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FUELWOOD: HOW MUCH DO WE NEED?

by: D. G. Donovan

As the price of petroleum products continues to rise, it becomes increasingly more clear that the peasant populations in many developing countries will be forced to rely upon traditional fuels for quite some years to come. Even many urban residents and small-scale industries, who in recent years had switched to commercial fuels, have reverted to using firewood. In some districts of Nepal, especially in the more densely populated areas, where wood has become scarce and expensive, people are burning crop residues, cow dung and mill wastes as fuel. Recognizing that there is little relief in sight from rising petroleum prices and that the introduction of new energy technologies may take many years, policy-makers have begun to take a second look at wood fuel. In reconsidering the management of forest resources for fuel production, development planners are asking: How much fuelwood do we need to satisfy the needs of the population? How many trees must be planted to meet present and projected levels of demand for wood fuel? What amount of land area devoted to tree crops will this require? In many developing countries, including Nepal, foresters and energy sector analysts have only recently joined forces to find the answers to these questions.

Attempts at Estimating Demand

In the last several years many individuals and groups have addressed the problem of defining the demand for fuelwood in Nepal. In general, attempts at estimating demand have focused on current usage, assuming prevailing consumption patterns to reflect accurately consumer preferences. The estimates of average annual per capita fuelwood consumption listed in Table 1 have been culled from numerous different sources, including publications on forestry, agriculture, and anthropology, among other topics. Though not exhaustive, this schedule presents the conclusions of the major works of the past 26 years that have touched upon the topic of firewood use in Nepal.

The main objective of the majority of studies noted in Table 1 has been to provide a descriptive overview of existing social and economic conditions in various regions of Nepal. Roughly half these estimates were generated in the information-gathering process preceding

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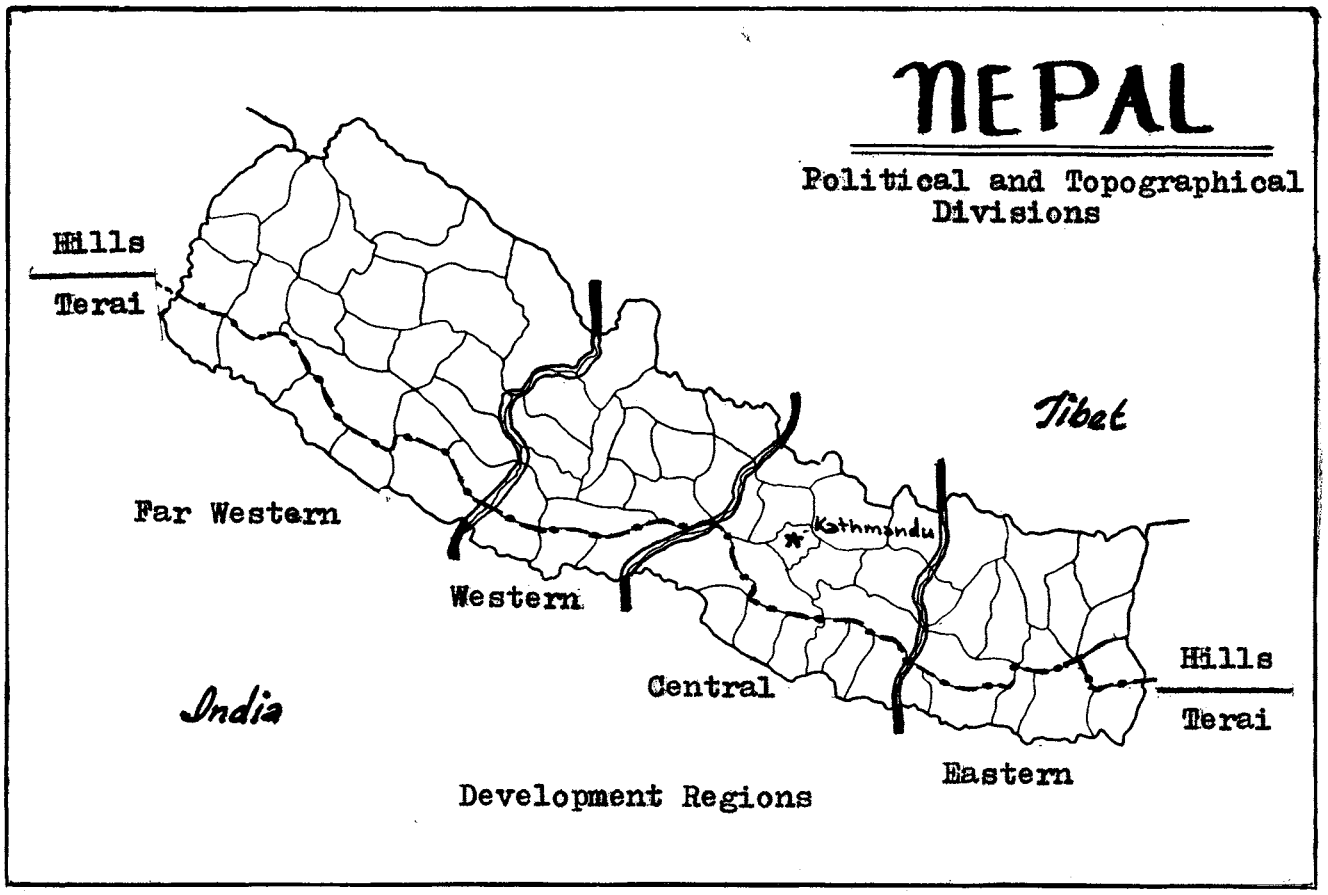

Figure 1. Political and Topographical Reference Areas

project identification and design (for example, Abell 1979, Mauch 1974, Rieger et al. 1976). The diverse geographic focus of the many foreign aid missions in Nepal and the limited exchange between these agencies has resulted in a proliferation of similar style documents on rural life. Early foreign assistance programs to Nepal tended toward a sectoral approach, and, thus, one finds the initial data on wood-fuel consumption presented, for instance, in forestry project reports (Robbe 1954; Hirshbrunner 1969). With data scarce and insufficient time to conduct extensive field research, these first consultants were forced to rely upon their own best guesses. Years before the publication of Eckholm's celebrated piece, "The Other Energy Crisis: Firewood", in 1975, forestry advisers had brought to light the extent and magnitude of wood fuel use, predicting dire consequences for forest resources if demand continued to grow apace with population.

In focusing more broadly upon the relationship of a particular regional population to its natural environment, later authors, especially anthropologists, sociologists and geographers, have provided

Table 1. Average Annual Per Capita Fuelwood Consumption, Nepal

Various Estimates
1954 - 1980

Reference [a] Area	Quantity [b] Cubic meters	Quantity [b] Kilograms	Source
nationwide	0.10*	60	Robbe 1954:3
Bhaktapur c	0.13	84* d	Rastra Bank 1974 m
western hills	0.18-0.36*	108-216	Wormald 1976:A1
Kathmandu valley	0.18	111*	NPC 1974:28
nationwide	0.20*	120	Clark 1970
Lalitpur c	0.22	136* d	Rastra Bank 1974 m
Kathmandu c	0.25	155* d	Rastra Bank 1974 m
central hills	0.26	156*	APROSC 1977
nationwide	0.33*	198	World Bank 1974
eastern hills	0.38*	228	Abell 1979:34
far west terai	0.44*	264	Moore 1974
central hills	0.46	276*	New ERA 1980:54
hills	0.52*	390 e	Earl 1973
terai	0.54*	324	FAO 1976:6
nationwide	0.57*	342	Donner 1972:354
nationwide	0.67-0.75	400-450*	Krasowski 1979
nationwide	0.71	442* d	Shrestha 1975 m
nationwide	0.75*	450	FAO 1978:88
central hills	0.75	450*	Grunenfelder 1979
far west terai	0.85-0.95*	638-713 e	Earl 1973
central terai	0.87	521*	Axinn and Axinn 1980:17
far west hills	0.88	527*	FAO 1977:15
far west hills	0.89	535*	APROSC 1978
far west terai	0.90-1.80*	540-1080	FAO 1974:sec. 5.3
nationwide	0.91	546*	ERDG 1976:15
eastern hills	0.91	547*	Burger 1978:365
central hills	0.91-6.06	545-3636*	Robinson 1978:55
western hills	0.93-1.05*	656-740 f	MacFarlane 1976:43
western hills	0.94	563*	Byers 1979:49
nationwide	1.00*	600	Schmid 1969:77
nationwide	1.00*	600	World Bank 1978a
nationwide	1.00*	650 g	FAO/World Bank 1979
central hills	1.00*	600	Mauch and Schwank 1979:51
central hills	1.08	540* h	Mauch 1974 and 1976:125
central hills	1.08	540* h	IHDP 1975:7
far west terai	1.09-1.49*	818-1118 e	Butkas 1972, Earl 1975:112
far west	1.18*	708	CEDA 1975:128
central hills	1.23*	738	Hirshbrunner 1969:App. 6
eastern hills	1.25	780* d	Bodenman 1971 m
western hills	1.33	687* i	Levenson 1979:31
central hills	1.35	810*	Howarth 1978:1
eastern hills	1.40	840*	Bajracharya 1980:3.2
central hills	1.53*	979 j	Chitrakar et al. 1974
western hills	1.55	928*	Kawakita 1979:36
far west terai	1.79-2.42*	1074-1452	Sinden 1971:8
far west hills	2.00	1200	Bishop 1976
eastern hills	2.08	1300*	Cooper 1974
western terai	2.57*	1542	Berry et al. 1974
nationwide	3.33-6.67	2000-4000* k	Rieger et al. 1976:152

continued...

Table 1. Average Annual Per Capita Fuelwood Consumption... continued

Notes:

a. East, central, west and far west correspond to government designated development regions as of 1979 (see Figure 1).

b. The mode of the original estimate is indicated by an asterisk in the appropriate column. To enable the preparation of comparable figures, the author assumed an average household size of 5.5 persons and the weight of one cubic meter of firewood to be approximately 600 kilograms. The adjustment of various volume and weight figures to metric measurement was done according to conversion factors presented in Section VII of the Commonwealth Forestry Handbook. Where it was necessary to reduce national consumption figures to per capita estimates, population totals were drawn from Kramer 1979. If within the source document assumptions as to family size and weight of wood were made, these took precedence over the above assumptions.

c. Urbanized areas in Kathmandu valley.

Individual author estimates of the weight of a cubic meter of firewood were:

d. 625 kg; e. 750 kg; f. 705 kg; g. 650 kg; h. 500 kg;

i. 517 kg; j. 640 kg.

k. On page 144 of Rieger et al., under the section entitled "Forest Administration in Practice", the authors report that according to the "Divisional Forest Offices....firewood demand is 50 bundles per family per year." Possibly then the authors' subsequent estimate on page 152 of "per capita annual fuel consumption....(of)50-100 bundles of 40 kilograms each" is a misprint.

m. Adapted from Burger 1978.

valuable insights into the complex social arrangements regarding natural resources utilization by different ethnic groups (Bajracharya 1980; Bishop 1976; Byers 1979; Kawakita 1979; MacFarlane 1976). A few recent authors have extended their work beyond a purely descriptive level in an attempt to model rural production systems (Axinn and Axinn 1980; Banskota 1979). The significance of the contribution of wildland resources to rural productivity, however, seems poorly represented in these models. In the effort to reduce tangible and intangible linkages between natural and manmade agricultural ecosystems to quantifiable factors, the rich complexity of the relationship is obscured.

Analysing the Data

The annual per capita fuelwood consumption estimates presented in Table 1 were initially expressed in a wide variety of volume and weight units, including cubic feet, hoppus feet, cubic meters, kilograms and pounds, as well as bundles, headloads and oxcarts. Moreover, estimates were presented in varying time periods of one day, one week, one month or one year. In addition, original estimates referred to diverse consumption units, primarily the individual, the family or the household. Given the economies of scale recognized in cooking, the household, and more specifically the eating group, is perhaps the most valid consumption unit on which to focus. Nevertheless, it was necessary to reduce family and household figures to per capita estimates to enable interregional and international comparison. The author made two major assumptions regarding family size and the weight to volume ratio of firewood. In accordance with official government estimates, the family--for convenience, taken to be synonymous with the household-- was assumed to include, on average, 5.5 persons. Furthermore, one cubic meter of fuelwood, presumably air-dry pieces of wood of assorted species varying in size and shape, was assumed to weigh approximately 600 kilograms. If, in the text of the source document, it was clear that the original author had made other assumptions, these assumptions took precedence and have been presented in the footnotes to Table 1.

Although the data seem to cluster around the one cubic meter mark, it is not always clear whether this is the result of corresponding, but independent, observations or the repetition of an earlier estimate. As Burger (1978) cautions, "The fact that some estimates are very close to each other must be considered with care. One estimate may have been the source, or at least, may have served as a reasonability criterion for, other estimates." Many authors are very lax regarding references. All too often visiting consultants have neglected to explain the methods used to arrive at their "expert" opinions. Consequently, it is difficult to determine what influence, if any, previously quoted figures may have had on succeeding generations of numbers.

The most outstanding feature of this collection of annual per capita fuelwood consumption estimates in Table 1 is their wide varia-

bility, over all and through time, as well as with regard to geographical area. One might expect that a growing scarcity of firewood or an increasing sophistication of research techniques would be registered in a tendency for the figures to decrease or increase respectively over the years. Nevertheless, with the estimates realigned chronologically, all together or by region, no such trend is readily discernible. From the lowest to the highest, the estimates vary by a factor of 67. If we exclude the somewhat exaggerated estimates of Rieger (see footnote k, Table 1) and Robinson (1978), within the entire group of figures this variability factor drops to 26. Apart from the estimates for the more urbanized areas of Kathmandu valley falling at the lower end of the continuum, geographical origin does not appear to influence the data. Regrouped by development region (see Figure 1) the estimates in the area group increased, so did variability. Regional averages, appeared to cluster around 1.22 cubic meter, with the exception of the western hills with a mean consumption figure of 1.02 cubic meters. The very low average of 0.66 cubic meters developed from the national estimates (excluding Rieger) probably reflects, more than anything, the poor quality of the statistics. Although national estimates would be influenced by the very low per capita consumption figures of the urban areas, with the urban population constituting only roughly 5 percent of total population, the impact of urban consumption levels should be minimal.

Apart from the wide variation of fuelwood consumption estimates, one notices the considerable disparity in various authors' assumptions regarding the weight of a given volume of firewood. Estimates as to the weight of one cubic meter of wood range from 500 kilograms to 750 kilograms. Disagreement appears to stem primarily from differences in opinion regarding wood moisture content. Although airdry wood of some broad-leaved tree species can weigh more than twice that of an equal volume of wood of coniferous species, one study found that the density of the several species collected for firewood in western Nepal varied by only 12 percent (Levenson 1979). Moisture content of freshly cut wood, however, can run as high as 60 percent or more*, being primarily a function of species and tree age, and more specifically the stage of growth. The leaves or needles, twigs and branches, for instance, contain more moisture than bole wood. The season in which the wood has been cut and the extent of time that it has been allowed to dry will also affect moisture content. The proper drying of fuelwood--to a moisture content of approximately 20 to 25 percent--will reduce the amount of wood needed for a specific heating requirement by roughly 20 percent (NAS 1980). One assumes that the authors noted in Table 1 were referring to fuelwood at the point of consumption, presumably partially dried. In the literature, assumptions as to the moisture content of air-dried wood ranged from 15 to 30 percent (Earl 1975; Levenson 1979; MacFarlane 1976).

A Closer Look

In an attempt to understand more clearly the figures presented in Table 1, the literature in which they were presented was subjected to careful scrutiny. Of particular interest was the determination of

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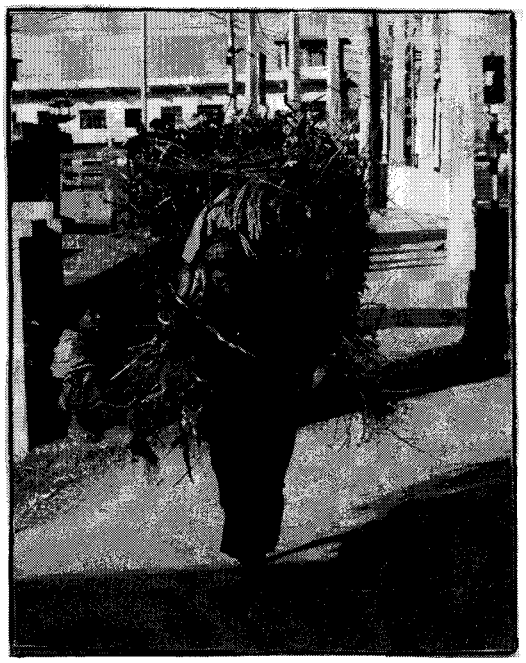
* Wet weight basis (i.e. freshly cut wood)

possible sources of variability. Two hypotheses were considered: first, that a high degree of variance is inherent in the data due to the many and complex factors influencing wood-fuel consumption, and second, that the variability has been introduced during the process of data collection and analysis.

The various factors affecting the amount of wood fuel consumed are both indogenous and exogenous to the consumption unit, that is, the family. For the vast majority of families in Nepal, energy requirements will be directly related to fuel use for cooking, heating, lighting and laundry. In most instances the demand for cooking fuel far outweighs the demand for alternative uses. In fact, one finds that it is often the remnants of the cooking fire that are used for space heating and other purposes. The energy requirements for cooking will be primarily a function of the quantity, type and method of preparation of the food to be cooked. Fuel requirements will be a function of the energy requirements plus the efficiency of the energy conversion process. Thus, the type of stove and the skill and thriftiness of the cook are important variables affecting total fuel consumption. The quantity of food prepared will vary not only with family size, but also with the physical activities, body size and age distribution of household members. Family income will affect the amount and type of food consumed, possibly the type of stove used and certainly the ability to purchase alternative fuels. Ethnic, religious or caste heritage also may influence household composition, vocations, cooking habits and dietary customs. For example, in a survey of fuel consumption in a far western Terai district, Butkas (see Earl 1975) noted lower per capita fuelwood consumption for indigenous peasants of the Tharu ethnic group, a phenomenon which he attributed to their traditionally larger family size. Bajracharya, studying food and fuel requirements in an eastern hill village, recorded a significantly greater consumption of fuelwood by those groups engaging in the production of alcohol, a task forbidden by religious strictures to certain social groups. Moreover, food items such as alcohol, clarified butter, beaten rice and sweetmeats, may be prepared by the housewife in large quantities, part of which will be sold to local shops. Regular cultural and religious festivals, generally involving lavish feasts, often continuing for several days, also boost a family's normal, everyday fuelwood needs.

Accessibility and ease of collection of forest fuel supplies as well as the availibility of alternative fuels are key parameters affecting fuel use. In a study of consumption patterns in the Terai, Browning observed that "in villages remote from the forest, consumption is much less" than "in places where there is free access to wood" (FAO 1974). Other environmental factors such as altitude, climate and season also may affect energy requirements. With elevations varying from 500 meters in the Terai to more than 8,000 meters in the high Himalayas, Nepal exhibits climatic zones varying from subtropical to arctic. Although several authors have referred to the significance of altitude on fuel consumption levels, little work has been done to prove the presumed correlation (Abell 1979; Bajracharya 1980; ERDG 1976). Kawakita (1979) noted that villagers in

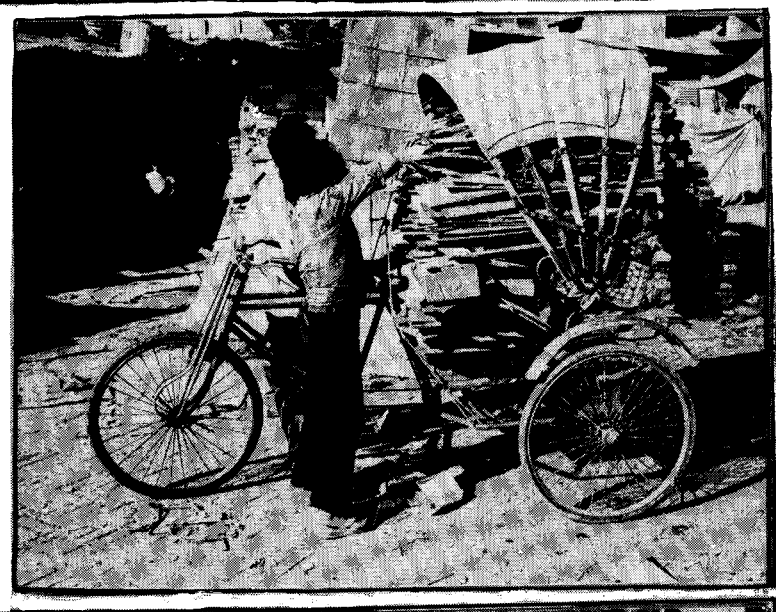


BRINGING

HOME

A

BUNDLE



EVERYONE

HELPS

the western hills reported using 80 percent more wood in the colder, dry season (November through April). In a hill village in eastern Nepal, Bajracharya (1980) observed that firewood consumption decreased in the spring months as cooking requirements fell considerably due to a scarcity of food grains. Farm management systems and cropping patterns will determine not only the amount and type of food available, but also the amount and type of crop residues and the extent of woody vegetation on marginal land, including terrace banks. Bajracharya noted that hill villagers in his study area collected approximately 14 percent of their fuel needs from the scattered trees growing around the homestead and in the small wooded areas interspersed with croplands. The presence of trees species along the perimeters of farm plots would reflect, among other factors, the intensity of demand, past and present, for fuel and fodder and the farmer's opinion as to competition between his crops and surrounding vegetation for sunlight, water and soil nutrients.

A detailed examination of the various surveys noted in Table 1 suggests that the lack of uniformity in research methods may be the most significant source of variation. Differences extend from the intent and design of the investigation through methods of data collection and analysis. The lack of a generally accepted research methodology for rural energy surveys has hampered proper data collection. As energy flows, and especially wood-fuel use, have become the focus of interest only relatively recently, one finds that the statistics presented in Table 1 were collected largely for purposes other than energy analyses, for example, forest industry feasibility studies, farm management surveys and anthropological research. Only in recent years has fuelwood consumption became of sufficient interest to warrant a separate paragraph in rural development project reports. Recent documents devoted primarily to an analysis of the energy sector give scant attention to the problems of rural community (NPC 1974; ERDG 1976; CIDA 1980).

Researchers focusing on wood fuel consumption find that wood fuel is very rarely a discrete item of regular form and standardized weight and volume. Indeed, what in some instances passes for firewood may have little actual wood content, being more of the nature of forest litter (See illustrations on pages 8 and 9). Presumably the majority of estimates presented in Table 1, estimated an average family's monthly fuel requirement at 375 to 560 kilograms, noting that "this consists of windfall branches, cow dung, animal fodder and crop residues. At present even tea bush prunings are being burnt for domestic fuel . . . ." (Berry 1979). Officially one bundle or bhari*, the common unit of fuelwood measurement throughout Nepal, is supposed to weigh one maund, a traditional weight measurement unit standardized at 37.3 kilograms. Despite government efforts at standardization of traditional measurement units, substantial variation still occurs from one locale to the next. As illustrated in Table 2, bhari weights may average above or below this mark. In recent field surveys the author has noted firewood bundles weighing from 16 to 46

* Nepalese words will be indicated by underscoring.

kilograms. Indeed, many factors such as wood form, density and moisture content, as well as the gather's preference may affect the composition and, thus, weight of the bhari.

The most common unit of observation in fuelwood consumption surveys is the family or household living group. As mentioned previously, a family will require fuelwood for a variety of household chores, including space heating, lighting and laundry, but primarily cooking, which in the Nepalese kitchen means, for the most part, the boiling and stewing of vegetables and grains. The production of food or beverages for sale to local shopkeepers may also take place in the household. In the majority of studies reviewed, the end-use of the fuelwood in question was unspecified. In some cases the authors referred to fuelwood used for cooking purposes, others mentioned firewood consumption as related to cooking, heating and lighting (Burger 1978; ERDG 1976; IHDP 1975; KHARDEP 1980; Mauch 1974; NPC 1974). Hughart's (1979) average wood-fuel consumption estimate of 0.68 cubic meter for Nepal in 1976/77 purportedly includes industrial as well as domestic consumption. Apart from the 1974 study focusing on Kathmandu Valley, fuel consumption of small-scale and cottage industries has largely been overlooked (Donovan 1979; NPC 1974). Very often, household fuel consumption for the production of commercial products, such as whiskey (raksi), beer (chang and jaad), beaten rice (chiura), clarified butter (ghee), and various sweetmeats, goes undistinguished from regular, family fuel requirements. Bajracharya (1980) noted that considerably more wood was used in the households of those groups engaged in the production of alcohol. The author also has observed the preparation of wax for candle manufacture over household cooking fires.

A diversity of data collection techniques also appears to contribute to the variability of the estimates presented in Table 1. Often one discovers that very little proper sampling has been conducted. In an attempt to account for climatic and cultural differences, the authors of the Nepal Energy Sector Study sampled a variety of population groups stratified by urban and rural characteristics and geophysical environment. Researchers admit, however, that a lack of randomization at the household level apparently resulted in a household size bias (ERDG 1976). With the difficulties of travel and communication facing researchers in this rugged mountain country, an accessibility bias is almost inevitable. Many studies, and especially those professing a nationwide scope appear to be based on geographically limited household surveys or extrapolations of statistics from neighboring countries (Clark 1970; FAO 1976). Observations or measurements made at one point in time apparently have been magnified to produce yearly estimates without regard to seasonal variations in consumption patterns. In most cases, figures have been casually incorporated into the text with little or no explanation as to their derivation or source. Occasionally, vague references have been made to field work and villager interrogation. The vast majority of estimates appear to be based either on the recollections of villagers or the subjective assessment of the observant researcher, often with little verification through regular measurement. Repeated measurement of the amount of fuel

Table 2: Average Size of Fuelwood Bundles
Nepal

Reference Region [a]	Bundle Size [b] Volume	Weight	Sources
	cubic meter	kilograms	
Eastern region			
hills	--	25	Burger 1978
hills	0.045	27	Donovan [c]
hills	0.050	30	Abell 1979
hills	--	40	Bajracharya 1979
Central region			
terai	--	20.4	Axinn and Axinn 1980
Western region			
hills	--	23	Levenson 1979
hills	0.040	30	MacFarlane 1976
Far Western region			
hills	0.050	--	CEDA 1975
hills	0.060	30	Donovan [c]
terai	--	37	Earl 1975
Nationwide	--	30	World Bank 1978a
" "	--	40	Rieger et al. 1976

Notes:

a. Government-designated development region as illustrated in Figure 1.

b. A bundle or bhari of firewood is generally assumed to weigh approximately one maund, a traditional Nepalese weight measurement unit which has been standardized at 37.5 kilograms.

c. Average of fifteen sample measurements conducted in 1979.

consumed by a household over a one year period is the recommended sampling technique, however, this procedure is seldom pursued. In very few instances have the authors mentioned any actual weighing of samples (Earl 1975; Levenson 1979). Bajracharya, in one of the most descriptive studies to date, interviewed 181 households, 31 percent of total households in the village under investigation. In addition, fourteen families cooperated by keeping daily records of their fuelwood collection and consumption for a period of one year. These tally sheets were collected on a weekly basis by survey enumerators living in the village. In another detailed study, focused more heavily on fuelwood production than consumption, Levenson has developed estimates of average fuelwood bundle weight through repeated sample measurement. However, he has relied mostly upon informer recall in the determination of estimates of average annual per capita firewood consumption. Interviews with rural villagers generally yield volume estimates in traditional, local measurement units, commonly bundles or bharis as described in Table 2 and illustrated in photographs on pages 8 and 9.

As seen from the foregoing analysis, there are numerous factors which contribute to the wide variability of the average annual fuelwood consumption figures in Table 1. Although unproven, it is very probable that the data contain a high degree of inherent variability. Nevertheless, it appears that the most significant amount of variability may be that introduced during the research process. The often quoted one cubic meter per person per year appears to have been adopted as much as for convenience in calculation as in distrust of other available estimates. In the author's opinion it probably underestimates the actual fuelwood consumption of the majority of the Nepalese population, especially in the rural areas of the hill and mountain districts. If an average size bundle weighs roughly 30 kilograms, an annual consumption level one cubic meter per person would be equivalent to a meager two bundles per family per week, or roughly one-eighth to one-tenth of a bundle per meal.* A truer estimate would probably be closer to almost three bundles, thus 1.4 cubic meters per person per year. It is interesting to note that recently completed research projects involving the author's prolonged residence in the study areas have produced estimates significantly greater than one cubic meter (e.g. Bajracharya 1980; Kawakita 1979; Levenson 1979). The considerably lower estimates of Byers (1979), Grunenfelder (1979) and New ERA (1980) were developed from survey work in areas where most of the natural forests have been destroyed, and thus, may reflect suboptimal consumption levels. For the urbanized areas of Kathmandu Valley and parts of the Terai, estimates are understandably lower. One recognizes the influence not only of the relatively high price of firewood and the availibility of alternative fuels--both petroleum fuels, such as natural gas and kerosene, and process wastes, such as sawdust and rice husks--but also of the change in eating habits. With the pressures of the more hectic urban lifestyle, people are consuming more commercially prepared food.

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* Assuming an average family size of 5.5 persons and the weight of one cubic meter of firewood to be 600 kilograms.

The phenomenon of widely divergent fuelwood consumption estimates is by no means unique to Nepal. Similar variations have been noted in statistics from countries such as Thailand and Indonesia, among others (Wiersum 1979). From Tables 3 and 4 one observes that the median national estimate from Nepal falls within the range of figures quoted from other developing countries in Asia and elsewhere. While national estimates of per capita annual fuelwood consumption can be both interesting and thought provoking, they provide a poor basis for program and project design. Inevitably, average per capita consumption figures conceal important regional, seasonal and socio-economic disparities. Thus, the gross generality of the national estimates renders them relevant to any particular locale only by chance. Although regional or local figures appear to be based more solidly on actual field research, it is equally erroneous to expect that estimates gleaned from a single, isolated village survey, may be suitable to other villages far removed from the study area. This dictum is especially true in Nepal where the great diversity of environmental conditions have significantly affected both social and economic development. Unfortunately, constraints of time and funding may force researchers to pass over significant descriptive details of local wood-fuel collection and consumption patterns in favor of quantifiable parameters that will fit neatly into a computerized data bank or project benefit-cost analysis. Focusing on numbers alone, however, the researcher may lose sight of their context, and, thus their relevance and reasonableness. Despite these difficulties and the dubious origins of many of the figures presented in Table 1, some estimates have been boldly quoted and requoted, often without citation, in ever more official and respectable documents, until a very casually contrived estimate has become the basis for policy formation and program planning.

Focus for the Future

Currently policy-makers and planners must work with wood-fuel statistics which with few exceptions are little more than educated guesses or estimates derived from partial samples and limited observations. Information regarding trends in fuelwood use over time are almost totally lacking. Our understanding of consumption patterns as related to environmental, cultural and economic conditions are sketchy at best. Although various researchers have observed that such factors as season, altitude and dietary customs appear to influence firewood use, none have yet attempted to define clearly the effect of these and other parameters on the level and pattern of fuelwood consumption. Indeed, in most survey analyses the sample data are reduced to averages, and the variation goes unexplored and unexplained. What becomes vividly clear through the investigation of data presented in Table 1, however, is the extent of our ignorance regarding materials and energy flows in rural production systems, especially with regard to the contribution of wildland resources. This shortcoming has important implications for the successful design and implementation of rural development programs and the continued productivity of associated natural ecosystems.

Table 3. Estimated Annual Per Capita Wood Fuel Consumption Selected Countries

Country and Year	Average Wood Fuel Use	Charcoal as Share of Total Wood Fuel Use	Household Use as Share of Total Wood Fuel Use
	-cubic meters-	- - percent - -	- - percent - -
Africa			
1. Gambia (1973)	1.61	26	85
2. Kenya (1960)	1.00	6	98
3. Sudan (1962)	1.66	42	98
4. Tanzania (1968)	2.29	3	93
5. Uganda (1959)	1.53	--	92
Asia			
6. Thailand (1970)	1.36	46	91
7. India (1970)	0.38	--	--
8. Indonesia (1976)	0.70	1	90
9. Pakistan (c. 1977)	1.50	--	--
10. Sri Lanka (1978)	0.70	--	--
11. Nepal (1975)	0.91	--	97

Sources:

Rows 1 - 7: Arnold, J. E. M., 1979.
8: Wiersum, 1979.
9: World Bank, 1978b.
10: Bialy, Jan, 1979 (adapted).
11: ERDG, 1976.

Table 4. Household Consumption of Traditional Fuels
National Survey Results
Selected Countries

Country	Firewood and Charcoal (traditional fuel users only)	Dung and Crop Residues (traditional fuel users only)	Total Traditional Fuel Use (traditional fuel users only)	Percentage of National Population Using Traditional Fuels
	- - - - GJ/capita/year* - - - -			- percent -
Bangladesh (1973/74)	0.41	2.15	2.56	91
Gambia (1972)	17.30	--	17.30	99
India (1970)	4.38	2.79	7.17	
Nepal (1974/75)	8.20	0.30	8.50	99
Peru (1976)	15.10	2.60	17.70	60
Sudan (1964)	14.20	--	14.20	99
Tanzania (1970)	23.20	--	23.20	99
Thailand (1972)	14.20	--	14.20	97

* Used here is the gigajoule (GJ), equivalent to one billion (10^9) joules, 0.95 million Btu, 0.24 million Kcal, or about 26 liters of kerosene.

Source: Adapted from Hughart (1979), Table I-1, page 63.

There is a growing awareness of the urgent need for more micro-level studies, specifically, investigations of resources utilization focused at the level of the village, watershed, ecological unit or ethnic group. Although the Australian Aid officials in Nepal have been running a highly touted community forestry program for several years now, it was only last year that they commissioned a survey of project area villagers in an attempt to determine requirements for various forest products, including wood fuel. In addition, project leaders felt they needed to know more about "attitudes of villagers toward various aspects of forest and forestry development" and especially those "factors that induce and/or inhibit . . . (villager) cooperation before launching any programmes that require their cooperation" (New ERA 1980).

Although few, if any of the studies reviewed above can provide an exemplary model of research methods, many should be able to offer useful guidelines for prospective investigators. As Wiersum (1979) has pointed out, "data from case studies are indispensable in the preparation of large scale fuelwood surveys as they provide information as to which are relevant questions to include and which measurements to use". Surveys should be better designed to gather information that may suggest possible points and paths of intervention. Quantitative data as to inputs and outputs should be supplemented by descriptive accounts of the processes employed and, if possible, the traditional knowledge systems underlying current practices. For example, to the technician, notes as to cooking habits, kitchen arrangement and dietary customs may seem to be merely pedantic trivia, but these seemingly insignificant details can provide some of the most important information collected in a survey accompanying stove technology development. Undoubtably, it is often the lack of attention to traditional cultural values and practices and the focus on purely technical aspects of a problem which signaled the failure of many development projects (for case studies see Evans and Adler 1979).

Conclusion

The initial response of both the government and the foreign aid community to the growing scarcity of fuelwood in Nepal has been to focus on efforts to increase production and supplies through reforestation. In some cases planting projects have succeeded admirably in improving watershed conditions, reducing soil erosion and beautifying once barren landscapes. Much remains to be done, however, in realizing the present and potential productivity of Nepal's forest lands. It must recognized by foresters and others involved in rural development that the benefits to be derived from forestry research and afforestation are, in most instances, many years away. Very likely, more immediate impacts on the level of fuelwood consumption can be realized through attention to demand, especially distribution and utilization. Researchers are investigating the possibilities for fuel conservation with the introduction of a more energy efficient wood-burning stove. The possibility of improving the efficiency of firewood utilization cannot be determined, however, from the data supplied by traditional

fuelwood surveys. A localized, detailed study of consumer attitudes and habits, including such things as fuel handling and food preparation, will be necessary to insure the development of an acceptable stove design and the successful adoption of this new technology. By increasing our knowledge of how forest products move through the community and the household, we may discover other ways to increase the efficiency of wood utilization and, thus, modify overall demand. Indeed, if we fail to come to a clear understanding of the various parameters affecting fuelwood collection and utilization, we may find the gains of increased production lost through profligate consumption.

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