times collecting wood; traveling further to collect wood; switching to other fuels (either superior or inferior depending on circumstances); increasing supplies of wood by planting trees; or changing eating and cooking habits so as to use less woodfuel (for example, using more uncooked food - possibly leading to lower standards of nutrition). Cutting standing stocks of wood is often viewed only as a last resort when faced with woodfuel scarcities. There is little more than anecdotal evidence about the scale and ranking of these responses which are likely to be highly location specific.

BOX 2. Spontaneous Responses to Woodfuel Scarcity

Improve Wood Cutting Practices

Improve Fire Management Practices

Reduce Less Essential End-Uses

Increase Collection Times

Increase Collection Distance

Enlist More Family Members to do Collection

Change Eating Habits

Switch to "Inferior" Biomass Fuels

Switch to "Superior" Fuels

Plant Trees

Cut Standing Stocks of Trees

Planned interventions to reduce problems of woodfuel availability can take many forms. They may be direct energy policy programs designed either to increase wood resources by planting more trees (for example through agroforestry, farm forestry or community forestry projects); or to decrease the rate of growth of consumption (for example by promoting the use of new "efficient" stoves or by promoting fuel-switching or electrification schemes). Alternatively they may take the form of wider economic policies targeted at the underlying causes of woodfuel scarcities (poverty, inappropriate patterns of urbanization etc.)

2.4 Deforestation: Is it Occurring and What are its Causes?

The term "deforestation" is not well defined (Hosier and Boberg, 1993). In this discussion it is simply used to refer to any long-term reduction in tree cover. Deforestation, which in turn can lead to soil erosion and desertification, is a highly location specific phenomenon. Nevertheless, its principal cause throughout human history has been land clearance for agriculture. Any land clearing will have some associated costs as well as benefits (see Eckholm et. al., 1984), but the fear is that today's widespread poverty coupled with the unique pressures of high population growth rates are causing rapid and uncontrolled deforestation. At the same time the poorest members of society may be unable to make the energy transition from biomass to higher quality (fossil) fuels. In some regions, most particularly Africa, this problem is exacerbated by the lack of a transition to higher intensity farming practices that require less land area, overall, to produce the same amount of food.

BOX 3. Cause of Deforestation

Land Clearances for Agriculture

Land Clearances for Commercial Logging

Overgrazing

Pest Control

Wood for Urban Energy

Rural Woodfuel Collection

A second related effect is the increasing numbers of livestock. Once again poverty and rapid population growth have combined to increase the requirements for animal and dairy products and to inhibit a transition to more intensive forms of livestock management. The net effect is to increase the land required for grazing and over which fodder (animal feed) is collected. These are examples of threshold problems. In moderate numbers, grazing animals and human gathering of fodder may cause few problems, but if too many animals are grazed for too long on a limited area, they can damage trees, stunt their growth and prevent the natural regeneration of woodland from fallow areas. Furthermore, biomass consumed as fodder will not be available to fertilize the land on which the trees grow. Some animal husbandry practices also use fires: to clear land, to encourage grass to grow, or to control cattle ticks. Fires, both deliberate and accidental, are another cause of deforestation (Eckholm et. al., 1984).

The demands for both domestic and industrial fuels in urban areas may also contribute to reduction in forest cover. Although the use of woodfuels in these areas is generally commercialized, the cutting of wood is rarely adequately regulated. Those involved in supplying wood to urban markets have little accountability for the social and environmental impacts of their trade. The problem is exacerbated in some areas because of the need to convert wood into charcoal to make its transportation over long distances cost-effective. Charcoal making in developing countries is usually carried out on an informal basis resulting in low conversion efficiencies which further increase the total amount of wood that must be harvested to meet urban fuel needs.

Thus, rural woodfuel collection is only one of a number of possible causes of deforestation.

2.5 Constraints on Policy Interventions

The many constraints on policy interventions that would reduce the problems of woodfuel availability have been discussed widely elsewhere (see for example Leach and Mearns, 1988 and Munslow et. al., 1988). Many projects, particularly those centered on large scale afforestation or on introducing new efficient stoves have failed to live up to their expectations, at least in so far as "success" was defined as saving woodfuel resources.

The reasons why projects have failed are diverse. One reason is that such projects have been targeted directly at curing woodfuel scarcities rather than at the wider and underlying social problems faced by the communities in which they took place. Projects have often failed to recognize the woodfuel crisis as only a symptom of the wider problems of poverty and rapid population growth.

For example, projects intended to promote the growth of trees have often failed to recognize that, even in circumstances where woodfuel is in short supply, there may be a whole range of perfectly rational reasons why people do not wish to plant trees. Eckholm et. al. (1984) list some of these, which include:

* **Priorities:** Even in situations where woodfuel availability is a problem, other issues may take precedence. For example, tending agricultural land may be a higher priority than planting and tending trees. In some cultures where men control family finances, but women are responsible for collecting wood, people may be prepared to grow wood products which can be sold such as building poles, but will not commit labor and other resources to grow firewood. Alternatively, there may simply be a lack of space for growing trees.

* **Land Tenure Issues:** If people do not have ownership or collection rights over the land where they are asked to plant trees, they are unlikely to be enthusiastic about tending any trees planted there.

* **Other Issues:** Trees may compete with agricultural land for nutrients or light or people may believe they will lower the water table. Tree cover may have been removed in the first place because it harbored seed-eating birds, malaria carrying insects, or cattle ticks. Under these circumstances, tree planting is unlikely to occur.

3. EARLY ATTEMPTS TO MODEL WOODFUEL ISSUES

In the 1970s, analysts and planners discovered the "other energy crisis" of woodfuel scarcities. At that time, the woodfuel crisis was perceived as a straightforward supply-demand imbalance. It appeared that population growth was leading to increased woodfuel consumption which in turn was causing widespread deforestation and desertification. "Gap theory" was adopted as the principal method for analyzing this problem. Its basic tenets were as follows:

(A) First, the current total consumption of woodfuels (and sometimes building poles, construction timber and other tree products) were estimated in the region under study.

(B) Next, the total standing stocks of wood and the annual sustainable yield of wood in the region were estimated. Often, these were based on national forestry department estimates of commercial forestry scaled down to account for the accessibility of wood resources by assuming the wood from areas such as game reserves, controlled forests or remote areas was not accessible.

(C) Consumption was then projected into the future (normally in direct proportion to the expected rate of population growth).

(D) Where consumption exceeded sustainable yields, the theory assumed that "the gap" was filled by cutting into wood stocks.

(E) Cutting of wood stocks was assumed to lead to a decrease in the future sustainable yield of wood. Hence the theory assumed that, without remedial action (namely planting more trees), a collapse in wood stocks would inevitably occur.

(F) The final step in gap theory was to make an estimate of what needed to be done to "close the gap". Because the theory assumed an ever-widening gap, the conclusion was invariably that massive afforestation was required.

Many influential studies were based on this approach, including the sixty UNDP/World Bank developing country energy sector assessments conducted in the 1980s and the UN Food and Agriculture Organization (FAO) study "Fuelwood Supplies in the Developing Countries" (UN Food and Agriculture Organization, 1983). That study used gap theory to make twenty year projections, region by region, of wood resources, consumption and wood fuel gaps.

3.1 Criticisms of Gap Theory

The fears of imminent exhaustion of tree stocks in large parts of the world have proved to be largely unfounded, and this has led to a reappraisal of gap theory.

(A) A basic premise of "gap theory" is that woodfuel scarcities are caused by woodfuel consumption. In this respect it makes the mistake of equating deforestation and the woodfuel crisis. In fact, as noted in section 2.1, woodfuel problems are more often a consequence than a cause of deforestation. The cutting of live wood for fuel by rural people is only one of a number of possible responses to woodfuel scarcity. Furthermore, even where "overcutting" of wood does occur, this may not be because of an absolute lack of trees, but rather because of land-tenure arrangements which deny access to resources to certain parts of the community - normally the landless poor.

(B) By taking too aggregate a spatial perspective, gap theory ignores the reality that woodfuel supply and demand situations are highly location specific. Patterns of woodfuel consumption can vary widely within countries, within regions and even within village communities themselves.

(C) The data on which woodfuel consumption and tree resource projections are made are rough, but because gap theory assumes that the response to scarcity is always to cut wood stocks, it is the typically small differences between data on consumption and data on tree resources which drive the gap forecast.

(D) As described in section 2.2, woodfuel can come from a wide range of sources. Estimates of wood resources are often based primarily on forestry department data for commercial forests and so will tend to severely underestimate the total woodfuel resources actually available.

(E) Most gap theory projections do not account for the natural regeneration of forests. Even when whole trees have been cut or land areas cleared it is possible, depending on the presence of grazing animals, that trees will begin to re-grow.

(F) Gap theory methodology does not account for spontaneous responses to woodfuel scarcity. Unfortunately, as noted in section 2.3, there is a lack of quantitative information about the ordering and scale of these responses or as Leach and Mearns (1988) put it, there is no information about the price elasticities of demand or supply for woodfuels. In the absence of such information, gap theory makes aggregate projections on the assumption that these elasticities are all zero. That is, neither woodfuel consumption patterns nor tree planting patterns are assumed to respond to scarcity, but instead continue on their preset trends.

4. TOWARDS A BETTER APPROACH

Bearing in mind the criticisms raised of early "gap theory" models, we can identify a range of issues which need to be addressed in any model of wood supply and demand. These issues include:

* **Land-Use Patterns:** Models must not assume deforestation is driven by woodfuel consumption. Instead of being based directly on a woodfuel supply demand balance, models needs to be based on a more complete consideration of all current land-uses and the likely changes in those land-uses over time. Furthermore, models must account for all possible sources of woodfuels: trees, bushes, shrubs and dead-wood. Including only commercial forest resources is not sufficient.

* **Disaggregation:** Because wood resource supplies, wood consumption patterns, wood management practices and responses to woodfuel scarcity are all likely to be highly location specific, any model must take a disaggregated perspective. The degree of disaggregation necessary will itself vary from area to area. Any model must therefore allow the planner the flexibility to choose where greater or lesser degrees of disaggregation are required.

* **Integration of Demand and Supply Side:** Any model must include a wide range of options and allow the planner to consider how they will interact; a demand-side policy that encourages, say LPG or kerosene, may affect the viability and economics of woodfuel plantations.

* **Wood Growth Patterns:** Any model must account for a range of wood growth patterns. It cannot, for example, be assumed that cutting into stocks will necessarily lead to lower tree growth rates. Informal wood cutting practices such as pruning or lopping may lead to higher wood growth rates. Models must account for the re-growth of trees where appropriate.

* **Data Availability:** Since data is often weak, any model needs to be flexible and user-friendly enough to (1) help make use of available data, (2) assist the user to make intelligent generic estimates where data is weak, (3) allow the user to identify priority areas where data needs to be improved (e.g. by making sensitivity analyses straight forward), and (4) be usable in-situ by planners in the developing countries so as to encourage an on-going data collection/analysis/data refinement cycle.

* **Spontaneous Responses to Scarcity:** Any model must account for a variety of responses and for a range of wood management practices. It must not simply assume that the only response to scarcity is to cut stocks.

* **Modern Biomass Options:** As concerns about global environmental issues such as climate change increase, modern sustainably harvested biomass plantations will become an increasingly attractive energy option. Any model designed to be applied to issues of woodfuel supplies and demands must be capable of analyzing the role of these options in an overall energy plan.

5. METHODS FOR BIOMASS ENERGY PLANNING

Two basic approaches for energy modeling are often referred to a "top-down" and "bottom-up". "Top-down" approaches attempt to capture the aggregate behavior of the energy sector by use of equilibrium or partial equilibrium models which simulate prices, demand, supply and investment interactions to seek a long-term market equilibrium. Such interdependent relationships are at best difficult to quantify and at worst an inaccurate description of the behavior of markets. This is particularly true of the markets seen in many developing countries which face severe constraints and are in any case dominated by the economies of more industrialized nations and the vertically integrated markets for many basic commodities. For example, the economies of smaller nations have little power over the prices of raw materials, especially fossil fuels.

For these reasons, a "bottom-up" or disaggregated approach is more suitable for modeling the energy systems of developing countries. This approach is not based on strict economic dogma, but instead takes a more pragmatic view of energy systems. Planners are encouraged to make demand and supply projections and investigate at a disaggregated level using available data and their own expertise and experiences of the energy system of their own country. This approach allows important (and often price-independent) effects such as technological innovations, energy transitions, market saturation and other structural shifts to be easily incorporated: something that would be virtually impossible using an econometric approach. Economic modeling methodologies are not rejected but instead are made use of on an ad hoc basis only where the planner feels they are appropriate. For example: a national or regional macro-economic model may be used as the basic framework within which "bottom-up" demand and supply projections are made.

A range of different methodologies are available for modeling energy systems. These include: normative (optimizing) models, systems dynamics models, and accounting framework simulation models. Optimizing models typically use linear programming techniques to discover a system configuration which maximizes or minimizes some objective function (e.g. minimizing costs). They have found favor in such applications as least cost electricity planning studies but have generally not been seen as suitable for modeling disaggregated energy systems (such as rural biomass systems) where the planner is not generally attempting to make an optimal investment decision, but instead is attempting to quantify the economic and environmental impacts of a range of different exogenous macro-economic scenarios. Systems dynamics models makes use of engineering control theory to simulate a system as a series of interconnected stock and flow variables. They are a powerful tool for studying the interrelationships of the different parts of a system, but because their behavior is dependent on the feedbacks between different variables, their predictive capabilities rely upon good knowledge both of the starting values of all variables, and of the relationships between those variables. Small errors in estimates of any of these values will tend to be exaggerated as the model is run over a long planning period. To date such models have not been applied as practical tools for examining biomass or other disaggregated energy systems.

Most models of disaggregated energy systems have been based instead on a simpler approach: the accounting framework. The philosophy behind these systems is that complex and difficult to understand models are not appropriate. Instead, what the planner is provided with is a set of accounting tools for checking the consequences and consistency of a range of different scenarios. The power of these tools lies, not in a complex model, but rather in their equal emphasis on data, models and an easy-to-use user interface.

LEAP is the Stockholm Environment Institute's computer-based tool for performing integrated energy planning. Structured as a family of microcomputer programs, LEAP is designed as an accounting framework and as such it serves several purposes. As a database it provides a comprehensive system for maintaining energy information. As a forecasting tool, it enables the user to make integrated projections of energy supplies and demands over a medium or long-term planning horizon. As a policy analysis tool, it simulates and assesses the effects - physical, economic and environmental of alternative energy programs, investments and actions. Its design is guided by a number of methodological considerations. These include:

* **The Scenario Approach:** Scenario analysis uses the computer to simulate alternative energy and economic futures under a range of different assumptions. An enormous range of "what if" questions can be asked, such as: "what if more efficient stoves are introduced?"; or "what if an agroforestry program is implemented?". Scenario analysis evaluates the physical, economic and environmental impacts of different scenarios and so helps to clarify which policies, investments and actions are needed to guide energy demands and supplies.

* **Integrated Energy-Environment Planning:** While emphasizing a disaggregated approach, LEAP also stresses the importance of integrating an analysis within a comprehensive planning framework. Integration is emphasized: across all fuels in the energy system; across all parts of the energy system (demands, intermediate conversions of fuels, primary resources and environmental and economic impacts); across separate geographical areas and across different sectors of the economy.

The system also integrates between rural and urban energy systems. A focus on rural energy alone would miss important interactions between rural and urban energy use, such as the effect of urban charcoal demand on the availability of firewood in rural areas. At the same time, focusing on commercial energy issues and national aggregates could fail to give biomass energy problems and potentials their full due.

* **End-Use, Needs-Driven Approach:** In LEAP, resource requirements and supply-side projections are not planned in isolation. Rather they follow from an analysis of the energy services required by different economic sectors. This approach places development objectives, such as the provision of end-use goods and services, at the foundation of energy analysis. It achieves the goal of integrated energy planning by allowing the development plans of different sectors to guide the evaluation of energy strategies.

* **Flexibility and User-Friendliness:** For a software tool to be useful to a planner it needs to be flexible, expandable and comprehensive. LEAP is designed as a set of model building tools, rather than as a set of rigidly structured models. These provide an expandable data structure which can be adapted to the diverse energy systems and different requirements and development views of planners. Its use of simple models whose structure (and hence results) are readily understandable and its simple and intuitive user-interface, including complete documentation and on-line context-sensitive help, makes it usable by analysts and decision-makers with little computing or energy modeling experience

* **Data Constraints:** One concern is that there are generally insufficient reliable quantitative data (particular concerning biomass issues) for a detailed and integrated energy planning approach. This concern reflects an overly sequential view of the relationship between data and analysis: one that can be summarized as "collect the data, then do the analysis". LEAP is intended to be used in a more iterative fashion. An initial data set is gathered for the first planning exercise, with some degree of incompleteness and incompatibility across fuels and sectors being inevitable. Initial runs produce preliminary outputs and energy policy analyses which help evaluate the status of the existing database, and identify areas where more or better information is required to improve the analyses. This data can then be collected in a second iteration of the process.

5.1 An Overview of The LEAP System

In this section a very brief outline of the LEAP program structure is provided. Special emphasis is put on the LEAP Biomass program although it should be stressed that this forms only a part of the complete set of tools provided for analyzing woodfuel supply and demand systems. The power of the system relies upon the integration of biomass issues into the overall energy-environment planning process. More detailed information can be obtained in the LEAP Overview and LEAP User Guide documents (SEI-B, 1992).

The LEAP program structure is presented schematically in Figure 1. It consists of three blocks of programs: Energy Scenarios, Aggregation, and the Environmental Database. The Energy Scenario programs address the main components of an integrated energy analysis: demand analysis, energy conversion, and resource assessment. There are three programs for building scenarios (Demand, Transformation, Biomass), a program for reporting environmental emissions and one for comparing and evaluating scenario costs and impacts. The planner uses the scenario building programs to develop current energy balances, projections of

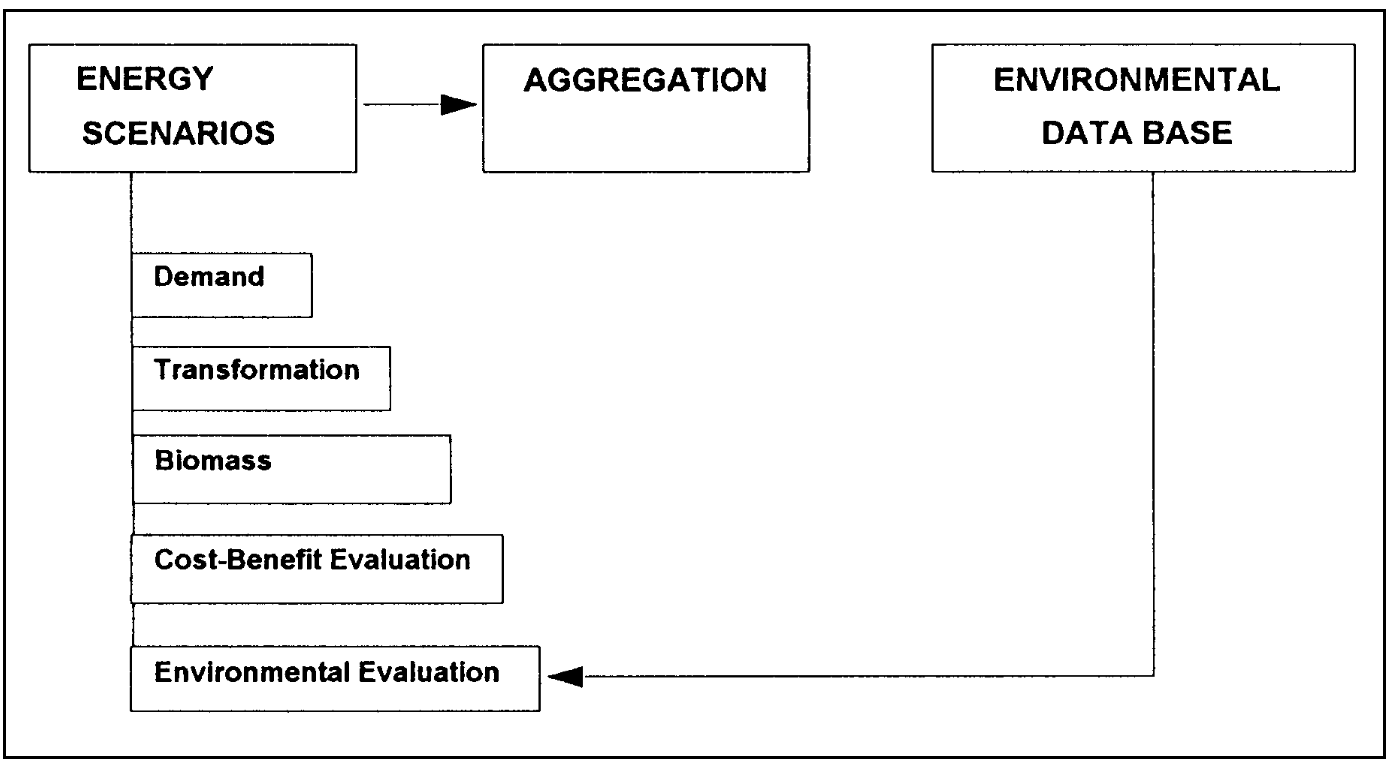

Figure 1: LEAP Programme Structure.

supply and demand trends, and scenarios representing the effects of energy policies, plans and actions. The Environmental and Evaluation programs compute the physical impacts of moving from one scenario to another, the economic costs and benefits, and the environmental emissions. The Aggregation program assembles area level (district, nation, region) energy accounts and projections into multi-area results. The Environmental Database (EDB) provides a comprehensive summary of the information linking energy production, conversion and consumption activities to air and water emissions, and other environmental and health consequences. These can be linked to energy scenarios to provide measures of the environmental consequences of alternative futures.

5.2 The LEAP Biomass Program

The Biomass program examines the impact of biomass consumption (both for energy and non-energy uses) and land-use changes (e.g. agricultural land clearances) on the biomass resource base. It is designed to help answer important questions pertaining to biomass energy. For example: "Will there be sufficient biomass to satisfy energy requirements?"; "Is deforestation likely to be a problem, and if so, what are its causes?"; "What are the impacts of possible afforestation programs?"; "What are the impacts of different urbanization scenarios on rural energy systems?"

The latest version of LEAP (to be released in 1993) expands the scope and flexibility of the existing program, removing many of the more rigid assumptions of the previous version. The program design has yet to be finalized, but will contain many new features, most notably expanding the scope of analysis to include dung, agricultural residues and other bioenergy resources. It will also improve the flexibility of the simulation of wood-growth models and land-management practices. The following description of the Biomass program is based on the provisional version of the program.

The basic unit of study in the Biomass program is land. Data may be represented at whatever level of spatial detail is appropriate. An area (e.g. a country, state or province) may be further disaggregated into three levels of detail nominally labeled as subareas, zones and land types. For example, the first level could be the provinces of a country. The second level typically identifies ecological zones within a province based, for example, on the annual rainfall or zones of soil fertility. The third level identifies common land-types, generally based on land usage such as small farms, grazing ranges, natural forest, commercial forests etc.

Wood stock and yield data are assigned to each disaggregated land-type and may vary from one subarea/zone to another. Different rates of growth and wood cutting practices may also be specified for each subarea, zone and land-type.

Dung resources are projected through an inventory of animals in each subarea and the dung they produce. Energy crop and agricultural residue projections are made on the basis of the land devoted to each crop and the yield of crops or agricultural residues per hectare of land.

Like the rest of LEAP, the Biomass program is demand driven (see figure 2). The energy demands for firewood, wood used for charcoal and any other biomass fuels are taken from the calculations of the Demand and Transformation programs. For example: a final demand for charcoal in the Demand program may be met in the Transformation program by a mix of traditional and efficient charcoal kilns. This will in turn produce a requirement for wood for the charcoal making process. As another example, demands for ethanol may be met in a Transformation module by processing appropriate biomass feed stocks.

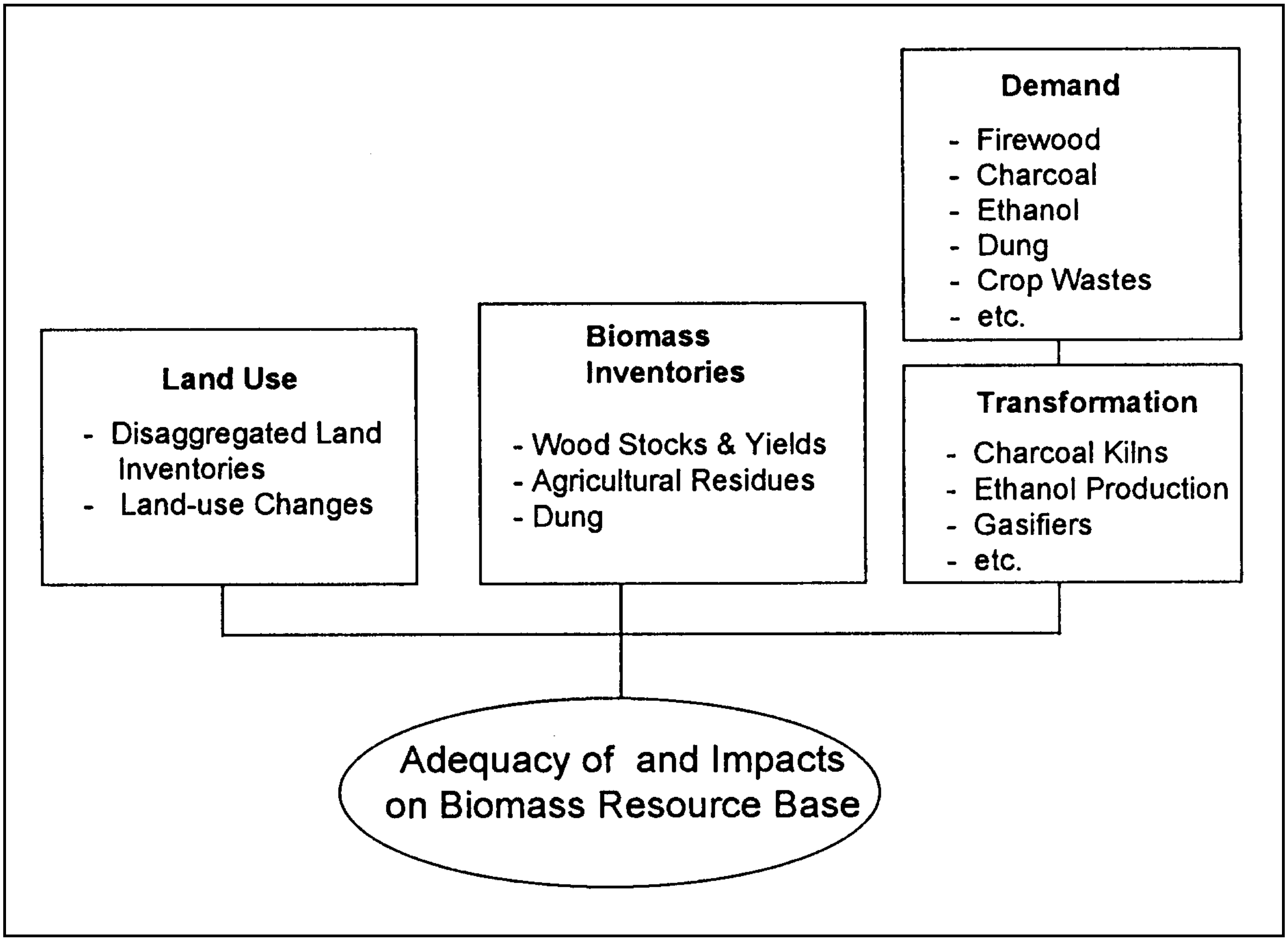

Figure 2: Methodology of LEAP Biomass Analysis

Area-wide biomass requirements can be flexibly disaggregated to simulate the requirements for wood and other biofuels in the individual subareas used in the analysis. At the same time, the effects of changing patterns of inter-subarea transportation of biofuels can be incorporated (e.g. production of wood or charcoal in a rural province for sale in an urban area). To these energy requirements are added separate estimates of the requirements for non-energy wood products: lumber, building poles, pulp and other items.

Projections of available wood resources, combined with estimates of the energy and non-energy requirements for biomass products, and scenarios describing land-use changes allow the Biomass program to simulate future wood growth and harvesting and to indicate the adequacy of wood and other biomass resources.

The Biomass program by itself, and when integrated into the rest of LEAP, addresses the requirements for an improved biomass modeling system outlined in section 4. In particular, the following issues have been addressed:

* **Land-Use Patterns:** The Biomass program does not assume deforestation is primarily caused by woodfuel collection. Instead, its approach is based on a fundamental assessment of land-uses and

land-use changes which encourages the user to explicitly account for all sources of deforestation and tree cutting. These may include cutting wood for rural woodfuel needs but will also include stocks cut during land clearing for agriculture and wood cutting for urban energy requirements.

* **Disaggregation:** The Biomass program has a disaggregated 'bottom-up' perspective, which encourages the user to account for all sources of woodfuel including on-farm trees, surplus wood from land clearances, inter-sub-area transport of woodfuel resources, waste wood from commercial logging and milling as well as the cutting of trees of fuel.

* **Wood Growth Patterns:** The Biomass program allows a wide range of different land management practices and wood growth patterns to be described within its disaggregated data structure. In particular, some of the more basic assumptions of "gap-theory" models are lifted: (1) Cutting into stocks is not necessarily assumed to lead to lower tree growth rates. (2) Re-growth of wood on fallow or cleared land is allowed (but not assumed).

* **Spontaneous Responses to Scarcity:** The Biomass program does not assume that the only response to scarcity is to cut wood stocks. The user describes land-management practices on each disaggregated land-type, indicating whether or not wood stocks are cut on that land-type.

At the present time, it has not been possible to endogenously model the wide range of spontaneous responses to woodfuel scarcity described in section 2.3, all of which are likely to lead to decreased consumption of woodfuel or to increased supplies. As has already been stated, these responses are likely to be highly location specific and there is little more than anecdotal evidence about their scale and ranking. To endogenously model such responses in an energy model, would require an equilibrium approach in which demands and supplies were interdependent. Section 5 has already indicated why such models may not be a valid approach. To solve such a system would require an iterative solution technique that would greatly increase the complexity (and time taken to solve) the system while at the same time making the structure (and results) of the model much more difficult to understand.

In the final analysis, like earlier "gap theory" models, the Biomass program is still based on a supply-demand balancing approach that ultimately calculates a supply-demand "shortfall" if resources are found to be inadequate to meet requirements. This "shortfall" is not intended as a projection of a "gap". It is only intended to indicate that responses will be necessary. If sufficient data is available, assumptions about these responses can be incorporated into revised scenarios. This may involve changing the assumptions in the Demand, Transformation or Biomass programs.

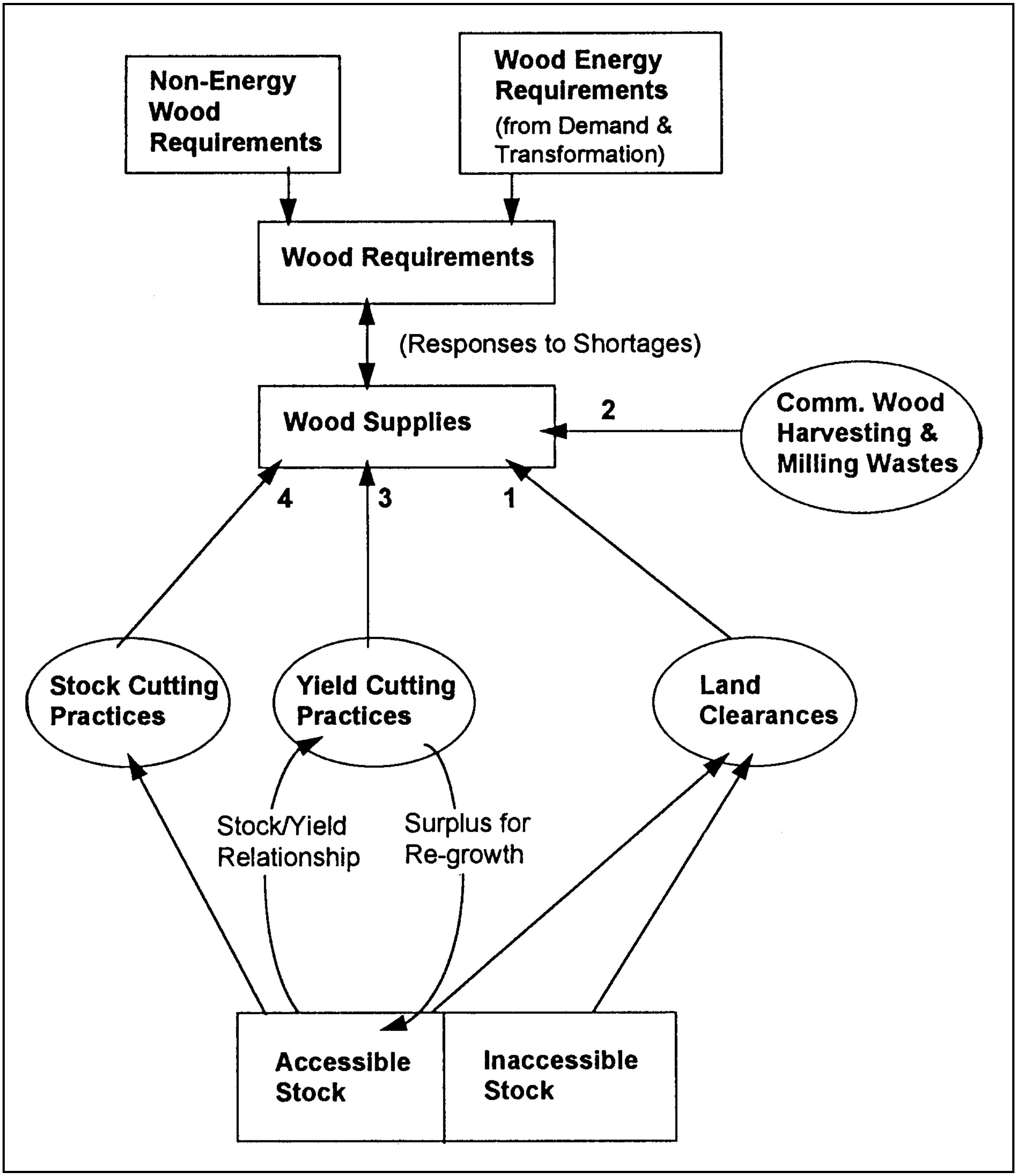

Figure 3: Simplified Schematic of Wood Demands and Supplies.

6. CASE STUDIES

LEAP is currently being used in over 40 countries worldwide. It was initially developed as part of the Kenya Fuelwood Project of 1980-1982, a project organized by the Beijer Institute and the Kenya Ministry of Energy and Regional Development (see description in O'Keefe and Raskin, 1985). Since then it has evolved extensively and has been used as a tool in a wide variety of studies, examples of which include a global energy-environment study "Toward a Fossil Free Future: The Next Energy Transition" (Lazarus, Greber, Hall et. al., 1992); a national study of the USA "America's Energy Choices" (Union of Concerned Scientists et. al., 1991); and energy-environment studies in Senegal (Lazarus, Diallo and Sokona, 1993) and Costa Rica (Von Hippel and Granda, 1992) that considered biomass questions in some detail.

6.1 Kenya

The Kenya fuelwood project launched in 1980 used an early version of LEAP as a tool to carry out one of the first major integrated energy planning exercises to be conducted in a developing country. The assessment of woodfuel resources and consumption patterns was a major component of the study. Unlike earlier studies, a high level of sectoral and spatial disaggregation was used in conducting surveys. Emphasis was also placed on gathering data from the non-commercial sector. A base case "business as usual" projection was used as a benchmark against which alternative issues were identified and the physical and economic impacts of energy policy initiatives were assessed. The recommendations of the Kenya fuelwood project were adopted into the national energy policy of the Kenyan Government.

Follow-up activities, have included more detailed and disaggregated local studies to investigate the dynamics of fuelwood collection and tree growing, the role of tree-growing as a part of farm economics, and the family dynamics of woodfuel collection and tree growing. These in turn, have led to new approaches being developed for, amongst other things, the dissemination of seedlings.

6.2 Tanzania

Tanzania is an example of a country where an iterative approach to energy planning has evolved, and where the LEAP system has been used both as an analytical and forecasting tool and as a means of focusing data collection efforts. Collaboration between the Stockholm Environment Institute-Boston (SEI-B) and the Tanzania Ministry of Water, Energy and Minerals (MWEM) has been continuous since 1987. With financial support from the Swedish International Development Agency (SIDA), an initial data development and analysis exercise and staff training courses were carried out in 1988. Since then, further intensive training courses, data refinement and results analysis iterations have been carried out periodically. Close cooperation between SEI-B and MWEM is continuing this year. Initial analytical efforts focused on looking at alternative approaches for meeting urban household energy demand (see Mrindoko and Lazarus, 1992). Using the LEAP system as a framework for the analysis, Demand scenarios considering different rates of introduction of improved charcoal stoves, and Transformation scenarios considering different rates of introduction of more efficient kilns were constructed as deviations from a base case scenario. MWEM staff used LEAP to assess the economic costs and benefits and the environmental implications of these different scenarios relative to the base case scenario. Through these studies, but also through its in-house role as an energy database and training tool, LEAP has assisted MWEM staff to quantify issues in a recently published Government document: The National Energy Policy (United Republic of Tanzania, 1992).

This work has helped to highlight areas where data is particularly weak. As expected, data on biomass consumption, tree stocks and tree growth rates are poorly known, but crucial to the understanding of Tanzania's energy system. The initial studies have helped MWEM and SEI-B staff to focus their efforts in subsequent years. In 1993, SEI-B and MWEM staff will be addressing biomass issues: updating and improving biomass data and identifying and assessing the implications of a range of different biomass energy policy options.

6.3 Other Countries

In Senegal, SEI-B collaborated with ENDA-TM (Energy and Environment in the Third World) in an investigation of the economic and environmental implications of continued or accelerated substitution of LPG for Charcoal in households. The study found that such a policy could actually reduce greenhouse gas emissions while at the same time contributing to the improvement of more important near-term environmental problems (e.g. rural ecosystem deterioration). At the same time, the impact of LPG substitution on increasing the oil import bill would be relatively small when compared to other petroleum product usage. Improving end-use efficiencies was also investigated and found to be promising.

In the Philippines, the Office of Energy Affairs Non-Conventional Resources Division has been using LEAP as an integrating analytical tool in an extensive effort to develop institutional capabilities for regional rural energy planning. We hope the experiences of this project will be discussed at the current workshop, given the presence of its initiator (Mr. Heruela) and other key participants.

7. CONSTRAINTS TO PLANNING

Effective systematic biomass energy planning must be evaluated in individual contexts. Some problems we and others (Hosier, 1992) have encountered include:

(A) Energy ministries are often the youngest, smallest and least powerful of Government ministries. Although one of their roles (as defined by the needs of integrated energy planning) is to act as a coordinating agency, they often have little authority over the decisions made by the other agencies. For example: electricity, gas and oil planning are often carried out independently by private or parastatal organizations, project approval is given by economics and finance ministries, and woodfuel development is carried out by forestry departments.

(B) Shortages of skilled personnel have reduced the effectiveness of energy ministries in many countries. Particularly in Africa, the type of highly skilled professionals who carry out energy policy studies can often obtain highly paid employment outside the ranks of the government. With high rates of staff turnover, it is difficult to reach a "critical mass" of talent, so that in-house knowledge can be passed-on and built-upon by newly arriving staff. The involvement of foreign consultants in planning studies can also lead to problems largely through a lack of familiarity with local conditions and planning institutions (see de Lucia and Jacoby, 1982).

(C) Finally, while it is always important to remember that energy planning must be a political and non-objective exercise, political factors such as vested interests and the inevitably short-term perspectives of periodically elected officials, may constrain the ability of energy policy analysis to be translated into rational policy making.

8. CONCLUSIONS

Questions about deforestation and the adequacy of woodfuel supplies continue to be of great importance in forming energy policy in developing countries, although a better understanding of woodfuel issues which has arisen since the early 1980s has shown that predictions of impending exhaustion of woodfuel stocks were, in most cases, unwarranted. On the one hand, woodfuel collection is no longer thought to be a major cause of deforestation and on the other, people are now known to be able to adapt when faced with woodfuel scarcities. Nevertheless, the responses which have to be made when people are faced with woodfuel scarcity often represent a decline in human welfare.

Early attempts to model the woodfuel crisis suffered from a number of problems: they assumed that deforestation was driven by woodfuel consumption; their perspective was too aggregate; their forecasts were based on the, typically, relatively small differences between consumption and supply estimates -- estimates which were themselves very approximate; they failed to account for all sources of woodfuels; they failed to account for the natural regeneration of wood and; they failed to account for the spontaneous responses of people collecting and using wood fuel.

Initial efforts to help solve the woodfuel crisis, spurred on in part by these analyses, were disappointing, largely because they were aimed directly at curing the symptoms of the woodfuel crisis itself. They failed to address the underlying problems of poverty, rapid population growth, inappropriate patterns of urbanization and deforestation.

Projects such as those listed in section 6 and the current Pakistan Household Energy Strategy Study have shown the importance and benefits of systematic and policy-oriented investigation of woodfuel data and dynamics. Improved models can play a part in improving our understanding of these systems. First, such models should be based on a more fundamental analysis of land-use changes enabling them to account for all possible causes of deforestation and all of the many different sources of woodfuels and biomass energy. Second, they should take an integrated perspective in which woodfuel demands and supplies are viewed as only a part of the wider national energy-economy system. Third, given the highly location specific nature of many woodfuel issues, they should encourage analysis at a more disaggregated level. The LEAP system, is one software tool which has been created to meet those design objectives.

Even with the aid of the most appropriate models, barriers still exist which prevent a full understanding of woodfuel issues. In many areas there remains a lack of reliable quantitative data. Institutional inertia and political and personnel constraints must be overcome through concerted and creative efforts, such as those underway in the Philippines. Finally, by their very nature, models are best suited for the analysis of quantitative data: they are not well suited for the analysis of complex social interactions. These interactions play very important roles in determining how wood and other biomass resources are provided and used. Analysts must always be aware of the limitations of models, and interpret their results accordingly.

Software tools cannot solve these problems, but can help to catalyze solutions by elucidating data needs and by helping planners to address important policy questions.

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Energy Modelling Studies on Wood and Biomass Energy in the Asean Region

by

Jean-Yves Garnier[1]

1. MODELLING BIOMASS ENERGY: WHY?

Biomass:

An Essential Component of the Energy Mix

- For example, in Thailand biomass accounts for 43% of the indigenous energy production and 18% of the net domestic energy consumption; in 1986, biomass in Indonesia accounted for 40% of the primary energy mix.

An Essential Component of the Environment

- On the one hand, diminishing of forest areas due to wood industries, energy use, etc.

- On the other hand, increase of pollution due to population growth, urbanization, industrialization.

An Increasing Role in the Energy Sector?

- Cogeneration (heat and power) in the wood and agroindustries (sugar, coconut, palm oil, etc.) could play a major role to avoid current (e.g., Philippines) or would be shortage of power.

- Depletion of the regional oil and gas reserves could lead to an increase in the use of biomass in the industrial sector as well as in the residential sector.

[1] EC Special Adviser, AEEMTRC.

Figure 1: Environmental Pollutants from Energy Conversion and Energy Use Attack the Sensitive Tropical Ecosystems.

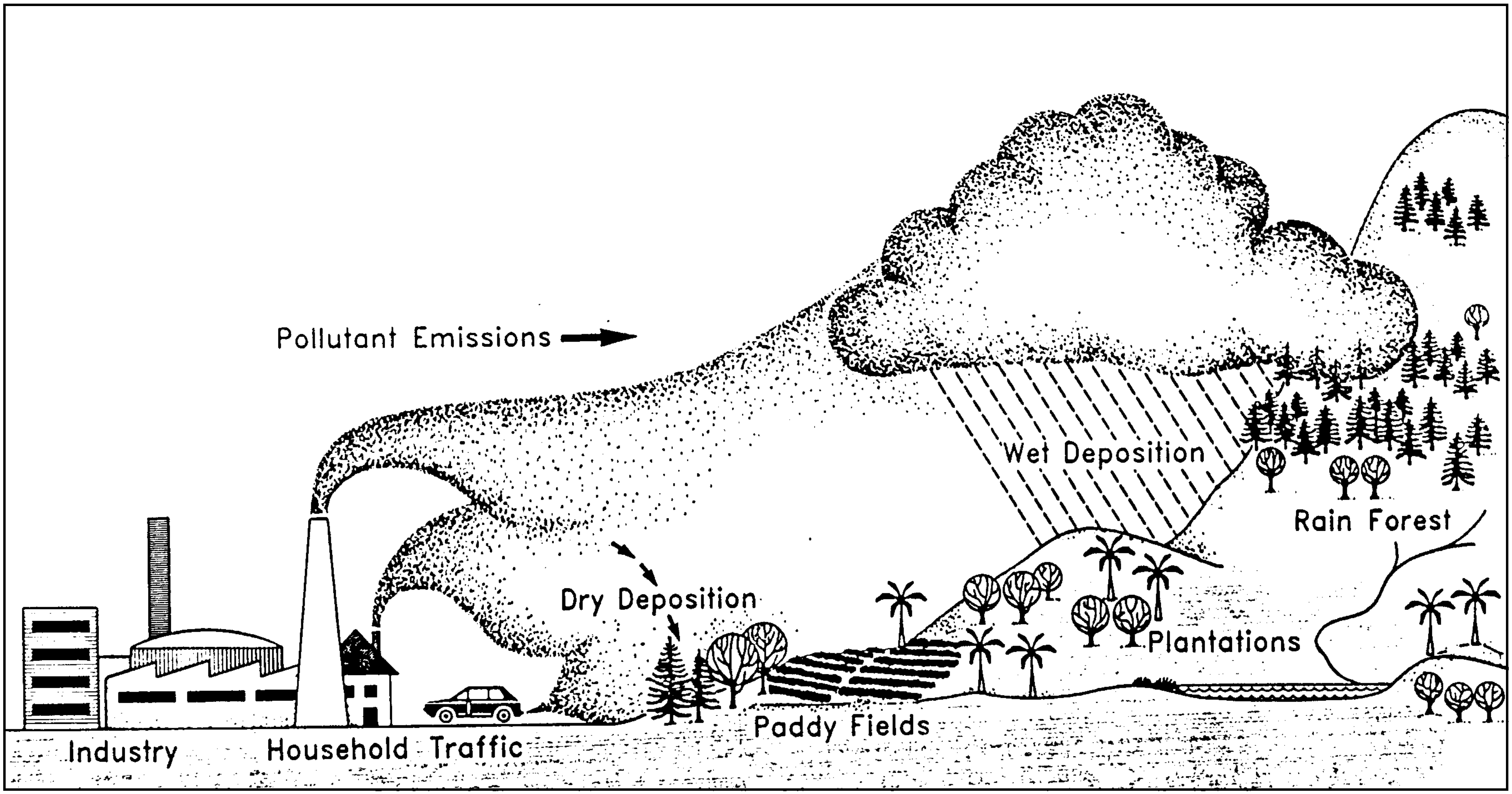


Figure 2: Evolution of the Biomass Energy Situation in Ivory Coast.

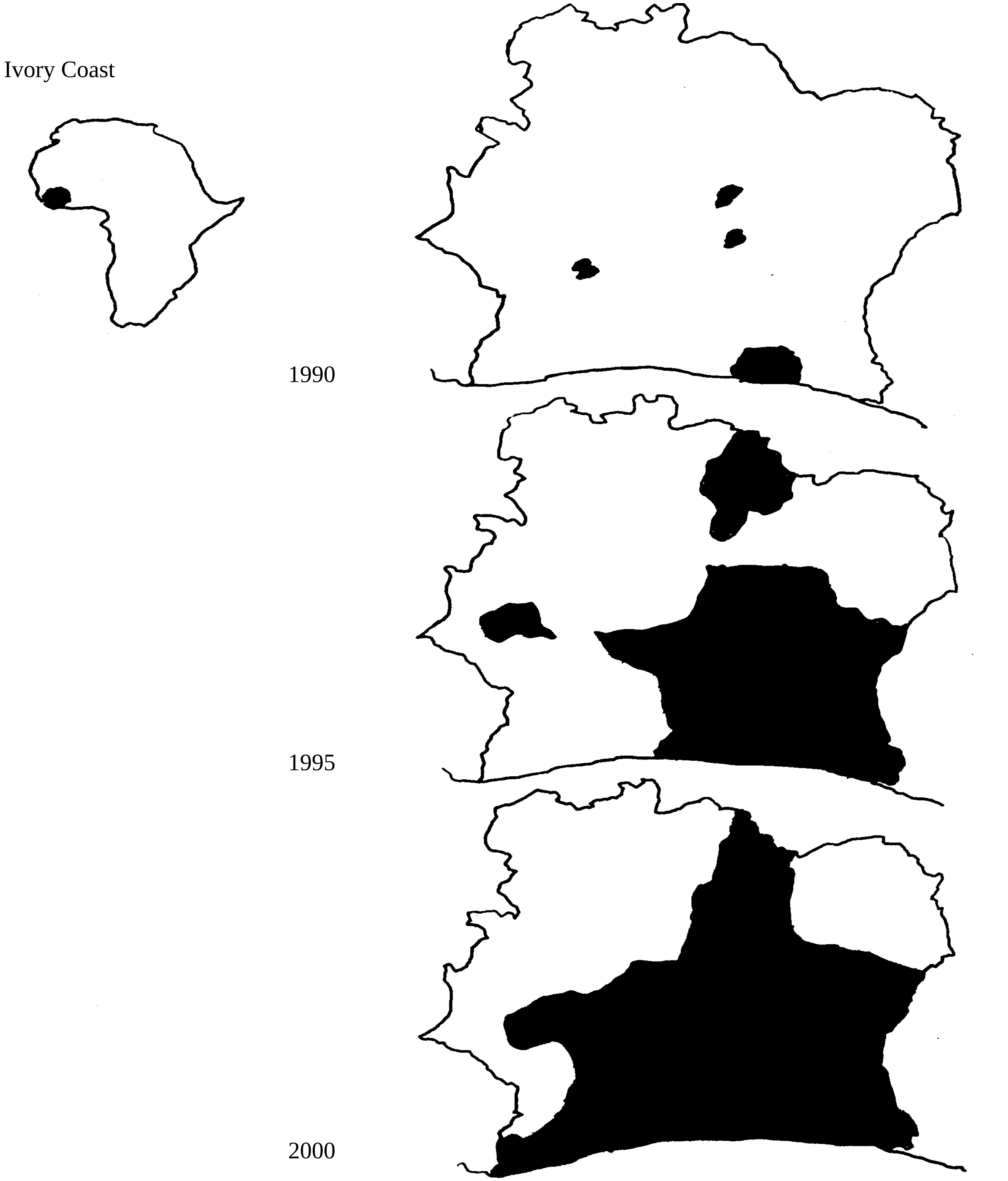


Figure 2 shows the importance of modelling and forecasting the evolution of the biomass energy demand-supply situation in countries where biomass represents a large part of the energy demand. The example chosen is Ivory Coast where biomass represents 70% of the overall energy consumption.

In 1990, the area presenting a supply-demand deficit covered only a few percentage in 1990 (around the main cities). In a "business-as-usual" situation, the deficit area will cover 40% in 1995 and 66% in 2000. If no concrete and efficient measures are taken now, this will lead to major ecological problems for the country.

Consequently, the energy policy makers have to know precisely:

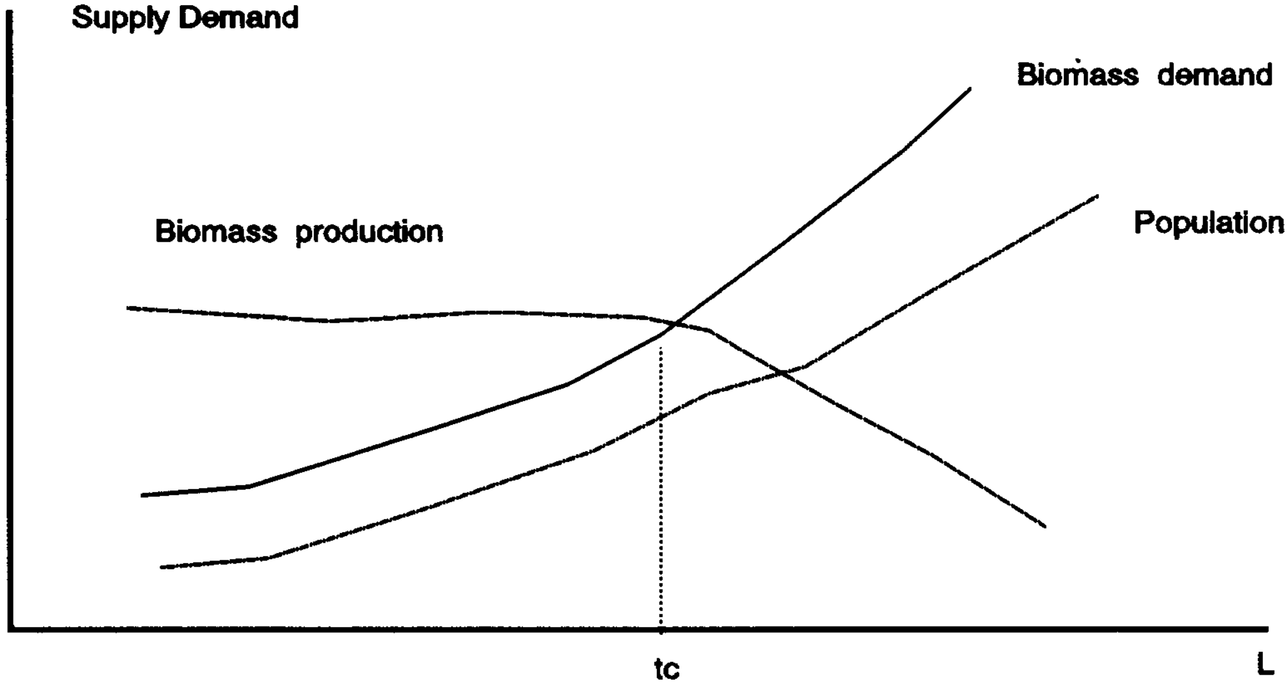
- what is the current situation, and
- what could be the situation in various scenarios of development (business-as-usual, efficient, etc.),
- in other words, what is the "critical time" (Tc, figure 3) when the demand is equal to the supply and what measures should be taken to have the supply meet the demand.

Therefore, energy planning <u>including biomass</u> must be a priority in order to:

1) know precisely the current situation (A or A1 or A2, figure 4),
2) find the optimum way from the current situation A to the target situation B.

Biomass, including biomass modelling, constitutes an essential and necessary component of any global energy and environment planning.

Figure 3: The use of energy biomass modelling in energy strategy and planning.



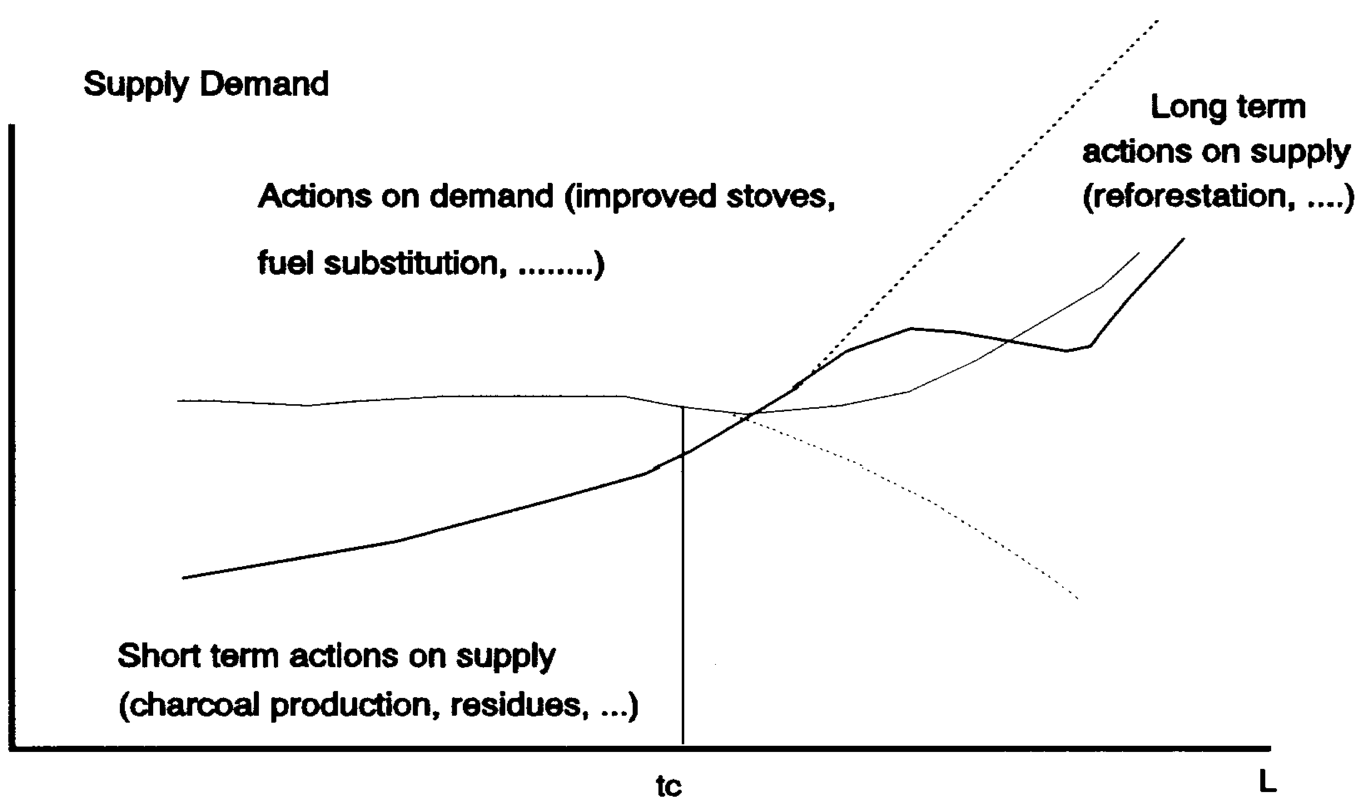
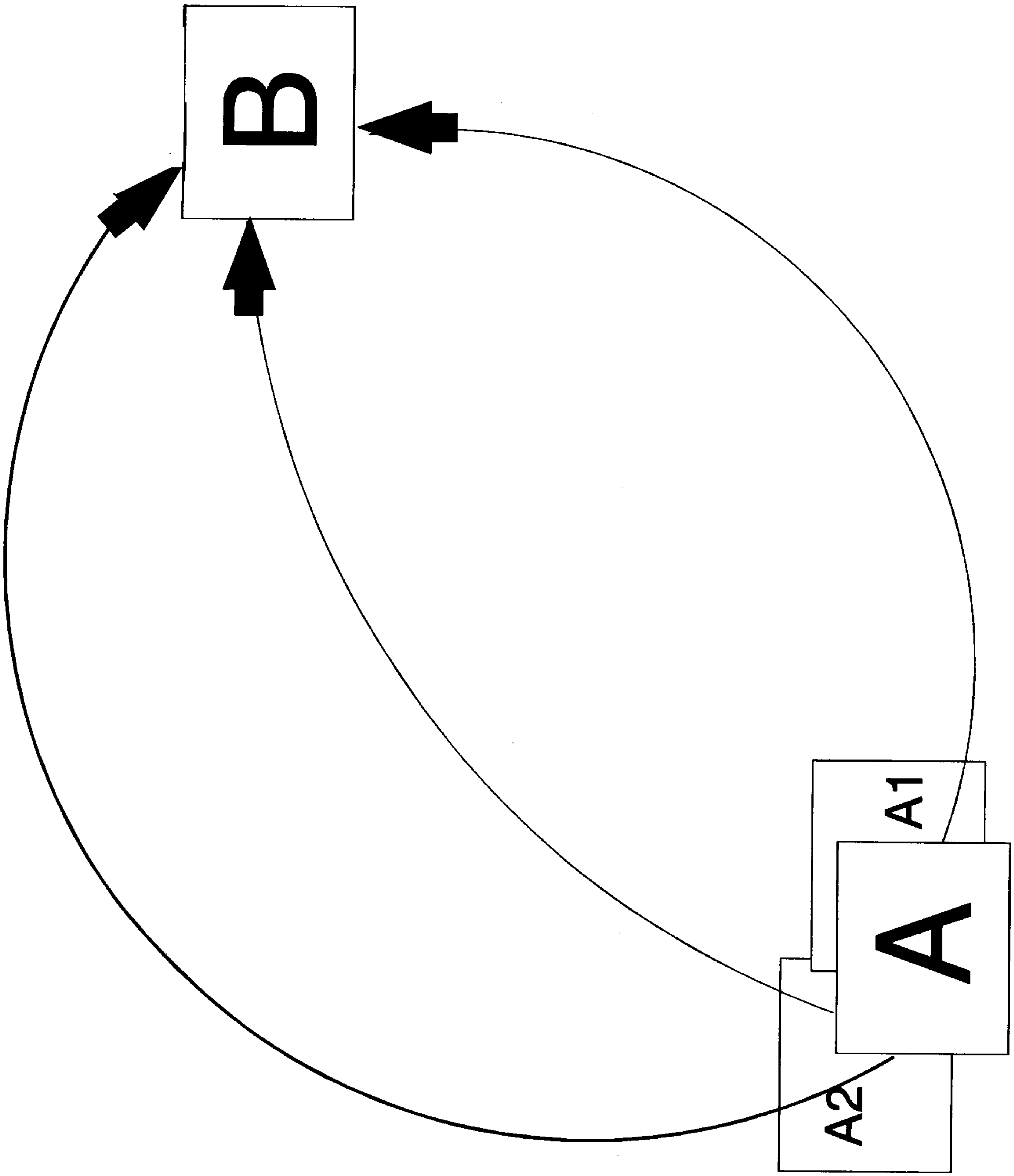


Figure 4: To find the optimum way between the current situation A and a target situation B.



2. MODELLING BIOMASS ENERGY: HOW?

2.1 The Current Situation

2.1.1 The supply

2.1.1.1 Wood and forests

The knowledge of the forest area and hardwood resources can be achieved through various techniques:

- aerial pictures
- surveys
- remote sensing, including:
  - a breakdown of an area in land use classes (primary forest, degraded primary forest, coconut plantation, rice fields, etc...) (figure 5),
  - Complementary in-site work (counting trees, measuring diameters and heights, etc..) (figure 6).

  Note: Remote sensing is already used in ASEAN for specific projects such as the "Integrated Swamp Development" study in Indonesia and the "Environment Resource Mapping" study in Malaysia (Annex 1).
- Others.

ASEAN Cooperation in Forestry: Recognizing the value of concrete action in the conservation and management of the tropical rain forest, the ASEAN member countries initiated cooperation in forestry in 1973. The ASEAN Economic Ministers on Agriculture and Forestry adopted the "Jakarta Consensus on ASEAN Tropical Forestry" in 1981 which laid the foundation for: ASEAN Common Forestry Policy, Technical Cooperation, Institution Development, Cooperation in Intra-ASEAN Timber Trade and ASEAN Common Stand on International Issues on Forestry.

Since then, various regional activities have been implemented and ASEAN has collaborated with its Dialogue Partners in the implementation of several major forestry projects such as the ASEAN-EC Timber Technology Centre in Kuala Lumpur, Malaysia.

Figure 5: Breakdown of an area in land use classes.

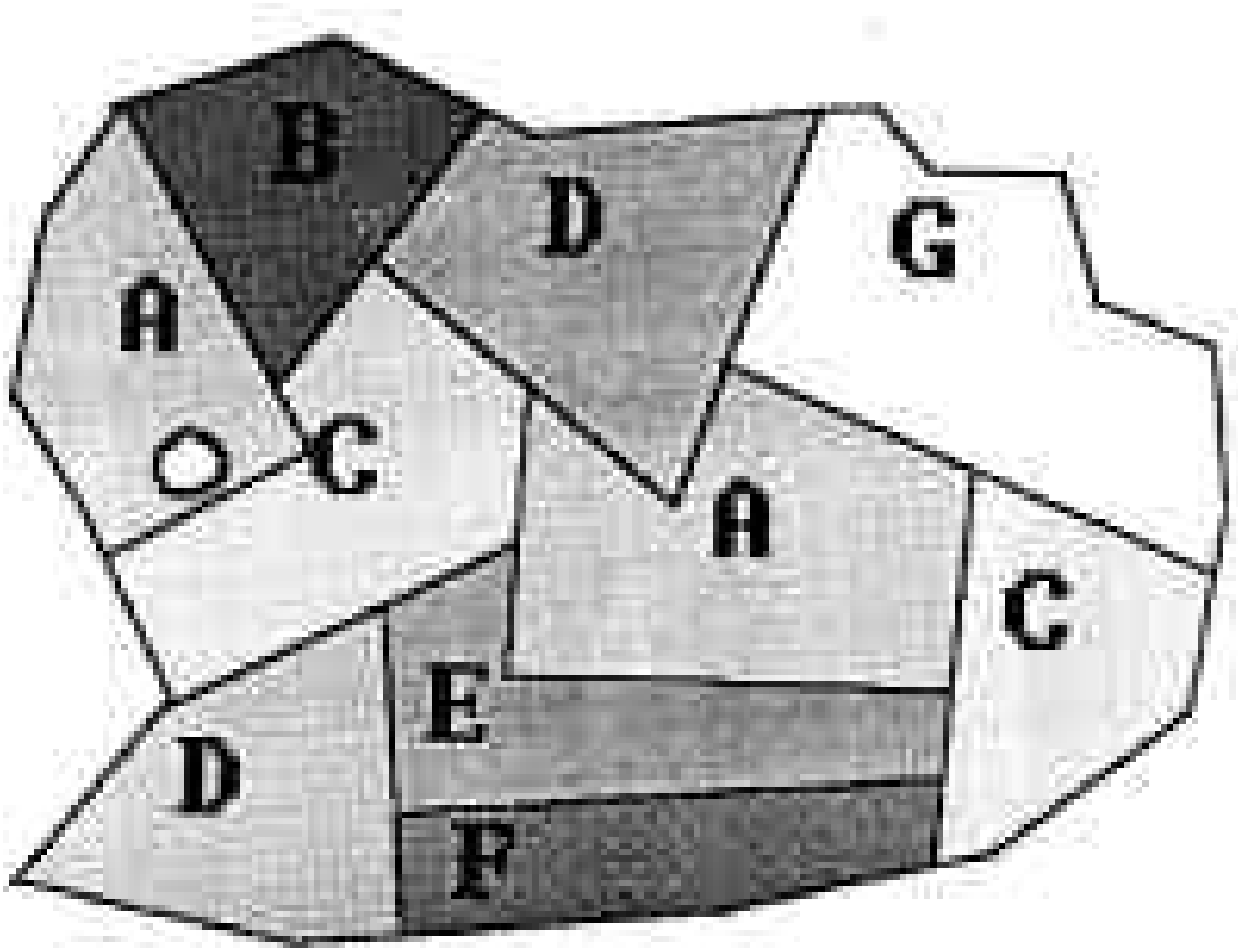
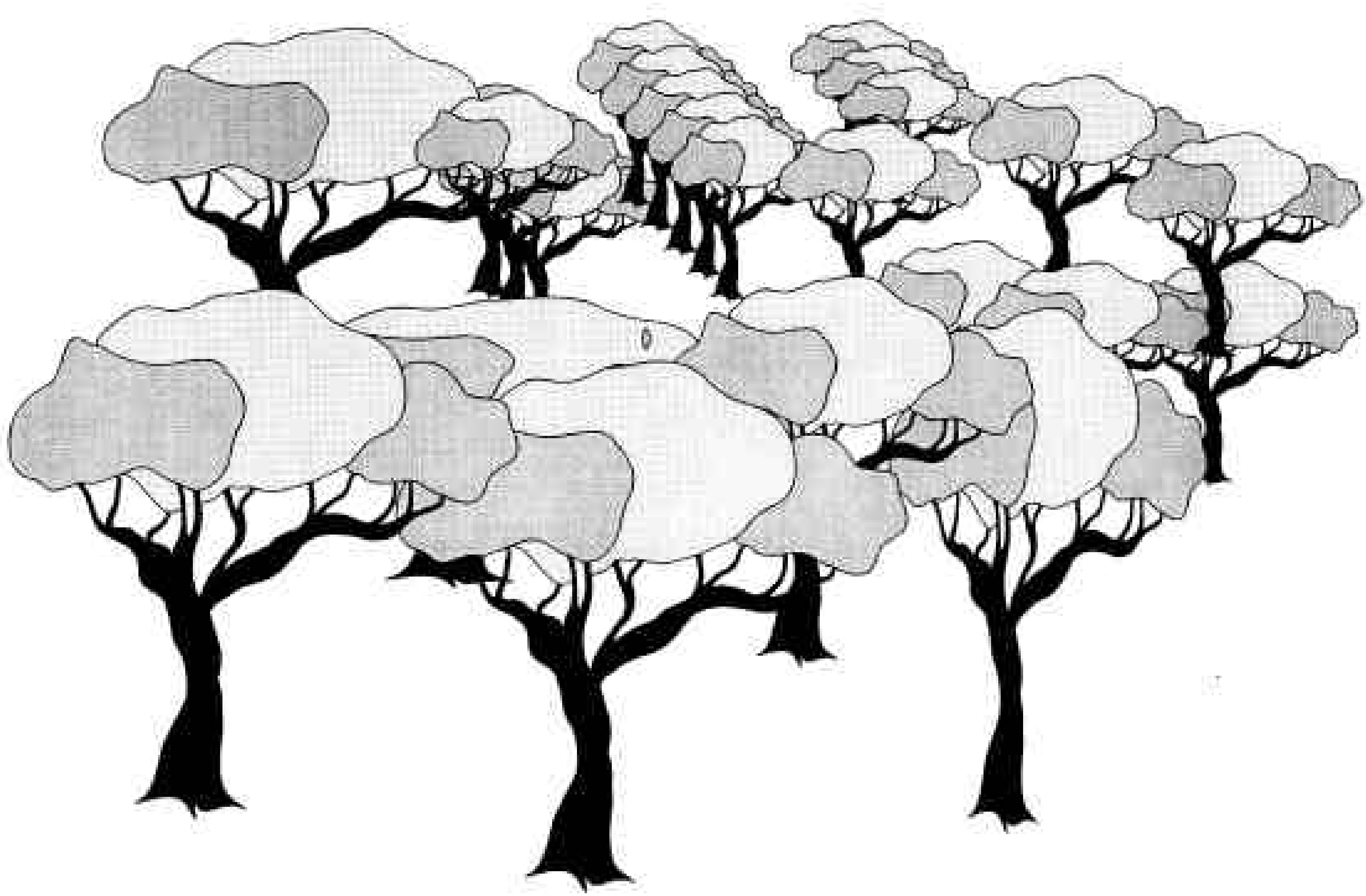


Figure 6: Complementary in site work (counting trees, measuring diameters and heights, etc...)



The overall ASEAN wood and forests situation is given in the following tables.

Forest Land in ASEAN	Land Area	Forest Area	% of Land Area (million hectares)
Brunei Darussalam	0.58	0.47	80.6
Indonesia	191.94	143.97	75.0
Malaysia	32.86	20.50	62.4
Philippines	30.00	16.15	53.8
Singapore	0.06	*	*
Thailand	51.31	14.90	29.0
Total	307.31	195.99	63.8

* Negligible

ASEAN Hardwood Resource	Estimated Commercial Volume (million m^3)
Brunei Darussalam	16
Indonesia	2,000 - 3,095
Malaysia	887 - 1,427
Philippines	641
Thailand	546
Total	**4,090 - 5,725**

2.1.1.2 Agro-industries and biomass residues

Various industries use biomass residues in the ASIA region as shown in figure 8: agro-processing, food-processing, mineral-processing, etc. Same techniques as for wood and forests also apply for the knowledge of the supply situation.

The COGEN Programme:

An impressive amount of work has already been achieved by the ASEAN-EC COGEN PROGRAMME with the support of the Asian Institute of Technology and the ASEAN Sub-Committee for Non-Conventional Energy Research (ASCNCER).

Based in Bangkok at the Asian Institute of Technology, the COGEN Programme has two main objectives:

* Heat and/or power generation from biomass or agro-industry residues to:
    - improve energy efficiency in the agro-industrial sector,
    - reduce dependence on oil, and
    - accelerate rural electrification.

* Transfer of Technology and know-how through Euro-Asean joint-ventures.

A compilation of all the available data on the crop and biomass residues collected in the six ASEAN countries was undertaken and lead to the publication of a Final Report (Ref 4) presenting the national and regional situation in 5 sub-sectors:

- the rice industry,
- the sugar industry,
- the palm oil industry,
- the coconut industry, and
- the wood industry.

Figure 9 gives an example of the information contained in the document. Other examples are given in Annex 2. Finally, table 2 presents a summary of the main biomass residues in ASEAN (in 1990).

Industry	Countries										
	BGD	BHU	BRU	IND	INS	NEP	PAK	PHI	SRL	THA	VIE
Agro-processing											
cocoa											
coconut				RW					R		
coffee						W					
rice parboiling	R			RW					RW		
rubber smoking				W					W	W	
spice processing						W	W		W		
sugar processing	R			RW		R	R		R		
tea leaf drying	WOG			WGOC		WE			WO		
tobacco curing	WR			WC			W	W	W	WSG	
tobacco products				WCh		W					
vanaspati ghee				WCR							
Food-processing											
bakeries	W			WCR		W	W	W	W		
coffee roasting					WRO	W					
dairy products						W	WR				
distilleries				RW		W			W		
fish smoking				W					W		
food preservation											
fruit juices											
fruit preservation							W				
herbal medicines	WR					W			W		
meat processing						W					
noodles											
oils and fats											
rice products						W					
roasting nuts						W	WR				
sugar products	RW					WR	R		RW		
Forest Products											
bamboo and cane											
extract./dist.	WR					W					
timber drying								W			
turpentine dist.											
Metal Products											
black smithy	Ch					Ch	Ch		ChW		
foundries				C							
jewelry	Ch					Ch	Ch		Ch		
Mineral Processing											
brick making	WCG			CWR	WRCO	WC	WR		W	WRC	
tile making	W			CW	WRO				W	WGO	
lime burning	R			WC	WG		WCG		W		
pottery	WR			WDR		R	WR		W	WGO	
ceramics				CW					WO		
refractories				C					O		
surkhi				W							
Textile Based											
dyeing/printing				W			W		W		
silk	WR			W			W				
Miscellaneous											
ceremonies				W		WR	WR		W		
cremation				W		WR			W		
animal fat proces.				W			W				
hot water supply							WR				
laundries							W		W		
road tarring	W			W		W			W		
soap making	W			WCR		W			W		
tyre retreading				W		W					
eating houses, etc.	WR			W		W	WCh		WR		
paper making				CW		W					
fishing nets/boats							W				

Source: FAO-RWEDP

Note: W = Fuelwood, R = residues, D = Dung, C = Coal, G = Gas, O = Oil, Ch = Charcoal, E = Electricity

Main Biomass Residues Production in ASEAN in 1989 (1000 t)

Residues / Country	Rice Husks	Sugar Cane Bagasse	Palm Oil			Coconut		Wood Residues	Total
			E. bunches	Fibers	Shells	Husks	Shells		
Indonesia	8945	7770	2352	1840	716	3530	1890	11760	38803
Thailand	5562	10630	253	198	77	483	220	752	18175
Philippines	2176	5320	-		-	5926	2540	966	16928
Malaysia	343	-	7047	5515	2145	440	236	6580	22306
Brunei	-	-	-	-	-	-	-	70	70
Singapore	-	-	-	-	-	-	-	273	273
TOTAL	17026	23720	9652	7553	2938	10379	4886	20401	96555
10^6 TOE	5,35	4,24	1,02	1,73	0,93	2,82	1,86	5,33	23,28

Figure 9: Paddy Production in Thailand During Crop Year 1989/90

(Source: Lacrosse (1991) from CAS figures)

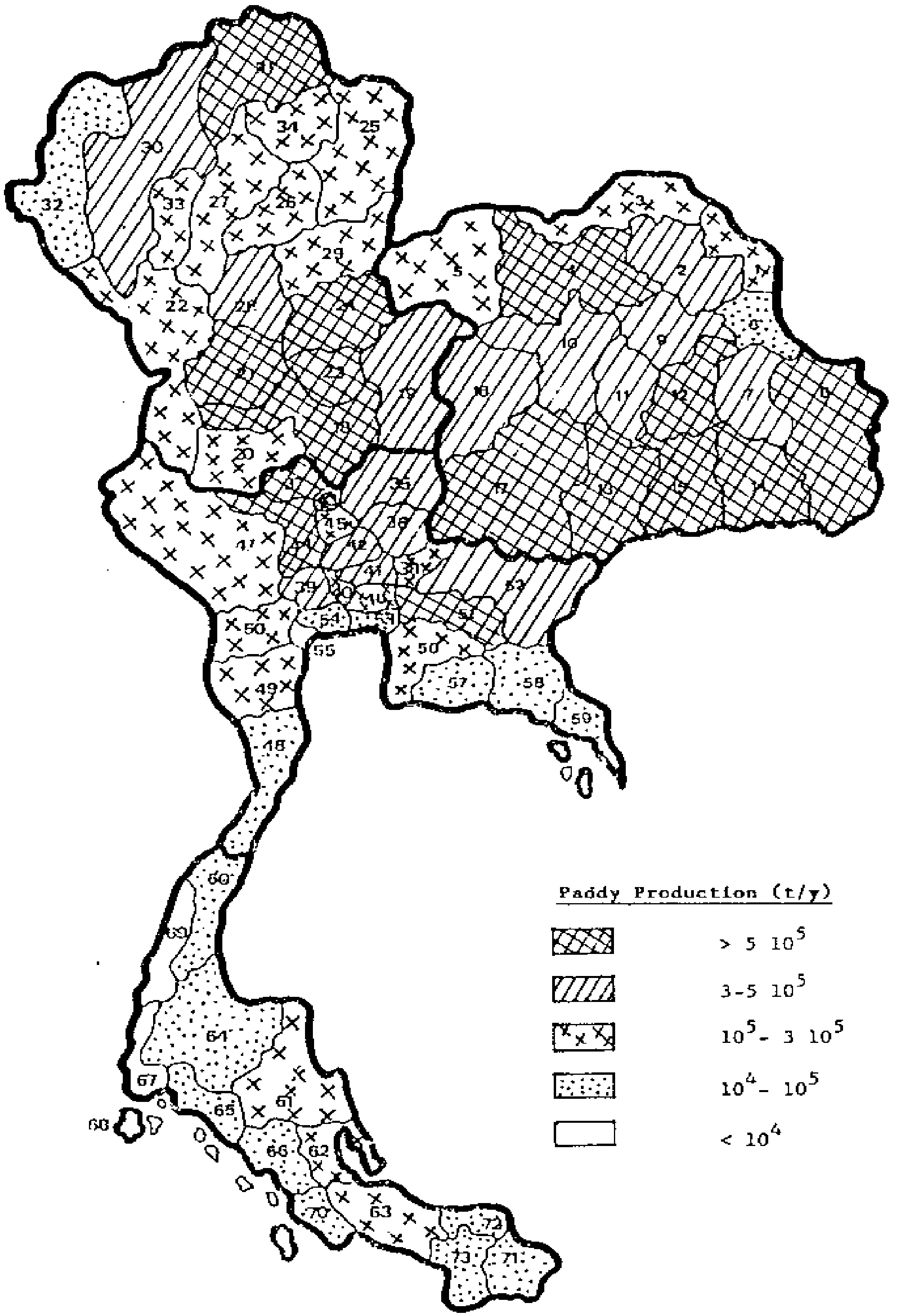
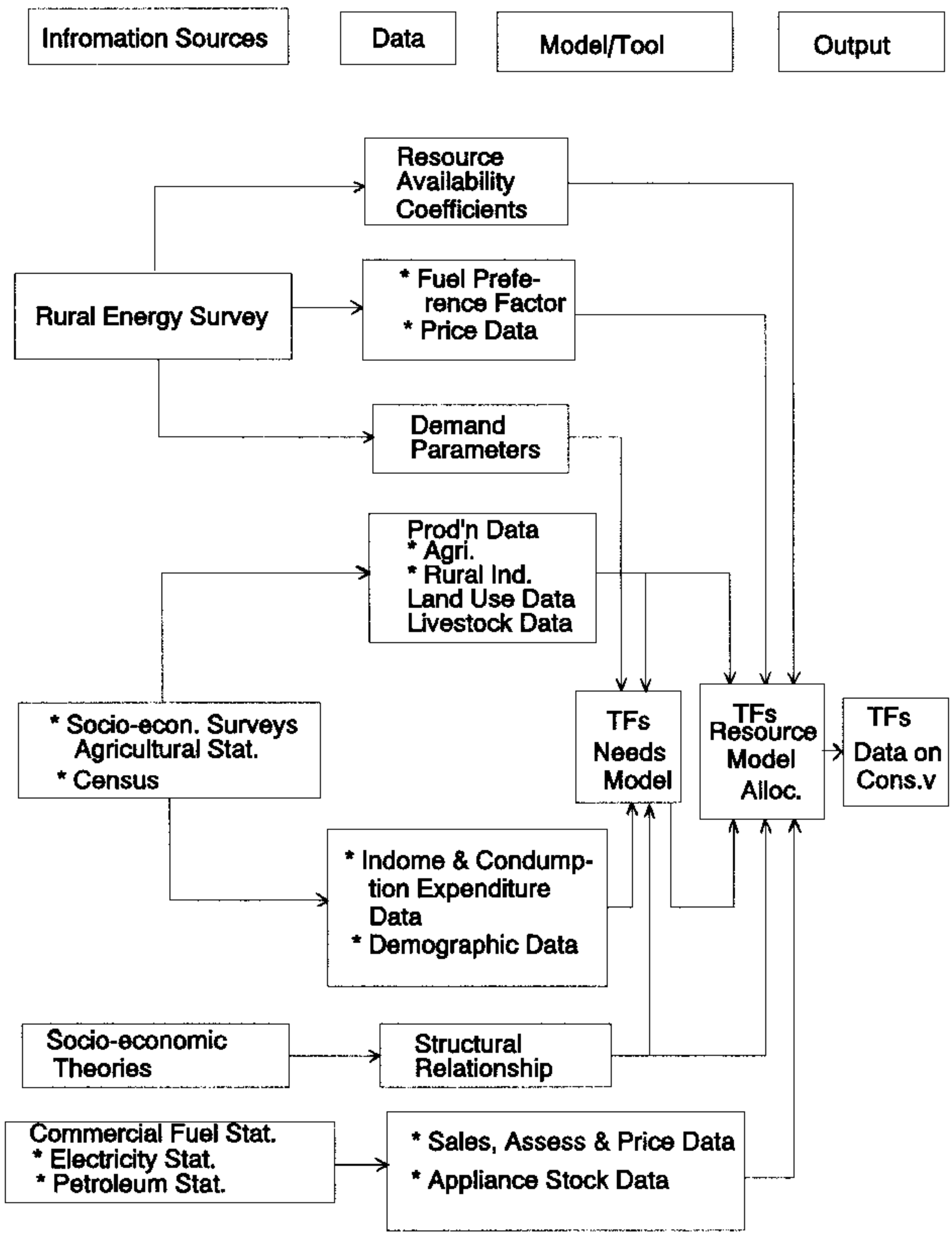


Figure 10: Integrated Framework for Traditional Fuel Data Estimation
(Source: AIT - Energy Technology Division)



1.2 The Demand

The estimation (the modelling) of the biomass energy demand faces various major problems:

- millions of households (especially located in remote areas) use biomass,

- often, the biomass is directly collected by the user, and therefore there is no sale and no record of sale and use,

- there are no major centralized biomass producers (as compared to the utility companies in the electricity sector or the refineries in the oil sector),

- etc.

Any modelling of the demand requires the knowledge of various techno-socio-economic data (figure 10), such as:

- population,
- household size,
- degree of urbanization,
- household distribution,
- fuels consumption,
- efficiency in the energy production/utilization,
- fuel preference,
- price data,
- etc.

1.2.1 The Residential Sector

Several models are used in ASEAN to estimate the energy demand:

A. <u>The Sophisticated Ones</u>

- MEDEE-S used in the Regional Energy Development Programme (REDP) by four ASEAN Member States. Thailand was the only one to incorporate biomass in its study. Annex 3 gives an idea of the data needed to run the cooking module of MEDEE-S,

- MARKAL, used in Indonesia by the Agency for the Assessment and Application of Technology (BPPT). Upstream work, such as tests on cooking stove, was part of the study (Annex 4).

B. <u>The Simplified Ones</u>

- Spreadsheet: The Asian Institute of Technology has undertaken a study on the biomass demand using a Lotus 1-2-3 spreadsheet (Annex 5). This study covers Indonesia, Malaysia, Philippines and Thailand.

- Others.

1.2.2 The Agro-Industrial Sector

The same surveys and models can also be used for this sector. Figure 12 shows an example of the results of the COGEN study; it gives detailed information on the users installation and consumption. Table 4 presents an example of the results of the AIT spreadsheet modelling of the traditional fuel consumption in the Philippines industrial sector.

The ASEAN biomass demand situation: The report "Traditional Fuel Uses in Southeast Asian Economic Basin" from the Division of Energy Technology of the Asian Institute of Technology not only gives a summary of their findings using the spreadsheet approach but compares this results with other regional modelling studies. Tables 3 present this very comprehensive summary.

Figure 11: A General framework to Estimate Traditional Fuel Counsumption in Households (Source: AIT - Energy technology Division)

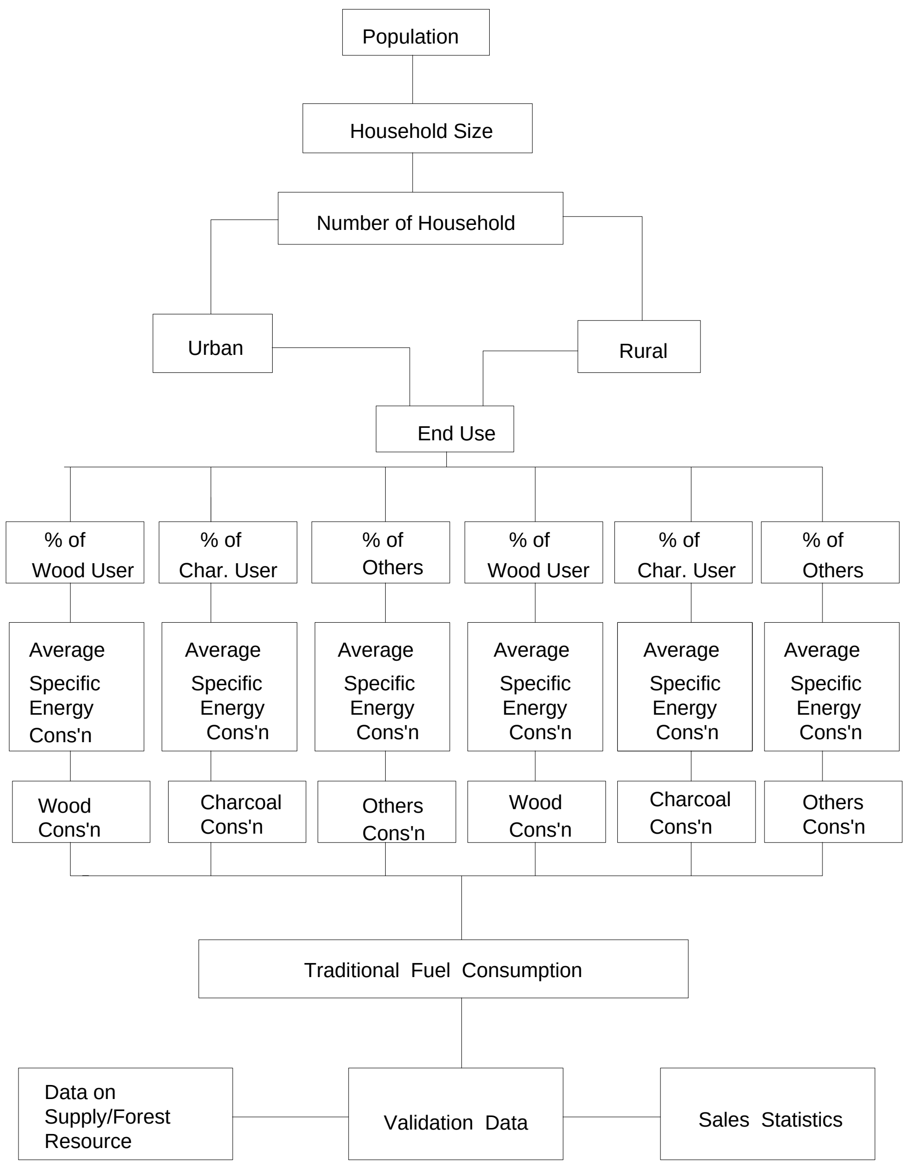


Figure 12: List of Sugar Factories in Indonesia *(Source: ITB, 1991)*

Island/Firm/Factory	District	Season	Milling capacity TCD	Sugar T/Year	Molasses T/Year	Boiler capacity T/Hour	Generator capacity Kwatt	Excess Bagasse T/Year
JAVA								
PT Perkebunan XIV								
Kadhipaten	Majalengka	May-Oct	1269	1422	4950	37	991	
Jatiwangi	Majalengka	May-Sep	1103	9575	3504	32	862	
Gempol	Cirabon	Jun-Sep	1144	5531	2226	33	894	
Sindang Laut	Cirabon	May-Oct	1832	24182	10063	53	1431	
Karang Suwung	Cirabon	May-Oct	1225	14183	6032	36	957	
Tersana Baru	Cirabon	May-Oct	2868	30278	12384	84	2241	21721
Jatitujuh	Majalengka	Jun-Oct	3893	15104	13842	114	3041	21968
Subang	Subang	Jun-Nov	3243	25300	19337	95	2534	25203
TOTAL			16577	125575	72338	484	12951	68892
PT Perkebunan XV-XVI								
Banjaratma	Brebes	May-Oct	1584	18028	6690	49	1238	
Jatibarang	Brebes	Apr-Oct	2024	27274	9941	59	1581	
Pangka	Tegal	May-Oct	1775	21491	9223	52	1387	
Sumberharjo	Pemalang	Apr-Oct	2025	27048	11686	59	1583	17350
Sragi	Pekalongan	Apr-Nov	3594	50480	26137	105	2808	39139
Copiring	Kendal	Apr-Oct	1646	21075	8754	48	1286	
Rendeng	Kudus	Apr-Oct	2058	27271	12755	60	1608	18541
Mojo	Sragen	Apr-Oct	2776	36472	16462	81	2169	25284
Tasikmadu	Karanganyar	Apr-Dec	3426	47832	16743	100	2677	31374
Colomadu	Karanganyar	Apr-Dec	1226	15048	8673	36	958	
Caper Baru	Klaten	Apr-Oct	1567	22451	6741	46	1224	
Gondang Baru	Klaten	Apr-Oct	1599	20973	6583	47	1218	
Kalibagor	Banyumas	Jun-Aug	1205	4894	2589	35	941	
TOTAL			26506	340337	142977	777	20678	131688
PT Perkebunan XX								
Sudhono	Ngawi	May-Nov	2497	27734	15467	73	1951	21507
Purwodadi	Magetan	May-Nov	2047	23655	10459	60	1599	
Rejosari	Magetan	May-Nov	1996	24522	10425	58	1559	
Pagottan	Madiun	May-Nov	1823	30870	9705	53	1424	16243
Kanigoro	Madiun	May-Nov	1892	22285	11183	55	1478	16296
TOTAL			10255	129066	57239	299	8011	54046
PT Perkebunan XXI-XXII								
Krian	Sidoarjo	May-Dec	1175	20555	9380	34	918	
Watutulis	Sidoarjo	May-Nov	1772	24968	12290	52	1384	
Tulangan	Sidoarjo	May-Dec	1201	17224	8620	35	938	
Kremboong	Sidoarjo	Jun-Dec	1290	19885	10490	38	1008	
Gempolkrap	Mojokerto	May-Dec	4500	73784	32610	131	3516	48560

COGEN - Lacrosse (1991)

Table 3

Indonesia Estimates of Traditional Fuel Consumption in Indonesia by Sectors from Various Studies

Sector	Source	Consumption (KTOE)				
		1970	1965	1980	1985	1988
Residential	AIT Estimates BPPT/Betchel DJK/EDI	15,083	19,507 24,916 (1978) 35,698 (1978)	17,516	22,086	20,940
Industrial	AIT Estimates BPPT/Betchei DJK/EDI	3,756	4,201 2,573 (1978) 261 (1978)	5,730	5,247	5,596
Whole	AIT Estimates UNYES/EI BPPT/Betchel DJK/EDI World Bank	18,839 21,282	23,708 27,460 (1978) 35,973 (1978)	23,246 26,499 19,497	27,333 29,520	26,536

Malaysia Estimates of Traditional Consumption from Various Studies

Sector	Source	Consumption (KTOE)				
		1970	1975	1980	1985	1988
Residential	AIT Estimates National Energy Planning Study	1,301	1,128	916 790	676	496
Industrial	AIT Estimates National Energy Planning Study	797	699	844 1,323	829	776
Total	AIT Estimates UNYES/EI National Energy Planning Study Fifth Malaysia 1986-90	2,098 1,211	1,827	1,760 1,604 2,113 1,623	1,505 1,838 2,000	1,272

Philippines Estimates of Traditional Fuel Consumption from Various Studies

Sector	Source	Consumption (KTOE)				
		1970	1975	1980	1985	1988
Residential	AIT Estimates	4,878	4,845	5,959	6,399	7,309
	OEA, Household Energy Demand Survey		2,748 (1977)			
	Material Energy Balances, OEA		4,080	4,507 (1979)	5,127 (1981)	
Commercial	AIT Estimates	214	169	61	55	52
	Commercial Establishments Energy Demand Survey			132 (1979)		
Industrial	AIT Estimates	4,848	4,885	3,183	938	671
	Industrial Energy Profile			1,612 (1979)		
	Material Energy Balances		2,022	2,185 (1979)	2,445 (1981)	
Whole	AIT Estimates		9,899	9,203	7,393	8,032
	UNYES/EI	5,783		7,430	7,788	

Thailand Estimates of Traditional Fuel Consumption from Various Studies

Sector	Source	Consumption (KTOE)			
		1975	1980	1985	1988
Residential	AIT Estimate	3,922	3,897	4,087	4,110
	Thailand Energy Situation		2,340 (1981)	4,721	4,600
	UNDP/WB			4,476 (1983)	
Industrial	AIT Estimate	2,682	3,194	2,815	2,487
	Thailand Energy Situation		1,050 (1981)	3,013	2,304
	UNDP/WB			2,363 (1983)	
Whole Country	AIT Estimate	6,103	6,731	6,662	6,481
	UNYES/EI		8,990	11,689	
	Thailand Energy Situation		5,951	7,062	6,904
	UNDP/WB			7,218	

Source: Energy Technology Division

Table 4: Traditional Fuel Consumption: Philippine Industrial Sector

Year (1)	Logging/Wood Production (000 cum wood) (2)	Unit Energy Consumption (BOE Wood/cu. Wood Produc.) (3)	Energy Consumption Subtotal (KTOE) (4)	Tobacco Production (000 tons Tobacco Cured) (5)	Unit Energy Consumption (BOE Wood/ Ton Tobacco Cured) (6)	Energy Consumption Subtotal (KTOE) (7)	Copra Production (000 tons Copra) (8)	Unit Energy Consumption (BOE Wood/ Ton Copra) (9)	Energy Consumption Subtotal (KTOE) (10)
1970		2.24			23.55			0.83	
1973	12504	1.98	3331	64.8	21.73	189	1698	0.76	174
1974	12234	1.90	3128	63.4	21.16	180	1703	0.74	169
1975	14162	1.83	3476	57.1	20.60	158	1718	0.72	166
1976	11074	1.75	2610	58.9	20.06	159	2007	0.70	188
1977	10425	1.68	2358	50.4	19.53	132	2248	0.68	205
1978	9821	1.62	2133	56.7	19.02	145	2332	0.66	206
1979	9359	1.55	1951	51.3	17.28	119	1731	0.64	149
1980	9110	1.49	1824	42.0	15.70	89	1860	0.62	155
1981	7440	1.32	1323	39.1	11.07	58	2160	0.60	175
1982	6295	1.17	993	46.8	7.80	49	1974	0.59	156
1983	6257	1.04	876	44.8	7.25	44	2052	0.57	158
1984	5768	0.93	717	66.3	6.74	60	1249	0.56	93
1985	5042	0.82	557	47.0	6.27	40	1877	0.54	137
1986	4870	0.73	477	56.0	5.83	44	2338	0.53	166
1987	5918	0.65	515	58.3	5.42	42	2396	0.51	165
1988	5333	0.57	412	53.5	5.04	36	2456	0.50	165
1989		0.51							

Column No.	Comment
2, 5, 8, 11, 16	Regional Wood Energy Development Programme - FAO Study on Energy Consumption of Selected Industries in the Philippines - Charting the Time Path of the Philippine Energy Strategy
3, 6, 9, 12, 13, 17	1986, 1988 and 1989 Philippine Statistical Yearbook FAO Production Handbook - Annual Series UN Statistical Yearbook
4, 7, 10, 14, 15, 18	Production x Specific Energy Consumption x Conversion Factor
19	Sum of Cols 5, 9, 13 and 18
20	Equal to Column 19
21	Equal to Column 23
22	Sum of Column 24, 25 and 26

Source: AIT - Energy Technology Division

II. FORECASTING

2.1 The Supply

Historical trends and models used in the estimation of the current situation should constitute the basis for forecasting the evolution of the supply.

Several Scenario should be studies taking into account various techno-socio-economic parameters, such as:

- evolution of the demography and its repartition,
- forestry policies relating to the exploitation, the reforestation, etc.
- development of the agro-industry sector,
- impact of the popllution (acid rain, etc.)
- impact of possible climate changes (less rain, etc.)
- others.

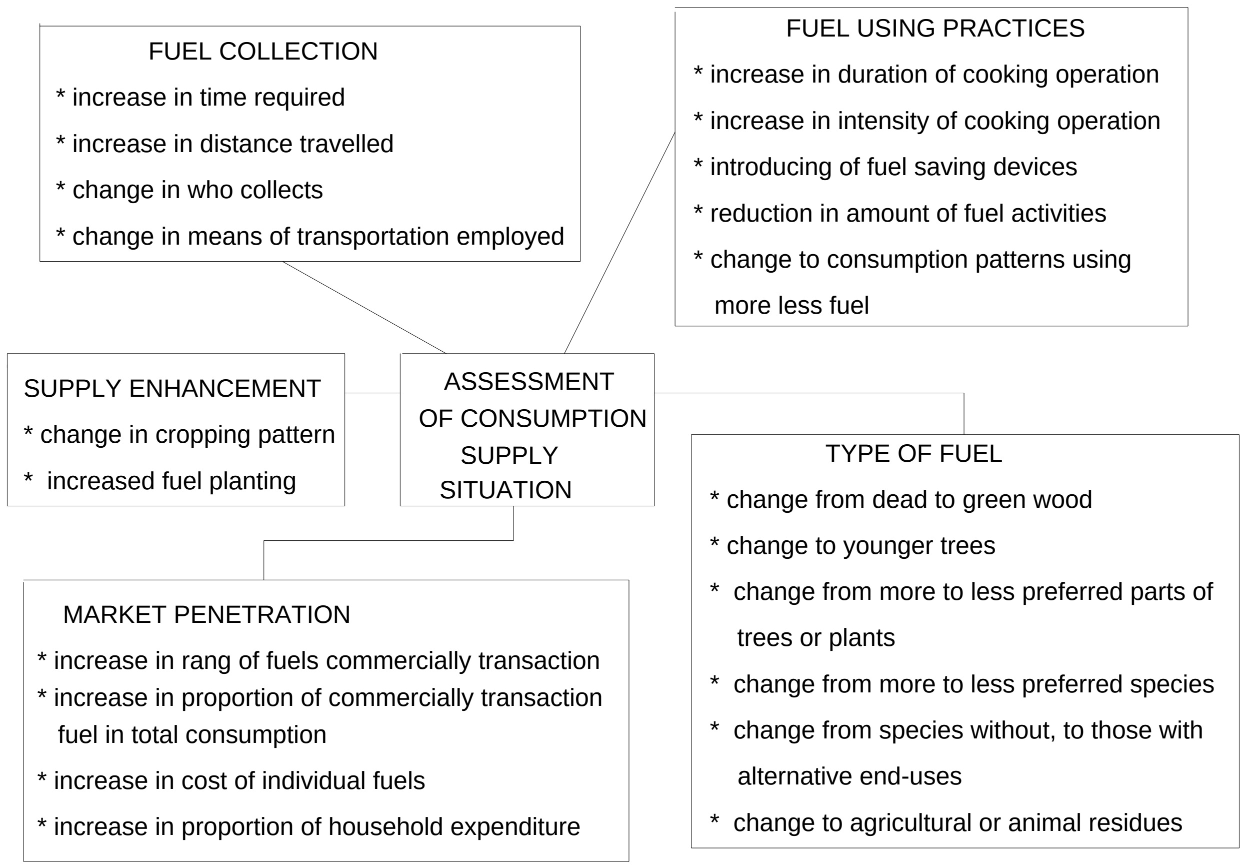
2.2 The Demand

The comments for supply apply also for the demand forecasting: scenarios, historical trends, current situation, models, etc. Other parameters have to be considered (figure 13).

- urbanization,
- evolution of the revenues,
- evolution of various fuel prices,
- introduction of fuel saving devices,
- change in the cooking operation,
- rural electrification,
- others.

MEDEE-S (already used in the REDP study) represents an excellent model taking into account all these parameters. The spreadsheet (AIT) approach can also be used for forecasting. Figure 14 shows the use of the model MARKAL for a BPPT study on Indonesia.

Figure 13: Indicators of Structural Change:
Consumption/Supply Situation Assessment

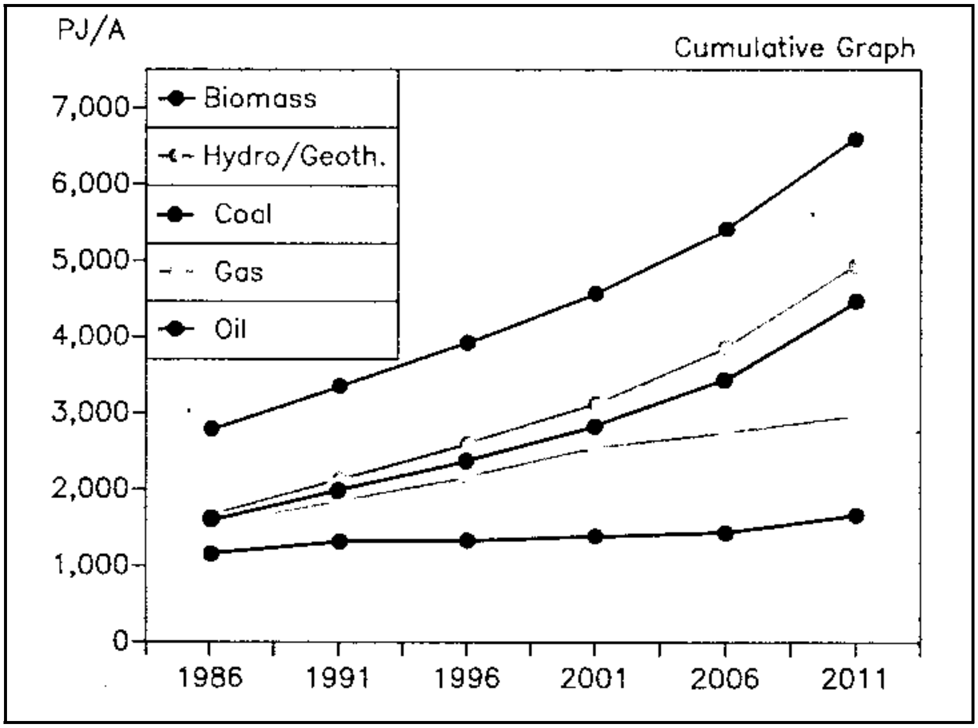


Biomass Share in the Domestic Demand Mix

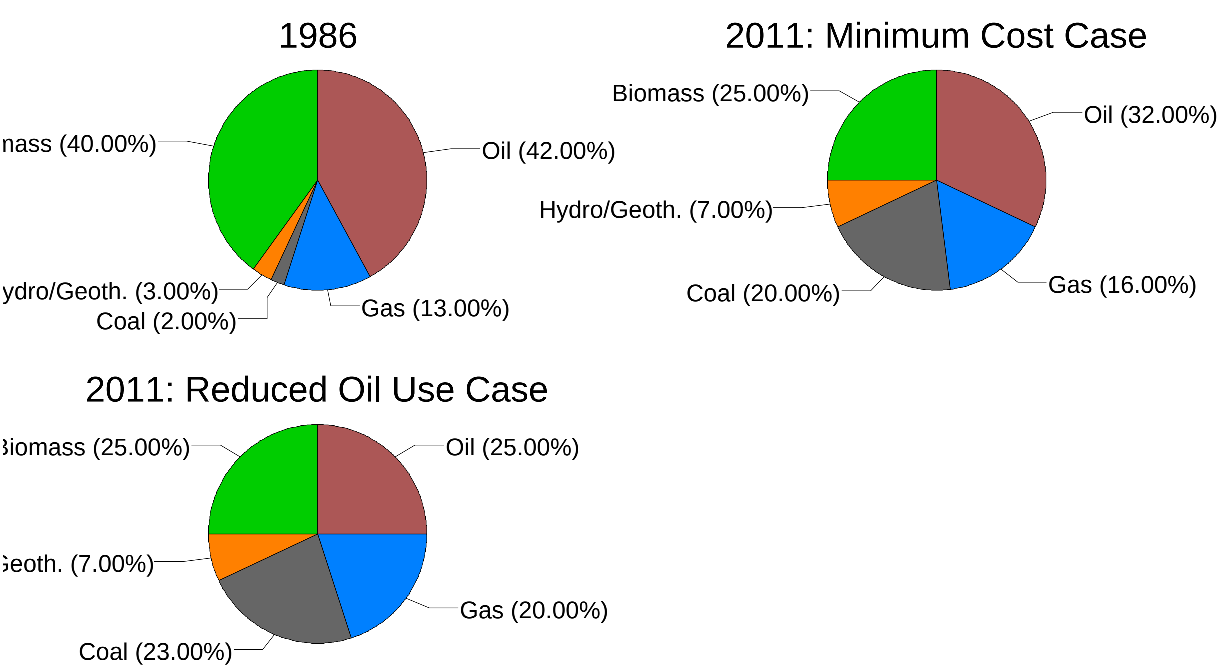
	Commercial Energy	Biomass	Total	% (Biomass)
Brunei	500		500	*
Indonesia	38000	26500	64500	41%
Malaysia	13100	1300	14400	9%
Philippines	10600	8000	18600	43%
Singapore	8200	*	6200	*
Thailand	21900	8500	28400	23%
Total ASEAN	90300	42300	132600	32%

Biomass data: 1988 AIT estimates
Commercial data: Volume 2 - ASEAN Energy Review (1990)

Figure 14



Structure and Development of the Domestic Primary Energy Supply
(High Scenario, Reduced Oil Use Case)



Change of Primary Energy Mix from 1986 to 2011
(Central Years of the First and last Period) for two Strategies

The Energy Balance Tables

The Energy Balance Table (EBT) represents a good way to know the placement of each energy form in a national energy supply-demand situation. Moreover, it also constitutes a way of knowing the placement of biomass in the overall energy policy. In ASEAN, for example, some of the member countries do not include biomass in their national Energy Balance Tables (either the data are not available or there is only a very limited production/consumption such as in the case of Brunei and Singapore). Some countries given an aggregated value (which often does not include all forms and sectors) and some do present a well structured breakdown in both the supply and the demand.

Figure 15 gives a view of the biomass part of the Thailand Energy Balance Table (ref 6) which represents a good example of such a detailed breakdown.

Annex 6 gives a set of the 6 ASEAN member states 1990 Energy Balance Table published by AEEMTRC in Volume 2 of its ASEAN Energy Review (ref 7). However, they do not include biomass.

Figure 15: Thailand Energy Balance 1991

unit: ktoe

Commodities Transaction		Solid Fossil Fuel: Steam Coal (1)	Anthra-cite (2)	Coke (3)	Others (4)	Sub-Total (5)	Total Modern Energy (30)	Renewable Energy: Fuelwood (31)	Charcoal (32)	Paddy Husk (33)	Bagasse (34)	Total Renewable Energy (35)	Grand Total (36)
Conversion Factor		0.62419	0.74309	0.65392	0.62419			0.37848	0.68364	0.34083	0.17834		
Domestic Product	1	-	-	-	-	-	14,430	7,933	-	957	1,968	10,858	25,288
Imports	2	192	14	56	69	331	19,352	-	9	-	-	9	19,361
Exports	3	-	-	-	-	-	(949)	-	(9)	-	-	(9)	(958)
Stock Change	4	-	-	-	-	-	242	-	-	-	-	-	242
Primary Supply	5	192	14	56	69	331	33,075	7,933	0	957	1,968	10,858	43,933
Oil Refining	6	-	-	-	-	-	(497)	-	-	-	-	-	(497)
NG. Processing Plant	7	-	-	-	-	-	110	-	-	-	-	-	110
Power Plant	8	-	-	-	-	-	(8,040)	-	-	-	-	-	(8,040)
Hydro	9	-	-	-	-	-	(624)	-	-	-	-	-	(624)
Steam	10	-	-	-	-	-	(4,647)	-	-	-	-	-	(4,647)
Gas Turbine	11	-	-	-	-	-	(1,447)	-	-	-	-	-	(1,447)
Combined Cycle	12	-	-	-	-	-	(1,319)	-	-	-	-	-	(1,319)
Diesel	13	-	-	-	-	-	(2)	-	-	-	-	-	(2)
Geothermal	14	-	-	-	-	-	(1)	-	-	-	-	-	(1)
Other Conversion	15	-	-	-	-	-	-	(5,140)	1,857	(294)	-	(3,577)	(3,577)
Total Transformation	16	-	-	-	-	-	(8,427)	(5,140)	1,857	(294)	-	(3,577)	(12,004)
Own Uses	17	-	-	-	-	-	(500)	-	-	-	-	-	(500)
Losses	18	-	-	-	-	-	(542)	-	-	-	-	-	(542)
Statistical Differences	19	-	-	-	-	-	-	-	-	-	-	-	-
Total Final Consumption	20	192	14	56	69	331	23,606	2,793	1,857	663	1,968	7,281	30,887
Final Non-Energy Uses	21	-	-	-	-	-	408	-	-	-	-	-	408
Final Energy Consumption	22	192	14	56	69	331	23,198	2,793	1,857	663	1,968	7,281	30,479
Agriculture	23	-	-	-	-	-	1,827	-	-	-	-	-	1,827
Mining	24	-	-	-	-	-	53	-	-	-	-	-	53
Manufacturing	25	192	14	56	69	331	6,292	628	-	398	1,968	2,994	9,286
Construction	26	-	-	-	-	-	194	-	-	-	-	-	194
Res. and Com.	27	-	-	-	-	-	2,922	2,165	1,857	265	-	4,287	7,209
Transportation - Total 1/	28	-	-	-	-	-	11,910	-	-	-	-	-	11,910
Road	29	-	-	-	-	-	8,775	-	-	-	-	-	8,775
Rail	30	-	-	-	-	-	116	-	-	-	-	-	116
Air	31	-	-	-	-	-	2,083	-	-	-	-	-	2,083
Waterway	32	-	-	-	-	-	936	-	-	-	-	-	936

Source: Department of Energy Affairs - Thailand

BIOMASS ENERGY MODELLING IN AEEMTRC

I. AEEMTRC

So as to strengthen cooperation in the energy sector among the ASEAN countries and between ASEAN and the Commission of the European Communities (EC) in the field of energy, and to contribute to the ASEAN-EC dialogue on energy issues of mutual interest, AEEMTRC, since its establishment in November 1988, has launched a comprehensive research and training work-programme.

The research and information programme is based on six in-house projects (figure 16):

4 research programmes:

- ASEAN 2020,
- Integrated Urban Energy Planning,
- Energy Pricing, Consumer Behaviors, Load Management,
- Energy and Buildings,

and 2 information programmes:

- ASEAN Database, and
- VALENTE

The training programme is based on energy management training courses (12 topics are currently available) and on seminar-workshops (9 since 1988) held in the 6 ASEAN member states.

Other studies are also carried out in the framework of third-party cooperation programme (AIT, etc.).

Two AEEMTRC programmes, namely ASEAN Database and ASEAN 2020, deal with biomass, the first one to prove data and information on the current energy situation and the second one to forecast the evolution of this situation up to the year 2020.

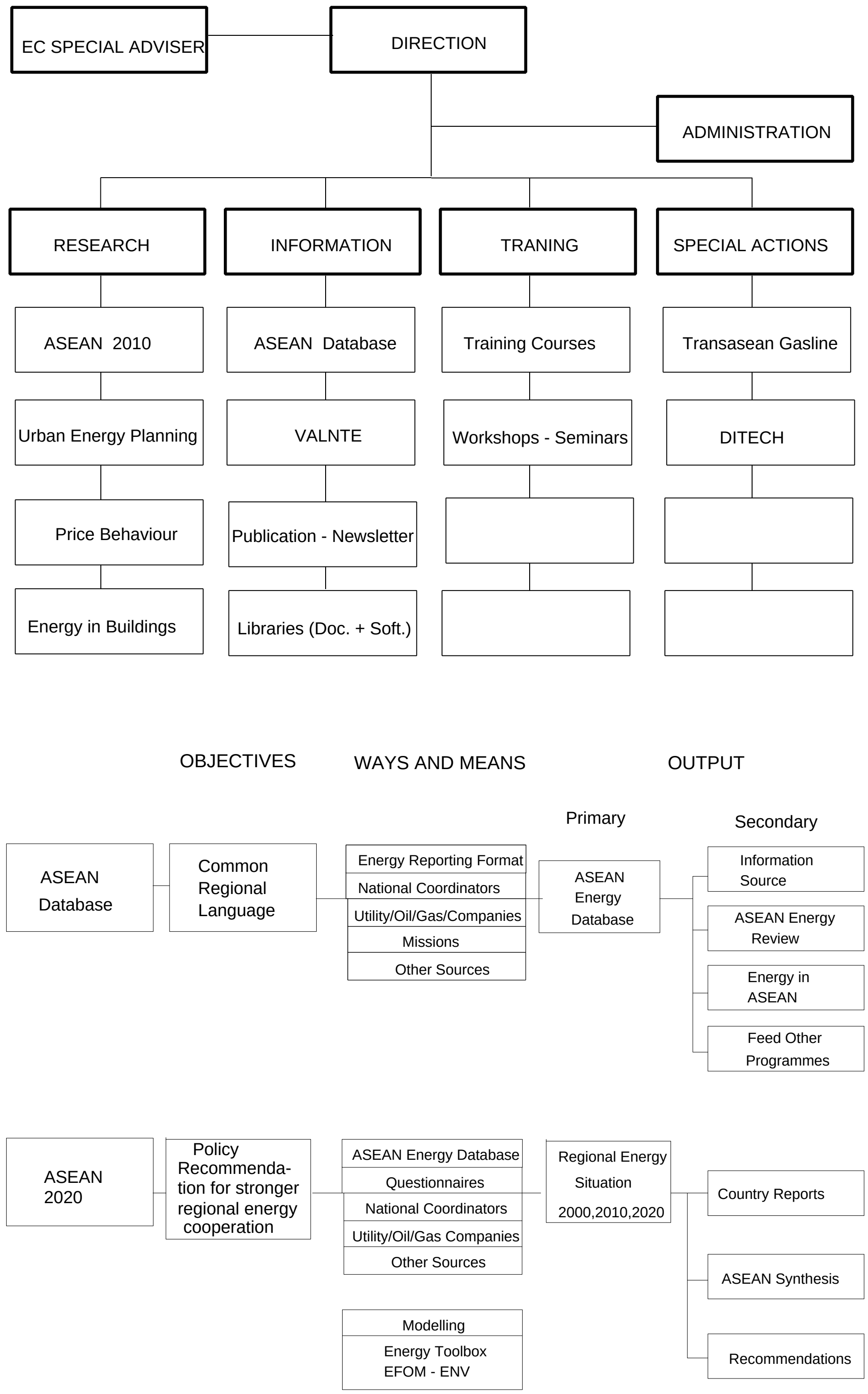
II. ASEAN DATABASE

Energy data is the basis for any project. AEEMTRC therefore has given priority to developing an effective data information system to support the production of reports on the ASEAN energy situation and to "feed" its other studies. This is in line with the very mission of AEEMTRC of enhancing the links between ASEAN Member States in the field of energy.

In order to achieve this objective, AEEMTRC fells it essential to have a common regional energy language among the 6 ASEAN countries. Consequently, on of the priorities of the Centre was to prepare a common Energy Reporting Format sent every year to each of its national coordinators.

After completion, these forms are sent back to AEEMTRC and processed as inputs for a common energy database, the purpose of which is to enable a regular analysis of the regional activities. Once processed, the data are cross-checked against various sources of information such as country statistical year books.

Figure 16: On-Going AEEMTRC's Programme



Up to six years (from 1985 to 1990) have been analysed by the centre which has led to the editing of 2 volumes of the ASEAN Energy Review. This document gives a detailed presentation of the supply, transformation, demand sectors in the 6 ASEAN countries. Volume 2 (May 1992) also includes a presentation of the electricity sector in the ASEAN region.

However, due to a lack of reliable information, biomass was not included in the first 2 volumes. Since the publication of Volume 2, AEEMTRC has started to gather some information on biomass and expects to include (indicative) data on biomass in Volume 3 (May 1993). On the side of the ASEAN Energy Review, AEEMTRC is working on other documents to give a wider presentation of the energy sector in ASEAN: "Energy in ASEAN" should, for instance, will give basic information on the energy sector: maps, organigrams, addresses, bibliography of energy documents, etc.

III. ASEAN 2020

ASEAN 2020 is a long-term energy supply-demand study for ASEAN member states to the year 2020. The programme provides for a regional perspective where member-states may situate their national plans. It therefore supports rather than replaces the long term-term studies made by the member-states. ASEAN 2020 supports the region's search for a more unified approach to energy planning as well as the ASEAN and European Community's joint search for more cooperative and mutually rewarding activities. ASEAN 2020's main objective is to provide a comprehensive assessment of the energy situation in ASEAN and to identify opportunities for regional action, such as:

- to develop a consolidated energy database on ASEAN,
- to demonstrate a common methodology for energy analysis and forecasting for all member states,
- to undertake a systematic analysis of the determinants of energy use in ASEAN,
- to review the main sources of uncertainties affecting energy supply and demand in ASEAN and translate the same into plausible future scenarios,
- to identify and evaluate long-term energy supply-demand prospects in selected relevant scenarios,
- to develop a regional framework for national energy programme and policies,
- to formulate policy recommendations for stronger regional cooperation in energy,
- to identify more cooperative and mutually rewarding activities in the field of energy between ASEAN and the European Community.

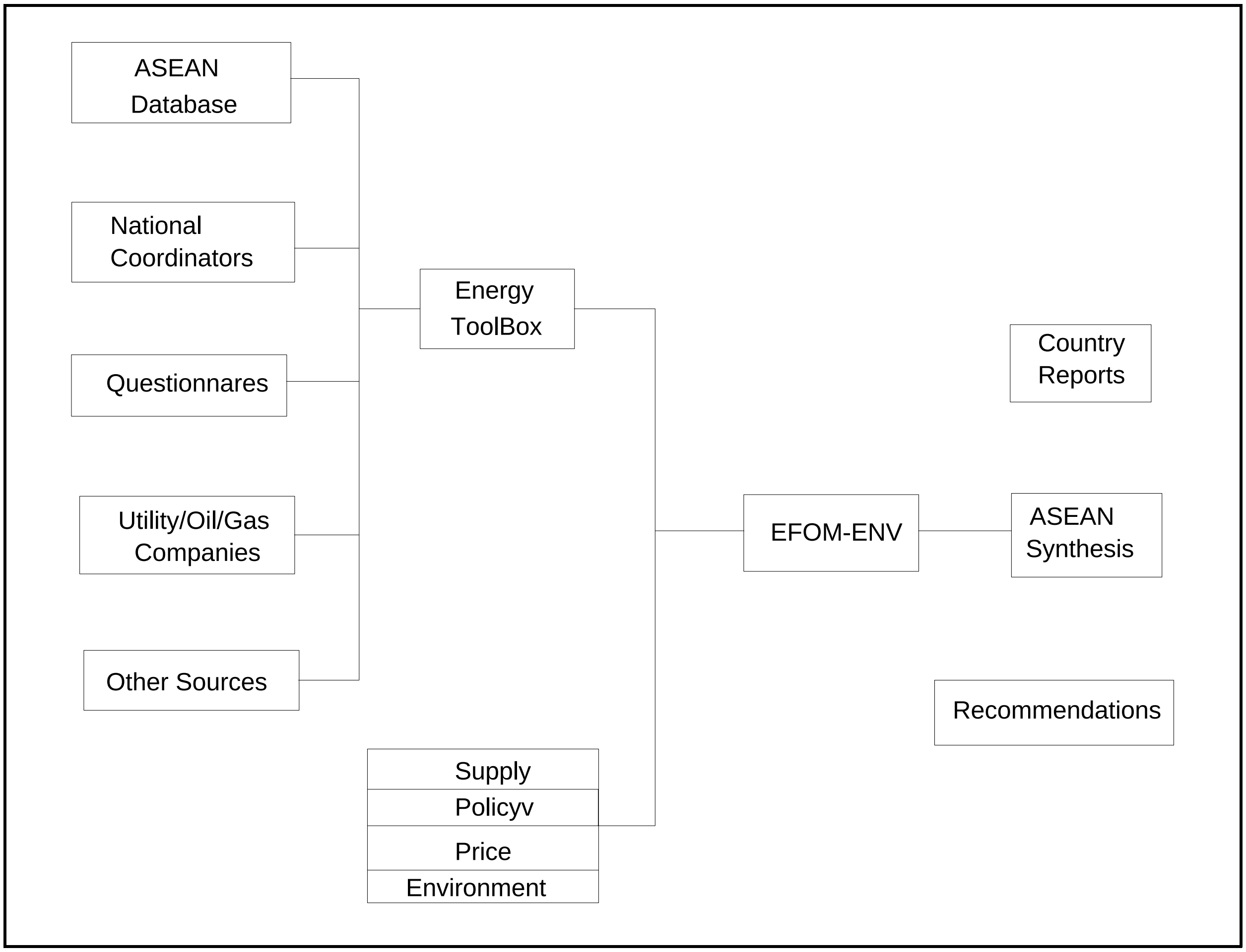
To achieve these objectives, AEEMTRC makes use of several energy planning methodologies and tools, especially of two computer softwares. The first one, Energy Toolbox deals mainly with the forecasting of the demand which constitutes an essential input to the second modelling programme (EFOM-ENV) which optimizes the energy supply-demand for several time horizons taking into account various parameters and constraints (resources, prices, environment, etc.) AEEMTRC has prepared Draft Country Reports detailing long-term energy supply-demand outlook for each of the ASEAN member states under three different scenarios. However these documents do not deal with biomass. Since the last AEEMTRC Seminar-Workshop on ASEAN Energy Outlook (may 1992, Jakarta), the Centre has started to include biomass as well as environment in its ASEAN 2020 programme. This requires additional data but also some upstream work on both Energy Toolbox and EFOM-ENV. A major part of this work has already been undertaken and AEEMTRC hopes to be able to present a new set of country reports which will include biomass strategy at the next ASEAN 2020 Workshop-Seminar which should be held in October 1993.

Figure 17: 1990 Energy Balance Table (no biomass data)

(Table not available)

Figure 18: Draft 1991 Energy Balance Table (including biomass data)

(Table not available)



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Integrated Swamp Development in Indonesia

The Jakarta office of French engineering consultance organization BCEOM is using spot satellite imagery as part of an integrated approach to the management and monitoring of four major mangrove swamp development schemes in Sumatra and Kalimantan, Indonesia. One scheme is located near Pontianak, Kalimantan (Borneo), the other three in the provinces of Jambi and Riau, Sumatra.

The first phase involved the visual interpretation of Spot multispectral and panchromatic scenes plus radar imagery mosaics including by a field verification survey. This enabled the BCEOM team to define the main land use/landcover classes in the four study areas and to select a field sampling to process one spot scene. The scene in question was selected in close consultation with the Directorate of Swamps, the central government agency responsible for planning and implementing swamp development schemes.

During the first phase, a land use map at 1:50000 was compiled by manual photointerpretation. On the basis of this mapping work the Jambi Pamusiran Scheme was chosen as the most representative for monitoring the impact of development work using multidate analysis. The spot multispectral scene recorded on 23 August 1990 was analysed to determine the land use classess which were then grouped into three aggregate classes, namely natural vegetation, crops and fruit trees, and "other".

The classification scheme and map legend were defined in collaboration with an agronomist, a soil scientist and a hydrologist. The map (see next page) will be used as the working tool for monitoring future land use changes.

E. Elizechea
Soil Scientist
Remote Sensing Expert

Natural vegetation covers 44.6% of the mapped area and includes:

* *primary forest: 15.3%*
* *degraded primary forest: 20.%*
* *secondary forest: 14.5%*
* *mangrove forest: 1.1%*
* *Secondary regrowth: 11.7%*

Crops and fruit trees cover 40% of the land and include:

* *coconut trees: 6.9%*
* *harvested ricefields and bare soil: 4.4%*
* *ricefields mixed with alang-alang (Imperata cylindrica) 5.7%*
* *ricefields: 9.0%*
* *alang-alang (imperata cylindrica): 14.0%*

The "other" class corresponds to 15.4% of the mapped area and comprises water (sea and rivers), clouds and shadows, and anything else that could not be classified (2.6% of the mapped area).

Environmental Resource Mapping in Malaysia

This project involved the use of Spot imagemaps for the interpretation of landcover and geology throughout a study area comprising the Malaysian states of Selangor and Kedah, which cover 8,200 and 9,500 sq.km respectively. Spot imagemaps proved effective for the task and considerably less expensive than alternative technologies. Figures 1 and 2 are examples of the types of imagemaps produced. In all the project called for 30 landcover imagemaps at 1:50000 and 12 geological imagemaps at 1:100000. The landcover classification uses 24 pure and 20 mixed classes. The geological imagemaps show both geological structures and lithological boundaries.

The project has been a joint effort by the Malaysian Center for Remote Sensing, MACRES, and SSC Satellibild, a sub-sidiary of the Swedish Space Corporation, and was funded by BITS, the Swedish Agency for International Technical and Economic Cooperation. The project was started in September 1991 and completed in December 1992.

A total of 24 multispectral (XS) and 20 panchromatic (P) Spot scenes were used plus two landsat TM scenes for additional information. The imagery was geometrically corrected to match the Malaysian map system. XS data were mosaicked to yield imagemaps with the same scale and coverage as the corresponding topographic maps of the study area.

This involved the following steps:

- study of satelite data and background materials;
- definition of preliminary classification scheme;
- draft interpretation of imagemaps;
- field survey for verification and identification;
- definition of final classification scheme;
- final interpretation of imagemaps;
- transfer of interpretation to GIS;
- printing of imagemaps.

To enable MACRES to study erosion hazards, the project team also processed spot stereopairs of portions of Kedah and Selangor states in conjunction with existing contour maps to yield slope/drainage maps at 1:100000.

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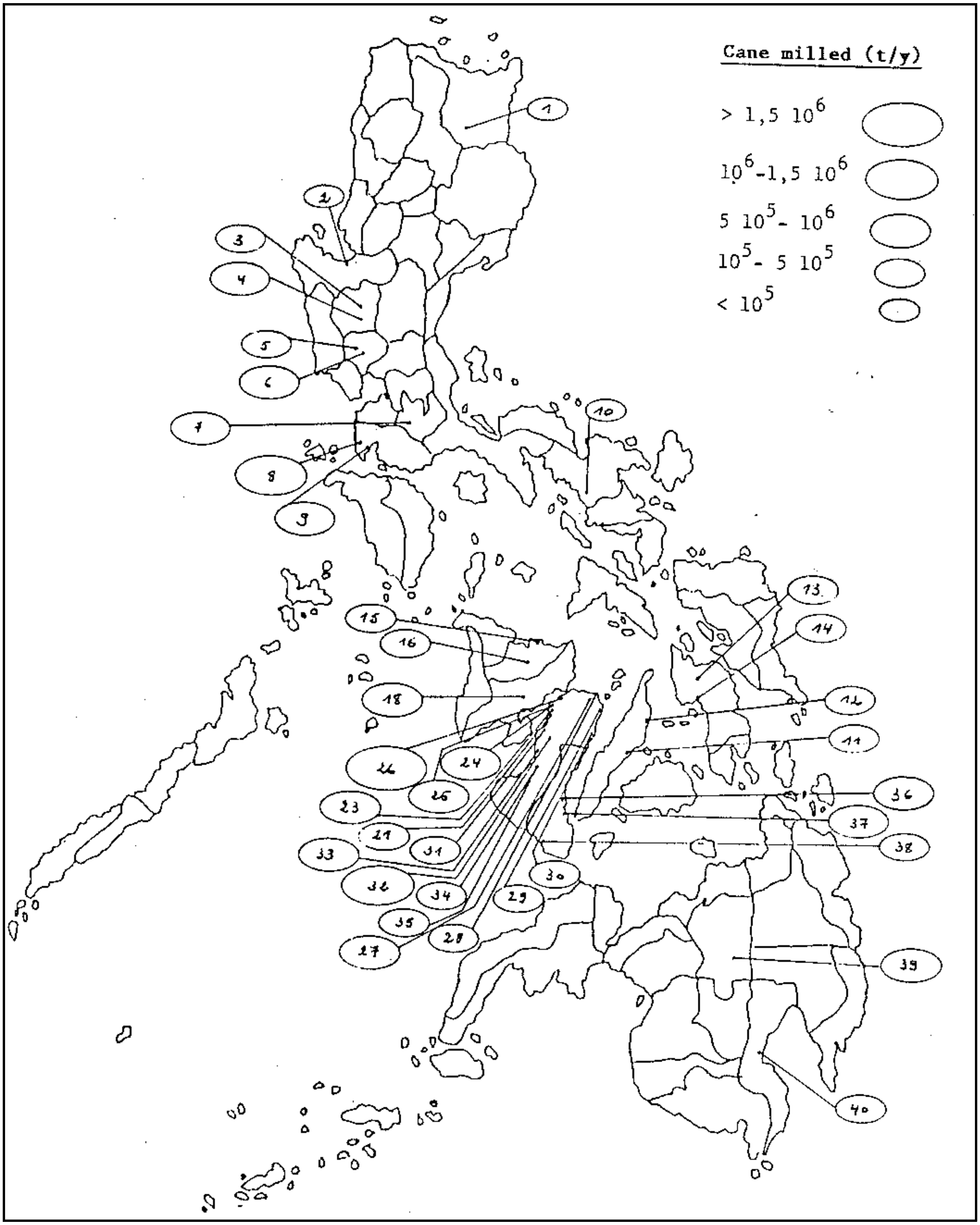
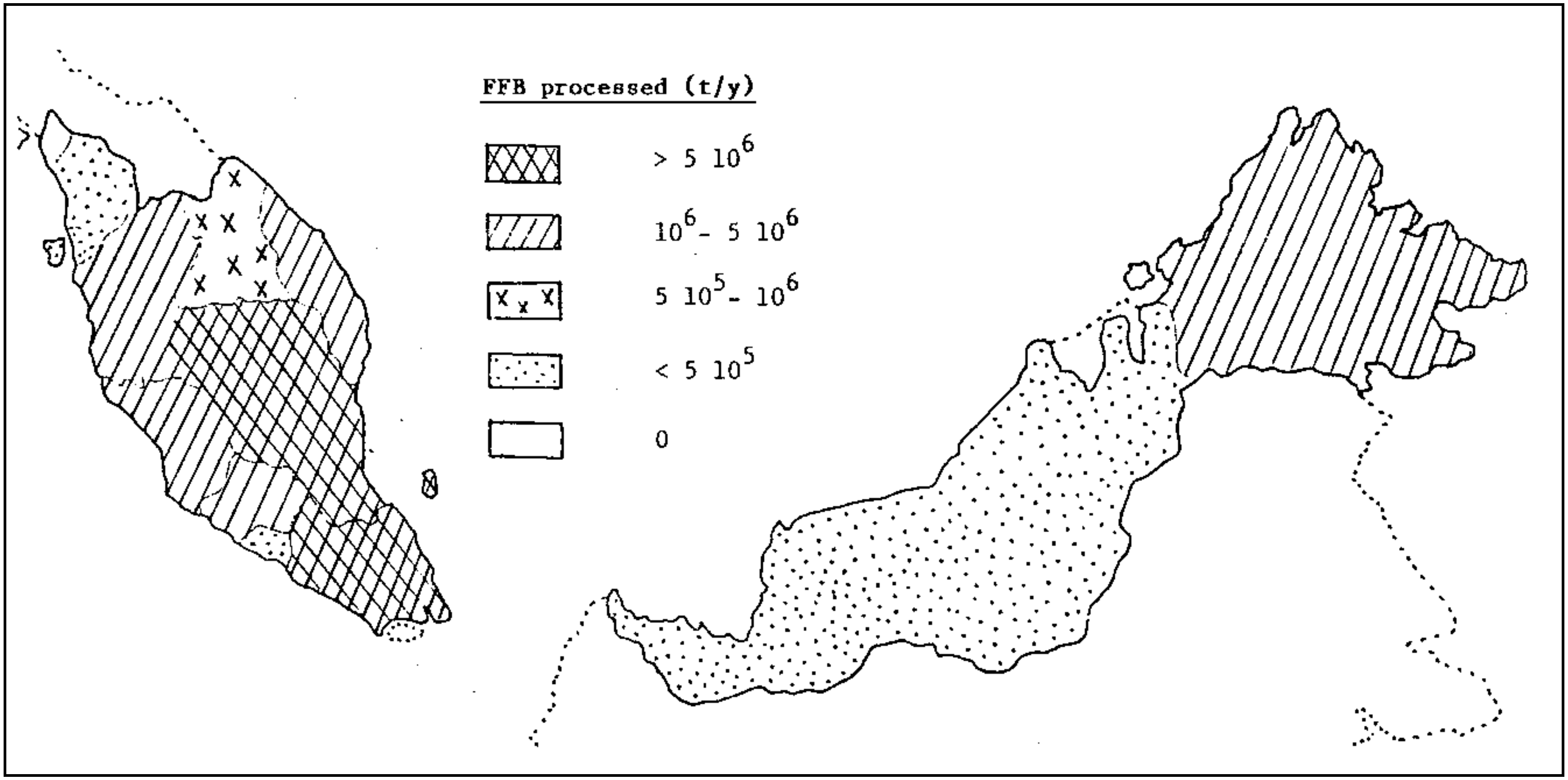


Location and production of Philippine Sugar Mills During Crop Year 1988-89
Source: Lacrosse (1991) from SRA figures

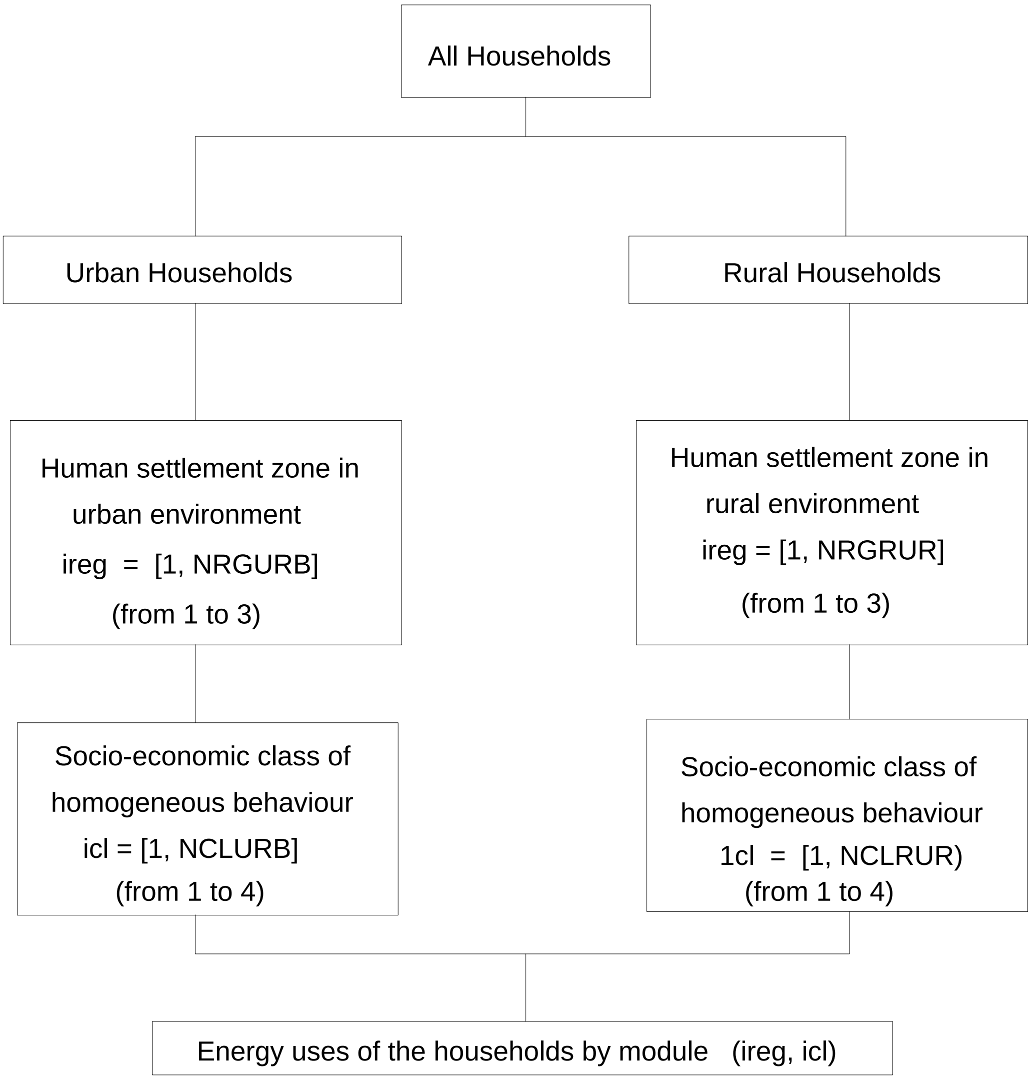


Quantities of FFB Processed Per State in Malaysia in 1989

(Source: Lacrosse (1991) from PORLA figures)

Disagregation of the households

in Homogeneous Category - or Module -



ENERGY DEMAND FOR COOKING

In most of the middle income countries, cooking cooresponds to the predominant household energy use[2]. Moreover, the cooking activity can also supply the hot water and heating requirements of the house.

Grasping this dominant energy use is not easy; its modes of satisfaction vary significantly according to the household categories: the cooking habits, the rate of monetarization[3] and the solvency of the households define the consumption pattern of electricity, fossil fuels (hydrocarbons, charcoal, coal) and commercial or traditional fuels (wood, animal and agricultural residues).

The energy demand is simulated in two stages:

- The first stage consists of evaluating the energy requirements for cooking in the households of the same zone and socio-economic class in terms of a final energy of reference. These requirements are determined by the product of the unit consumption of households belonging to the same class and of the number of households related to the module. The scenario hypotheses give the fuel mix, i.e., the distribution of households according to the main fuel use for cooking - electricity, traditional fuels by type and conventional fuels by type.

- The final demand by energy type then corresponds to the ratio of the previous requirements and the coefficients of substitution of each energy type compared to the reference energy[4].

Figure 5 presents the simulation method of the energy demand of the households for cooking.

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[2] Except a very few countries requiring space heating in the houses (e.g. republic of Korea, Peoples Republic of China)

[3]Indicator of the importance of monetary transactions.

[4]The coefficient of substitution of the final energy type taken as teh reference is by definition equal to unity.

1.1 Energy Requirements

1.1.1 Evaluation of Requirements

- Urban zones: ireg = [1, NRGURB]
  icl = [1, NCLURB]

(1)

$$USCKU\ (ireg,icl) = \frac{CKURBY\ (icl) \times CKURCY\ (icl) \times HHUCLR\ (ireg,\ icl)}{U} \times 10$$

With

CKURBY: Unit energy consumption for cooking by urban households by class, measured in final energy of reference of useful energy 10^3 kcal/household/ year).

CKURCY: Evolution index of unit consumption for cooking by class, of urban households (base year = 1).

HHUCLR: Number of urban households by class and urban zone (10^6).

U: Coefficient used to express the demand in the units selected by the user.

- Rural Zones: ireg = [1, NRGRUR]
  icl = [1, NCLRUR]

(2)

$$USCKR\ (ireg,\ icl) = \frac{CKRUBY\ (incl) \times CKRUCY\ (icl) \times HHRCLR\ (ireg,\ icl)}{U}$$

With

CKRUBY: Unit energy consumption for cooking of rural households by class, measured in final energy of reference (or useful energy) (10^3 kcal/household/year).

CKRUCY: Evolution index of unit consumption for cooking by class, of rural households (base year = 1).

HHRCLR: Number of rural households by class and rural zone (10^6).

1.1.2 Structure of Energy Requirements by Energy Type (Fuel Mix)

The three main types of energy considered are electricity, traditional fuels and conventional fuels. The penetration rates of the first two are given as hypotheses, the share of conventional fuels is obtained from the difference between the total and the shares attributed to electricity and traditional fuels (in % of households).

1.1.2.1 Share of Conventional Fuels

- Urban zones

(3) PCOMM (ireg, icl) = 1-PETCKU (ireg, icl) - PELCKU (ireg, icl)

With

PETCKU: Share of urban households by class and zone using traditional fuels for cooking.

PELCKU: Share of electrified urban households by class and zone using electricity for cooking.

- Rural zones

(4) PCOMM (ireg, icl) = 1-PETCKR (ireg, icl) - PELCKR (ireg. icl)

With

PETCKR: Share of rural households by class and zone using traditional fuels for cooking.

PELCKR: Share of electrified rural households by class and zone using electricity for cooking.

1.1.2.2 Distribution of Conventional Fossil Fuels by Type

The relative importance of each type of conventional fuels, by calculation period, is evaluated on the basis of their initial structure and the penetration rate of those considered as strategic (scenario).

For convenience, we can note

icvs: index of strategic fuel among the NCVSN considered in the household sector

icvs = [1, NCVSN]
where NCVSN ≤ NCVHH

icvr: index of the other conventional fuels (non strategic).

The relation between these indexes with those of the fuels used in the household sector is defined by the user for the strategic fuels (variables LCVSN) and from the sub-program CPLISt for the others (function LREST).

The re ations of equivalence are:

LCVSN (icvs) = icv
LREST (icvr) = icv

- Urban zones

(5)

$$PMCKCV(ireg, icl, icvr) = \left(1 - \sum_{icvs}^{ncsvn} PUCKCY(ireg, icl, icvs)\right) \times \frac{}{\sum^{ncvhh\ ncvsd} PUCKBY(ireg.\ icl.\ icvr)}$$

$$PMCKCY(ireg, icl, icvs) = PUCKCY(ireg.\ icl.\ icvs)$$

With

PUCKCY: Share of strategic fuel in the consumption of conventional fossil fuels for cooking by class and zone.

PUCKBY: Share of conventional fuel for cooking in the urban households by class and zone.

(the number of conventional fuels, NCVHH = 5)

ICV = 1: coal
= 2: charcoal
= 3: kerosene
= 4: gas
= 5: LPG

$$\sum_{icv = 1}^{5} PUCKBY(ireg, icl, icv) = 1 \text{ for constant ireg, icl}$$

- Rural zones

(6)

$$PMCKCV(ireg, icl, icvr) = \left(1 - \sum_{icvs = 1} PRCKCY(ireg, icl, icvs)\right) \times \frac{}{\sum_{icvr = 1}^{ncvhh-ncvsn} PRCKBY(ireg, icl, icvr)}$$

$$PMCKCV(ireg, icl, icvr) = PRCKCY(ireg, icl, icvs)$$

With

PRCKCY: Share of strategic fuel in the consumption of conventional fossil fuels for cooking by class and zone.

PRCKBY: Share of conventional fuel for cooking in the rural households by class and zone.

Where

$$\sum_{icv = 1}^{ncvhh} PRCKBY(ireg, icl, icv) = 1$$

1.2 Final Energy Demand

The fossil fuel and electricity demand corresponds to the energy requirements previously evaluated for each type, divided by their substitution coefficient[5]. The model makes the distinction between the fossil fuel demand according to two forms:

- at aggregate level, with a distinction between urban and rural households for the traditional fuels, due to data constraints.

- at module level, for the conventional fuels.

The total demand of the households for cooking is obtained by successive aggregation of human settlement zones, socio-economic classes and urban and rural environment.

Finally the results separate the commercial and non-commercial energy demand.

1.2.1 Traditional Fuel Demand

1.2.1.1 Demand by module

- Urban zones

(7)

$$CKUET\ (ireg, icl) = \frac{USCKU\ (ireg, icl) \times PETCKU\ (ireg, icl)}{CCMETU \times CCETCY}$$

With

CCMETU: Substitution coefficient of traditional fuels for urban household cooking (base year=1).

CCETCY: Evolution index of substitution coefficient (or efficiency) for traditional fuels (base year=1).

(8)

$$CCMETU = \sum_{iet=1}^{nethh} CCETU\ (iet) \times PMUET\ (iet)$$

With

iet: Index of traditional fuel

CCETU: Substitution coefficient (or efficiency) of traditional fuels for urban households.

PMUET: share of each traditional fuel in the total consumption of traditional fuel for urban household cooking.

[5]Note that this coefficient reflects the influence of changes in efficiency and behaviour when an energy is substituted by another. It is measured relative to a final energy taken as reference, whose efficiency corresponds to unity.

- Rural Zones

(9)

$$CKRUET\ (ireg, icl) = \frac{USCKR\ (ireg, icl) \times PETCKR\ (ireg, icl)}{CCMETR \times CCETCY}$$

With

CCMETR: Substitution coefficient of traditional fuels for rural household cooking (base year = 1).

Where

(10)

$$CCMETR = \sum_{iet=1}^{nethh} CCETR\ (iet) \times PMRET\ (iet)$$

with

CCETR: Substitution coefficient (or efficiency) of traditional fuels for rural households.

PMRET: Share of each traditional fuel in the total consumption of traditional fuel for rural household cooking.

1.2.1.2 Total Demand by Type of Traditional Fuel

- Total demand

- Urban

(11)

$$CKETU = \sum_{icl=1}^{nclurb} \sum_{ireg=1}^{nrgurb} CKURET\ (ireg.icl)$$

- Rural

(12)

$$CKETR = \sum_{icl=1}^{nclrur} \sum_{ireg=1}^{nrgrur} CKRUET\ (ireg.icl)$$

- Demand by fuel type

- Urban

(13)

$$CKETUT\ (iet) = CKETU \times PMUET\ (iet)$$

- Rural

(14)

$$CKETRT\ (iet) = CKETR \times PMRET\ (iet)$$

- Total

(15)

$$CKETTY\ (iet) = CKETUT\ (iet) + CKETRT\ (iet)$$

1.2.1.3 Total Demand of Traditional Fuels

(16)

$$COOKET = CKETU + CKETR$$

1.2.2.1 Demand by Module and Fuel Type

- Urban Zones

(17)

$$CKURCT(ireg, icl, icv) = \frac{USCKU(ireg.icl) \times PCOMM(ireg.icl) \times PMCKCV(ireg.icl.icv)}{CCCK(icv)}$$

With

icv: Index of conventional fuel

CCCK: Substitution coefficient (or efficiency) of conventional fuel for cooking (for reference fuel = 1)

Where

(18)

$$CCCK(icv) = CCCKBY(icv) \times CCCKCY$$

With

CCCKBY: Substitution coefficient (or end use efficiency) of conventional fuel.

CCCKCY: Evolution index of substitution coefficients (or efficiencies) for all conventional fuels (base year = 1.)

- Rural Zones

(19)

$$CKRRCT(ireg.icl.icv) = \frac{USCKR(ireg.icl) \times PCOMM(ireg.icl) \times PMCKCV(ireg.icl.icv)}{CCCK(icv)}$$

1.2.2.2 Fuel Demand by Urban and Rural Zones

- Demand by zone and fuel -
- Urban zones

(20)

$$CKRRTY(ireg.icv) = \sum_{icl=1}^{nclrur} CKURCT(ireg.icl,icv)$$

- Rural zones

(21)

$$CKRRTY(ireg.icv) = \sum_{icl=1}^{nclrur} CKRRCT(ireg,icl,icv)$$

- Demand by household class and fuel -
- Urban households

(22) $$CKUCTY(icl,icv) = \sum_{ireg=1}^{nrgurb} CKURCT(ireg,icl,icv)$$

- Rural households

(23) $$CKRCTY(icl,icv) = \sum_{icl=1}^{nrgrur} CKRRCT(ireg,icl,icv)$$

- Demand by type of fuel -
- Urban

(24) $$CKUTYP(icv) = \sum_{icl=1}^{nclurb} \sum_{ireg=1}^{nrgurb} CKRRCT(ireg,icl,icv)$$

- Rural

(25) $$CKRTYP(icv) = \sum_{icl=1}^{nclrur} \sum_{ireg=1}^{nugrur} CKRRCT(ireg,icl,icv)$$

- Total -

(26) CKCVTY (icv) = CKUTYP (icv) + CKRTYP (icv)

- Global urban and rural demand -
- Urban

(27) $$CKURBA = \sum_{icl=1}^{nclurb} \sum_{ireg=1}^{nrgurb} \sum_{icv=1}^{ncvhn} CKURCT(ireg,icl,icv)$$

- Rural

(28) $$CKRURA = \sum_{icl=1}^{nclrur} \sum_{ireg=1}^{nrgrur} \sum_{icv=1}^{ncvhh} CKRRCT(ireg,icl,icv)$$

1.2.2.3 Total demand of conventional fuels

(29) COOKCV = CKURBA + CKRURA

1.2.3 Electricity demand

The rate of households ownership of electric cooker corresponds to a scenario variable defined in percentage of the number of households by module.

1.2.3.1 Demand by module

- Urban zones

(30) $$CKUREL\ (ireg,icl) = \frac{USCKU\ (ireg,icl) \times PELCKU\ (ireg,icl)}{CCELBY \times CCELCY}$$

with

PELCKU : Share of urban households, by class and zone, using electricity for cooking.

CCELBY : Substitution coefficient (or end-use efficiency) of electricity.

CCELCY : Evolution index of substitution coefficient (or efficiency) of electricity (base year = 1).

- Rural zones

(31) $$CKRUEL\ (ireg,icl) = \frac{USCKR\ (ireg,icl \times PELCKR\ (ireg,icl)}{CCELBY \times CCELCY}$$

PELCKR : Share of rural households, by class and zone, using eletricity for cooking.

1.2.3.2 Urban and rural demand

- Urban

(32) $$CKUEL = \sum_{ireg=1}^{nrgrub} \sum_{icl=1}^{nclurb} CKUREL\ (ireg,icl)$$

- Rural

(33) $$CKREL = \sum_{ireg=1}^{nrgrur} \sum_{icl=1}^{nclrur} CKRUEL\ (ireg,icl)$$

1.2.3.3 Total demand

(34) $$COOKEL = CKUEL + CKREL$$

1.2.4 Total household energy demand for cooking

The aggregated results make distinction between the commercial energies (including commercial traditional fuels) and the others.

1.2.4.1 Commercial energy demand

(35) CKCM = COOKCV + CKETCM + COOKEL

with

CKETCM : Commercial traditional fuel demand of the households for cooking.

where

CXETCM = COOKET + PETCM
with

PETCH : Share of traditional fuels that are commercialized.

1.2.4.2 Non-commercial energy demand

(37) CKNOCM = COOKET - CKETCM

1.2.4.3 Total energy demand for cooking

(38) COOK = COOKCV + COOKET + COOKEL

Demand Devices for End Users[6]

The Problem of Stove Efficiency

There are no standard test procedures available to determine the efficiency of a cooking stove. Therefore, the water boiling test is often used (references 4, 5). In general the efficiency can be defined as follows:

Useful energy at cooking pot Final energy input at cooking stove

The final energy input can be determined very easily. In the case of a fuel it is the mass of the fuel multiplied by the calorific heat content. The amount of fuel must be determined by weighing. The calorific value can only be determined in a laboratory with the respective equipment. For biomass the calorific value can vary considerably, depending on the kind of biomass and moisture.

Severe problems arise when the useful energy output at the cooking pot must be determined. There are two methods commonly used to define the efficiency (references 4, 5):

1. efficiency during the heating up phase and

2. efficiency during steady state conditions (case A and case B).

Both methods can be realized with relatively simple testing instruments. This is the reason why most of the efficiency values for stoves given in the literature are based on one of these methods.

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6 Article from *"Demand Devices for Endusers - Cooking Stoves, Boilers, Burners for Cement Industry, Transport Devices"*, Final Data and Modeling Report, March 1988.

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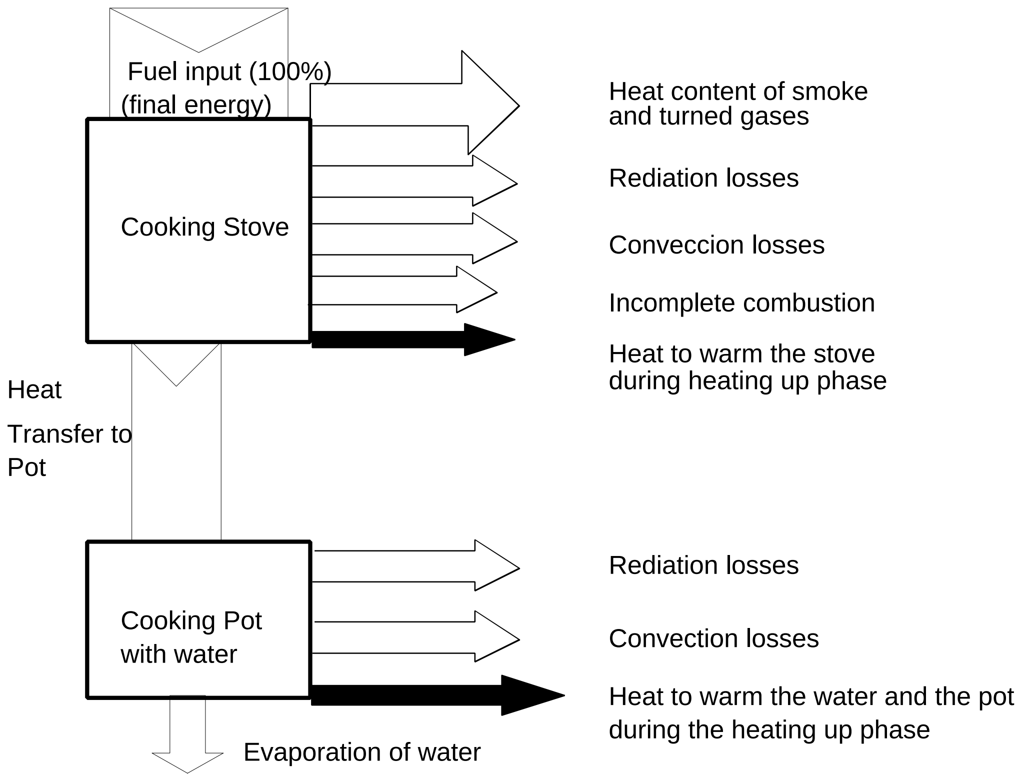
Agency for Assessment and Application of Technology

Bundesministerium fur Forschung und Technologie, Bonn
Ministry of Research and Technology

Figure 1: Energy Flow Diagram of a Cooking Stove



Efficiency During the Heating Up Phase

In this case the heat to warm the water from the environmental temperature up to a certain temperature below cooking temperature e.g. 95°C is defined as useful energy. All other heat flows shown in figure 1 are considered as losses. It should be noticed that evaporation already occurs below 100%. The efficiency is then:

$$EEF_1 = \frac{\text{Energy to warm up the water}}{\text{Final energy input at cooking stove}}$$

$$EEF_1 = \frac{m_w \quad t_w \quad . \; c_w}{m_F \quad h_F}$$

m_W = mass of water
t_W = temperature rise of water, the upper temperature must be below 100°C
C_W = specific heat of water
m_F = mass of fuel
h_F = calorific heat content of fuel

The losses at the pot depend on size, shape and material of th pot. The efficiency of a stove can therefore not be measured without a pot.

Steady State Conditions

In this case the water is heated up to the boiling temperature of 100^{o}C. All temperatures and the fuel input are kept constant. The two energy flows which warm up the stove and the water (dark arrows in figure 1) do not appear under steady state conditons.

The heat content of the boiling water and the heat used for the evaporation of water are defined as useful energy. Here it should be noticed that the evaporation strongly depands on the covering of the pot. The efficiency can be written as:

$$EEF_2 = \frac{\text{Heat content of water + evaporation heat}}{\text{Final energy input at cooking stove}}$$

$$EEF_2 = \frac{M_W \, . \, (100^{o}C - t_o) \, . \, C_W + m_e \, r_w}{m_F \, h_F} \qquad \text{(case A)}$$

t_O = starting temperature (environmental temperature)
m_e = evaporated mass flow rate
r_W = latent heat

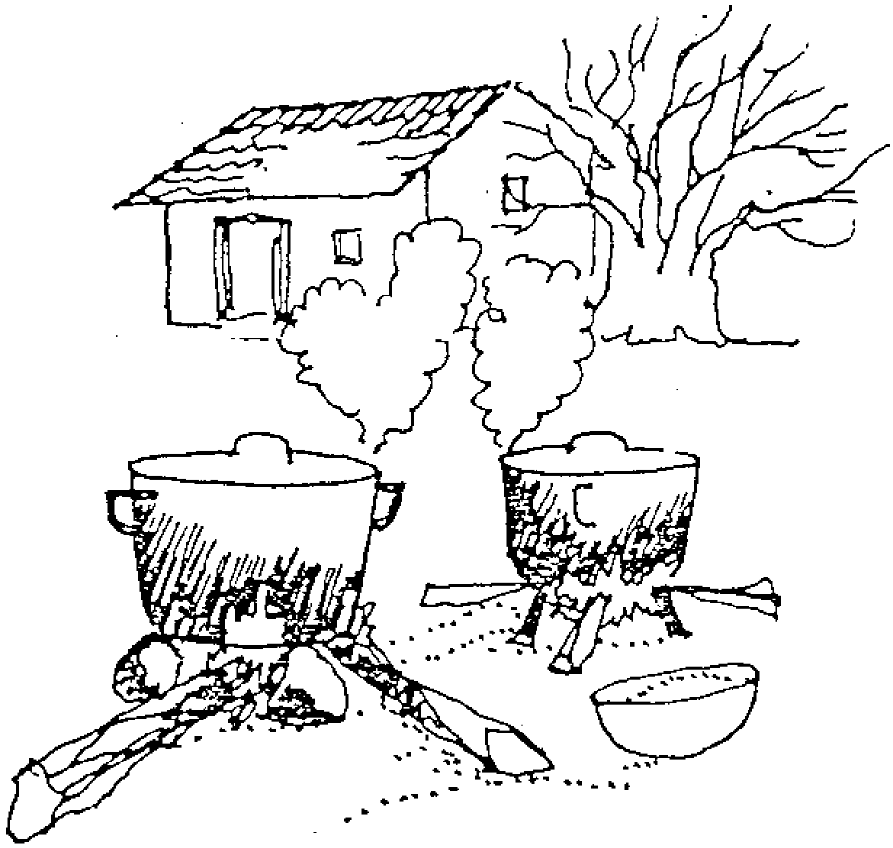
The case B only steady state evaporation is considered:

$$EFF_3 = \frac{m_e \, r_w}{m_F \, h_F} \qquad \text{(case B)}$$

Efficiency

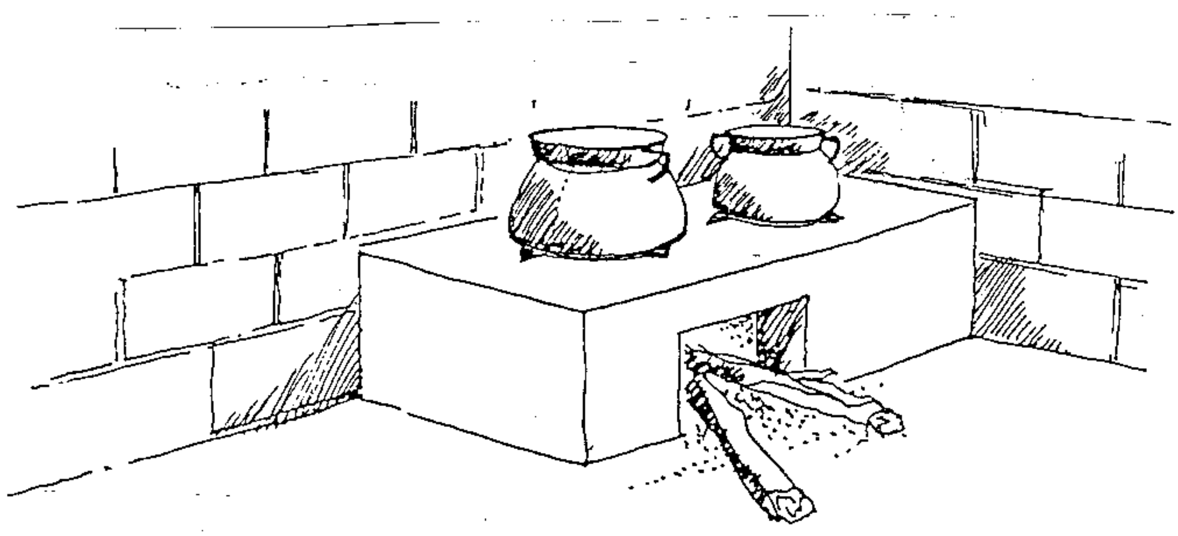
As described in chapter 2 the efficiency strongly depends on the type of the stove. The traditional type in rural areas is the three-stone open fire place (Figure 2). According to references 4,5 and 6 it has an efficiency in the range of 6% to 14%.

Figure 2: Traditional Three Stone Open Fire Place

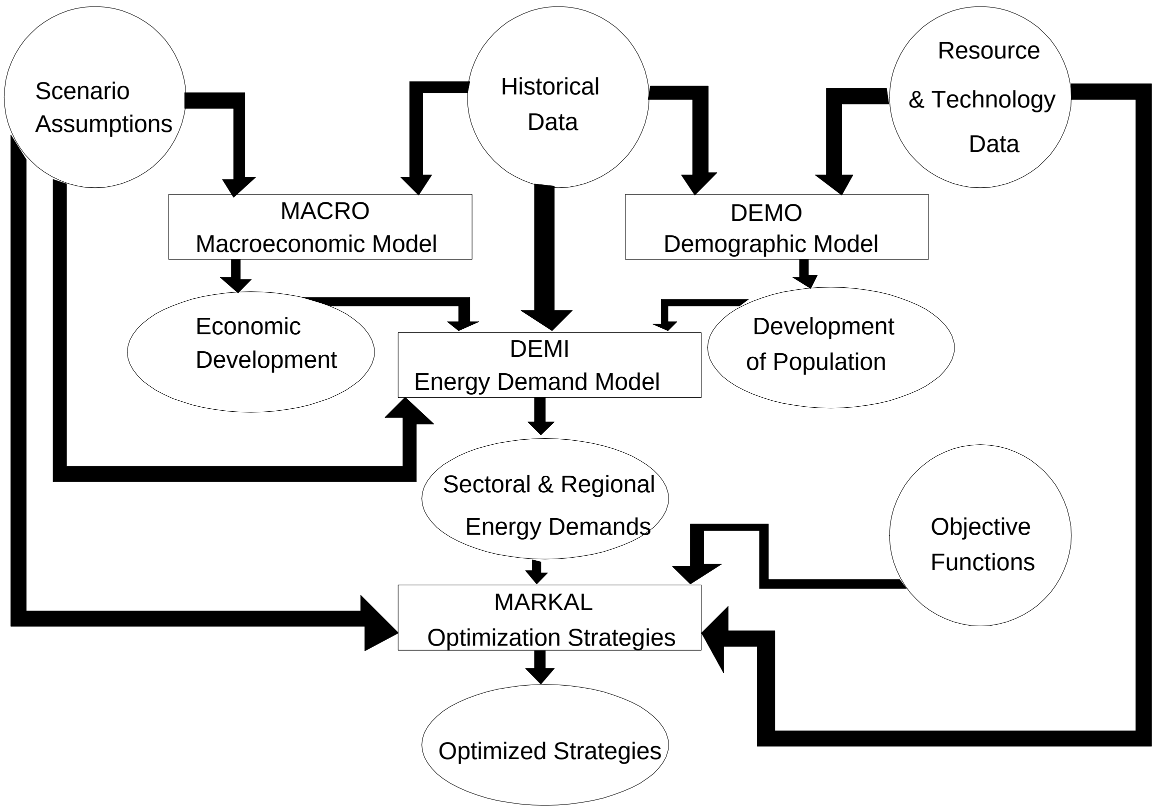


Modified stoves with enclosed fireboxes, made of clay, mud or bricks (figure 3) have a higher efficiency. From references 4,5 and 6 and efficiency range between 10% and 20% can be derived. This type of stove might be representative for many selfmade two hole stoves used in Indonesia.

Figure 3: Modified Stove with Enclosed Firebox (Principle)



Computer Models and Execution Flow Chart



Annex 5: Traditional Fuel Uses - AIT

Table A1: Traditional Fuel Consumption: Philippine Residential Sector

Year	Population	H'hold Size	H'hold No (000)	Cooking % of Urban H'hold	% of Urban H'Hold Using: Modern Fuels	% of Urban H'Hold Using: Traditional Fuels: Wood	% of Urban H'Hold Using: Traditional Fuels: Charcoal	% of Urban H'Hold Using: Traditional Fuels: Others	% of Rural H'Hold	% of Rural H'Hold Uisng: Modern Fuels	% of Rural H'Hold Uisng: Traditional Fuels: Wood	% of Rural H'Hold Uisng: Traditional Fuels: Charcoal	% of Rural H'Hold Uisng: Traditional Fuels: Others	Weighted Average: % HH Using Wood	Weighted Average: % HH Using Charcoal	Weighted Average: % HH Using Others
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1960	27087685	5.83	4648	24.80					75.08					92.77	0.55	0.98
1970	36684486	5.95	6163	30.62	49.35	49.31	0.78	0.57	69.43	6.18	92.45	0.21	1.16	79.29	0.38	0.98
1971	37862421	5.97	6347	32.19	50.80	47.64	0.96	0.61	67.81	6.48	92.02	0.29	1.21	77.73	0.50	1.02
1972	38914239	5.91	6588	32.00	52.28	45.89	1.18	0.65	68.00	6.80	91.54	0.39	1.26	76.93	0.64	1.07
1973	39390059	5.80	6786	33.31	53.82	44.05	1.45	0.69	66.69	7.14	91.01	0.54	1.32	75.36	0.84	1.11
1974	40656345	5.78	7031	32.38	55.39	42.09	1.78	0.73	67.62	7.49	90.40	0.73	1.38	74.76	1.07	1.17
1975	42070665	5.78	7285	33.39	57.02	40.01	2.19	0.78	66.61	7.86	89.70	1.00	1.44	73.11	1.40	1.22
1976	43406278	5.76	7535	34.26	58.69	37.79	2.69	0.83	65.74	8.25	88.89	1.36	1.50	71.38	1.82	1.27
1977	44584324	5.73	7782	35.03	60.41	35.40	3.31	0.88	64.97	8.66	87.92	1.86	1.56	69.52	2.37	1.33
1978	45794343	5.70	8032	35.82	62.18	32.82	4.07	0.94	64.18	9.08	86.74	2.55	1.63	67.42	3.09	1.38
1979	47037201	5.68	8285	36.32	64.00	30.00	5.00	1.00	63.38	9.53	85.29	3.48	1.70	64.95	4.02	1.44
1980	48098460	5.59	8607	37.40	53.59	38.93	6.47	1.00	62.60	10.00	83.47	4.75	1.78	66.81	5.39	1.49
1981	49536022	5.58	8876	37.71	49.23	41.72	7.99	1.06	62.29	6.30	87.25	4.94	1.51	70.08	6.09	1.34
1982	51283065	5.57	9201	37.89	47.23	41.77	9.88	1.12	62.11	4.00	89.60	5.10	1.30	71.48	6.91	1.23
1983	52055370	5.57	9352	38.81	48.61	39.53	10.67	1.18	61.19	4.20	89.14	5.30	1.36	69.89	7.39	1.29
1984	53351220	5.56	9597	39.36	50.04	37.41	11.30	1.25	60.64	4.40	88.66	5.52	1.42	68.49	7.79	1.35
1985	54668332	5.55	9847	39.92	51.50	35.40	11.77	1.32	60.08	4.62	88.16	5.74	1.48	67.10	8.15	1.42
1986	56004130	5.53	10120	40.47	53.01	33.50	12.09	1.40	59.53	4.85	87.64	5.97	1.54	65.73	8.44	1.49
1987	57356042	5.52	10389	41.02	54.57	31.70	12.25	1.48	58.98	5.09	87.10	6.20	1.61	64.37	8.69	1.56
1988	58721307	5.51	10659	41.58	56.17	29.99	12.27	1.57	58.42	5.34	86.53	6.45	1.68	63.02	8.87	1.63

Colume No.	Comments
2	1960, 1970 & 1980 Population and Housing Census: Philippines 1975 Census of Population
	1986, 1988 & 1989 Philippine Statistical Yarbook
3	1960, 1970 & 1980 Population and Housing Census: Philippines
	1989 Philippine Energy Statistics for 1971 and 1985 Values
4	Column 2 divided by column 3
5	Same as column 2
6, 7, 8, 9, 11, 12	1977 Household Energy Demand (Survey by Ministry of Energy - Philippines)
12, 14, 18, 19, 20	1979 Urban Household Energy Demand, 1982 Rural Energy Needs Survey
24, 25, 26, 41, 42	1987 Biomass Resource Survey Project, 1989 Rural Energy Conference - OEA, Philippines
10	100 minus Column 5
15	Sum of the Products of Columns 5 6 7 and Columns 10 & 12
16	Sum of the Products of Columns 5 & 8 and Columns 10 & 13
17	Sum of the Products of Columns 5 & 9 and Columns 10 & 14

(Table A1 - continued)

Year	Average Household Consumption												Energy Consumed for Cooking (KTOE)					
	Urban						Rural						Urban			Rural		
	All H'Hold BOE/Month/H'hold			by Fuel Type BOE/Month/H'hold			All H'Hold BOE/Month/H'hold			by Fuel Type BOE/Month/H'hold			Wood Stove	Char-coal	Others	Wood Stove	Char-coal	Others
	Wood Stove	Charcoal Stove	Others	Wood Stove	Charcoal Stove	Others	Wood Stove	Charcoal Stove	Others	Wood Stove	Charcoal Stove	Others						
	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
1960																		
1970	0.349	0.008	0.011	0.708	0.987	1.912	0.109	0.0008	0.018	0.118	0.361	1.574	1062	23	33	756	5	126
1971	0.339	0.009	0.011	0.712	0.926	1.895	0.111	0.0009	0.021	0.121	0.303	1.697	1117	29	38	770	6	143
1972	0.330	0.010	0.012	0.718	0.868	1.878	0.112	0.0010	0.023	0.123	0.255	1.829	1121	35	41	812	7	167
1973	0.320	0.012	0.013	0.727	0.814	1.861	0.114	0.0011	0.026	0.125	0.215	1.971	1168	43	47	831	8	190
1974	0.311	0.014	0.013	0.740	0.763	1.844	0.115	0.0013	0.029	0.128	0.180	2.125	1143	50	50	885	10	224
1975	0.303	0.016	0.014	0.756	0.716	1.827	0.117	0.0015	0.033	0.130	0.152	2.291	1187	61	56	915	12	258
1976	0.294	0.018	0.015	0.778	0.671	1.810	0.118	0.0017	0.037	0.133	0.128	2.470	1225	75	63	946	14	296
1977	0.286	0.021	0.016	0.807	0.630	1.794	0.120	0.0020	0.042	0.136	0.107	2.663	1257	92	70	978	16	340
1978	0.278	0.010	0.017	0.847	0.251	1.778	0.151	0.0023	0.038	0.174	0.090	2.321	1289	47	77	1256	19	315
1979	0.270	0.005	0.018	0.900	0.100	1.762	0.190	0.0026	0.035	0.223	0.076	2.024	1310	24	85	1612	22	292
1980	0.262	0.005	0.019	0.672	0.075	1.858	0.240	0.0030	0.031	0.287	0.064	1.764	1358	25	96	2082	26	273
1981	0.254	0.005	0.020	0.608	0.059	1.853	0.302	0.0035	0.029	0.346	0.070	1.888	1369	26	106	2691	31	255
1982	0.246	0.005	0.021	0.588	0.047	1.848	0.340	0.0040	0.026	0.379	0.078	2.000	1382	26	116	3134	37	240
1983	0.238	0.004	0.022	0.602	0.042	1.842	0.344	0.0066	0.024	0.386	0.124	1.744	1394	26	128	3179	61	218
1984	0.231	0.004	0.023	0.617	0.038	1.837	0.349	0.0108	0.022	0.394	0.195	1.520	1406	26	140	3276	101	202
1985	0.224	0.004	0.024	0.632	0.036	1.832	0.354	0.0176	0.020	0.401	0.307	1.326	1418	27	154	3374	168	187
1986	0.217	0.004	0.026	0.647	0.034	1.827	0.358	0.0289	0.018	0.409	0.485	1.156	1432	27	169	3481	281	173
1987	0.210	0.004	0.027	0.663	0.033	1.822	0.363	0.0474	0.016	0.417	0.764	1.008	1444	27	186	3587	468	160
1988	0.204	0.004	0.028	0.679	0.032	1.816	0.411	0.0777	0.015	0.475	1.204	0.879	1455	28	204	4129	780	148

Column No.	Comments
21	(Col 18 x Col 5 x Col ..) / (Col 7 x Col 5 x Col 4)
22	(Col 19 x Col 5 x Col ..) / (Col 8 x Col 5 x Col 4)
	(Col 20 x Col 5 x Col ..) / (Col 9 x Col 5 x Col 4)
27	(Col 21 x Col 10 x Col .) / (Col 12 x Col 10 x Col 4)
28	(Col 22 x Col 10 x Col .) / (Col 13 x Col 10 x Col 4)
29	(Col 23 x Col 10 x Col .) / (Col 14 x Col 10 x Col 4)
30	Col 4 x Col 5 x Col 7 x Col 21 ... 12 mons/yr x 0.1344 TOE/BOE
31	Col 4 x Col 5 x Col 8 x Col 22 ... 12 mons/yr x 0.1344 TOE/BOE
32	Col 4 x Col 5 x Col 9 x Col 23 ... 12 mons/yr x 0.1344 TOE/BOE
33	Col 4 x Col 10 x Col 12 x Col .....12 mons/yr x 0.1344 TOE/BOE
34	Col 4 x Col 10 x Col 13 x Col .....12 mons/yr x 0.1344 TOE/BOE
35	Col 4 x Col 10 x Col 14 x Col .....12 mons/yr x 0.1344 TOE/BOE

Column No.	Comments
39, 40	1979 Urban Household Survey, ... Rural Energy Needs Survey 1960 and 1988 figures were estimated assuming the proportion of charcoal users in urban and rural areas followed the trend in the number of houshold with 23 no electricity.
43	(Col 41 x Col 5 x Col 4) / (Col 33 x Col 5 x Col 4)
44	(Col 42 x Col 10 x Col 4) / (Col 40 x Col 10 x Col 4)
45	Col 4 x Col 5 x Col 39 x Col 43 x 12 mons/yr x 0.1344 TOE/BOE
46	Col 4 x Col 10 x Col 40 x Col 44 x 12 mons/yr x 0.1344 TOE/BOE

(Table A1 - continued)

Year	Whole Country			Ironing % Urban H'hold Using Charcoal	% Rural H'Hold Using Charcoal	Average Energy Consumption (BOE/Month/H'Hold)				Energy for Ironing (KTOE)			Total Energy Consumption (KTOE)		
	Wood	Char-coal	Others			All H'hold		by Fuel Type		Urban	Rural	Total	Wood	Char-cola	Others
						Urban	Rural	Urban	Rural						
	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)	(45)	(46)	(47)	(48)	(49)	(50)
1960				83.09	93.32										
1970	1818	29	159	81.30	89.39	0.1091	0.069	0.438	0.111	1760	1113	2873	1818	2902	159.16
1971	1887	35	180	77.80	86.55	0.1048	0.066	0.418	0.113	1690	1072	2761	1887	2797	180.46
1972	1933	42	208	74.45	83.80	0.1006	0.064	0.422	0.112	1622	1032	2654	1933	2696	208.20
1973	1999	51	236	71.24	81.14	0.0965	0.062	0.407	0.114	1557	994	2551	1999	2602	236.42
1974	2028	60	274	68.17	78.56	0.0927	0.059	0.420	0.112	1495	957	2452	2028	2512	273.85
1975	2102	73	313	65.24	76.07	0.0890	0.057	0.408	0.113	1435	922	2357	2102	2430	313.85
1976	2171	89	358	62.43	73.65	0.0854	0.055	0.399	0.114	1378	888	2265	2171	2354	358.32
1977	2235	108	409	59.74	71.31	0.0820	0.053	0.392	0.114	1322	855	2177	2235	2285	409.34
1978	2545	66	393	57.17	69.05	0.0738	0.063	0.360	0.142	1190	1015	2205	2545	2272	392.71
1979	2922	47	378	36.00	50.00	0.0590	0.075	0.452	0.236	952	1205	2157	2922	2204	377.71
1980	3441	52	369	34.22	48.88	0.0413	0.089	0.323	0.290	667	1430	2097	3441	2148	369.32
1981	4060	57	361	32.53	47.79	0.0248	0.105	0.202	0.354	400	1698	2098	4060	2155	360.58
1982	4515	63	356	30.93	46.72	0.0124	0.125	0.106	0.431	200	2016	2216	4515	2279	355.88
1983	1573	87	346	29.40	45.67	0.0050	0.101	0.043	0.362	80	1631	1711	4573	1797	346.01
1984	4782	127	342	27.95	44.65	0.0015	0.082	0.014	0.302	24	1319	1343	4682	1470	342.22
1985	4792	195	341	26.57	43.65	0.0003	0.066	0.003	0.252	5	1067	1071	4792	1266	340.76
1986	4913	308	342	25.26	42.67	0.0000	0.053	0.000	0.211	0	863	863	4913	1171	342.28
1987	5031	496	346	24.02	41.71	0.0000	0.043	0.000	0.176	0	698	698	5031	1194	345.93
1988	5584	808	352	22.83	40.78	0.0000	0.035	0.000	0.147	0	564	564	5584	1373	351.86

Table A2. Traditional Fuel Consumption: Philippine Commercial Sector

Year	Type of Establishment	No. of Establishment	Types of Fuel Used (% of Establishment)			Avg Monthly Cons'n (TOE/Est't)			Total Annual Consumption (TOE)			
			Wood	Charcoal	Others	Wood	Charcoal	Others	Wood	Charcoal	Others	Total
1972									230113	24294	0	254407
	Community & Business Services	699		6	1	1.7749	0.0000	0.0000	2679	0	0	2679
	Hotels, Motels & Restaurants	36195		33	2	1.7749	0.1684	0.0000	84800	24142	0	108942
	Commerce & Trade	10228		1	6	0.0022	0.0000	0.0000	19	0	0	19
	Manufacturing Industry	35700		9	2	1.3314	0.0039	0.0000	142594	149	0	142743
	Printing & Publication	6		3		1.3314	0.0000	0.0000	15	0	0	15
	Recreational Services	508				0.0000	0.0000	0.0000	0	0	0	0
	Personal Services	94		16		0.0022	0.0152	0.0000	0	3	0	3
	Others	2119		5	17	0.0022	0.0000	0.0000	6	0	0	6
1973									194222	19994	0	214216
	Community & Business Services	865		6	1	1.7749	0.0000	0.0000	3316	0	0	3316
	Hotels, Motels & Restaurants	29780		33	2	1.7749	0.1684	0.0000	69770	19863	0	89634
	Commerce & Trade	15422		1	6	0.0022	0.0000	0.0000	29	0	0	29
	Manufacturing Industry	30311		9	2	1.3314	0.0039	0.0000	121070	127	0	121197
	Printing & Publication	12		3		1.3314	0.0000	0.0000	30	0	0	30
	Recreational Services	557				0.0000	0.0000	0.0000	0	0	0	0
	Personal Services	156		16		0.0022	0.0152	0.0000	1	5	0	5
	Others	2190		5	17	0.0022	0.0000	0.0000	6	0	0	6
1974									162040	19754	0	181793
	Community & Business Services	1071		6	1	1.6270	0.0000	0.0000	3762	0	0	3762
	Hotels, Motels & Restaurants	29780		33	2	1.6270	0.1665	0.0000	63956	19639	0	83595
	Commerce & Trade	19147		1	6	0.0020	0.0000	0.0000	33	0	0	33
	Manufacturing Industry	25736		9	2	1.2205	0.0039	0.0000	94229	107	0	94336
	Printing & Publication	23		3		1.2205	0.0000	0.0000	53	0	0	53
	Recreational Services	611				0.0000	0.0000	0.0000	0	0	0	0
	Personal Services	260		16		0.0020	0.0150	0.0000	1	8	0	9
	Others	2262		5	17	0.0020	0.0000	0.0000	6	0	0	6
1975									148769	19743	0	168512
	Community & Business Services	1325		6	1	1.6270	0.0000	0.0000	4656	0	0	4656
	Hotels, Motels & Restaurants	29780		33	2	1.6270	0.1665	0.0000	63956	19639	0	83595
	Commerce & Trade	23772		1	6	0.0020	0.0000	0.0000	41	0	0	41
	Manufacturing Industry	21851		9	2	1.2205	0.0039	0.0000	80005	91	0	80097
	Printing & Publication	44		3		1.2205	0.0000	0.0000	103	0	0	103
	Recreational Services	671				0.0000	0.0000	0.0000	0	0	0	0
	Personal Services	434		16		0.0020	0.0150	0.0000	2	13	0	14
	Others	2337		5	17	0.0020	0.0000	0.0000	6	0	0	6

(Table A2 - Continued)

Year	Type of Establishment	No. of Establishment	Types of Fuel Used (% of Establishment)			Avg Monthly Cons'n (TOE/Est't)			Total Annual Consumption (TOE)			
			Wood	Charcoal	Others	Wood	Charcoal	Others	Wood	Charcoal	Others	Total
1976									106446	20457	0	126903
	Community & Business Services	2747	18	6	1	1.5018	0.0000	0.0000	8911	0	0	8911
	Hotels, Motels & Restaurants	31214	11	33	2	1.5018	0.1648	0.0000	61880	20376	0	82256
	Commerce & Trade	23043	7	1	6	0.0019	0.0000	0.0000	36	0	0	36
	Manufacturing Industry	10443	25	9	2	1.1266	0.0039	0.0000	35294	44	0	35337
	Printing & Publication	143	16	3		1.1266	0.0000	0.0000	310	0	0	310
	Recreational Services	1295				0.0000	0.0000	0.0000	0	0	0	0
	Personal Services	1302	16	16		0.0019	0.0149	0.0000	5	37	0	42
	Others	4343	10	5	17	0.0019	0.0000	0.0000	10	0	0	10
1977									101281	21490	0	122771
	Community & Business Services	5695	18	6	1	1.502	0.000	0.0000	18476	0	0	18476
	Hotels, Motels & Restaurants	32718	11	33	2	1.502	0.165	0.0000	64861	21357	0	86218
	Commerce & Trade	22336	7	1	6	0.002	0.000	0.0000	35	0	0	35
	Manufacturing Industry	4991	25	9	2	1.127	0.004	0.0000	16867	21	0	16888
	Printing & Publication	467	16	3		1.127	0.000	0.0000	1010	0	0	1010
	Recreational Services	2500				0.000	0.000	0.0000	0	0	0	0
	Personal Services	3903	16	16		0.002	0.015	0.0000	14	112	0	126
	Others	8069	10	5	17	0.002	0.000	0.0000	18	0	0	18
1978									117752	22524	0	140276
	Community & Business Services	11808	18	6	1	1.502	0.000	0.0000	38305	0	0	38305
	Hotels, Motels & Restaurants	34294	11	33	2	1.502	0.163	0.0000	67985	22181	0	90166
	Commerce & Trade	21651	7	1	6	0.002	0.000	0.0000	34	0	0	34
	Manufacturing Industry	2385	25	9	2	1.127	0.004	0.0000	8061	10	0	8071
	Printing & Publication	1522	16	3		1.127	0.000	0.0000	3291	0	0	3291
	Recreational Services	4827				0.000	0.000	0.0000	0	0	0	0
	Personal Services	11705	16	16		0.002	0.015	0.0000	42	334	0	376
	Others	14994	10	5	17	0.002	0.000	0.0000	34	0	0	34
1979									108428	22091	0	130520
	Community & Business Services	11788	18	6	1	1.395	0.000	0.0000	35508	0	0	35508
	Hotels, Motels & Restaurants	33647	11	33	2	1.395	0.163	0.0000	61938	21762	0	83700
	Commerce & Trade	29300	7	1	6	0.002	0.000	0.0000	43	0	0	43
	Manufacturing Industry	2445	25	9	2	1.046	0.004	0.0000	7673	10	0	7683
	Printing & Publication	1592	16	3		1.046	0.000	0.0000	3198	0	0	3198
	Recreational Services	4806				0.000	0.000	0.0000	0	0	0	0
	Personal Services	11173	16	16		0.002	0.015	0.0000	37	319	0	356
	Others	14707	10	5	17	0.002	0.000	0.0000	31	0	0	31

(Table A2 - continued)

Year	Type of Establishment	No. of Establishment	Types of Fuel Used (% of Establishment)			Avg Monthly Cons'n (TOE/Est't)			Total Annual Consumption (TOE)			
			Wood	Charcoal	Others	Wood	Charcoal	Others	Wood	Charcoal	Others	Total
1980									48916	12490	0	61406
	Community & Business Services	5948	14	6	1	1.220	0.000	0.00	12193	0	0	12193
	Hotels, Motels & Restaurants	19345	11	33	2	1.220	0.162	0.00	31159	12408	0	43567
	Commerce & Trade	36948	5	1	7	0.002	0.000	0.00	34	0	0	34
	Manufacturing Industry	2356	20	8	2	0.915	0.004	0.00	5176	9	0	5185
	Printing & Publication	239	13	3		0.915	0.000	0.00	341	0	0	341
	Recreational Services	1634				0.000	0.000	0.00	0	0	0	0
	Personal Services	2772	13	15		0.002	0.015	0.00	7	74	0	80
	Others	3782	8	5	19	0.002	0.000	0.00	6	0	0	6
1981									47037	13104	0	60141
	Community & Business Services	7090	12	5	1	1.148	0.000	0.00	11725	0	0	11725
	Hotels, Motels & Restaurants	20277	11	33	2	1.148	0.162	0.00	30740	13006	0	43746
	Commerce & Trade	44134	4	1	7	0.001	0.000	0.00	30	0	0	30
	Manufacturing Industry	2415	17	8	2	0.862	0.004	0.00	4245	9	0	4254
	Printing & Publication	250	11	3		0.862	0.000	0.00	284	0	0	284
	Recreational Services	1779				0.000	0.000	0.00	0	0	0	0
	Personal Services	3882	11	13		0.001	0.015	0.00	7	89	0	97
	Others	3903	7	4	20	0.001	0.000	0.00	5	0	0	5
1982												
	Community & Business Services	8451	9	5	1	1.085						
	Hotels, Motels & Restaurants	21255	11	33	2	1.085						
	Commerce & Trade	52719	3	1	8	0.001						
	Manufacturing Industry	2476	14	7	3	0.814						
	Printing & Publication	262	9	3		0.814						
	Recreational Services	1937				0.000						
	Personal Services	5437	9	12		0.001						
	Others	4029	5	4	22	0.001						
1983												
	Community & Business Services	10074	7	4	1	1.028						
	Hotels, Motels & Restaurants	22279	11	33	2	1.028						
	Commerce & Trade	62972	3	1	8	0.001						
	Manufacturing Industry	2539	11	7	3	0.771						
	Printing & Publication	274	7	2		0.771						
	Recreational Services	2109				0.000						
	Personal Services	7615	7	11		0.001						
	Others	4158	4	4	24	0.001						

(Table A2 - continued)

Year	Type of Establishment	No. of Establishment	Types of Fuel Used (% of Establishment)			Avg Monthly Cons'n (TOE/Est't)			Total Annual Consumption (TOE)			
			Wood	Charcoal	Others	Wood	Charcoal	Others	Wood	Charcoal	Others	Total
1984									40776	14955	0	55731
	Community & Business Services	12008	6	4	2	0.976	0.000	0.00	8440	0	0	8440
	Hotels, Motels & Restaurants	23353	11	33	2	0.976	0.160	0.00	30092	14761	0	44853
	Commerce & Trade	75220	2	1	9	0.001	0.000	0.00	22	0	0	22
	Manufacturing Industry	2603	9	6	3	0.732	0.004	0.00	2058	7	0	2066
	Printing & Publication	286	6	2		0.732	0.000	0.00	151	0	0	151
	Recreational Services	2296				0.000	0.000	0.00	0	0	0	0
	Personal Services	10664	6	10		0.001	0.015	0.00	9	187	0	196
	Others	4291	4	4	27	0.001	0.000	0.00	3	0	0	3
1985									39751	15642	0	55393
	Community & Business Services	14314	5	4	2	0.930	0.000	0.00	7985	0	0	7985
	Hotels, Motels & Restaurants	24479	11	33	2	0.930	0.159	0.00	30041	15374	0	45414
	Commerce & Trade	89851	2	1	10	0.001	0.000	0.00	25	0	0	25
	Manufacturing Industry	2668	7	6	3	0.697	0.004	0.00	1563	7	0	1571
	Printing & Publication	300	5	2		0.697	0.000	0.00	125	0	0	125
	Recreational Services	2499				0.000	0.000	0.00	0	0	0	0
	Personal Services	14935	5	10		0.001	0.015	0.00	10	261	0	271
	Others	4429	3	3	29	0.001	0.000	0.00	2	0	0	2
1986									38763	16353	0	55116
	Community & Business Services	17062	4	3	2	0.887	0.000	0.00	7268	0	0	7268
	Hotels, Motels & Restaurants	25659	11	33	2	0.887	0.158	0.00	30057	16019	0	46077
	Commerce & Trade	107327	1	1	11	0.001	0.000	0.00	14	0	0	14
	Manufacturing Industry	2735	6	5	4	0.666	0.004	0.00	1311	6	0	1317
	Printing & Publication	314	4	2		0.666	0.000	0.00	100	0	0	100
	Recreational Services	2721				0.000	0.000	0.00	0	0	0	0
	Personal Services	20917	4	9		0.001	0.014	0.00	11	327	0	339
	Others	4571	2	3	32	0.001	0.000	0.00	1	0	0	1

(Table A2 - continued)

Year	Type of Establishment	No. of Establishment	Types of Fuel Used (% of Establishment)			Avg Monthly Cons'n (TOE/Est't)			Total Annual Consumption (TOE)			
			Wood	Charcoal	Others	Wood	Charcoal	Others	Wood	Charcoal	Others	Total
1987									38216	17222	0	55439
	Community & Business Services	20338	3	3	2	0.849	0.000	0.00	6970	0	0	6970
	Hotels, Motels & Restaurants	26895	11	33	2	0.849	0.158	0.00	30136	16791	0	46928
	Commerce & Trade	128202	1	1	12	0.001	0.000	0.00	21	0	0	21
	Manufacturing Industry	2804	5	5	4	0.637	0.004	0.00	1001	6	0	1007
	Printing & Publication	328	3	2		0.637	0.000	0.00	75	0	0	75
	Recreational Services	2962				0.000	0.000	0.00	0	0	0	0
	Personal Services	29294	3	8		0.001	0.014	0.00	11	425	0	436
	Others	4718	2	3	35	0.001	0.000	0.00	1	0	0	1
1988									34491	18009	0	52500
	Community & Business Services	24243	2	3	2	0.781	0.000	0.00	4544	0	0	4544
	Hotels, Motels & Restaurants	28192	11	33	2	0.781	0.157	0.00	29062	17505	0	46566
	Commerce & Trade	153137	1	1	13	0.001	0.000	0.00	18	0	0	18
	Manufacturing Industry	2875	4	5	4	0.586	0.004	0.00	808	7	0	815
	Printing & Publication	343	2	2		0.586	0.000	0.00	48	0	0	48
	Recreational Services	3225				0.000	0.000	0.00	0	0	0	0
	Personal Services	41026	2	7		0.001	0.014	0.00	10	498	0	507
	Others	4870	2	3	38	0.001	0.000	0.00	1	0	0	1

Column	Comments
3	Annual Census of Establishment - 1972, 1975, 1978, 1979, 1980 & 1984
4-9	1979 Commercial Establishments Energy Demand Survey by MOE - Philippines 1987 Biomass Survey Project From survey only 1% used alternate fuel before 1979 values for other years were interpolated using trend.
10	col 3 x col 4 x col 7 x 12/100
11	col 3 x col 5 x col 8 x 12/100
12'	col 3 x col 6 x col 9 x 12/100

Table A 3. (Continued)

Year	Bakeries production (ton flour)	**Unit energy consumption (MJ Wood/ kg flour)**	Unit energy consumption (MJ charcoal/ kg flour)	Firewood consumption subtotal (TOE)	Charcoal consumption subtotal (TOE)	Sugar production (000 tons sugar)	Unit energy consumption (BOE bagasse/ ton sugar)	Energy consumption subtotal (KTOE)	Total energy consumption (KTOE)			
									Wood	Charcoal	Bagasse	Total
1970		30.00	50.00									
1973	400304	26.57	45.92	253	438	2191.7	3.92	1154	3694	0.44	1154	4848
1974	346076	25.51	44.63	210	368	2445.6	3.85	1265	3478	0.37	1265	4744
1975	396541	24.50	43.38	231	410	2393.8	3.37	1084	3800	0.41	1084	4885
1976	464505	23.53	42.17	260	466	2875.2	3.64	1407	2957	0.47	1407	4364
1977	482575	22.59	40.99	260	471	2670.9	3.49	1253	2695	0.47	1253	3949
1978	442805	21.70	39.84	229	420	2335.0	3.53	1108	2484	0.42	1108	3592
1979	582163	20.83	38.72	289	537	2286.7	3.47	1066	2219	0.54	1066	3286
1980	570158	20.00	37.64	272	511	2432.6	3.41	1115	2068	0.51	1115	3183
1981	599707	18.76	36.58	268	522	2724.5	3.35	1227	1556	0.52	1227	2784
1982	630787	17.60	35.56	264	534	2773.3	3.29	1228	1199	0.53	1228	2427
1983	663477	16.52	34.56	261	546	2432.7	3.24	1058	1078	0.55	1058	2137
1984	697862	15.50	33.60	257	558	973.1	3.18	416	871	0.56	416	1288
1985	734029	14.54	32.66	254	571	486.5	3.13	204	733	0.57	204	938
1986	772070	13.64	31.74	251	583	243.3	3.07	100	687	0.58	100	788
1987	812083	12.80	30.85	247	597	162.9	3.02	66	723	0.60	66	790
1988	854170	12.00	30.00	244	610	142.6	2.97	57	613	0.61	57	671
1989												

Table A4. Conversion Factors

Fuel	Physical Unit	Energy Equivalent
Wood	MT	1.626 BOE
Charcoal	MT	4.823 BOE
Coconut shells	MT	2.242 BOE
Coconut husks	MT	2.242 BOE
Coconut stalks	MT	2.242 BOE
Bagasse*	MT	1.701 BOE
Rice husks	MT	1.626 BOE
Biogas	1,000 CU.M.	1.212 BOE
Sawdus	MT	1.626 BOE
		1 BOE = 0.1344 TOE

* assumed 50% moisture
** assumed 10% moisture

ENERGY BALANCE TABLE FOR BRUNEI-DARUSSALAM

(Table not available)

ENERGY BALANCE TABLE FOR INDONESIA

(Table not available)

ENERGY BALANCE TABLE FOR MALAYSIA

(Table not available)

ENERGY BALANCE TABLE FOR PHILIPPINES

(Table not available)

ENERGY BALANCE TABLE FOR SINGAPORE

(Table not available)

ENERGY BALANCE TABLE FOR THAILAND

(Table not available)

Expanding the use of Financial, Economic and Environment Criteria in the Formulation of Developmental Plans for Wood Energy

by

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1. INTRODUCTION

1.1 Overview of Analytical Problem

Utilization of efficient, modern wood energy systems for meeting household and commercial/industrial demand offers the Asian region a potentially enormous net savings in terms of capital, natural and human resources. Yet one major impediment to the development and more efficient use of modern wood energy systems is the accounting or financial framework. The present system used by the financial sector (i.e. the multilateral, bilateral and national development agencies) fails to adjust for the long-term environmental net benefits of sustainable energy use.

Financial/Economic Criteria. In brief, the financial/economic criteria used for assessing energy projects by the financial sector generally accounts for only financial prices and utilizes discount rates that have inherent biases favoring fossil fuels over wood energy or other biomass fuels. In many cases, the environmental damages of conventional energy systems in the upstream (resource procurement and handling) and downstream (energy production, transport and waste disposal) sides are ignored by the financial sectors' conventional evaluation system. In contrast, extended cost-benefit analysis, that includes the full social and environmental costs of prospective energy options, could lead towards alternative views on the viability of biomass energy systems, as well as more positive investment decisions by financing institutions.

Focus of Paper. This paper explores several key, inherent problems in the conventional financial and economic criteria used by the financial sector and demonstrates that many of the social benefits from wood energy systems are either ignored, or marginalized. The key elements that are discussed include:

(a) The current versus preferable accounting or criteria methods for determining economic worth of wood and other energy systems by the financial sector; and

(b) The failure to conduct comprehensive upstream and downstream analyses of alternative energy systems.

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Following These Issues. The paper briefly discusses the related issue of the lack of reasonable institutional/policy frameworks and financial instruments for fostering the market penetration of innovative, modern wood energy technologies. Prior to discussing these themes, however, a brief overview highlights the significant contribution of the biomass sub-sector in Asian countries.

1.2 Biomass Sub-Sector

Wood and Other Biomass Energy Contribution. Despite the stated importance, the fact is that wood energy use around the world has received scant attention from most energy financing and planning agencies. Wood fuels, along with other biomass, represent roughly 20-25% of the total energy use in most Asian countries. In particular, wood is by far the most important single source of rural fuel for cooking, heating and small-scale industrial processing (Koopmans, 1990). Over the past decade, billions have been spent on switching developing countries to imported fuels while in the developed countries, large-scale industrial wood energy systems have become the technology of choice by virtually all the wood and agricultural processing industries. However, the developed world has seen very little attention paid to introducing improved and more efficient modern wood and biomass energy systems.

The question that must be asked is why investment in the sub-sector as a whole has been overlooked, despite the contribution of wood and biomass to total energy consumption. In part, the answer to this question is that it is the perceived financial viability of wood and biomass-based energy systems, or lack thereof, that discourage development in the sub-sector. Again, financing of energy services has been the domain of multilateral donors, government central banks and national ministries that use accounting procedures which favor energy systems with low capital costs and which ignore any environmental externalities in the upstream and downstream production sides of energy use. In addition, the financial institutions have historically lent to national utilities, which were considered natural monopolies, where central grid-based systems powered by "commercial fuels", oil, gas, coal, nuclear, hydro, received the majority of the funding.

The contention here is that the model of economic evaluation and the practice of lending to conventional energy systems has never been capable of integrating, fostering, nor financing the use of dispersed, local energy systems as typified by wood and biomass energy systems. Now, however, recognition of significant environmental externalities, increasingly limited access to domestic and foreign capital by the national utilities, and poor reliability of central grid-based power systems has catalyzed some innovative donors to explore new avenues for evaluating and financing wood and biomass energy systems. The key analytical problems related to the financial/economic assessments of such systems, as well as recommendations for new approaches, are highlighted in the following section.

2. CONVENTIONAL ASSESSMENT APPROACHES

2.1 Financial/Economic Analysis

Conventional Perceptions. Two pillars of energy economics that shaped the reliance on fossil fuels around the globe over the past fifty years have been:

(a) The belief that energy production was a decreasing cost industry; and

(b) The failure to fully include the environmental and inter-generational costs and benefits from the upstream energy production process, to disposal.

In the past decade, these pillars have been, in the first case, invalidated and, in the latter case, clearly demonstrated by the economic community (Schramm, 1990; Munasinghe, 1989; Kahn, 1988, among others) with the realization that society was not being best served and natural resources were being needlessly wasted.

In the first instance, energy generation and distribution was previously believed to be a decreasing cost industry whereby the most cost-effective means of serving peoples' energy needs was through the creation of natural monopolies, such as utilities. This model meant supporting almost exclusively large-scale energy systems -- major oil, coal, nuclear, and hydro facilities -- without regard to the extreme environmental problems often associated with the upstream and downstream parts of the fuel-cycles.

Secondly, in the past decade technological breakthroughs for renewables and a far greater recognition of the need for the internalization of the high environmental costs associated with many large-scale energy systems have changed how many economists and energy planners view the efficiency and economics of the provision of energy services (Kahn, 1988; PACE 1991). In fact, when using a more appropriate environmentally-based,life-cycle cost analysis, whereby the full capital, operational, and environmental costs over the functioning life of the energy system are counted, many renewables have proven to be better options than diesel or grid systems (Jezek and Weingarten, 1989; Gowen, 1989; Waddle and Perlack, 1991).

2.2 Conventional Financial Framework and Evaluation Techniques

In general, financing oil, gas, nuclear and large hydro facilities has been favored over nontraditional energy systems because:

(a) A systematized, analytical approach is used with conventional fuels -- a composite upstream and downstream component analysis; and

(b) The set of financial criteria utilized for judging the economic viability generally fails to "level the playing field" between conventional and nonconventional fuels.

Lack of Integrated Approach. In general, the oil and gas industry employs a standard set of procedures, incorporating the critical upstream and downstream components (i.e. supply, production, market) thereby assessing all links in the development chain to determine the profitability of any project. In contrast, wood energy systems, like other renewable fuels, rarely undergo such indepth, thorough fuel-cycle analyses. Part of the reason is the lack of data, including uncertainty in supply and market variables. This, in turn, results in the failure to apply such thorough, methodological assessment methods to wood energy systems.

Financial Criteria. The financial biases in evaluating biomass energy systems are:

(a) Incomplete analyses of all social costs and benefits from energy use; and

(b) Employing discount rates that favor particular energy production systems. That is, most "economic" analyses of wood and conventional energy systems confuse counting the market or financial prices for all components in the fuel-cycle process with what are the real or social economic values for all energy services. In contrast, a real "economic evaluation" or social cost assessment removes any subsidies and incorporates social (shadow) values for all labor, capital and environmental goods and services. Furthermore, it utilizes such prices in a cost-benefit or life-cycle analysis mode and conducts sensitivity analyses on the discount rates.

Most institutions, however, still account only for the financial costs of energy production in their "economic" evaluations of proposed energy loans. Notably missing in such evaluations are adjustments for:

(a) Subsidies: Prices of most fossil fuels, hydro and nuclear energy systems contain many hidden or mandated subsidies that distort the market signals regarding the use of conventional fuels over alternatives such as wood. For example, Weingart and Jezek (1989) found that a fifty percent subsidy for diesel fuels in rural Kalimantan was sufficient to make diesel generators appear more economical for wood processing industries than the utilization of their own on-site wood wastes. If these subsidies were removed (which has consequently occurred in Indonesia), wood energy provided a much higher internal rate of return than diesel systems; and

(b) Environmental Externalities: The local and global environmental costs and benefits associated with fuel procurement, energy production and waste disposal are rarely measured and internalized into an evaluation of alternative energy options in a country. From the local perspective, fossil fuel production and consumption results in a significant direct and indirect environmental and social impact. The global environmental impacts of fossil fuel consumption have only recently drawn attention resulting in the Climate Change Convention of Rio signed by 158 countries.

Economic Costs of Energy Production. Adjustments for the full, life-cycle social or, what is referred to by economists as, economic costs of energy production and use has only recently been promoted by international donor institutions, and is virtually unheard of in the financial community. To create a "level playing field" for financing, the existing subsidies and other price distortions, which now dominate the commercial energy sectors throughout the world, must be removed to create incentives for indigenous, wood energy use. To change these distorted pricing structures, new accounting methods for evaluating energy systems need to be employed by the governments, multilateral development banks (MDBs) and national banks.

Discount Rate. In addition, the use of the appropriate discount rate is particularly important to renewable energy systems due to their cost structures (heavy initial capital costs but lower operating costs) and the long-run use (scarcity costs) associated with environmental damages resulting from many fossil and conventional energy systems, notably nuclear. High discount rates will favor and tend to produce better economic indicators such as the Internal Rate of Return (IRR) and Net Present Values (NPVs) for low capital intensive projects, such as fossil fuels. In contrast, wood energy systems, with high initial capital costs but lower feedstock and other operating costs, will be hurt by using high social discount rates.

In addition, the environmental damages from pollution and disposal for many conventional energy systems will be realized over long periods, so a high discount rate will minimize such impacts because values in the future are heavily reduced. In contrast, assuming the wood energy system is sustainably based (e.g. plantation with sustainable yield forestry management), the benefits to society from such a system will not receive any real "values" in an accounting system that places no long term benefit on providing positive intergenerational transfers.

Unfortunately, few financial institutions even attempt to employ such extended benefit-cost analysis and discounting techniques when conducting their economic assessments. Rarely are the primary and secondary net environmental costs and benefits of an energy system internalized into a financier's books. If they come in at all, it is only after legislation forces them into the equation through pollution abatement and damage control costs.

A full environmental net benefit analysis for wood and alternative energy systems would, therefore, include at least some of the following costs or benefits:

Environmental Costs

- Local environmental impacts
- Global environmental impacts

Resource Depletion

- Long-run resource depletion costs or scarcity rents
- Habitat and biodiversity losses

Air/Water/Land Pollution

- Particulate, sulfur, nitrous oxides, carbon dioxide emissions
- Land reclamation and disturbance
- Water scarcity values (loss water tables), improvements
- Waste disposal costs
- Scenic and recreational amenity losses

Human Factors

- Health costs
- Resettlement
- Livelihood losses

Environmental Benefits

- Aesthetic improvements
- Pollution mitigation, etc.

Resource Management Benefits

- Sustainable resource use
- Environmental enhancement
- Creation of spin-off environmental benefits (eco-tourism,biodiversity preservation, habitat management)

Air/Water/Land Pollution Abatement Improvements

- Air quality improvements (vis a vis alternative fuels)
- Land enhancements
- Water quality improvements
- Waste disposal costs not incurred through by-product utilization as an energy feedstock
- Scenic and recreational amenity improvements (sustainable forest management versus mining or other non-sustainable land management practices

Human Factors

- Health cost savings
- Multiple land use
- Job creation

The assertion here is that if the correct type of economic evaluations were the norm, this would encourage the production of biomass fuels on a sustainable basis and the adoption of cleaner, more efficient wood stoves, the incorporation of wood waste-to-energy plants at wood processing facilities and the creation of new financing structures to support the whole process. It would also mean that for areas where wood cannot be sustainably harvested, they would witness much higher feedstock costs to reflect stumpage values that have incorporated the long-run user costs from resource depletion.

Failure to use life-cycle costing has historically biased energy planners towards conventional energy systems such as fossil fuels with low up-front costs, while ignoring their higher environmental, operational and long-term fuel costs. By comparing all conventional and non-conventional energy options based on life-cycle costs, the services for the local user must be affordable initially and over the full life of the service.

2.3 Institutional/Policy Framework Promoting Energy Services

In addition to the incomplete evaluation techniques, many of the problems associated with the adoption of modern wood energy systems also stem from a fractured institutional/policy framework regarding the utilization and financing of renewable energy systems. For example, in terms of policy structures, in most developing countries, energy means electrification, which is the responsibility of state-owned centralized utilities. By mandate, prices charged to electricity consumers are often insufficient to meet even generation costs. Cost for transmission, distribution and connections are heavily subsidized under the guise of social development. Regulations also often prohibit private sector involvement and work against the introduction of decentralized energy options.

Subsidies. Only recently have countries in Asia, notably Pakistan, the Philippines, Indonesia, India and Thailand either changed their laws to allow private power sales or opened up the generation market in some other manner. However, many of these countries continue to maintain subsidies on conventional fuels. If subsidies still exist that favor conventional fuels, it is likely that these distorted pricing policies will continue to inhibit wood energy expansion in the industrial/commercial markets.

On an institutional basis, domestic wood energy use receives little substantive attention, with national programs usually relegated to small programs that lack sufficient funding and organizational support at the higher levels of government. That is, while non-electric based energy services (for cooking, heating and processing) still represent the major demand in rural areas, little attention and subsequently financing have been directed at improving and increasing the supply of these services. What is more common are sporadic programs of support generally from marginalized ministry or non-governmental (NGO) institutions, without access to long-term and concessional financing. Such programs are usually run and financed by regional arms of energy ministries in a top-down manner that has not been effective due to the lack of local support and national commitment to the operational needs of such systems.

2.4 Additional Barriers to Developing Wood and Biomass Energy

Despite the general lack of sustained investment, research experience of the past two decades has helped develop and identify those wood energy systems that are technically proven and commercially viable. Reductions in costs due to technical innovations, improved efficiencies and large-scale production have been demonstrated in newer, modern wood energy systems.   Improved stoves and the steam injected gas turbines that can operate on wood fuels are two examples of innovations over the past decade.

However, many household and industrial wood energy systems are characterized by a set of attributes that tends to make them less amenable to integration into a institutional framework that employs a top-down energy financing model. Some of these key characteristics include:

Wood Stoves

(a) Improved wood stoves often are more expensive than traditional models, and these initial higher costs pose a barrier to middle and low income households. In fact, most rural households have limited financial capabilities and access to capital to be able to invest in higher up-front system costs. Even if capital is available to these households, the fact that wood fuels are usually gathered as a "free good" provides a negative incentive for any capital outlays;

(b) In the case of urban dwellers, where wood fuel has a financial cost, difficult payment requirements that make the user pay the full capital costs at the time of purchase are a major constraint. However, if the repayment schedule allowed payment over a longer period these improved stoves would have a chance of being adopted more widely;

(c) Lack of local participation -- particularly by women -- in both the upstream and downstream design of wood stove systems, as well as in the management of household finances. Although widely recognized by most wood stove experts, this failure to make the design, manufacturing, and financing locally/user determined has led to a waste of resources and lack of adoption in many programs.

Industrial Wood Energy Systems

(a) Wood energy systems typically produce and meet lower energy demands in rural areas -- either at the household level, in wood processing or small products industries (10 to 50 kW) all the way through to small industries (1 to 10 MW);

(b) A lack of cost-effective modern wood energy system options in this demand range, i.e. modern technology producers have not focused on commercializing end of the line, small-scale systems. The lack of appropriate sizing, technical and infrastructure support to replicate and sustain such systems on a wide scale that matches installed capacity to average needs and local resource supply has limited the proliferation of these systems;

(c) Despite lower operating costs than most fossil fuel systems, the high initial capital costs associated with new industrial-level wood energy technologies creates a barrier for most potential buyers. Most rural households and wood processing industries have limited financial capabilities and access to capital to be able to invest in high up-front system costs;

(d) The lack of information on the wood energy systems that work and those that do not in a given area is also a major barrier. An information and implementation gap exists in rural wood energy users regarding the reliability and long-term costs of modern wood energy systems over more traditional inefficient rural energy systems;

(e) Poor marketing and financing infrastructures in many countries are barriers in providing access to capital and, in turn, the appropriate products;

(f) Difficult payment requirements for small-scale wood energy systems that make the user pay the full plant and transmission/distribution costs at the time of purchase, which is not how most grid connected buyers are required to payback their energy use;

(g) Financing mechanisms do not have programs to reach the existing and potential wood energy users; such institutions and lending instruments do not lend themselves to readily dealing with the dispersed nature and the equity/cash flow structure of these rural clients (wood energy users); and

(h) A biased regulatory and policy environment for the provision of energy services that prohibits the use of wood or other renewables except for on-site uses.

Detailed solutions to each of these barriers is outside the scope of this paper. However, it is useful to discuss several key points that have distorted the economics and, hence, the financing of renewable resources.

Market Constraints. One of the major constraints to affordability that inhibits the adoption of the more efficient wood energy technologies is the approach with which they are being marketed to users. For example, improved wood stoves often command higher prices than more inefficient traditional wood stoves. Also, many users do not pay for their woodfuels, so the savings to the country in terms of deforestation that results from use of more efficient stoves is never realized by the consumer. Thus, their choice of technologies will often be based on capital not operational, environmental or other social costs.

For industrial/commercial and residential electricity users, conventional grid-based electricity is sold on a "pay as you take" basis. That is, consumers are not required to buy the power plant and 30 years of electricity when they are connected to the grid. Instead, end-users are required to pay, on a periodic basis, for the energy service (electricity) that they actually receive. If the tariff is properly structured, the end-user pays an energy charge (the fuel and O&M costs) and a demand charge (the amortized capital costs) for the electricity. The enormous benefit of this approach is that the end-user is not burdened with financing, owning, operating and maintaining the power plant just because he or she wants some basic energy services. In addition, a centralized entity is capable of obtaining more attractive financing terms for the capital required to construct the energy system.

Alternately, the primary implementation approach for small-scale wood energy systems has been to require the end-user to purchase the complete energy system up-front. Wood energy systems tend to have significantly lower operating fuel costs over diesel or other fossil fuel systems, but their initial capital costs tend to be much higher than conventional systems. The resulting per unit energy costs of wood-based renewable energy systems, when the capital costs are amortized, is, in many cases, lower than conventional energy systems (Jezek and Weingart 1989; Waddle and Perlack, 1991; Mendis, 1991).

By requiring wood energy systems to be purchased up front, the end-user is made to not only pay for 10 to 30 years of electricity all at once, but the consumer also becomes a power plant financier, owner, operator and maintainer. These conditions are not imposed with conventional energy systems. Furthermore, if the renewable energy system fails, the responsibility and financial risk is borne completely by the consumer. Again, this is not the case with conventional electricity systems.

In addition, new organizational frameworks for accepting financing and providing wood energy services at the household and industrial levels will need to emerge and be supported by the financing community. This will include producer cooperatives, micro-utilities, energy service corporations or cooperatives, private energy service companies, non-government energy service organizations, and private sector power generators. Innovative programs for spurring new rural energy service financing, such as the World Bank's Project for Financing Energy Services to Small-Scale End-Users" (FINESSE), and the GEF will be catalysts to such change.

3. RECOMMENDATIONS

While no one financial or institutional model can be transplanted from site to site nor country to country given the diversity of Asian institutional and financial realities, key elements to foster success for expansion of wood energy utilization will require significant mind set changes in how the energy source is analyzed and addressed.

At a minimum, a composite upstream and downstream assessment of wood energy systems must be undertaken by all parties interested in fostering higher adoption of modern wood energy systems. This will require changes on the financing, as well as wood energy production side. From the wood energy management/production/processing sector, those that produce the fuel and manufacture residential and industrial wood energy technologies need to squarely address and overcome their limitations. As noted, these barriers include:

(a) Utilizing a Composite Upstream and Downstream Perspective: The gas and oil industry conduct composite upstream and downstream assessments for any new project to identify and propose solutions to any potential barriers to project success. The wood industry will need to adopt such an integrated approach if it wants to compete on any significant level with conventional energy sources;

(b) Technology Development: Developing a broader range of technological options that more adequately match the scale of local demand to resource supply capabilities. Again by using a composite approach, the technology manufacturers will find that successful wood energy use in most developing countries will mean downsizing equipment to meet the local energy needs and match the realistic, sustainable resource supply;

(c) Resource Supply Management: Too often planners and industry promoters fail to account for the realistic, sustainable amount of wood resources that exists in an area. An honest assessment of the upstream capabilities for wood energy must ensure that a sustainable supply of wood resources exists from which wood energy users can draw upon over the long-term;

(d) Manufacturer-User Payment Option: Providing wood energy users -- households and small-scale industrial facilities -- with flexible payment options. These may include extending credit, creating levelized payment over the equipment life, or leasing wood energy systems; and

(e) Diversifying Financing Options: Working with the financial and donor community to develop new financing instruments services that meet the wood energy users' and industry's needs.

On the other side of the relationship, the financial community, which includes the government, national banking system and multilateral or bilateral development agencies, must also introduce new elements into their energy financing paradigm to foster the success of wood energy and other renewable energy systems. These include:

(a) Proper Economic Assessment Techniques and Criteria: Changing the economic accounting methods currently employed by the financial and donor sector to incorporate the full economic -- social and environmental -- costs for determining "financial" viability of an energy system, be it wood or fossil fuel;

(b) Representative Discounting Methods: Representative and innovative discounting methods that more accurately reflect the future environmental, social and inter-generational benefits and costs of both conventional and renewable energy options;

(c) Understanding and Implementing "User-Friendly" Financial Instruments: Involving local users in the design of and responsibility for flexible financing instruments, mechanisms and servicing structures. This means providing affordable repayment options to households or business users;

(d) Training Technical Staff: Most financing agencies from the MDBs to the local banks do not have staff that are technically competent to make complete assessments of wood energy systems, let alone conduct composite evaluations; and

(e) "Leveling the Playing Field" among Fuel Options: Removing price subsidies to conventional energy sources and developing innovative financing options that do not favor conventional fuels over indigenous, renewable fuels such as wood. This often will involve changing the regulatory and policy framework for the energy mix in a country.

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Data assessment and analysis for wood energy planning: Policy and institutional issues

by

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1. INTRODUCTION

The major policies in Forestry sector in many countries are related to conservation of forests whereas the Energy Ministry or the other ministries (Rural development, Urban development, Village and small industries etc.) do not pay adequate attention to wood as a significant energy source in the formulation of their plans and policies and (GOI, 1992). One hurdle in undertaking development of a comprehensive wood energy plan would be lack of adequate data and information. The large gap between the supply estimates provided by the Ministry of environment and forests and the consumption estimates from surveys TERI, 1992a illustrates the status of data in India. In the case of India a single nodal agency under the Ministry of Energy has been recommended to develop a comprehensive system of energy statistics and to coordinate the data compilation and dissemination.(CSO,1990)

"The fact that wood fuel remains the main energy source, as well as major use of wood, in terms of its share to total energy and wood consumption, as well as numbers of people involved... is sufficient reason to justify the development of an adequate information base that allows for rational decision making.." (Veer and Enevoldsen, 1993). The authors further identify that the challenge in wood energy development is how to capture and generalize diversity without ignoring it. The diversity lies not only in the vary nature of the resource but also due to the different ways in which it is managed, and its multiple uses. However, in most countries only the macro picture is captured and the diversity is recognized but is understood well.

The biomass fuels account for about 20-90% of energy consumption in different countries of the region. A significant patien of wood fuel is also derived from lands other than those oned by the Forest Departments. The main users of biofuels, today are rural households, poor urban. households, small commercial establishments and industries. These users will continue to depend on biofuels because of low purchasing power and lack of availability of other more preferred fuel systems. A shift towards convenient forms of commercial fuels is evident in many urban areas. If biomass fuels are to play a role in the future energy development, then fuel processing and conversion technologies would have to be developed so that the new wood energy systems can compete with other options in meeting the demand for clean and convenient energy services. The development of wood (biomass) energy has to incorporate the protecting need to play an important role in improving the environment, the need to meet the energy requirements of the poorer section of the society and the need to develop processes and technologies to strengthen its role in managing the demand for convenient form of energy services.

The wood fuel flows are complex and are not well understood in term of supply, in term of the role they play in economic activities. This often has led to in appropriate programmes development and implementation in the part. It can be said that the intervention made so far in many instances have been

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inadequate in scale to achieve an impact on the national energy or environment scene. The experiences with the techniques and technology development indicate that a were focussed approach may had to better results. Instead of large scale national programmes, it will be more appropriate to develop intervention packages suitable to different problem areas. In case of wood-energy system, an understanding of the local level trade-offs and participation of local people is critical in developing and implementing such packages. Thus, the wood energy systems should be developed as decentralized options. Their potential or impact should be assessed in the framework of fuelcycle analysis including the impacts on environment and economy. New and were convenient from of fuel system based on biomass have to be developed.

However, given the decentralized nature of biomass resources and the varied methods of their management and use, it is proposed here that the data be analyzed at the level at which planning is most appropriate. The resource data in the areas owned by the Department of forests in most countries is well organized to the extent that a Master Plan is prepared or is being prepared[2]. The data related to availability of wood from other lands is of crucial importance to the wood energy development[3].

In the following sections, an approach to data assessment and analysis is proposed to facilitate planning at levels closer to the area of implementation. This can strengthen the identification of problem areas and can provide inputs to agregation at higher levels. The biomass systems can be categorized based on how the wood fuel is acquired.

2. RURAL WOOD ENERGY SYSTEMS

The rural wood energy systems in most Asian countries are essentially local. The wood is collected from areas near the villages. The areas could be private lands, common lands or forest lands where the villagers may have some rights. There is no sale involved in acquiring the fuel either for self use or for external markets. However, there may be situations where extensive sharing takes place. There could be variations in such systems. In these, the resource could be far away from the village but the essential character would be that the wood is available at zero private cost. In many areas like in India the wood may often be used with other biomass like crop residues and dung cakes. The wood energy systems then become biomass energy systems (TERI, 1992b). The objective in examining these systems can be to develop sustainable biomass systems for rural areas considering the energy and non-energy demand and also the impacts on environment. The main tasks in characterizing such rural wood/biomass energy systems will be to collect data and information on following aspects: (i) identification of system boundaries, (ii) assessment of resource, (iii) estimation of consumption levels and mix, (iv) characterizing the stress on the resources, (v) understanding the present management structure and (vi) features of the end use.

(i) **Identification of system boundaries**: This would first involve deciding on the unit at which biomass energy systems would have to be planned. In case of rural energy system, it is necessary to include crop residues, dung cakes and other fuels used for cooking and heating even if one is only considering interventions in the wood energy

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2 But the availability (or the lack of it) of wood fuel from these lands is yet not understood adequately by the energy planners.

3 Assessments in regards to the impacts of interventions can provide this information.

systems. The unit could be of one village or a number of villages under Van Panchayat or villages that share rights in a demarcated area like the forest panchayats in India. The criteria would be to choose a unit which comes under one local body.

(ii) **Assessment of resources**: In case of wood energy resources the basic data items would be -i) land area, ii)ownership and iii) sustainable production. From an energy perspective, all categories of land (owned by Forest department, revenue department, common lands, and private land etc.) where trees are grown form a resource base. The information on area is normally available in some land records office but would have to be collated to represent different resource and energy management systems.Having identified the system boundaries, the resource can be estimated using different methods that are available. The main constraint still seems to be the limitations of existing methods and information to assess biomass energy resources. Ryan and Openshaw(1991) have discussed different methodologies and their appropriateness. They have also highlighted the dearth of reliable data on standing stock and sustainable yield.

At present in most countries, the Department of forests are responsible for compilation of information related to biomass on forest land and its use. This is generally done for the areas covered by the working plans. The skills to assess these resources are also largely with the Foresters. In some countries, professionals with forest management background have begun to undertake these tasks. But it is important to include shrubs and other category of biomass which are used as fuels. In addition to the assessment of the wood resources it is necessary to assess the availability of crop residues and dung. A combination of survey and measurement method is found to be useful.

(iii) **Estimation of consumption levels and mix**. In rural biomass energy systems, it is important to examine the competing energy and non energy uses. For each of the resources, the survey can be carried out in a sample number of households to develop norms for characterizing these uses. For example the wood can be used for timber or fuel, the dung can be used as fuel manure or coating, crop residues can be used as fodder, fuel etc. This would help us to identify the role of wood in the biomass energy system as well as the stress it exerts on the resource base.

(iv) **Characterizing the stress on resource**. A matching of sustainable production of the resource with the consumption will give an idea of the stress caused by wood energy as well as by other non energy uses. However, to identify the contribution to different type of resources (private, common forest) one would have to make a more extensive survey. This would help in identifying the major interventions and in assessing their possible impact.

(v) **Understanding the present management structure**. The information here is mainly related to how the local bodies function and how they interact with the block or the district authorities. The understanding of right and sharing arrangements can help in realizing the trade offs and opportunities for local participation.

(vi) **Features of the end use**. In most countries, the fuelwood in rural areas is used for cooking and space heating. The fuel consumption practices affected by the availability of the fuels as these are available at zero private cost.

(vii) **Development of biomass management plan**. This would require the technical skills of biomass specialists, energy analysis and management personnelsThis essentially would involve interactions with the local bodies and the district/block officials to facilitate the adoption of the plan, the choice of species, implementation plan etc.

In areas with surplus fuelwood the incentive to avoid access consumption is not there. In such situations, it may be hard to promote either better fuels which cost more. So strategies can be to combine promotion of awareness with additional incentives for using the resource more efficiently. The opportunities to generate additional income can play very important role. A study to implement some of these ideas is in programme (TERI 1992b).

Initially, at the national level areas can be demarcated to represent different biomass situations based on some secondary indicators such as availability of forest land per capita, common land per capita, agricultural land per capita, bovine population per capita. A sample can be chosen to conduct such studies from different agroclimatic areas. The exercise can be coordinated by the rural development department. At the level of district, a number of agencies need to participate. These are - department of forest, agriculture, livestock, and revenue for land records. The department of statistics and economics has repository of substantial data and information. With recent progress in computerization it is possible to install data management systems and decision support software to assist in providing data for higher level aggregation and analysis for local decision making. The collection of data, preparation of plans and their subsequent implementation would have to be with the active participation of villagers.

3. SEMI-URBAN FUELWOOD SYSTEMS.

These systems represent transition from use of gathered fuelwood to market based fuelwood for cooking. These markets also are due to constrained availability of higher quality fuels. Thus these systems also represent transition to modern fuels. The fuelwood extraction is done by workers in informal sector mostly women as headloaders from nearby forest resources. The extraction in most cases is not legally allowed or has very informal arrangements. Poor households in such areas would also use fuelwood gathered from nearby sources.The commercial establishments begin to play an important role in these areas. Some of the rural industries based on fuelwood can also be found in these areas. These systems reflect strong linkages between energy, economy and environment and provide opportunities for interventions. The observations made by Barner and Oian (1992) and the results of recent studies in Pakistan and Philippines presented at this meeting can provide very valuable insights in developing appropriate interventions. The objective of such studies could be to prepare detailed project feasibility studies keeping in mind entrepreneur based technology interventions to provide clean and convenient energy for different enduses.

Unlike other studies where biomass resources are either estimated as available or are estimated based on area, these studies would go into a detailed assessment of resource availability. A detailed understanding of different type of commercial units as well as households would be required. Thus, the wood energy systems in such areas would involve a study of extraction methods and assessment of the use of fuelwood through markets and otherwise. Thus a survey of markets would be quite essential.

In earlier interventions to manage stress on forest resources in such areas a concentrated effort at protecting the resource was made without paying adequate attention to linkages with the subsistence economy. i.e. the head loaders. The new project feasibility studies would consider management of these resource with the help of head loaders to provide additional biomass for running a clean energy system. Therefore, the institutional linkages would be with the forest department and the local authorities. The type of technology interventions may also require more detailed characterization of buildings. In addition, the end use devices like solar water heaters and solar cookers can be promoted. The energy development agencies at the state level can coordinate such projects.

4. URBAN FUELWOOD SYSTEMS

These are commercial fuelwood systems where wood is extracted by the contractors from forestry resource. This is then, sold to a large number of bulk and small consumers. Here again, there would be an informal sector i.e. the urban poor who would depend on the biomass available in the cities itself in the form of parks, road side trees, trees in the areas adjoining the cities etc. The commercial fuelwood systems may meet the bulk of the demand in the informal sector of the economy and would have important implications on development wood energy systems. These systems may be contributing to resource degradation in the vicinity of cities as well as in remote forest resources from where wood is extracted. The enduse oriented technology interventions as well as developing decentralized sustainable energy systems are possible and should be promoted.

Urban authorities can plan for supplying cooking energy at a price to these users. The potential for increasing enduse efficiency are maximum in these wood energy systems. The enduses would be more complex such as road construction, brick kilns etc. The urban development authority can co-ordinate collection of data and information.

5. CONCLUSIONS:

1. The wood energy systems should be examined at different levels with the purpose of developing intervention plans with appropriate energy, environment and development objectives.

2. The information collected in such exercises can be used to develop norms to estimate supply and consumption of woodfuel at different levels of aggregations. This will enable the national planners to examine wood energy in the same manner as other energy resources. This may also lead to adequate budgetary allocations.

3. While there are institutional setup and capabilities at the national and provincial level, there seems to a gap at the district level.

6. RECOMMENDATIONS:

1. At the policy level, a wood energy commission should be entrusted with the responsibility of improving upon the statistics on wood energy supply in coordination with the planning ministry which is responsible for collection of data. This commission can develop plans in co-ordination with orther ministries (forest, agriculture, land related, rural and urban development etc.)

2. At the regional level, collection and analysis of data can be the responsibility of the planning department in co-ordination with the department of forests, rural and urban development, public works, small scale industries, revenue, and agency for new and renewable sources of energy.

3. The development of various norms based on the analysis of wood energy systems should be the responsibility of the local planning department at the district level in co-ordination with the implementing agency and other departments.

4. Strengthening of capabilities and development of local institutional linkages should be the focus in the immediate future.

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