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Fuelwood Revisited:

What Has Changed in the Last Decade?

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Acronyms and abbreviations

CPR	Common Pool Resources
DfID	Department for International Development, London
ESD	Energy for Sustainable Development Ltd, Corsham, UK
ESMAP	Energy Sector Management Assistance Programme (Joint initiative of UNDP and the World Bank)
FAO	UN Food and Agriculture Organization
GOI	Government of India
ICRAF	International Centre for Research in Agroforestry (World Agroforestry Centre), Nairobi, Kenya
IEA	International Energy Agency
ILO	International Labour Organization
JFM	Joint Forest Management, India
NAS	National Academy of Sciences, Washington
NSSO	National Sample Survey Organisation, India
NTFPs	Non-Timber Forest Products
NWFPs	Non-Wood Forest Products
ODI	Overseas Development Institute, London
OFI	Oxford Forestry Institute
RPTES	Regional Program for the Traditional Energy Sector, Africa, World Bank
RWEDP	FAO/Netherlands Regional Wood Energy Development Programme in Asia
SEI	Stockholm Environment Institute, Sweden
SIDA	Swedish International Development Cooperation Agency
TERI	Tata Energy Research Institute, India
TFAP	Tropical Forestry Action Plan
UNDP	United Nations Development Programme
UWET	Unified Wood Energy Technology
WCFS	World Commission on Forests and Sustainable Development
WHO	UN World Health Organization

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We want to acknowledge all those who participated in the meeting at Göteborg University, in June 2001, to review progress with the study. We would also like to thank the Swedish International Development Cooperation Agency (Sida) for their funding contribution for this project and for sponsoring the Gothenburg workshop. And finally, we wish to express our appreciation to colleagues in CIFOR and to an external reviewer, for valuable comments on the first draft of this report.



Millions of poor people around the world depend upon fuelwood for their cooking and heating needs. Here, a group of villagers in Cameroon collectively prepare their food over an open fire. (Photo by Edmond Dounias)

Foreword

This report reviews recent patterns and trends in the supply and use of wood for fuels in developing countries, drawing on new information that has become available over the past decade. It examines whether the results of this exercise indicate a need for changes in our approach to this facet of forestry. Rather than seeking to draw definitive policy conclusions however, the main purpose of this review is to identify aspects of the woodfuels' situation that may require further investigation and discussion.

The review commences by looking at the period from the mid 1970s, when a major increase in interest in woodfuels led to their supply becoming a higher priority objective for forest policy and management. By the mid 1980s however, accumulating information suggested the use of woodfuels was having less of an impact on forests than had earlier been believed. Also, there were growing indications that forestry interventions to stimulate increased fuelwood production from new plantations had only a limited role in meeting the greater part of fuelwood demand. As a result, the high profile woodfuel components in forestry programmes were generally revised downwards from the late 1980s onwards.

In the 1990s, this diminished interest in woodfuels led to a marked reduction in research and analysis, which has limited further discussion about the role and importance of woodfuel use and supply for forestry. This current report was initiated due to concerns that, as a result, insufficient attention was

being paid to certain aspects of the subject. Three main areas of concern were identified:

1. Global wood supply and demand projections in the late 1990s (Nilsson 1996, FAO 1997, Brooks 1997) again indicated there could be a large and growing 'gap' between fuelwood supply and demand, reviving some of the earlier arguments about fuelwood demand and its contribution to deforestation. This review therefore set out to explore whether there have been recent improvements in the data base and models for analysing and projecting trends in demand, and whether these have resulted in more refined estimates about the levels and changes in use and about the share of woodfuel supplies coming from forests.
2. Recent work on rural livelihoods and poverty alleviation indicated a need to revise earlier analyses about the impacts of declining access to fuelwood supplies on subsistence users. Issues were also being raised about the effectiveness and appropriateness of the existing options to cope with shortages. In light of new findings, is a more pro-active role for forestry and agroforestry required in maintaining woodfuel resources, accessible to the rural poor?
3. Earlier assessments that concentrated demand for woodfuels in towns and cities could have major implications for forests, forestry and the livelihoods of

those supplying these markets, raised a number of questions. For example, what changes have occurred in urban woodfuel use patterns and levels and what does recent analysis of the factors influencing such changes indicate about likely future market demand? What impacts have changes in the rural-urban woodfuel supply chain had on producers and traders and the forest and tree resources being drawn upon? And what can we now deduce about woodfuel production and trading as a source of income for the poor?

This study was designed as an initial exploration of these issues and has been pursued through a number of enquiries into selected areas and aspects of the topic. Consequently, it is not intended to provide a comprehensive review of knowledge relating to woodfuels. The issues examined are those of particular importance within the overall woodfuel picture, where new information could be accessed or generated. The emphasis is on linkages between woodfuel use and the role of the forest sector, with special reference to the relationship between forests and poverty reduction. The report is based largely on the evaluation of information from India and Africa, with supplementary data from other developing countries and regions. It does not deal with industrial forms of fuel based on wood or with the industrial production of woodfuels.

The study's investigations confirm a marked decline in the amount of research on woodfuel issues since the late 1980s. For instance, the number of items on fuelwood or woodfuel listed in the Tree-CD database dropped from a peak of 264 in the period 1982-1986, down to 114 in 1997-2001 (Sunderlin pers.comm.). Furthermore, much of the recent work has entailed repetition or reworking of earlier studies. Researchers who have previously studied this issue indicate that this reflects the shift away from the subject following the downward revision of the importance of woodfuels in the late 1980s. There has also been a perception that the subject no longer presents very interesting or challenging problems requiring investigation. Hence, the body of new information available to explore changes over the past decade is quite limited. Much of what was accessed is drawn from studies in the energy sector rather than the forestry sector.

It was discovered that the first of the three main issues outlined above (on data bases and analytical models), was to be the subject of a major exercise within the UN Food and Agriculture Organisation's Forest Policy and Planning Division. As those involved offered to make available both their raw material and the results of their analysis as it developed, this aspect of our review is drawn largely from this FAO work. The FAO/Netherlands Regional Wood Energy Development Programme in Asia (RWEDP) also provided results from its extensive series of studies into the sources of woodfuels in Asian countries.

For the current study, an exercise focusing on the analytical framework was carried out at Göteborg University. This assessment synthesized economic studies of fuelwood and charcoal supply and demand in developing countries (including specially commissioned studies of material from India and Ethiopia).

At the country level, the main emphasis in generating additional information was placed on India because of the large amount of information available there and the presence of a number of institutions actively interested in woodfuel issues. With the assistance of the Tata Energy Research Institute (TERI), a detailed study of woodfuel production and use statistics was carried out for India, drawing upon existing sources of related information. The other geographical focus was Africa because of the high dependence on woodfuels in many parts of this region—with use continuing to grow more rapidly than in other regions (see Tables 2 and 3). The Overseas Development Institute (ODI) conducted a review of recent literature regarding the ways rural users in the region respond to fuelwood shortages and it also undertook follow up field investigations in Niger and Tanzania, to gather additional material.

Reports on each of the component studies, together with reports on work underway at FAO and World Bank, were presented and discussed at a workshop in Gothenburg, Sweden, in June 2001. The resulting papers, revised to incorporate the workshop discussions, are available in a proceedings volume, from Göteborg University².

As a result of this meeting, the coverage of our fuelwood study was expanded to include a number of related, ongoing or recently completed enquiries. In particular, the Joint UNDP/World Bank Energy Sector Management

Assistance Programme (ESMAP) made available results from work underway on a wide ranging analysis of trends in urban energy use, drawing on data from ESMAP studies in 46 cities, across 13 countries in Asia, Africa and Latin America. Other material provided by the World Bank included results from a recent ESMAP survey of rural household energy use and supply in six states in India and reports on evaluations of programmes to develop functioning 'fuelwood markets' in West Africa by ESMAP and the Regional Program for the Traditional Energy Sector.

The following review is therefore based both on our own investigations and the results of related work made available from other organisations. We are grateful to our collaborators in FAO, the World Bank and elsewhere, who so generously assisted us in this way.

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Abstract

The impact of woodfuel collection on forests has been controversial and its role in rural livelihoods and deforestation the subject of considerable debate. This study reviews the main dimensions of this discourse and the resulting responses from the forestry sector. It assesses new information that has come to light over the past decade, looking at national and global trends in woodfuel production and use and the evolution of patterns of urban and rural demand and supply. It examines livelihood and environmental dimensions of relevance to forestry and outlines some of the main issues that warrant additional attention. It is thus intended more as a foundation for further discussion, rather than being a set of prescriptions for action by forestry, though where these are evident they are identified.

The available evidence does not substantiate earlier concerns that woodfuel demand has been outpacing sustainable supply on a scale that makes it a major cause of deforestation. It appears the balance between the two is seldom an issue requiring forestry intervention on a national scale. However, the rapid rise in charcoal production and its concentration, to supply large urban markets, certainly warrants further investigation. Overall, the woodfuels situation is an important consideration for particular areas within a country and for particular groups of users and suppliers. Globally, fuelwood consumption appears to have peaked (although charcoal consumption is continuing to rise) and in some developing countries, it now appears to be in decline. However, the total quantities of woodfuels being used, and the number of people using them, are still huge. In poor households almost everywhere, woodfuels are among the main forest related inputs, although the level of attention they receive does not currently reflect this, despite the growing focus on giving forestry a stronger livelihood orientation. Forestry initiatives need to be compatible with the energy sector's objective of helping poor users move up the energy ladder to greater fuel efficiency and alternative fuels. The main task though, is likely to be facilitating access to supplies for those who continue to depend on biomass fuels, for their own use or as an important source of income. Forestry measures will need to integrate meeting this demand into wider forestry objectives, rather than, as in the past, developing responses focusing on the fuelwood issue alone.

Keywords: Woodfuels, fuelwood, charcoal, energy, rural livelihoods

1. Introduction

In industrialised countries, wood based fuels (fuelwood or firewood and charcoal) have long been replaced by more efficient and convenient sources of fuel. However, in developing regions, less able to afford and access alternative sources of energy, wood has remained a dominant fuel. Huge numbers of subsistence users depend upon it for their domestic energy and a large number of poor people rely on woodfuel trading as a source of income.

The impact of woodfuel collection on forests has been controversial and its role in rural livelihoods and deforestation the subject of considerable debate. This study covers the main dimensions of this discourse and the resulting responses from the forestry sector and

reviews new information that has come to light in the past decade.

The initial explosion of interest in the topic in the mid 1970s was directed towards addressing what were perceived to be the potentially devastating effects on forest resources, of increasing fuelwood demand. Serious, negative socio-economic consequences were also predicted for the rural poor, arising from expected future shortages. A series of early estimates forecast alarming discrepancies between woodfuel demand and supply (a fuelwood 'gap') and assumed the shortfall would be met by over cutting of the forest resource. Woodfuels became a significant development issue and went on to attract strong funding flows.



Collecting firewood in Taman Nasional Kerinci Seblat (TNKS), Jambi, Indonesia. (Photo by Antonius Djogo)

In the late 1980s however, revised estimates led to a marked downgrading in both research and forestry interventions. But has the pendulum swung too far back the other way—resulting in an important livelihood and environmental issue being neglected? This is one of the questions the current report addresses, in contributing to the debate about the best way forward for this aspect of forestry.

This review commences with an examination of early developments, before assessing the findings of recent and ongoing studies. On the basis of this appraisal, some of the main options and issues that appear to require further exploration are outlined. The results of this project are thus intended more as a foundation for further discussion, rather than being a set of prescriptions for action by forestry (though where these are evident they are identified).

Section Two outlines the thinking and approaches that emerged in the 1970s and the revisions that occurred in the latter part of the 1980s. Section Three reviews more recent information bearing on national and global trends in woodfuel production and use and the evolution of patterns of urban and rural demand and supply. Section Four examines livelihood and environmental dimensions of relevance to forestry and Section Five suggests a number of key aspects that appear to warrant additional examination and attention.

2. Historical background

Until roughly the middle of the nineteenth century, wood was used everywhere as the principal source of energy, even in North America and Europe. It has since been steadily replaced by cheaper, more efficient and convenient sources of fuel— first coal and later oil, gas and electricity. Although, it was probably not until the early twentieth century that wood lost its place as the main fuel in the rural areas of most industrialised countries. Its decline has since been rapid and continuous.

Yet, in less developed countries, much less able to afford alternative sources of energy, wood has remained a dominant fuel. Particularly in rural areas, wood is the preferred form of domestic energy, largely because it doesn't require complex, expensive equipment. It can be used in an open fire and can be procured often at no greater cost than the labour of collecting and preparing it. Most of its supply and use occurs outside the monetary economy, carried out largely by subsistence users.

In many countries, public forests were historically managed to accommodate local fuelwood needs and forest department activities often included the creation of village woodlots for populations living distant from the forests. Hence, the production of fuelwood already featured in most public forestry programmes prior to the explosion of interest

surrounding it in the 1970s, contrary to what was argued in some of the early energy literature focussing on woodfuels (e.g. NAS 1980).

2.1 Discovering and confronting the 'Fuelwood Gap'

It was largely the broader preoccupation with energy supplies following the rise in fossil fuel prices in 1973 that triggered the increased focus on woodfuel issues in the mid-1970s. Attention was drawn to the fact that, in the developing world, fuelwood was the principal source of energy that households used to cook food and provide domestic heating. Issues were raised relating to the use of wood on such a massive aggregate scale. In an influential early publication on the subject, entitled 'The Other Energy Crisis: Fuelwood', Eckholm (1975) characterised the situation as follows: "For more than a third of the world's people, the real energy crisis is a daily scramble to find the wood they need to cook dinner". Fuelwood became an important energy issue.

The perception that many people and the rural poor in particular, were encountering increasing difficulty obtaining sufficient supplies of fuelwood, led to arguments that this could have serious, negative socio-economic consequences for their livelihoods. It was postulated that:

- As people need to go further afield to gather supplies, the burden increases on women and children, to whom this task usually falls—constraining even further the amount of time women have for other tasks and activities.
- In the absence of sufficient fuelwood, increasing quantities of crop residues and animal dung get used for fuel, reducing what is available for livestock feed and use as soil conditioner and fertilizer.
- Enforced use of such 'inferior', smokier fuels can be damaging to eyes and lungs.
- With less fuel, the amount of cooked food available may decline, with adverse effects on nutrition and health.
- More scarce income may have to go towards purchasing fuels.

Hence, at a time when the whole development focus was shifting towards giving higher priority to rural development and ensuring the rural poor could meet their 'basic

needs', the adequacy of fuelwood supplies became a significant development issue.

However, the dimension of the fuelwood situation that had the most direct implications for forestry was the perception that it was a major factor leading to forest degradation and destruction. It was argued that, as the poor often had no alternative to woodfuel or other locally available organic materials, "one consequence of growing rural populations is ... an inexorable growth in the pressures on locally available forest resources and other sources of woody material. The source of woodfuel extends progressively from collecting deadwood to the lopping of live trees, the felling of trees, the total destruction of tree cover, the loss of organic matter to the soil and eventually to the uprooting of stumps and removal of shrubs" (FAO 1978).

Massive removal of woody biomass to meet fuelwood demand was believed to be a major factor underlying the environmental damage being experienced at that time in the Sahel, the Himalayas and elsewhere. The need to address the causes of such environmental damage was one of the driving forces behind prominent early initiatives to restructure approaches to forestry and make them more effective in meeting fuelwood demands.

For example, a huge South Korean government initiative in the 1970s, encouraged villagers to meet fuelwood needs by creating collective woodlots on their lands. The perception was that this was necessary in order to stop the destructive use of hill forests, which were important in protecting downstream agricultural lands (Gregersen 1982). The even larger Social Forestry programme in India had its origins in a National Commission on Agriculture report of 1976. It recommended people be encouraged to grow trees on their village and farm lands, to reduce pressure on timber production forests from mounting rural demands for fuelwood and other forest products (GOI 1976).

For dealing with fuelwood shortages, four main approaches were identified:

- Substitute other fuels and sources of energy (such as alternative organic fuels and biogas, kerosene, LPG and electricity).
- Encourage the adoption of stoves or the use of improved stoves to burn woodfuels more efficiently.
- Improve the production of woodfuel from existing wood resources, through

better management of the resource and the use of charcoal rather than fuelwood where appropriate.

- Create additional woodfuel resources, through plantations and farm forestry.

While the first three were seen to have important contributions to make, the perceived magnitude of fuelwood use and the apparently exponential growth in its user population, focussed most attention on the fourth option. "The logical immediate response to the firewood shortage ... is to plant more trees ... The inexorable growth in the demand for firewood calls for tree planting efforts on a scale more massive than most bureaucrats have ever contemplated, much less planned for" (Eckholm 1975).

Creation of fuelwood plantations was an activity forest departments were well equipped to take on. Hence early programmes to tackle perceived fuelwood shortages tended to focus on plantations, drawing on foresters' experience in growing industrial tree species, to create additional wood resources for use as fuel.

The apparent magnitude of actual or prospective shortfalls in supply created pressure to identify the areas with the largest and most pressing imbalances, so interventions could be targeted where they were most needed. In preparation for the 1981 UN Conference on New and Renewable Sources of Energy, FAO carried out an exercise to develop estimates of the fuelwood balance in each country and region (FAO 1981, de Montalembert and Clément 1983).

Estimates of consumption and future fuelwood demand were developed and these were compared with estimates of annual growth rates from existing forest resources. It was assumed that overcutting in the forests was making up the difference between the amount of fuelwood actually being used and the amount that would be sustainably available from the forests (i.e. annual growth). Within a given period, the margin by which the projected fuelwood demand exceeded the estimated annual growth indicated the extent to which a 'gap' would exist between projected demand and sustainable supply.

The FAO study provided estimates for 1980 that, in aggregate, some 2000 million people depended on fuelwood and other biomass fuel. More than half of these people were estimated to be unable to meet their minimum energy requirements without over cutting and about

100 million were living in situations of acute energy shortage. The study went on to report that "extrapolation of present trends in population, deforestation and plantation work produces a picture of a gigantic problem by the year 2000 ... some 2.7 thousand million people dependent on traditional fuels, of which 2.4 thousand million would be in situations of acute scarcity or deficit". It was further estimated that the annual shortfall in fuelwood supplies by 2000 could amount to 1000 million m³. A warning was issued that "in vast zones of western and eastern Africa and in the Indian sub-continent, fuelwood may well be playing no more than a marginal role [by the year 2000]".

On the basis of this study, the 1981 UN Conference endorsed a recommendation for a five-fold increase above existing levels of tree planting for fuelwood. This took the form of large scale plantations near urban and other concentrated sources of market demand, with community and individual plantings to meet more localised rural needs. Interventions to bring this into effect rapidly emerged in both donor and national forestry programmes, attracting large funding flows.

Fuelwood was selected as one of the five action programmes in the 1985 donor-organized Tropical Forestry Action Plan (TFAP), initiated to increase commitment to addressing deforestation and forest degradation. Citing the UN Conference target of a five-fold increase in tree growing, the TFAP set a target of more than \$10,000 million in aid funding over ten years to address the fuelwood issue. The World Bank later projected a need for \$1,636 million in the period 1987-91 for just 31 of the deficit countries.

Concerns did exist about the reliability of the database used in estimating the supply of, and demand for, fuelwood and any prospective 'gap' between them. However, the task of identifying the tree planting that would be needed in individual regions and countries in order to avoid projected shortfalls was also based on estimates of future 'balances' between fuelwood supply and demand using these same data. A widely quoted World Bank report along these lines (Anderson and Fishwick 1984) suggested that the rate of tree planting in Africa would need to increase fifteen-fold to meet demands for fuelwood by the year 2000 and avoid the destruction of existing tree stocks.

The call for widespread, rapid action resulted in a proliferation of fuelwood tree

planting projects. Some of these, like the Social Forestry programme in India, were on a very large scale. The design of early projects concentrated on community woodlot planting, in part because the more striking, existing examples of fuelwood-focussed plantation programmes, such as those in South Korea, had been organised in this way. There were also arguments for mobilising users to create the new resources, in order to keep costs to a minimum and locate the new resources where they would be readily accessible and where user communities could exercise more control over their supplies. Creating community woodlots also facilitated the task of forest departments in achieving dispersed and often hugely ambitious planting targets.

2.2 The reappraisal in the 1980s

By the mid 1980s, sufficient experience with fuelwood-oriented programmes had accumulated to allow an evaluation of their effectiveness. Progress nearly everywhere was clearly falling short of what had been expected or hoped for. Even in urban areas, where alternative fuels were available, shifts away from domestic woodfuel use were not taking place on a very large scale. Cost constraints made it difficult for users to purchase stoves in which to use the new fuels. People were also unfamiliar with the new (and sometimes risky) cooking devices and alternative fuels and there were reliability problems relating to their supply as well. Equipment costs and reliability problems hindered the adoption of improved wood-burning stoves and biogas plants in rural areas as well.

Where most of the effort had been concentrated, on establishing new fuelwood plantations, again the reality was often falling short of expectations. In some countries, such as India, where tens of thousands of woodlots were established through Social Forestry programmes, considerable new resources were created. However, these did little to augment fuelwood supplies for rural users. Usually established under forest department supervision, they proved difficult for local institutions to manage or control, particularly as they were usually structured more towards commercial rather than subsistence products. Moreover, the planting up of communal lands often deprived subsistence users of the supplies of fuelwood and other biomass products that the land had previously provided (Saxena 1997).

Individual farmers often responded quite well to fuelwood programmes encouraging them to plant more trees but their focus was largely on tree products other than fuelwood.

Even projects aimed at increasing planting to meet fuelwood demands in growing urban markets were encountering problems. Subsidised prices for other forms of energy tended to keep fuelwood prices low, as did competition from continuing supplies mined from naturally occurring tree stocks. In such an environment, it usually proved difficult to produce and sell plantation-based fuelwood at a price that covered its production costs (Leach and Mearns 1988, Dewees and Saxena 1997). The widespread trend for urban users to shift from fuelwood to charcoal as prices of the former rose, further limited the potential for developing competitive supplies of plantation produced fuelwood (Barnes *et al.* 2002).

It was also becoming clear in many situations that shortages were not growing or emerging to the extent predicted. Questions began to be raised about the 'gap' approach. It was argued (e.g. Foley 1987, Leach and Mearns 1988, Dewees 1989) that it was liable to grossly underestimate the actual supply situation because it was based on stock and yield figures relating to forest resources, whereas most fuelwood in practice, comes from woody plant resources other than forests—scrub, bush fallow, farm trees etc—and much of this can regenerate. Furthermore, fuelwood is also drawn from deadwood, pruning, lopping and other forms of harvesting other than felling trees.

Equally, it was argued, projecting consumption in line with population growth, while ignoring the adjustments to use people would employ if shortages were actually occurring in the ways projected, was likely to seriously overestimate future demand. Reappraisal of the data from individual countries, to take account of more realistic assumptions, frequently showed an aggregate potential surplus rather deficit (e.g. Foley 1987, for Mali and Dewees 1989, for Kenya).

An important outcome of this more careful assessment of actual supply patterns was the finding that much of the fuelwood coming from the felling of trees was on land being cleared for agriculture. It was the latter, not rural fuelwood demand in itself that was posing a major cause of deforestation. The possible contribution of fuelwood demand to forest degradation and loss was seen as being largely confined to pressures on the resource from

concentrated urban and industrial demands. This radical reassessment of the linkages between fuelwood use and deforestation was to prove very important in influencing perceptions about the role of fuelwood supply as an objective in forestry and forestry aid programmes.

The 'gap' and 'balance' approaches were also criticised for the focus they placed on national or regional aggregates, whereas fuelwood supply and use issues are inherently location specific (Leach and Mearns 1988). Fuelwood 'gap' analyses extrapolated existing consumption and supply patterns without recognising the various ways people actually adjust to decreases in fuelwood supplies or the fact that changes in usage can be due to constraints other than shortages of wood.

As Dewees (1989) pointed out, much of the early analysis failed to distinguish between the physical and economic measures relating to woodfuel scarcity and abundance. The fact that users may not be able to access as much fuelwood as they were previously doesn't necessarily mean there is physically less of it. It could well be because they have less time to gather it or in other words, they are experiencing a labour shortage rather than a fuelwood shortage. With growing out-migration to wage employment, the reduction in available labour to rural households could be a significant factor affecting woodfuel use.

Dewees' examination of the costs and benefits associated with the options available to rural households identified additional factors affecting fuel use and the incentives or disincentives to increasing woodfuel resources. One common option was to increase the efficiency with which available supplies are used—through more careful use of fires, more controlled use of cooking vessels, sharing cooking amongst two or more households, incorporating a greater use of foods and dishes requiring less cooking, etc. Another approach was to increase the use of other biomass fuels, available at a lower cost to users than wood.

Exploration of this connection brought into question earlier arguments about the burning of crop residues and dung depriving people of their alternative uses. The practice of working dung into fields proved to be quite limited because farmers found the resulting increases in soil productivity were not commensurate with the labour and associated costs involved. Similarly, crop residue often has to be burned on site for phytosanitary reasons. In these

cases, burning dung or crop residues as household fuel therefore does not divert them from higher value uses (Dewees 1989, McIntire *et al.* 1992). While they may be lower quality fuels than wood for most cooking purposes, this is likely to be offset by their low cost and ease of access.

In regard to growing trees, this always involves costs in terms of land, labour and capital and only makes sense if outputs are produced of corresponding value to the farm household. Where farmers were planting trees, these were usually species to create protection or produce fruit, fodder, construction timbers or products for sale. Fuel, as a low value commodity, was being supplied from lower cost sources, such as existing woody material or agricultural waste products or as a by-product or co-product of trees grown for other purposes. It became clear that there were few situations where farmers have been growing trees to use solely for fuel purposes (Dewees 1989).

It also became evident that people did not necessarily rate fuelwood shortages as a priority problem, along the lines of what had initially been expected. For example, in an extensive International Labour Organization (ILO) study on the impacts of fuelwood shortages on women, it was found that "in most of the villages studied women did not regard woodfuel and cooking efficiency as top priorities. Their immediate preoccupation is the need for quick solutions to desperate food and income deficits" (Cecelski 1987).

The picture that increasingly emerged was one where fuelwood shortages frequently did exist and users often suffered inconvenience or increased hardship as a result, however the scope for intervening to encourage more tree planting as an appropriate response was much more limited than had been earlier assumed. Moreover, where more intensive tree management was warranted, this needed to be based on a better understanding of the broader roles that trees and tree outputs play in rural livelihoods (Shepherd 1990).

Interventions narrowly focused on just the one tree-related issue of fuelwood were likely to encourage tree growing where trees were not an appropriate component of the farm household economy. It could also induce the growing of inappropriate trees or require changes in institutional or social frameworks in order to be successful that could not realistically be achieved in connection with just tree growing (Dewees 1995a).

In short, it became increasingly clear that although there could often be a need for heightened plantation or forest management activities to provide woodfuel supplies to large urban markets or to exploit the potential of wood as an efficient industrial fuel (FAO 2000), the case for forestry programmes just to meet rural fuelwood needs was likely to be limited. Rural fuelwood production was more likely to be addressed effectively through more holistic support for local tree and forest management and within broader based interventions for rural development and livelihood enhancement.

2.3 Adjustments following the reappraisal

The late 1980s and the 1990s saw a marked shift in the focus of a lot of forestry aid, towards 'participatory' forestry—with greater attention being paid to involving local people and responding to their livelihood needs. This highlighted the need for forestry activities to contribute to a broader set of objectives for the rural poor—like reducing and spreading agricultural risk over space and time, reducing vulnerability to external shock, contributing to coping strategies that help alleviate poverty and enabling people to take better advantage of opportunities to escape poverty. This shift increasingly spawned rural forestry programmes within which fuelwood formed just one component, rather than the sole or principal activity.

Programmes focused more narrowly on fuelwood were still developed where these seemed to be needed to meet urban needs. However, they were increasingly pursued through local forest management rather than plantations, or through the creation of an institutional and economic setting that encouraged and enabled smallholder private tree growing responses to emerge (Barnes and Floor 1996).

In practice however, there was some resistance to the shift away from the earlier emphasis on fuelwood plantations, not least because so much of the rationale for funding forestry in the 1980s had been built around the 'fuelwood gap' thesis and its seemingly catastrophic implications for deforestation and forest degradation. Thus, the World Bank's forestry strategy, formulated in 1991, again identified additional planting and more intensive management of existing tree resources to meet rural fuelwood and other needs, as one of the two main challenges the

Bank had to address in combating deforestation and degradation (World Bank 1991)³. In some quarters, aspects of the earlier interpretation of the fuelwood situation and of the need for forest departments to intervene to create fuelwood plantations, have persisted to the present day.

Elements of the earlier assessment have also persisted in the energy sector. Recently, examination of woodfuel use by the poor, in relation to the United Nations Millennium Development Goals, has focused on: the perceived burden fuelwood places on women and children, reducing the time they might have for education or more remunerative activities; on the contribution that burning woodfuels is said to make to respiratory ailments; on the barriers to advancement that reliance on fuels that cannot power machinery can create; and on the ecological damage caused by harvesting fuelwood and diverting dung and crop residues from higher value uses in agriculture (e.g. IEA 2002, DfID 2002).

This energy debate, which tends to pay little attention to arguments and evidence that much of this impact is less clear cut or severe than is often postulated, has resulted in a strong focus in energy programmes on the need to replace woodfuels. The issue of how to secure continued access to woodfuel supplies for users tends to receive only limited attention in this literature.

3. Woodfuel patterns and trends at the national and global level

The general thrust of woodfuel research has been on examining fuelwood and charcoal issues at more disaggregated and focussed levels, given the considerable differences that exist amongst various user and supply situations. However, two aspects of national overviews have continued to attract attention, with both having significant potential implications for forest policies. One is the overall magnitude of fuelwood and charcoal usage at the national level and the direction and rate of changes in consumption. The other relates to the pattern of supply and the way this pattern is changing and impacting on the forest resource. These aspects are reviewed in this section, along with recent information about the evolution of different woodfuel use and supply trends amongst urban and rural users.



Collecting debris from Chinese fir (*Cunninghamia lanceolata*) for firewood in Fujian, China. (Photo by Christian Cossalter)

3.1 Macro magnitudes and trends

As noted in the Foreword, in the latter half of the 1990s a number of studies produced revised forward projections of future consumption or demand at both national and global levels. As Table 1 illustrates, they all predicted that global consumption of fuelwood would continue to rise in the period 2000-2010. Most estimated global consumption at the turn of the century would be close to 2000 million m³, accounting for roughly half of all wood harvested.

In the “most likely” projection scenario contained in the FAO (1997) study, consumption was estimated to grow over the decade to 2010 at an average annual rate of 0.71%. In the Nilsson (1996) study, based on FAO estimates of per capita consumption in 1980, total consumption in 2000 was estimated to be close to 4000 million m³ and was projected to grow over the next decade at 1.6% annually. The World Commission on Forests and Sustainable Development (WCSFD 1999) estimated that demand for fuelwood would grow from 3000 million m³ at the turn of the century to 3500 million by 2050.

All of the studies commented on the limitations that uncertainties associated with the underlying data and assumptions in their analytical models imposed and stressed the importance of improving this database. Nearly all the global, regional and often national analyses of fuelwood and charcoal consumption, trade and production use the FAO forest products statistics series as their starting point. Of the 225 countries the series covers, 30-40 report fuelwood data each year and on average, 13 countries report charcoal data (though this number is steadily rising). For countries that do not report, the FAO figures are based on national per capita estimates formulated in 1980.

This means that exercises using the FAO figures as a foundation for projection models,

Table 1. Projections during the 1990s of world consumption of fuelwood for 2000-2010 (1000 million cubic metres)

Source	2000	2010
FAO (1995)	2.09	2.38
FAO (1997) ^a	1.89	2.05
Apsey & Reed (1995) ^b	Na	2.31
Zuidema <i>et al.</i> (1997) ^c	Na	1.50
Nilsson (1996) ^d	3.80	4.25
Brooks <i>et al.</i> (1997) ^e	1.90	1.98
Brooks <i>et al.</i> (1997) ^f	1.90	1.94

Notes: a. Scenario 2 (medium economic growth); b. Consumption projection; c. Availability (estimated based on land-use changes); d. “Basic requirements” using a “bottom-up” approach; e. Lower GDP growth; f. Higher GDP growth.

Source: Brooks 1997

have been drawing on data which itself is already 80% based on models. Also, since 1980, annual changes in the national figures in the FAO database have not taken into account influences other than population growth, such as the impact of rising fuelwood costs. Therefore, the projections of growth in consumption for most countries have probably been overestimated (Broadhead *et al.* 2001).

Over the past few years, FAO has carried out a major revision of its fuelwood and charcoal data and has developed more rigorous and realistic analytical and projection models. The new figures use the non-modelled FAO data between 1970 and 1998 as a starting point. Altogether, 1056 records of fuelwood data and 370 records of charcoal data were collated. An extensive search of a wide variety of sources was also undertaken to unearth and incorporate as many additional records relating to actual usage as possible.

This information was used in developing new analytical models to revise estimates of per capita consumption. For countries where sufficient total national consumption data were available, models of consumption at this level were used. For others, estimates of non-household use were added to modelled household consumption figures, to arrive at estimates of total national consumption. The household consumption models for each country included dummy variables⁴ related to either 'national' or 'regional' consumption, according to the data available (Broadhead *et al.* 2001).

These new analytical models introduced a number of explanatory variables in addition to population—including income, urbanisation, oil

production and for fuelwood, forest cover, land area and temperature. Although as expected, there were great variations between countries, a general result was that income⁵ consistently turned out to be an important influence on the level of woodfuel usage (see Box 1). The authors of the FAO study report that, if country variation is disregarded, the consumption of both fuelwood and charcoal decreased with an increase in income (with an income elasticity of demand of around -0.18 for fuelwood and -0.3 for charcoal). They also found urbanization typically decreases fuelwood use and increases charcoal consumption and per capita fuelwood consumption increases as the proportion of land area under forest cover increases (FAO in press).

Estimates arising from the new analytical models indicate that global annual consumption of fuelwood appears to have peaked in the mid 1990s, at about 1600 million m³ and it is now believed to be slowly declining. Though in contrast, global consumption of charcoal is growing rapidly. It apparently doubled in the quarter century to 2000, when the utilisation of wood for charcoal was estimated to amount to roughly 270 million m³ per annum. The combined aggregate of fuelwood plus wood for charcoal is still rising but at a declining rate and substantially less rapidly than the equivalent growth in population.

The situation between and within developing regions differs markedly (see FAO study, Table 2). In Asia, which accounts for nearly half of the world's woodfuel consumption, aggregate consumption of fuelwood is declining. This reflects a significant decline in China and much of East and Southeast Asia

Table 2. FAO projections of woodfuel consumption in main developing regions to 2030

	1970	1980	1990	2000	2010	2020	2030
<i>Fuelwood (Million cubic metres)</i>							
South Asia	234.5	286.6	336.4	359.9	372.5	361.5	338.6
Southeast Asia	294.6	263.1	221.7	178.0	139.1	107.5	81.3
East Asia	293.4	311.4	282.5	224.3	186.3	155.4	127.1
Africa	261.1	305.1	364.6	440.0	485.7	526.0	544.8
South America	88.6	92.0	96.4	100.2	107.1	114.9	122.0
World	1444.7	1572.7	1611.6	1616.2	1591.3	1558.3	1501.6
<i>Charcoal (Million tons)</i>							
South Asia	1.3	1.6	1.9	2.1	2.2	2.4	2.5
Southeast Asia	0.8	1.2	1.4	1.6	1.9	2.1	2.3
East Asia	2.1	2.3	2.3	2.2	2.1	2.0	1.8
Africa	8.1	11.0	16.1	23.0	30.2	38.4	46.1
South America	7.2	9.0	12.1	14.4	16.7	18.6	20.0
World	21.2	27.0	35.8	45.8	55.8	66.3	75.6

Source: Broadhead *et al.* 2001

Box 1. Economic factors influencing household demand for woodfuel

A synthesis of economic studies on woodfuel supply and demand in developing countries was carried out for this study (Cooke St. Clair, Hyde and Köhlin 2001). Although a number of factors often turn out to be significant in explaining woodfuel demand, income and fuel prices are the most predominant.

Income

The most pervasive hypothesis regarding woodfuel demand is that of the "energy ladder", where a progression to modern fuels is expected as income rises, implying that fuelwood is an 'inferior' good. The economic literature contains a number of 'multivariate econometric analyses' of household woodfuel demand that include income as an explanatory variable. Most of the income elasticities are negative, validating the energy ladder hypothesis. However, this result is not completely general. The effect of income on fuelwood consumption in most studies appears to be small, regardless of how income is measured. Relatively few of the observed income elasticities are significantly different from zero and those that are, range from -0.31 to 0.06. However, this is not necessarily true for all parts of the population or even for the majority of the population in poor countries such as Ethiopia.

The reason for this can also be explained by the energy ladder hypothesis since it implies that the income elasticity of demand changes as income changes. Some analyses observe that fuelwood is a 'normal' good for lower income households but an 'inferior' good for higher income households. For charcoal, the shift from a normal to an inferior good comes at a higher income level than for fuelwood. Therefore, we need to take income distribution into consideration, as well as a number of interacting variables such as urbanization. For example, an analysis of Indian data from a NSSO survey found fuelwood to be a normal good in rural areas and among the poor in urban areas, while it showed a negative expenditure elasticity of demand (-0.8) for the highest income group in urban areas (Gundimeda and Köhlin 2003).

Price

How responsive fuelwood demand is to its own price is at the heart of the fuelwood scarcity issue. In rural areas, the range of own-price elasticities of demand lies between -0.21 and -1.47, with only two out of 17 estimates being greater than 1 in absolute value. These results, mainly from South Asian case studies, indicate that rural fuelwood demand is not very responsive to increased scarcity. This implies that households have few fuelwood substitutes readily available, which is borne out by evidence of

household fuelwood expenditures or collection times increasing as fuelwood becomes more costly. However, more case studies from other regions are needed in order to determine whether the inelasticity of fuelwood demand is a general phenomenon.

Surprisingly, in view of the options to use other fuels, the few economic estimates of own-price elasticity of demand for fuelwood and charcoal in urban areas are also inelastic. The ESMAP multi-country analysis (Barnes *et al.* 2002) shows the own-price elasticity for fuelwood to be -0.38, with the low income group being a bit more price responsive, with an elasticity of -0.51. However, Gundimeda and Köhlin (2003) found the richest group in urban areas to be more responsive, with an elasticity of -1.1 for fuelwood.

Cross-price elasticities between woodfuels and other fuels indicate how close they are as substitutes. The ESMAP study shows charcoal to be a significant substitute for wood. Overall, it appears that use of wood declines by 3 % for every 10% increase in its price relative to kerosene, while the use of charcoal increases by about 6% for every 10% increase in the price of wood relative to kerosene. This is consistent with the hypothesis that wood scarcity near urban areas, accompanied by rising prices, causes switching from wood to charcoal. Analysis of NSSO data from 1994 indicates small cross-price elasticities for fuelwood, especially with respect to kerosene, while electricity shows some more potential for interventions, with a cross-price elasticity of almost 0.4 for medium and high income households (Gundimeda and Köhlin 2003). In urban areas, kerosene is a better candidate to substitute fuelwood, at least for low and medium income households.

Other factors

However, there is more to woodfuel demand than just income and fuel prices. Exercises to map how preferences for different attributes affect the choice of fuel show that the three main attributes influencing the transition process to modern fuels seem to be convenience, price and reliability of supplies. In general, woodfuel consumption decisions depend on how household characteristics (such as size and composition, tastes and the opportunity cost relating to time) interact with external factors (such as prices, forest cover and urbanization). In a study on the choice of fuel in Kolkata, India, it was found that price, availability and ease of use were very important characteristics affecting the choice of fuel, while the price of stoves and level of pollution from the fuel did not seem to matter when it came to making choices (Gupta and Köhlin 2003).

since the 1980s. There has also been little change in consumption in South Asia, where it appears to be at or close to its peak. Overall, the Asian region's charcoal consumption (which accounts for only a small part of total woodfuel use in most countries, other than those in West and Central Asia and Japan) is also declining. Where its use is substantial however, consumption is usually continuing to grow.

In Africa, where fuelwood use per capita is on average, considerably higher than in Asia, consumption is still growing, though less rapidly than population. Only in some of the wealthier and more urbanised countries in the north and south of the region does consumption appear to be approaching a peak. Consumption of charcoal however, an important fuel across much of the region, is continuing to grow rapidly. In fact, it takes the combined aggregate of fuelwood plus wood for charcoal to a rate of increase close to that of population growth.

In South America, where fuelwood is a less important fuel, its overall consumption appears to be rising only slowly. On the other hand, consumption of charcoal, a major fuel in the tropical countries of the region, is growing quite strongly. Indeed, the consumption of wood for charcoal is currently as large as that for fuelwood. As in Africa, the aggregate of both fuel types is growing at close to the rate of growth in population. In Central America, charcoal is little used and woodfuel consumption appears to be close to its peak.

The authors of the FAO study are careful to point out the limitations relating to its data. In fact, one of the objectives of the exercise was to draw the attention of national authorities to the paucity of reliable information in this area and to encourage more complete monitoring of the two products. The estimates are based on cross sectional data, which could mean that elasticities are too high. The assumptions of population growth taken from UN Medium Fertility projections could also prove to be optimistic (FAO in press).

Nevertheless, the study clearly provides a more rigorously analysed and more realistic future scenario than has been previously available. It confirms that fuelwood consumption is not growing as rapidly as population growth and is not about to. In fact, in many countries it has already peaked and is now in decline, while in others, it appears close to its peak. The study also illustrates very clearly the rapidly growing importance of

charcoal. Both of these developments evidently have important implications for forestry.

Broadly similar results emerge from an International Energy Agency study of trends in the use of biomass fuels (IEA 2002). This study also examined the number of people relying on traditional biomass fuels for cooking and heating. Its estimates show that, although shifts to other sources of energy could be expected to substantially reduce the share of these fuels by 2030, the number of people relying on them would actually increase by the end of that period, particularly in Africa (Table 3).

Table 3. Number of people relying on biomass for cooking and heating in developing countries (million)

	2000	2030
China	706	645
India	585	632
Other Asia	420	456
Africa	583	823
Latin America	96	72

Source: International Energy Agency 2002

The IEA study predicts that by 2030, biomass energy in Africa will still account for an estimated three quarters of total residential energy and the region will have far surpassed China and South Asia in terms of the quantities of woodfuels used⁶. If correct, these estimates underline the importance of facilitating continued access to woodfuels, particularly in Africa.

3.2 National demand and supply balances

Many countries, particularly those in which ESMAP has been working, have given considerable attention to developing more accurate assessments of their national fuelwood 'balances'. In many places, this has occurred within broader energy assessment and projection exercises. The more recent and comprehensive of these exercises recognize and attempt to assess the output (including sustainable output) from tree resources outside forests, as well as forest resources. They also assess the contribution and potential of other biomass fuels, such as crop residues and animal dung, as substitutes for fuelwood. However, these estimates relate to physical availability and provide little information as to

what extent, given the realities of location and cost, the resources can be accessed economically. Furthermore, the very rough indications regarding the extent and productivity of these resources means that such estimates have large margins of error and at best, can only be very broadly indicative of the likely potential.

Nevertheless, even when these qualifications are taken into account, the results for most of the countries studied show that wood and related biomass fuel resources exist in sufficient abundance to provide more than adequate physical coverage of woodfuel needs. The FAO/Netherlands Regional Wood Energy Development Programme in Asia has brought together the results of such work in 16 Asian countries (RWEDP 1997). Their findings show that for the aggregate of these 16 countries, total potential woodfuel supplies exceeded woodfuel demand in 1994 and it is likely this will continue to be the case in 2010. However, in two countries (Bangladesh and Pakistan) and in parts of other countries, demand was apparently pressing up against the limits of sustainable supply.

There is an increased focus on gaining a better understanding of the relative importance of the various sources of woodfuel. These include forests, trees and other woody plants outside forests (on common lands, farms, plantations etc), as well as other wood resources (wood processing residues, reuse of wood, woody crop residues etc). As illustrated in Table 4, which reproduces information from

13 Asian countries, trees outside the forests appear to supply a large share of overall woodfuel output. In many of these countries, they actually account for the greater part of total supplies (Bhattarai 2001). As noted earlier however, few countries have reliable records of fuelwood production from forests and even fewer have any systematic record of outputs from other sources (or alternative biomass fuels). Much of what has been assembled has been derived from non-forest data sources, like energy or household consumption and expenditure surveys.

Nevertheless, such broad-brush information supports the thesis that much fuelwood use is being met from tree sources outside forests. This reinforces the view that demand for fuel is unlikely to deplete or remove forest cover on a large scale. Recent reviews of findings from studies on the causes of deforestation tend to support this. For example, an assessment of economic models of tropical deforestation, while indicating the existence of multiple rather than single causes and noting that evidence regarding fuelwood is weak, points to it being an occasional cause, mainly in parts of Africa (Kaimowitz and Angelsen 1998).

An analysis based on a wide range of case studies in tropical countries also found multiple causes of deforestation, with fuelwood harvesting being important in some situations in Africa where deforestation is associated with wood extraction (Geist and Lambin 2002)⁷. A substantial World Bank study in six countries in West Africa similarly concluded that in those

Table 4. Fuelwood production from forest and non-forest land in countries in Asia

Country	Forest (%) ^a	Non-forest (%) ^b	Unknown (%)
Bangladesh	13/75/ ^{-c}	87/25/82	-
Bhutan	84	16	-
China	na	26	-
India	51/17 ^d	49/83	-
Indonesia	6	65	29
Laos	>90	<10	-
Myanmar	60	40	-
Nepal	82.5/73 ^d	17.5/27	-
Pakistan	12.6	84.1	3.3
Philippines	13.7	86.3	-
Sri Lanka	11/12 ^d	75/69	14/20
Thailand	-	93	7
Vietnam	80	20	-

Notes: a. Includes forest plantations; b. Includes farms, homesteads, community lands, scrub and waste lands, linear plantations etc.; c. Estimates from three different sources; d. Estimates from two different sources. Source: Bhattarai 2001

Box 2. Fuelwood information in India

An in-depth study was undertaken as part of this current research, to identify and review the available information on fuelwood supply and use in India (Pandey 2002). This country was chosen because of its particularly well developed statistical gathering and analysis system. The study identified eight national level surveys that had produced data on fuelwood use since 1985. Several different agencies had carried out these surveys, employing various methodologies and measures of fuelwood (volume, weight, value and energy equivalent). This hampered a comparison of results regarding changes over time. Also, fuelwood consumption had been investigated mostly through household interviews, raising questions about the reliability of recall and a possible reluctance to provide accurate responses about the sources of fuelwood obtained (possibly illegally) from government forests.

A number of states had also carried out surveys and studies, some of them examining patterns of supply as well as consumption. But again, weaknesses in the data often limited the precision and scope of analysis. In particular cities, more information proved to be available about changes in patterns of urban woodfuel consumption, from detailed studies over time.

The results of this research exercise indicate that even in India, which has more existing records than most countries, the database is poor and definitive conclusions are therefore difficult to arrive at.

areas where charcoal production is concentrated, this can represent the main source of tree loss (Ninnin 1994).

3.3 Urban and rural patterns of woodfuel use and supply**Urban patterns**

A considerable amount of information on woodfuel use in urban areas has been assembled, particularly from surveys carried out by the Joint UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP). As noted in the Foreword, an ongoing ESMAP study has collated and analysed data from more than 25,000 urban household surveys. These were conducted between 1984 and 1997, in 46 cities, across 13 countries in Africa, Asia and Latin America (Barnes *et al.* 2002). The results provide a major source of information on patterns and trends of urban fuelwood and charcoal use and supply. The study emphasises the variety of factors affecting the woodfuel situation from city to city and the wide differences in outcome between various regions. Yet, it also identifies a broad process of transition from intensive use of wood in the first stage, to situations where LPG and electricity are the main fuels in the final stage (Table 5).

Charcoal (with its higher energy content per weight unit) is identified as the 'transition' fuel to which fuelwood users are most likely to switch. It is likely to surpass wood, in terms of the number of users and share of urban energy, as prices of wood increase relative to prices of other fuels and as incomes rise and cities become larger (Box 1). Other transition fuels, with which charcoal competes, include kerosene and coal. A general finding across the 46 cities surveyed, is the persistence of some woodfuel use (and charcoal in particular), even in high income households, in large cities within which modern fuels dominate. Another general finding is the extent to which even poor households use some modern fuels (in addition to wood and/or charcoal) for particular purposes—for instance, kerosene or electricity for lighting.

Table 5. Relationship between income and energy use in urban areas of 12 countries

Income class (per capita)	Monthly income (US/cap)	Firewood	Charcoal	Coal	Kerosene	LPG	Electricity	Total
Fuel use (KgOE ^a per capita per month)								
Low	8.59	3.63	3.28	2.38	1.33	0.15	0.60	11.59
Mid-low	15.51	2.57	2.66	3.21	1.73	0.42	0.82	11.59
Middle	25.02	2.10	2.20	2.83	1.50	1.25	1.15	11.15
Mid-high	41.94	2.62	2.54	0.67	1.14	2.09	1.77	10.82
High	116.95	1.66	1.79	0.00	0.60	3.70	4.15	11.62

Note: a. Oil Equivalent

Source: ESMAP studies (in Barnes *et al.* 2002)

The available evidence indicates that, with shifts to other fuels as incomes and city size increase, consumption of woodfuels in much of urban Asia is growing only slowly, if at all. In some places, the shift away from woodfuels has been quite marked and even rapid. For example, in Indonesia, kerosene is widely and cheaply available everywhere and has largely displaced wood as an urban fuel. Throughout much of China, the availability of cheap, low grade coal has had a similar effect. In Vientiane, Laos, abundant hydropower and cheap appliances have enabled people to shift directly from wood to electricity in recent years. A recent shift away from woodfuels in Bangkok has been linked to this country's logging ban (Barnes *et al.* 2000).

In Hyderabad, India, where repeat studies 13 years apart have provided a particularly good data base (ESMAP 1999), it was found that while the population trebled within that period, the quantities of woodfuels remained roughly the same. Overall, household consumption fell by 60%, while use by commercial and social/religious establishments more than doubled. The study attributes this huge shift in the choice of household cooking fuels to liberalization of fossil fuel supplies and a differential movement between subsidised prices of these fuels and the price of fuelwood (which became more costly due to a shift away from forests to farm tree sources, following a logging ban). The growth in the commercial use of fuelwood is explained by its increased availability, given the decline in the household market and user dissatisfaction with the alternative of low grade coal.

The rapid population growth in urban areas of Africa, often accompanied with persistently low urban incomes, means that strong growth in the use of woodfuels will probably continue to occur. However, the investigations carried out in three countries for this current study, show that poor data often make this difficult to investigate. In Ethiopia, the available information actually indicates a decline in urban use (Mekonnen and Alemu 2001), while in Niamey, Niger, volumes of woodfuel entering the city appear to have grown only slowly over the past 12 years (Manvell and Shepherd 2001). In Tanzania on the other hand, the results of studies in 1993 and 1999 indicate that urban consumption of woodfuels has apparently grown in volume by about 250% during that period (Yahya 2001).

Rural patterns

There is generally much less reliable quantitative information about household use of woodfuels in rural rather than urban areas. A substantial 1996 survey in six states in India (ESMAP 2002) shows biomass fuels dominate, with wood accounting for 56 percent of use and charcoal 1 percent (dung rates at 19 percent and straw 18 percent). The results of a National Sample Survey Organisation (NSSO) study in India in 1993-94, show that on average, 'about 55% of household needs for firewood are collected free⁸, most of which can be assumed to come from [common pool resources (CPRs)]' (Chopra and Dasgupta 2001). For rural labourers and those with very small land holdings, the dependence on collected sources is even higher.

Forest, woodland and scrub areas containing woody vegetation can in practice, constitute a substantial part of the overall CPR resource. It has been estimated (Chopra and Gulati 2001) that across 16 states in India, 36% of the CPR area is 'forest-based'. However, CPRs are shrinking in area in India at a quinquennial or five yearly rate of 1.9%. Depletion in the productivity of what remains is widespread and access is often becoming increasingly restricted (Chopra and Dasgupta 2001, Jodha 1990).

The 1996 survey of rural energy in six Indian states (ESMAP 2001) found, "There is almost unanimous consensus among rural households that fuelwood is scarce and that its future availability is in doubt". The share of fuelwood being purchased is increasing. Some households are also moving down to straw and dung, while other, wealthier households are shifting up the energy ladder to purchase different fuels. However, the most common response to reduced access for households that collect their fuel is to increase their collection time (Amacher *et al.* 1993, 1999; Cooke 1998a, 2000; Köhlin 1998)⁹.

In Africa, formal and informal privatisation of land holdings is reducing the areas available as CPRs. This is disrupting or extinguishing the multiple forms of land and resource rights (including both individual and group rights)—which traditionally provided access to sources of fuelwood and other biomass products for many users (Neumann 1996). With less in the way of common property sources and progressive exclusion from gathering on other lands, households are reduced to what they can generate on their own land or what they can purchase or steal (Vermeulen 2001, Manvell and Shepherd 2001, Cooke St Clair *et al.* 2001).



Firewood sale point on the Maroua–Mokolo road, 65 km north west of Maroua in North Cameroon. *Acacia seyal* has yellow wood and *Acacia nilotica* has red wood. (Photo by Christian Cossalter)

The review of information from Africa carried out as part of this current research (Vermeulen 2001), confirms widespread adoption of measures to economise in the use of woodfuels. Adaptations include having fewer cooked meals, shifting to foods that take less time or fuel to cook, changing cooking methods, substituting home cooking with purchased food, reducing space and water heating and reducing fires for the protection of livestock. As supplies of the preferred types of fuelwood decrease, users switch first to less favoured alternatives and then to crop residues, livestock dung and even noxious weeds.

The observational evidence that shortages of fuelwood for subsistence users are becoming more pronounced, particularly for the landless and those with little land, is considerable. The next Section considers the available evidence related to the welfare effects of such shortages. It also looks at recent information on spontaneous and introduced forestry and agroforestry measures that could help alleviate such shortages. The arguments put forward towards the end of the 1980's are revisited—these being that the adaptations to scarcity that users adopt usually involve lower costs to the household and are generally better matched to their needs, constraints and priorities than investing in fuelwood plantations or other forms of forestry intervention.

4. Forestry-related issues

The previous Section's appraisal of the available evidence does not substantiate earlier concerns that woodfuel demand has been outpacing sustainable supply on a scale that makes it a major cause of deforestation and forest degradation. It appears the balance between fuelwood supply and demand is seldom an issue requiring forestry intervention on a national scale, although the rapid rise of charcoal as an urban fuel is posing some concern at this level. Overall, the woodfuels situation is an important consideration for particular areas within a country and for particular groups of users and suppliers. From the evidence reviewed, three main categories of 'problem areas' of relevance to forestry emerge:

- Reductions in access to woodfuels can negatively affect poor subsistence users
- Certain situations can adversely affect those generating income from woodfuels
- Woodfuel harvesting and use can have negative conservation consequences

These aspects are discussed below, identifying the main issues that emerge in each case and the impact that forestry measures may have had.

4.1 Reductions in access to woodfuels can negatively affect poor subsistence users

The adverse impact on poor subsistence users, arising from reduced access to woodfuels, is mainly a rural issue and predominantly relates to fuelwood, as charcoal is not a subsistence fuel. In urban areas, diminished access to supplies can negatively affect many poor households, however this relates largely to purchased rather than gathered supplies. In most rural areas on the other hand, gathered supplies of fuelwood still constitute the main source of domestic energy for rural households (Barnes and Floor 1996) and hence these users are more vulnerable to changes that affect their ability to access fuelwood. With few indications in Africa or India of a large scale or rapid shift to non-biomass fuels being possible in the majority of rural areas, wood is likely to remain the principal rural domestic fuel for the foreseeable future.

Where access to fuelwood supplies is reduced for some reason, this implies a welfare loss for those affected. How serious this is depends on each household's ability to adapt to the new situation. As discussed earlier, this is largely determined by the household's capacity to access resources such as labour, land and money. It also depends on other factors, such as access to common pool resources and the availability and price of substitute fuels. The following discussion focuses on circumstances where the management of trees and other woody plants to supply fuelwood has proven to be a viable option. It also looks at the effects of forestry interventions in supporting or hindering such developments.

Where government or local authority forests still exist in the vicinity or where there are woodstocks on communal or other forms of land that are accessible as common pool resources, rural populations are often entitled in principle, to obtain fuelwood for their own use. However, access tends to be in the form of concessions, which can be withdrawn, rather than legally secured rights that can be enforced through the courts. These weaknesses are not always removed in measures such as the Joint Forest Management programmes (JFM) in India or the community forestry management initiatives in many parts of Africa, which are designed to give local user groups greater control over the resources and their use.

Particularly in earlier interventions of this kind, a major intention was often to specifically

improve access to fuelwood supplies for subsistence users. In practice though, marketable outputs have been more highly favoured. Take the Social Forestry woodlot projects in India for instance, set up largely to generate fuelwood supplies on village lands. In effect, they essentially replaced vegetation previously used by local households for fuelwood collection and grazing, with polewood crops, often sold to generate income at the community level¹⁰ (Saxena 1997).

More recent shifts in forestry programmes targeted towards rural populations have tended to be less oriented towards meeting fuelwood needs. By moving the focus of people-oriented forestry from village lands to forest lands, JFM in India shifted it further away from most of the people who were dependent on tree resources for fuelwood. As the World Bank has pointed out in evaluating its own forestry programmes in India (Kumar *et al.* 2000), whereas fuelwood production was the main focus of the Social Forestry projects supported earlier, "Since 1991 ... fuelwood production has not been a project objective". This shift in focus is also demonstrated in the following case study from northern Ethiopia, where a government programme has successfully created local communal woodlots in an area largely denuded of trees. Priority however, is given to environmental objectives and people are prevented from harvesting for fuelwood (Gebremedhin *et al.* 2000).

This is indicative of changes over the past decade, where most forestry programmes have been paying a lot less attention to the sustainability of fuelwood supplies from CPRs. There has also been a decline in programme interventions addressing the needs of the growing number of people who lack access to CPRs and are therefore dependent on supplies from their own lands. As noted in Section 2, early interventions designed to encourage and enable farm households to grow their own fuelwood experienced little success. Mounting evidence indicated this was frequently because planted and managed tree stocks were likely to create wood outputs with too high an alternative value and produced at too high a cost for growers to be able to afford to burn the wood for their own household use (Deweese 1989). Hence, programmes to support farm fuelwood lots were progressively cut back.

Farm forestry programmes lived on but they were directed more at outputs of greater economic value, as well as the protective

functions of shelterbelts, contour plantings, shade, etc. It was essentially accepted that the spontaneous adaptations to fuelwood shortages that households adopted involved lower costs and were more efficient than farm forestry interventions in addressing the constraints being faced.

That said, there is growing evidence that tree management by farmers is on the rise and that some of the resulting outputs are going towards increasing the fuelwood supplies of the households involved. For instance, compilations and assessments of available survey information in the better watered areas of eastern Africa show that farmers with land are managing their own tree resources more intensively (e.g. Warner 1993). A recent ICRAF inventory of all trees on farms in an area in western Kenya, found fuelwood was reported as the most frequently used output from the trees. Yet only a small proportion had been planted primarily to provide fuelwood (Kindt *et al.* 2002). What is not known is whether this reflects a deliberate strategy on the part of the farmers to grow species that generate fuelwood as a low cost bi-product or whether this is an unplanned consequence of growing trees generally selected for other purposes.

What is clear is that little appears to have been done, since the early enthusiasm created by a US National Academy of Sciences programme in the 1970s, to promote 'firewood crops' (NAS 1980). This programme actively supported spontaneous farm level initiatives to produce fuelwood as a bi-product of other farm activities. For example, via multi-product and multipurpose trees, the adoption of woody stemmed agricultural crops such as pigeon pea (*Cajanus cajan*) and the incorporation of woody shrubs as hedges and boundaries.

In recent research into the species farmers choose to meet their tree output needs, the focus has shifted away from fuelwood as a primary output. This is a consequence of the downgrading in priority given to fuelwood at the end of the 1980s, the arguments that farmers give higher priority to other tree outputs and other ways of meeting their fuel needs and concerns about exotic species and species with invasive traits (some of which were favoured as earlier fuelwood crops) (Hughes pers. comm., Simons pers. comm.).

The other main area of intervention aimed at improving the situation of rural households dependent on fuelwood was encouraging and enabling the adoption of more fuel efficient

stoves. Results however, have been limited. Despite major government programmes in India, it is reported that most initiatives to promote the use of improved wood burning stoves in rural areas have had little impact (Gundimeda and Kohlin 2001). The 1996 ESMAP survey of six states showed that in most cases, less than 10% of households contained improved stoves (ESMAP 2002).

Rural households in Africa do not appear to have adopted improved stoves on a significant scale either, even where, as in Ethiopia and Kenya, they have been quite widely adopted in towns (Vermeulen 2001, ESD 2001). Assessments indicate that lack of uptake is often due to failure to understand that users value stoves for reasons other than fuel economy. For example, for safety or time saving reasons and it appears 'improved' stove designs have not addressed these needs. There are also the cost constraints of purchasing stoves (Vermeulen 2001). Some evidence suggests that where stoves are seen as saving *money* (in towns) they are more popular but where they are merely seen as saving *time* or *biomass* (in rural areas), men are not prepared to spend money purchasing them (Shepherd 1995). A survey in India found that a high proportion of rural households in 5 of 6 states surveyed, expressed interest in acquiring improved wood stoves (chulhas) if they could be purchased on credit (ESMAP 2002).

Recent attention on improved stoves has shifted from increasing fuel efficiency to reducing damage to health from air borne particulates and the noxious fumes associated with burning wood and charcoal (and dung). The World Health Organization (WHO) estimates that 2.5 million women and young children die prematurely due to breathing the fumes from indoor biomass stoves (IEA 2002). However, other reviews caution that the evidence linking indoor air pollution to increased respiratory infection is limited and that there is currently no convincing evidence that upgraded stoves improve health (DfID 2002).

A recent survey in India to assess the impact of a stove programme designed to reduce damage to health caused by stove emissions, found that women considered this a low priority issue, compared to problems such as water supply and sanitation (Parikh and Laxmi 2000). Thus, there is uncertainty relating to the extent and nature of the impacts improved stoves can have and the potential for further intervention in this area.

4.2 Certain situations can adversely affect those generating income from woodfuels

The sale and trading of woodfuels provide some income for huge numbers of people. There is ease of access both to the resource and entry into the trade. Combining this with the wide spread of rural market demand, allows large numbers of the landless to gather and sell wood for fuel and large numbers of farmers to harvest and sell it as well. Where fuelwood harvesting comes from the clearing of forest, scrub or farm bush, it can also provide short term employment for large numbers of labourers.

Much of woodfuel retailing is small scale and accessible to the urban poor as well. Overall, it is a major source of income for the poor, including some of the poorest (e.g. headloaders¹¹) and it can be one of the main sources of income from forest product activities (Box 3). For farmers who have available land not needed for food production and who are in situations where there are growing local woodfuel markets, fuelwood or wood for charcoal may become a profitable product, or bi-product, of growing farm trees.

Box 3. Woodfuel selling and trading as a source of income and employment—some examples

- In India, it has been estimated that 2 to 3 million people are engaged in fuelwood 'headloading', making it the largest source of employment in the country's energy sector. Some researchers believe this is an underestimation—for instance, a survey in nine villages in Bihar, showed that this was a major source of income for 20% of households (Khare *et al* 2000).
- In southern Africa, a study in the 1990s, on the supply of charcoal to three cities, indicated that the total number of people involved was around 125,000 for Dar es Salaam, 78,000 for Lusaka and 40,000 for Maputo. Of this total, about 111,000 were involved as producers, 2250 as transporters and 130,000 as retailers. In the areas concerned, these activities provided the main source of cash income (SEI 2002).
- In the forest zone of southern Ghana, a survey of rural employment in small scale commercial forest product activities in 1994, estimated that approximately 258,000 people were involved, from 38% of the households in the region. Of these people, 11 % were producing and selling or trading fuelwood and 2% were dealing in charcoal (Townson 1995b).

Though attention tends to focus on urban markets, the increasing commercialisation of rural fuelwood transactions means that rural markets are often growing and in aggregate, present a sizeable demand. For instance, in Ghana, in 1991-92, 27% of all fuelwood purchased by households and 13% of charcoal, was bought by households in rural areas (Townson 1995b). In six Indian states surveyed in 1996, rural households were on average, purchasing 13% of their total fuelwood supplies (ESMAP 2001). In a northern Thailand study, it was found that rural market demand for woodfuels was rising at a rate that more than offset a concurrent decline in urban demand (Panya *et al.* 1988 in Townson 1995a). However, urban use usually dominates trading in woodfuels and because of its concentration, can have particular importance for forestry.

For some of the people engaged in woodfuel production, selling or trading, such activities represent their main source of income. For example, a study investigating the areas supplying charcoal to three cities in southern Africa (Dar es Salaam, Maputo and Lusaka), found that these activities provided upwards of 70% of the cash income of the rural populations involved (SEI 2002).

Many instances are recorded where woodfuel gathering and trading activities are associated with land clearance and the formation of farms and therefore this declines as the farmers involved move beyond that phase in the farm cycle (e.g. Townson 1995b in Ghana, Wunder 1996 in Ecuador). Elsewhere, involvement is associated with other aspects of the life cycle. For example, in East Africa, it is often young men before marriage and older, poorer men whose children have left home who are found doing these activities. For others, woodfuel gathering and trading helps bridge seasonal gaps in income (Falconer 1990) or generates working capital to finance the start of a new agricultural or trading year (Leach and Fairhead 1994). It also widely serves as a 'safety net' activity in times of hardship (Townson 1995a). For example, as observed in the increase in the number of people involved in woodfuel selling in Zambia when crop incomes fell (SEI 2002) or in fuelwood trading in South Africa as urban job opportunities shrank (Gandar 1994).

Contrary to the widespread assumptions about disproportionate returns accruing to middlemen, studies of returns at different points in the supply chain have usually indicated

they are reasonably equitable (e.g. Boberg 2000 in Tanzania, Leach 1993 in Pakistan [in Townson 1995a], Wunder 1996 in Ecuador). However, in some of the larger and more complex supply systems, such as those supplying charcoal to cities in West Africa, studies have found a high degree of control by merchants, who may substitute their own employees or contractors to replace local producers (Ribot 1998, Dewees 1991, Townson 1995a).

There are other ways in which the growth in woodfuel markets and trading can have differential impacts on those taking part. Growing market opportunities can cause diversion of local woodfuel supplies from 'own use' to sales. This can result in conflicts between men favouring income and women who need continued supplies for household use (Falconer 1990, Manvell and Shepherd 2001). Although women often handle small scale fuelwood selling, as it increases in scale and becomes directed more towards urban markets, it tends to get taken over by men (who are more likely to have access to transport). This can deprive the women of an important source of income with which to meet household expenses (Vermeulen 2001).

Moreover, although it provides opportunities for such large numbers of the poor, the ease of entry into woodfuel trading means that it is usually characterised by strong competition and very low returns¹². For instance, fuelwood headloaders in Ethiopia (Haile 1991 in Townson 1995a) and India are amongst the poorest in their communities. Similarly, in the charcoal sector in southern Africa, low prices prevent producers investing in improvements in productivity (SEI 2002).

Dependence on such low paid activities, declining longer term market prospects and limited potential for improvement, can make reliance on income from fuelwood selling a livelihood of last resort. Many of those taking part may best be assisted by helping them to move into more rewarding, alternative activities as these become available. In his review of studies on woodfuel trading systems, Townson (1995a) found that involvement with woodfuel selling does decline where there are alternative sources of income—e.g. farmers in northeast Thailand withdrew from fuelwood selling when farm incomes improved (RWEDP 1991 in Townson 1995a).

Competition from woodfuel supplies 'mined' from existing natural wood resources exerts strong downward pressure on prices and

limits the potential for farmers to produce woodfuel as a cash crop from planted and managed farm tree stocks. A paper by Dewees and Saxena (1995) illustrates this in a comparison of three different situations. Firstly, in the Sudan, the availability of abundant cheap supplies of raw material for the charcoal industry from land clearing has meant production by farmers is simply not viable. In central Kenya, some of the farm woodlots originally developed to produce other tree products are now able to compete in supplying the charcoal industry. Finally, in parts of northern India, farmer tree growing emerged in response to market signals and government incentives but it was largely abandoned in the face of competitive and policy constraints that in practice, severely curtailed its profitability.

However, there is some evidence, albeit only anecdotally at times, that trees grown on farms are becoming a more significant commercial source of woodfuels. For instance, in the largely deforested province of Cebu, in the Philippines, the bulk of traded woodfuels come from farm trees (RWEDP 1993 in Townson 1995a). In southern Ethiopia, flourishing fuelwood and charcoal (and pole) markets have developed along roads in areas where many farmers have established farm woodlots (Jagger pers.comm.). Similarly, a small but growing share of the wood feeding the charcoal markets in Dar es Salaam is reported to now be coming from woodlots (Yahya 2001). In western Kenya, as local markets for fuelwood emerged and grew, farmers who were already producing fuelwood for their own use increased their on-farm planted tree stocks in order to produce fuelwood for sale as well (Scherr 1995).

Impacts of regulatory interventions

In contrast to fuelwood gathering for 'own use', gathering for sale has historically been widely subject to charges and restrictions imposed by forest departments (and nowadays, often local level bodies) to control what is being harvested and also, to generate revenue. In practice however, such fees usually prove difficult to collect. The in-depth study of three charcoal supply systems in southern Africa (SEI 2002) found that in the area around Maputo in Madagascar, only about 1% of the fees and other charges are actually collected, while in Zambia it is about 10% and in Tanzania, about 25%. Yet, as the same study points out, the possibility that charcoal production and trading could be liable for the full level of

charges can itself negatively affect the development of these activities (for instance, by discouraging investment in improved kilns or resource management).

Devolution and decentralisation of forest management (i.e., the transfer of rights to use forests and authority to manage them, to the local level) is supposed to transfer an increased amount of the rental revenue from productive activities such as woodfuel selling, to local producers. However, it has generally proved to be only partially successful in doing so. As has been widely documented, forest departments have usually retained considerable control and often maintain continuing rights to a share of the revenue.

For fuelwood sellers, a more direct consequence of local collective management programmes is that they have often been required to give up fuelwood harvesting until the resource has been put on a more productive footing. Monitoring of the longest running JFM project in India, in the southwest of the State of West Bengal, has shown that the benefits accruing from management have in due course included an increase in the availability of fuelwood (Pattnaik and Dutta, 1997). However, those who had been dependent on fuelwood selling for their income were unable to draw on these sites to maintain this activity for a number of years. Detailed studies of the forest management models being introduced have indicated that, although most user groups within local communities benefit from the changes, the poorest fuelwood headloaders are left less well off (Hill and Shields 1998)¹³.

Other evaluations of the JFM process have drawn attention to the fact that women, who are often particularly dependent on fuelwood headloading as a source of income, are often disproportionately disadvantaged by the changes that arise. The restrictions on fuelwood harvesting can lead to JFM excluding women and this can add to the harassment they are subject to when forced to harvest fuelwood illegally from other areas (Sarin *et al.* 1998, Khare *et al.* 2000, Locke 1999). Some JFM projects have attempted to address such issues by compensating ex-headloaders with cash payments, while others have provided alternative sources of employment and income (World Bank 2000). However, questions have been raised as to whether these measures are always appropriate or sustainable.

In dry forest areas in West Africa, where wood for commercial production of charcoal

constitutes the main output, conflicts have arisen between the communities with rights over the resource and the merchants who have been granted licences (by the controlling authority) to harvest woodfuels. The extent to which decentralisation and devolution of rights over local forest resources have vested communities with real power to control the granting of such licenses and the way they are implemented, varies from country to country. However in general, forest departments retain considerable control and they (and often local authorities as well) can be more responsive to merchant pressures than to the interests of local people participating more fully in the benefits of the trade (Ribot 1999, Kerkhof *et al.* 2001).

A long running programme to develop 'fuelwood markets' in a number of West African countries, with support from the World Bank, has sought to put the production of woodfuel on a more sustainable footing and increase the returns to communities in the producing areas. Communities are granted formal control over their areas of natural woodland and are given exclusive rights to the sale of all fuelwood produced. In return, the villages enter into an agreement to manage the woodland sustainably. Funding for the government and the participating communities comes from differential taxation of woodfuel sales in the urban markets. Supplies from uncontrolled sources are taxed more heavily than supplies from the 'fuelwood markets' and suppliers close to the urban areas are taxed more heavily than those from more distant areas.

Recent evaluations of the projects in Niger, where there has been more than a decade of experience and in Mali and elsewhere (Foley *et al.* 1997, Kerkhof *et al.* 2001, Bertrand 2002), show that some fuelwood market structures have made progress but much remains to be done if such systems are to become widely effective. In Niger, it was found that organised markets covered only part of the trade and that this share was actually in decline. Controls were poor, often deteriorating and open to manipulation by corrupt forest service and local officials. Only 10% of the tax due was being collected and tax revenues were often being diverted elsewhere rather than back to the producer communities and the project. Costs of management plans and controls were also high.

In short, the functioning of these earlier initiatives has been hampered by the complexity of their design, the scope for corrupt manipulation and difficulties in

preventing competition from cheaper, uncontrolled sources. The evaluation reports argue that the fact some have survived is evidence that they have a role and should be persisted with. 'Fuelwood markets' do have the real advantage of being based near the resource rather than in towns. It is argued that what is required is a simplification of the complex procedures and differential taxation system, along with local producer entities being given stronger legal presence and safeguarded against forest service interference.

Combinations of taxes and subsidies have also been used to attempt to curb woodfuel production from natural forests, in favour of plantation supplies. In Malawi, again in a World Bank supported project, taxes were imposed on woodfuel being transported into urban markets, while smallholders planting trees for woodfuel were heavily subsidised. However, to limit the consequent rise in urban woodfuel prices, woodfuel was sold from government plantations at below the price from other sources—which had the effect of discouraging farmers from producing for the market. Costs of the scheme were high and the efforts to stop flows from forest sources proved impossible to implement successfully (Deweese 1995b). In addition to such attempts to control patterns of woodfuel supply through price manipulation, some governments intervened to keep prices to urban users low for political reasons, to the detriment of farmer managed production (Deweese and Scherr 1996).

Various other forestry-related measures can change woodfuel supplies in ways that impact upon supplier livelihoods. On occasion, large scale land clearance, forest management operations (Kumar *et al.* 2000) and even big plantation programmes (Saxena 1997), have produced such substantial quantities of woodfuel as to temporarily depress prices, at the expense of small suppliers. Policies or regulations that restrict access to a category of resource (such as logging bans or the re-gazetting of a forest as a protected area) can force suppliers to divert their harvesting elsewhere and can be similarly disruptive (Vermeulen 2001, Barnes *et al.* 2002).

Overall, institutional measures that the forestry sector has initiated and administered have usually not proven to be very effective in bringing about an orderly evolution of commercial woodfuel supply and trading. In particular, it has been difficult to develop and put in place institutional systems and

procedures that allow local producers to capture equitable returns and which encourage investment in the sustainable management of woodfuel resources. It appears that the transaction costs of trying to control collection from natural forests and differentiate in the marketplace between fuelwood from natural and planted sources, are too high in comparison with the value of the wood being traded.

4.3 Woodfuel harvesting and use can have negative conservation consequences

The application of location theory in explaining spatial patterns of agriculture and other land uses indicates that woodfuel demand in large and growing urban areas is likely to lead to large scale tree removal in periurban zones, spreading progressively further out into a given city's hinterland as the population increases. The analysis in the ESMAP study (Barnes *et al.* 2001) of data from 46 cities shows a pattern of forest depletion that is initially heavy near urban areas but this slows down, as cities get larger and wealthier. This pattern is consistent with the earlier discussion on fuel substitution during the urban energy transition process.

However, this study points out, as do others (Cline-Cole *et al.* 1988, Townson 1995a), that several factors can be involved and their interaction in different situations can result in quite different outcomes. The periurban areas in which fuelwood production is likely to be concentrated in the early stages of urban growth are likely to be areas that are also under pressure from clearance for agriculture. Therefore the patterns of deforestation could be explained just as much by this as the growing urban demand for woodfuels (which may not be depleting wood stocks beyond what would be cleared anyway).

A number of the studies consulted show that fuelwood supplies to urban markets were in fact being sourced mainly from farm clearance rather than forest areas (e.g. Wunder 1996, Demenou 1997, Yahya 2001, Townson 1995b, Ninnin 1994, SEI 2002). When much of the land being cleared is used for shifting cultivation, it is likely to regenerate to woody cover of some kind, contributing to future supplies available for woodfuel use.

Patterns of supply also reflect the state of the road infrastructure and the value of alternative uses of tree stocks close to urban

markets. For instance, as the population in the northern Nigerian city of Kano started to grow rapidly, increased woodfuels did not come through harvesting the substantial managed tree stocks in the well established agroforestry systems in the periurban zone. Rather, an improving road infrastructure and transport system was exploited to tap more distant forest and woodland areas (Cline-Cole *et al.* 1988).

The ability to expand supplies in this way appears to have contributed to the relative stability in the real price of woodfuels in urban markets, over lengthy periods of time. This is observed in a number of studies and has occurred even as use has grown rapidly. Of the southern African cities studied, the charcoal price in Dar es Salaam and Lusaka fluctuated around the same level for more than 20 years and in Maputo, it only rose substantially during the war years.

Similar instances of significant price rises being attributable to external factors rather than resource scarcity have been documented in west Africa (Cline-Cole *et al.* 1988, Manvell and Shepherd 2001) and in south Asia (Leach 1986). The usual economic signals of shortage that price rises provide are therefore often not present, which helps explain why, without this link, depletion of physical woodstocks often does not trigger investment in maintaining woodfuel supplies. This feature of woodfuel supply and demand is clearly important in assessing what kinds and forms of intervention might be viable and appropriate.

As the use of charcoal, with a much higher value to weight ratio, comes to surpass fuelwood in a given city, sourcing may occur at considerable distances from the metropolitan area. Most of the charcoal for the large coastal cities in West Africa, for instance, comes not from the adjacent high forest zone but from the dry forests further inland, where it is often the main wood product harvested. As the raw material needs to be processed into charcoal close to its point of origin to be competitive, its production can cause a substantial drain on nearby forest stocks (Townson 1995a).

Harvesting to supply charcoal production can result in the clearfelling of all sizes of wood and most woody species (SEI 2002). However, some recent studies (Ribot 1999, Kerkhof *et al.* 2001) have argued that the levels and intensity of harvesting are generally not out of balance with the productive capacity of the wood stocks involved and that where problems arise, these are due to failure to manage the

woodfuel production in a manner that allows for regeneration and sustainable production. Much of the impetus behind the 'fuelwood markets' initiatives discussed above and other moves to strengthen local involvement in and commitment to, forest management, relates to concerns about bringing unregulated levels of woodfuel production under better control.

Clearly, there are situations where woodfuel production is causing destruction of the forest resources being drawn upon but apparently this is not as widespread as is frequently assumed. However, the in-depth studies of the charcoal supply basins around three cities in southern Africa, show how harvesting, though it contributes to only limited deforestation, can materially alter the woodstock resources where extraction is taking place (SEI 2002). These are areas where charcoal is the principal forest output but where only a minor part of the areas harvested are being cleared solely to supply the charcoal trade.

In the area supplying Dar es Salaam, changes to the closed and open woodland and bush areas were recorded. The extent of closed woodland diminished during the decade studied, with the lost parts being transformed mainly into open woodland and bush. Areas of open woodland at the start of the period were reduced as cutting downgraded parts of them to bush. Some parts of the initial area of bush regenerated to woodland but other parts were further depleted or lost to cultivation—as were parts of the closed and open woodland.

Regrowth on all but the areas put under continuous cultivation ensured a considerable measure of regeneration of wood resources but at far less than its potential. Felling in excess of regeneration was concentrated in areas along roads and around villages. In such places, pressure to generate income could result in the damaging cutting of all species in some less well endowed locations and even the cutting of stumps and tree and bush cover on slopes and other fragile sites. In areas more than 10km from the road though, harvesting was found to be within sustainable limits.

Patterns of the impact of woodfuel harvesting on wood resources can therefore be quite complex. Even charcoal production is likely to have only a limited impact on forest or woodland loss but by depleting preferred species, favouring coppicing species, etc., the composition and biological productivity of the resource can be adversely affected (Vermeulen 2001). In some cases however,



Young Kenyah girls of Gemar, bringing home firewood in East Kalimantan, Indonesia. (Photo by Carol J.P Colfer)

woodfuel harvesting can contribute to converting a resource into something of more economic value to the users. For example, by controlling the encroachment of woody vegetation on grasslands of importance for grazing (Kgathi 1994 in Vermeulen 2001). In addition, it can stimulate the more active management of woody biomass on farmland (Vermeulen 2001, Manvell and Shepherd 2001).

5. Discussion

The picture that emerges from the preceding review of available information is quite a complex one. There are usually a number of different categories of woodfuel users, with each drawing supplies from a variety of sources. Meeting the needs of one group of users may adversely affect the interests or situations relating to other groups. For instance, rural users often have to compete with demands from urban and industrial users and amongst the rural users themselves, the interests of subsistence users may conflict with the interests of those able to participate in woodfuel markets (and vice versa). Privatisation of rural land resources can be advantageous for those able to invest in tree growing to provide their own woodfuel supplies. But it can disadvantage the landless, who

continue to rely on access to common pool resources. And so on.

Another characteristic of the woodfuel situation that makes it difficult to identify and deliver effective interventions is the set of features that keep prices low, even as demand increases and supplies have to be obtained from further afield or through more intensive exploitation. Unless prices rise, there is little incentive for producers to invest in woodfuel resources or for users to move to other, more efficient fuels. The low value of woodfuels also makes it difficult to develop interventions with transaction costs that are compatible with the value of the benefits they could generate.

Consequently, there are probably few solutions that the forestry sector can apply across the board in dealing with woodfuel demand and supply issues. It is likely that many will need to be tackled on a case by case basis. Others may require further discussion or investigation before it becomes clearer what the role of forestry should be. In this section, we set out some of the main options and issues that appear to require further exploration. It is thus intended more as a basis for discussion, rather than as a set of prescriptions for action by forestry¹⁴ (though where these are evident they are identified).

The following discussion is organised into three parts, to cover:

- The place of woodfuels in the broader forestry and energy context
- Identification of possible forest sector initiatives and responses
- Issues that appear to need further investigation

5.1 Overview of the broader context

Though the use of woodfuels is not growing at the rates assumed in the past, the quantities used and the numbers using them are still huge. Both forest and energy sector studies estimate that in parts of the developing world, the level of woodfuel use will continue to be very high for the foreseeable future, particularly in rural areas. In addition to the implications for forestry, this has important energy, development and poverty reduction dimensions.

Although wood is the principal source of energy for cooking and heating for so many poor people, it is the least efficient—being a low density form of energy that is used in thermally inefficient devices. Unless people have access to technology able to convert wood and charcoal into modern forms of energy like electricity, the real costs of energy from woodfuels can be high even for the poor. Lack of access to more efficient energy sources can also be an important constraint to livelihood enhancement and broader economic improvement. Energy policies therefore tend to focus on helping users to move from woodfuels to more efficient fuels.

Forestry initiatives clearly need to be compatible with this objective of helping poor users move up the energy ladder. The main task for forestry though, is likely to be facilitating access to supplies for those who continue to depend on biomass fuels, for their own use or as an important source of income (from their production and trading). A central argument put forward in the earlier reassessment of the implications for forestry (and agroforestry) regarding woodfuel demand and its production and trade, was that the task of meeting this demand should be recognised as being an integral part of forest management, rather than being in need of responses largely developed separately from the rest of forestry.

This reflects the findings that alternative responses to fuel shortages are often better adapted to the needs, constraints and priorities of poor users than investing in tree growing

can be. Where more intensive tree management is appropriate, this needs to reflect the multiple roles that trees and tree outputs play in rural livelihoods. Fuelwood and charcoal are two of the many material forest outputs that subsistence users and the market require. The management of forests and other tree stocks needs to integrate meeting demands for woodfuels with meeting the demands for other forest outputs and services.

One conclusion that emerges from the present review is that arguments about special programmes and initiatives to address woodfuel demand being neither needed nor appropriate in most circumstances, have been widely acted upon. Yet the need to incorporate woodfuels more fully into the forestry mainstream has not. Despite the growing focus on giving forestry a stronger livelihood orientation, woodfuels have not received attention commensurate with the fact that they are amongst the main forest related inputs into poor household systems almost everywhere.

This may be partly due to a delay in response. Forestry agencies may not yet have worked through the implications of the winding down of special woodfuel programmes that took place in the late 1980s and early 1990s, once it was accepted that these were not needed. It may also reflect a measure of misunderstanding about the messages coming out of the reassessment literature. Writing about the experience of the large and long running Rural Wood Energy Development Programme in Asia (RWEDP), Koopmans (2002) suggested that the relative neglect of woodfuels in the 1990s has been because the arguments for moving away from the earlier fuelwood focus in forestry have been widely misinterpreted as meaning that woodfuel use is rapidly diminishing.

It also appears that the process of adjustment away from fuelwood-centred programmes may have been affected by the increasing attention being paid to non-wood or non-timber forest products (NWFPs or NTFPs), within participatory and livelihood oriented forestry approaches. In some instances, woodfuel is specifically excluded (e.g. FAO's definition of NWFP), while in others it has simply not attracted the same focus as say, fruit, fodder, handicrafts or medicinal products. It could be argued that fuelwood has in a sense, become stranded between timber and non-timber in the current approaches to forestry and development.

At the national level, supply issues calling for intervention are likely to be associated with urban areas where demand for woodfuels is still growing, particularly where this demand is for charcoal. However, the importance of woodfuels in the livelihoods of the rural and urban poor raises issues applicable more widely.

For rural households, the priority is likely to be creating an environment that enables users to develop solutions they can implement themselves. For urban households, the main concern is likely to be facilitating the transition to more efficient energy sources or alternatively, facilitating access to technologies that use woodfuels more efficiently. In both rural and urban areas, a further priority will be enhancing access to viable income earning opportunities arising from woodfuel production and trading. In the rest of this section we examine particular areas in which forestry action may be needed and look at issues that appear to warrant more attention and investigation.

5.2 Possible forest sector responses

Potential forest sector initiatives are discussed within a framework of three broad forest policy areas:

- Local management of common pool woody resources
- Farmer management of on-farm tree resources
- Trade and markets in woodfuels

5.2.1 Locally managed woody resources

With respect to woodfuels sourced from common pool resources, the issues that arise are to a large extent, the ones that are also central to the devolution of the control and management of forests as a whole. More specifically, real transfer of power needs to occur, with rights entrenched in law and backed up with effective mechanisms for supporting and protecting these rights. Local institutions need to be accountable to their members and able to manage on their behalf. Conflict management mechanisms are also required to deal with differences relating to how the resource should be used, both within the user community and between the community and outsiders. Woodfuel related issues therefore need to be addressed as part of this broader framework.

Effective transfer and enforcement of local rights to the resource

Where real transfer of rights does not occur (or effective measures are not put in place to protect local communities in exercising their rights), communities that have a resource with a major potential for woodfuel production are likely to encounter difficulties with external commercial entities wishing to exploit that potential. Where the devolution of control and management of local forest resources has taken place, there has been some progress in this area.

However, as noted in the earlier discussion on the charcoal producing woodland areas in West Africa, much remains to be done to achieve workable and viable arrangements, even in such long running initiatives as the 'fuelwood markets' programmes. The issues that remain to be resolved include identifying the appropriate role of forest departments and dealing with the problems posed by community leaderships that have interests at variance with those of their members. Also needing to be addressed are the difficulties in devising and implementing control and management mechanisms that do not involve transaction costs disproportionate to the value of the woodfuel outputs.

Equitable access by fuelwood users to locally managed resources

Though it is usually the poorest within the community who are most dependent on woodfuels, these people are often the least likely to have equitable access to the resource. Fuelwood harvesting in locally managed resources is often curbed or banned in order to put the resource under more productive management. Also, decisions about resource management within a user community are often dominated by men, who favour usage that produces products of higher value, at the expense of meeting the fuelwood needs of women. External support from the forest sector may help by developing forest management practices that better reflect the balance of needs within the user group, minimise the disruption to fuelwood use or assist those previously dependent on fuelwood trading to find alternative sources of energy or income. Again however, difficulties tend to arise in developing solutions with acceptable transaction costs.

Protecting access by the landless to common pool woodfuel resources

Land titling and other forms of *de facto* privatisation of land can provide incentives for landholders to invest in creating and managing wood resources. But for those without land, the loss of access to common pool biomass resources can leave such people without sources of woodfuel that they can gather. As these sorts of land policy decisions are made outside the forestry sector, there is usually not much that forestry authorities can do directly, other than to flag these issues at the policy level in connection with proposed changes to land tenure. Intervention may also be appropriate to assist users to evolve new 'tenurial niches' that will continue to give them some access to woodfuel resources in the new landscapes. It could be argued that the enthusiasm in some countries for turning open access resources into communal forests is because it may enable users to benefit from the group rights and hopefully, protection from outsiders that this can bring.

Creating additional common pool woodfuel resources

When the Social Forestry woodlot programmes to create additional communal woodfuel resources in India, in the 1970s and early 1980s, were deemed not to have met this objective sufficiently, the response was to abandon this approach in favour of the quite different Joint Forest Management (JFM) initiatives on reserved forest lands. Most other countries followed suit. However, it could be argued that quite a lot of what has emerged since the Social Forestry experience could lead to revised or new approaches to enriching the wood resources on village lands, which could prove more appropriate and effective in providing fuelwood for the rural poor¹⁵.

For instance, *Prosopis juliflora*, an invasive shrub widely introduced into drylands in India as groundcover, has spread rapidly and now forms a major source of fuelwood on communal lands. A recent project to collate available information about it has shown that better choices of planting material and improved management and use technologies can markedly improve its usefulness (e.g. Pasciecznik 2001). Questions may arise as to the cost effectiveness of such interventions when applied to such a low value resource but the exercise does illustrate the potential for low input woody cover other than forest trees, as a source of affordable woodfuel.

5.2.2 Management of on-farm woodfuel resources

The earlier analysis that woodfuel shortages in rural areas are more effectively addressed through households choosing from the options available to them, rather than by forestry interventions to provide fuelwood plantations, appears to still be valid. However, little attention seems to have been given to what forms of enabling environment people need in order to assist this process.

The shift to individual land tenure should create a more secure basis for tree management by farmers. This is illustrated for example, in the widespread increases in spontaneous tree planting that have been well documented on farms in the better watered areas of eastern Africa (Warner 1993). However, households can only assess the relevance and potential of trees and shrubs as a component of their land use system in terms of the species and knowledge available to them.

There appears to be more scope for interventions that could increase the spectrum of low cost, multi-purpose woody species and husbandry options available to farmers. Broadening their choices could in turn, increase their supply of fuelwood as a co- or bi-product of wider strategies for incorporating and managing on-farm trees and shrubs (Scherr 1995). This is not an argument for revival of the planting of 'fuelwood tree species'. Rather, it puts forward the case that the decline in attention to fuelwood as a co-product of farm and agroforestry systems (noted earlier), now seems in need of review.

5.2.3 Generating income from woodfuel trade and markets

Urban demand for woodfuels remains the area most likely to have an impact on forest resources and potentially, is the most amenable to forestry intervention. The information on recent trends in urban demand reviewed here, shows that it can change much more sharply than had previously been thought. Though fuelwood use in some urban areas is growing rapidly, in others, substitution by other fuels is eroding the share and even the volume, of fuelwood being used. However, in many situations charcoal is the main fuel that is replacing fuelwood and where this is occurring, charcoal use is often growing rapidly. The following paragraphs highlight some aspects of these changes that could require more attention from forestry.

Identifying conditions for livelihood-friendly involvement in woodfuel trading

Market demand for woodfuel can provide an important source of income for the poor but reliance on it can impede progress out of poverty. Changes in the size and structure of the trade can also expose those involved to the risk of declining income. There is hence a need to better understand the conditions in which expanding urban demand for fuelwood or charcoal can provide useful income and how it is best to support those engaging in it. By comparison with other major non-timber forest products, the dynamics of producer-to-consumer relationships in woodfuel supply systems have been the subject of relatively little study. So there is only limited information about what could be done to avoid or alleviate problems relating to production and trading inefficiencies, resource depletion or the exploitation of small producers. Yet, as studies of the charcoal trade in parts of Africa and South America indicate (Ninnin 1994, Ribot 1998, SEI 2002, Wunder 1996), charcoal can become both the main forest product output and a principal source of income in a region.

It is important to identify when assistance needs to focus on helping participants to diversify into other income generating activities. Woodfuel harvesting and selling, with low entry thresholds, are mainly activities available to and engaged in by the very poor, who have few income earning alternatives. The study of areas supplying charcoal to cities in southern Africa (SEI 2002) shows that declining prices or increasing costs rapidly eroded the viability of these activities for poor participants. In fuelwood trading, these participants can also suffer when urban demand for that fuel declines.

Forestry, in identifying needs for interventions to support woodfuel activities, will also need to be alert to the often substantial changes that can take place as rural economies develop. The expansion and upgrading of rural infrastructure improves access to markets but also facilitates the emergence of other rural income earning opportunities, which may reduce the attraction of woodfuel harvesting and selling and enable people to shift to other activities.

Revising regulatory regimes

Regulations governing the sale and trading of woodfuels and restrictions on participants' access to, and competitiveness in markets, can impose significant constraints on who can participate and can also create trade and market distortions. As noted earlier, this can

take the form of competition from subsidised woodfuel supplies from government forests, or taxes and other charges to generate government revenue from the trade. It can also come in the form of restrictions imposed in the name of conservation and the prevention of 'excessive' forest harvesting (Deweese and Scherr 1996). Such interventions are often unnecessary, counter-productive or poorly designed and implemented. They need to be critically examined and where necessary, removed or revised.

Another important issue is that of the general failure of licences and fees, designed to raise prices closer to replacement values and capture some of the revenue in ways that could contribute to meeting the costs of management and regeneration. The reports reviewed here, which examine exercises to implement such mechanisms to control charcoal production in west and southern Africa (Kerkhof *et al.* 2001, Bertrand 2002, SEI 2002), argue that these shortcomings are best addressed by implementing the controls more effectively. However, as the SEI (2002) study points out, this would raise costs for producers and lead to higher prices for urban users. This in turn, could result in considerable hardship for producers and aggravate existing problems of poor productivity by making it even more difficult to invest in improved kilning practices (SEI 2002). It could also create hardship for poorer users by forcing them to move to more costly, alternative fuels.

Applying more rigorous controls is therefore not a solution that could be implemented just within the forest sector. It would need cross-sectoral support. Also, as experience has shown, it is extremely difficult to pursue as long as producers can shift to other areas where they can avoid such restrictions. Questions have been raised about the efficiency of such controls as well and whether the benefits are commensurate with the costs of enforcing such regulations, in operations as disperse and transient as woodfuel production and trading (Hofstad 1997). It would appear therefore, that this is an issue that requires further exploration, particularly in areas where charcoal is a major forest output and where its production is still growing strongly. In such places, it could be that this issue, together with the problem of distortions created by continued forest department involvement and rent seeking, warrant the most forestry attention.

Box 4. Implications for forest policy

Forest policy needs to act in concert with energy policy and other related policy areas, to facilitate access to woodfuel supplies for those who still rely on them, either for their own use or as a source of income.

Actions in support of livelihood amelioration and enhancement may be needed in the following areas to:

- Ensure that the reliance of the landless and very poor on access to woody resources, available as Common Pool Resources, is taken into account in the pursuit of tenurial reforms that effectively privatise communal and common lands and resources.
- Pursue collective participatory forest management initiatives in such a way as to safeguard the interests of the poorer and weaker participants, who are the most reliant on continued access to resources for their woodfuel supplies.
- Provide access to low input farm forestry and agroforestry options that support farmers with land to meet their woodfuel needs on-farm.

Forest and woodland management to produce fuelwood and charcoal would often benefit from a more appropriate regulatory environment. Key elements:

- Remove or reduce measures (such as subsidised supplies from government forests or fuel subsidies for urban users) that keep woodfuel prices artificially low and discourage investment in regeneration and management.
- Empower local level forest management bodies with effective authority, to enable them to secure an equitable share of the value their resource generates and also, avoid undue interference or rent capture by forest departments.
- Remove unnecessary or counterproductive licensing, fees and other regulatory measures that discourage communal and private involvement in woodfuel production and trading.

Monitoring of the impact of woodfuel demand and use on forest and woodland resources should focus on situations where there is, or is likely to be, substantial and rapid change. In particular:

- Areas supplying large and growing urban markets for charcoal, where interventions may be needed to put production on a more sustainable footing.
- Situations where markets for woodfuels are declining or changing in ways that adversely affect existing small producers and traders. Interventions may be needed to assist these people in responding to such changes.

5.3 Planning and data needs

Issues for policy and planning

The main areas where forestry action might be needed in particular situations are summarised in Box 4. Discussion of potential forestry applications, when dealing with circumstances defined by the characteristics of multiple categories of user, low value returns and high transaction costs, raises a number of alternative scenarios.

At one end of the spectrum of possible options, it is argued that there could often be little scope for useful and effective intervention. It is postulated that, even where it is becoming more difficult for subsistence users to obtain fuelwood supplies, this seldom creates problems that rate highly amongst the concerns of these people and they find options that meet their needs more effectively than investment in woodfuel resources would. Also, woodfuel selling is overwhelmingly a low input, low margin source of income, which tends to be replaced by better alternatives as they emerge or when users move on to other fuels. Under such circumstances, it is unlikely that interventions can be implemented to shift resource management towards a more sustainable basis. However, it is likely that the changes such interventions would bring about could undermine the comparative advantage that the poor had in the first place. In this scenario, it is argued in effect, that the interests of most poor woodfuel users could often best be served by minimal interference with the status quo.

A contrasting view is that it is necessary to intervene, in order to raise woodfuel prices to levels that reflect their real (replacement cost) values. Only in this way could investment in resource renewal, creation and management, and in improved production and processing, become viable. In this sense, intervention is also seen as necessary to encourage users to make the shift to more efficient fuels. It is argued that the difficulties poorer users and producers would encounter as prices and costs rose would stem from the unavoidable transitional impacts associated with putting woodfuel production and use on a more sustainable and efficient footing. One of the tasks of interventions would then be to help cushion these impacts on the poor—e.g. by assisting those no longer able to compete as sellers to move on to other activities or through providing credit or subsidised introductory rates to those needing to shift to other energy sources.

In practice, it is likely that different components of the woodfuel situation in a particular region will require different approaches. However, the fact that there are such contrasting interpretations about how to proceed suggests that there is more to be learned before forestry responses to some aspects of the woodfuel situation can be defined with confidence.

Forest sector data needs

In the past, the focus in gathering woodfuels data has tended to be on monitoring the impact of demand on the forest resource, by estimating woodfuel balances. This approach can still be found, often forming part of broader energy planning exercises¹⁶. However, it could be argued that, as a tool for identifying and planning forestry interventions, balance studies appear to have only a limited role. Given the ease of substitution between wood and other biomass fuels, the time scale and range of options involved in creating new wood resources for local use, and the marked differences in patterns of woodfuel use and supply that exist within most countries, national or regional balance studies may help indicate that problems exist or are likely to arise but they do little to contribute to the identification and planning of appropriate forestry responses¹⁷.

What could be more useful are single or periodic studies that illuminate spatial differences and thereby identify particular areas where problems are arising or can be expected to arise. Also, more in-depth studies are needed, such as those the Stockholm Environment Institute (2002) carried out investigating the charcoal potential in southern Africa, using remote sensing and various forms of 'ground truthing'¹⁸, to identify the nature of the changes taking place and the underlying reasons behind these changes¹⁹.

In addition, where relatively large and concentrated quantities are involved (such as those associated with charcoal supplies for a city), other methods of investigation and planning, such as sub-sector or production-to-consumption analysis, may be appropriate as well. These situations are also likely to be ones where depletion of the forest resource is an issue too. It is here that conventional forest management, plantation and farm woodlot interventions are most likely to be appropriate responses to the woodfuel situation. It is also in these types of situations, where woodfuels are becoming the main forest product of locally

managed tree resources, that the need to develop more effective governance and management arrangements can be a priority.

It is evident that we need to know more about how woodfuel use, energy policies and forestry and livelihood interventions relate to each other. For example, the review of related economic work carried out for this project found a distinct lack of knowledge in regard to how different factors affect substitution between fuels. Much more information is required about important basic relationships, like how woodfuel demand changes with alterations in income and the price of close substitutes. Developments in other policy areas need to be monitored as well. One issue that could become important in this respect is how energy policies might change in response to the increased interest in reducing the use of fuels that emit greenhouse gases.

6. Conclusions

This review supports the conclusions arrived at in the late 1980s that there is not a 'fuelwood crisis' of such a magnitude and with such potentially dire consequences, as to require major interventions devoted just to this issue. More accurate and better defined data and more realistic analytical and projection models show that demand is not growing at the rates earlier estimated. Increasing urbanisation and rising incomes are reflected in a slowing down of the rate of increase in fuelwood use and in some areas, consumption is now in decline.

Supplies are in practice, being drawn from a much wider base than just forests and users have access to a range of responses that enable them to adjust to changes in the availability of fuelwood without necessarily needing to invest in additional wood resources. Charcoal use on the other hand, is usually continuing to grow and is becoming a much larger part of the woodfuels total in some regions.

Where there are significant imbalances between supply and use, these are likely to be associated with large urban areas where demand is still growing, and particularly where this demand is for charcoal. The growing importance of charcoal production and its concentration, in order to supply large urban markets, certainly warrants attention. Where supply of urban markets does raise issues about resource depletion and the efficiency of production, studies that help map the nature and causes of

the problem may provide a more appropriate form of investigation than supply-demand balance studies.

The earlier analysis that shortages of woodfuels at the rural household level are most effectively addressed by households choosing from among the range of options available to them appears to still be valid. However to facilitate this, more attention needs to be given to the forms of enabling environment that people require. In particular, the needs of the landless and very poor, who continue to rely on access to supplies available as common pool resources, seem to be relatively neglected. While privatisation can create a more favourable environment for those with rights to land to invest in maintaining or creating woody resources, it can severely disadvantage those without land, unless their needs are recognised and also taken into account.

The potential and constraints of woodfuel selling as a source of income for the poor (urban as well as rural) also appear to be insufficiently recognised in poverty reduction initiatives, which often seem to be oriented mainly towards timber or non-wood products. In addition, the implications for poor producers and traders, of large and rapid structural changes in urban market demand for woodfuels, need to be better understood.

Woodfuels remain one of the larger outputs of the forest resource and in some situations, the largest. Wood obtained for fuel provides inputs into the livelihoods of larger numbers of people, most of them poor, than possibly any other forest product. However, the attention this receives in forest management and in participatory forestry and forest product programmes and research, is not commensurate with this level of use. Woodfuel use may be less of a concern to the security of the forest estate than previously feared, however it is a larger component of the contribution that forestry can make to poverty alleviation than is reflected in most current forest policies and programmes.

Project working papers²⁰

Bhattarai, T. 2001 Trees outside forests: the woodfuel production context. RWEDP, FAO, Bangkok.

Cooke St. Clair, P., Hyde, W.F. and Köhlin, G. 2001 A fuelwood crisis: where and for whom?

Gundimeda, H. and Köhlin, G. 2001 What do we know about the fuelwood scenario in India? Environmental Economics Unit, Göteborg University.

Manvell, A. and Shepherd, G. 2001 Woodfuel in Niger: Crisis or adaptation in the last ten years? Overseas Development Institute (ODI).

Mekonnen, A. and Alemu, T. 2001 Fuelwood situation in Ethiopia: pattern, trend and challenges. Department of Economics, Addis Ababa University.

Pandey, D. 2003 Fuelwood Studies in India: Myth and Reality. CIFOR, Bogor.

Vermeulen, S. 2001 Woodfuel in Africa: Crisis or adaptation? Literature review. ODI.

Yahya, S.S. 2001 Woodfuel and change in urban Tanzania. ODI.

Endnotes

¹ The term 'woodfuel' covers both fuelwood (or firewood) and charcoal, while the terms 'forests' and 'forestry' are used broadly to encompass, where appropriate, trees and woody resources outside forests as well as within them. The report does not deal with industrial forms of fuel based on wood or the industrial production of woodfuels.

² 'Fuelwood—Crisis or Balance? Workshop Proceedings, Marstrand June 6 - 8, 2001', Environmental Economics Unit, Department of Economics, Göteborg University, July 2002. This volume is available in printed or electronic form from eeu@economics.gu.se or www.handels.gu.se/econ/EEU/publications.htm.

³ However, the World Bank's evaluation in 1999 of its performance in implementing the 1991 forestry strategy concluded that, "The poor have been less a source of deforestation ... than the 1991 strategy assumed" (World Bank 2000).

⁴ Dummy variable—an additional independent variable introduced into an estimated regression equation in a simple binary (0/1) form, to test whether the variable (1) helps improve the fit of the estimated

equation to the available data, compared with when the variable is absent (0).

⁵ Income was measured as per capita GDP in 1997 USD, adjusted with a purchasing power parity index.

⁶ The study estimated that in 2000, 80-90% of the biomass used in Africa was woodfuel, whereas more than half of biomass energy in South Asia was met from dung and agricultural residues (IEA 2002).

⁷ This is more likely to be the case where production of wood fuels generates sufficient income to finance alternative land uses that would not be otherwise possible. Woodfuel harvesting and conversion to the new land use then work in tandem as causal factors of deforestation (Wunder pers comm, Geist and Lambin 2002).

⁸ With about 33% coming from sources on the household's own land and 13% being purchased.

⁹ Information from the survey in six Indian states indicates that as supplies have to be fetched from increasingly further away, the method eventually shifts from headloading to bullock carts, which reduces the time per month spent on obtaining fuelwood. However, 75% of households in the areas surveyed still rely on headloading (ESMAP 2001).

¹⁰ Although, as Kohlin (1998) has reported, there were instances where subsistence supplies of fuelwood also increased. His analysis of a social forestry programme in Orissa, India, showed marked welfare gains in terms of increased fuel consumption and reduced collection time, especially for women. However, the results differed greatly between villages, highlighting the need for careful targeting of interventions.

¹¹ 'Headloader'—an individual gathering or harvesting fuelwood and carrying it to market to sell (usually in bundles of a size that can be carried on the head).

¹² Charcoal selling is reported to be somewhat more rewarding than fuelwood, apparently because it has higher skill and capital entry thresholds (Townson 1995a).

¹³ It is also reported that in the middle hills of Nepal both Forestry Department officials and wealthier villagers are reluctant to contemplate management systems for community forests that would produce wood outputs other than timber (Shepherd and Gill 1999).

¹⁴ In this discussion we continue to use the term 'forestry' to encompass activities covering tree and other woody resources inside as well as outside forests, that form or could form part of the woodfuel supply base.

¹⁵ Köhlin (2001) explores the potential for successful social forestry implementation in Orissa, India, and discusses a method of data collection that could be used for more efficient targeting of such interventions.

¹⁶ See the paper by E.M. Remedio in RWEDP 2001 and other papers in that publication, for a discussion on energy planning models covering woodfuels.

¹⁷ Where balance studies are needed for forest planning, supply data needs to be disaggregated to distinguish between woodfuel from forests and from other sources. A recent initiative to revise the woodfuels terminology and definitions (FAO 2001a) moves in this direction. The Unified Wood Energy Technology (UWET) proposal makes a distinction between woodfuels that are produced directly from trees and those that come from industrial wood waste or other sources (e.g. reused wood). However, it does not distinguish, in regard to woodfuels obtained from tree sources, between supplies from forests or from trees and other woody plants outside forests.

¹⁸ 'Ground truthing'—carrying out studies on the ground in the area being studied to help analysts interpret the remote sensing data more fully and accurately.

¹⁹ The RPTES survey in six countries in west Africa (Ninnin 1994) is another example of a study designed to show spatial patterns of the overuse or prospective overuse of woodfuels, in order to identify where problems exist or might appear within national aggregates. A third example is a project, supported by the FAO Wood Energy Programme and tested in Mexico, to develop a methodology for creating 'woodfuel sustainability maps' (FAO 2001b).

²⁰ These papers, together with Broadhead, J., Bahdon, J. and Whiteman A. 2001 (see references below), are included in the Proceedings volume 'Fuelwood—Crisis or Balance? Workshop Proceedings, Marstrand June 6 - 8, 2001', available from eeu@economics.gu.se or www.handels.gu.se/econ/EEU/publications.htm

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