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Forest Degradation in the Himalayas: Determinants and Policy Options

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9.1 Introduction

Deforestation and forest degradation in the Himalayas are a major concern for social scientists and policymakers because of the large common property externalities involved at both the global and the local levels. At the global level, the Himalayan range is one of the most unstable and fragile mountain areas in the world (Ives and Messerly 1989). Deforestation speeds up global warming and tends to accentuate the disastrous consequences of earthquakes, and is a significant contributing factor to landslides and flooding. This has a serious impact on the equilibrium of the Ganges and Brahmaputra river basins, and heightens the frequency of flooding in Bangladesh (Metz 1991).

At a more local level, the alpine zone of the Himalayas is home to populations who rely mainly on agriculture and livestock-rearing for their livelihood. Their livelihoods rely strongly on the forests adjoining their villages. Firewood, timber, fodder and leaf-litter for livestock are collected from these forests. The forests are also used for grazing livestock. Environmental degradation reduces the amount of available resource and increases the time required for their collection. A number of studies have argued that these losses adversely affect the poor in a number of ways, for example, health, nutrition, and child education (Amacher et al. 2004; Cooke 1998; Dasgupta 1995; Dasgupta and Mäler 1995; Kumar and Hotchkiss 1988).

Other concerns include the likely impact of economic growth in poor countries on environmental resources (Arrow et al. 1995; Dasgupta and Mäler 1995, 2009; Dasgupta et al. 2000). As developing countries catch up with the rest of the world, what will be the impact on the world's forests?

Our project which was initiated in the late 1990s had a number of objectives. The first was to empirically assess the extent and the nature of deforestation or forest degradation in the Himalayas, using ground-level forest ecology surveys. The second objective was to use this data along with detailed household surveys in areas adjoining the forests to empirically investigate the role of different underlying causes commonly alleged by academic researchers, policymakers and environmental groups. These include local poverty, inequality and its deleterious effects on local collective action, economic growth and commercialization pressures, demographic changes comprising rapid population growth, household fragmentation and migratory patterns, property rights over forests and ineffective management of state-owned forests. We also sought to measure effects on standards of living of rural communities living near the forests, identify suitable policy options and estimate their effectiveness.

The primary hypotheses concerning factors driving environmental degradation in developing countries can be roughly classified as follows. At one extreme is the Poverty-Environment Hypothesis, originally proposed by the 1987 United Nations Brundtland Commission, asserting that poverty is the root cause of environmental problems, as degradation arises owing to exploitation of common property resources particularly by the poor (Barbier 1997; Duraiappah 1998; Jalal 1993; Lele 1991; Lopez 1998; Mäler 1998). According to this view, solutions to environmental problems require first and foremost reduction in local poverty, either via economic growth or other state-initiated anti-poverty programs. At the other extreme is the view that environmental degradation owes to economic growth, which raises the demand for environmental resources in tandem with private goods (e.g., views expressed in the media, 2006 Summit Report of the World Economic Forum, or World Bank reports on deforestation in India).[1] An intermediate hypothesis referred to as the "Environmental Kuznets Curve", is that economic growth may initially aggravate environmental problems in poor countries at early stages of development, but will eventually ease them once the level of per capita income passes a threshold (Barbier 1997b; Grossman and Krueger 1995; Yandle, Vijayaraghavan, and Bhattarai 2002).

Other viewpoints stress the importance of local institutions such as monitoring systems and community property rights (Baland and Platteau 1996; Bardhan 2005; Bardhan and Dayton-Johnson 1997; Dasgupta and Mäler 2009; Jodha 2001; Somanathan 1991; Varughese 2000). Some argue that deforestation in the past owed primarily to poor control and monitoring systems: once local communities are assigned control they will be successful in regulating environmental pressures, implying there is not much role for external state interventions. And some argue that local collective action is undermined by social and economic inequality within neighboring communities.

[1] See *Economist* magazine, "No Economic Fire Without Smoke," 8 July 2004, Books and Arts section; <http://www.economist.com/node/2896990> and World Bank (2000).

These hypotheses present different perspectives on the environmental consequences of development, and the role of policy. Yet there is remarkably little systematic micro-empirical evidence on their validity. Efforts to test these hypotheses have been cast mainly on the basis of macro cross-country regressions. There are only a handful of recent efforts to use micro-econometric evidence concerning behavior of households and local institutions governing use of environmental resources (Chaudhuri and Pfaff 2003; Foster and Rosenzweig 2003; Somanathan, Prabhakar, and Mehta 2009).

Accordingly we started by using household-level surveys (with World Bank Living Standards Surveys) in Nepal to address these questions. These household level surveys were not designed to address detailed questions concerning deforestation. We therefore subsequently conducted surveys of forests, village communities, and households in two northern Indian states in the same mid-Himalayan region between 2000 and 2003. Anthropological surveys in six villages in the sample were also commissioned, in order to test and/or corroborate our empirical findings. Resource and time limitations necessitated our relying on a single cross-section round of surveys, with limited use of recall data to estimate historical patterns of deforestation. This imposes inevitable restrictions on the econometric analysis and the nature of reliable inferences that can be drawn. However we have recently had the opportunity to access a panel dataset for Nepal from the LSMS surveys in collaboration with Francois Libois, from which preliminary results indicate that the main results of the cross-section analyses continue to hold (Baland, Libois, and Mookherjee 2011).

This chapter provides an overview of the main findings so far. We first describe in Section 9.2 what we learnt regarding pressure on the Indian Himalayan forests on the basis of our forest ecology surveys. As we shall see, the key problem appears to be forest degradation owing to firewood and fodder collected by neighboring households, rather than deforestation. Local collective action constraining forest use is conspicuous by its absence, implying that self-interested behaviour of households drives firewood and fodder collection. Section 9.3 thereafter describes our findings concerning determinants of household firewood collection activities. Section 9.4 focuses on community property rights, where we assess the performance of the differing regimes of property management in Uttaranchal. Section 9.5 concludes.

9.2 DEGRADATION OF THE HIMALAYAN FORESTS

9.2.1 The India survey

Our analysis is based on household, community, and forest ecology surveys of a random sample of 165 villages divided equally between Himachal Pradesh and Uttaranchal, carried out by our field investigators between 2000 and 2003. On the basis of census data, villages were stratified on the basis of altitude, population, and distance to the nearest town. Villages were then selected randomly within each stratum. A random sample of twenty households was selected in each village, on the basis of a stratification procedure combining landholding and caste-distribution in the village.

Three sets of questionnaires were used to conduct surveys in each village: (a) a household questionnaire administered to the twenty sample households dealt with the socioeconomic structure of the household and its dependence on forests; (b) a village questionnaire was designed to secure information on a host of village-level characteristics such as demographic size, access to physical and social infrastructure, the market environment, and institutions of local governance; (c) an ecology questionnaire intended to gather quantitative and qualitative evidence on the condition of the forest stock accessed by the villagers.

The forest surveys were carried out by trained ecologists who first identified local forest zones accessed by each village in the sample, which were mapped by interacting with the villagers. Random transects (100 meters in length) were laid in each forest area and measurements were recorded at three equidistant plots (of 5.63 meters radius) on the transect to record the species composition, canopy cover, basal area, heights and girths of trees above 3 meters in height as well as regeneration characteristics. Qualitative assessment of grazing, lopping, leaf-litter accumulation, timber extraction, and evidence on natural calamities such as fire and snowfall damage to trees was also recorded at each plot in terms of a predetermined qualitative scale. We collected detailed information on 619 forests by taking measures in 3,512 forest plots (as the number of transects varied with the size of the forest). The second part of the ecology surveys interviewed three to four members of each village (chosen randomly within each village) with regard to their perceptions of changes in forest stock over the past quarter-century and the nature of institutions governing access and use of the forest.

In the context of Nepal we utilized only the World Bank Living Standard Measurement Surveys carried out in 1995–1996 and 2002–2003. While these surveys contain very little information on forests and village ecology, they have detailed information at the household level, particularly relative to household consumption, income, and firewood collection. We will also, when possible, compare the results for Nepal and India.

9.2.2 Measuring Himalayan Forest Degradation

The few quantitative studies available are based on satellite imagery and indicate substantial degradation of the Himalayan forest over the last decades.

Prabhakar et al. (2006) estimate that 61 percent[2] of forests in two districts of Uttarankhand are severely deteriorated (with crown cover of under 40 percent). This observation suggests that the present trend differs substantially from past developments, which were characterized more by deforestation, that is, a decline of forest area. Myers (1986) calculates for example that, in Nepal between 1947 and 1980, forest cover of national territory dropped from 57 percent to 23 percent. By contrast, Foster and Rosenzweig (2003) find that, for India as a whole, the proportion of land covered by forests (measured on the basis of satellite images) has increased significantly over the past three decades.

In our own survey, we used physical measurements taken directly in the forests, rather than rely on aerial satellite images. Our view is that important dimensions of forest quality can only be assessed by ground-level ecology studies. Various measures have been devised by forest ecologists for assessing the state of a forest. The conventional forest management indicators measure the available tree stock. These include *canopy cover* (the amount of ground area covered by the canopy through which direct light passes),[3] which measures the density of foliage, and *basal area* (the total area covered by the cross-sectional area of tree trunks per hectare), which measures the density of standing trees per hectare. The latter measure depends on tree-felling for timber by villagers. Another set of measures captures, for a given stock of trees, the quality and the state of the standing trees. These measures, which include *lopping* (the proportion of a tree trunk that has been lopped) reflect another type of pressure on the forests coming from firewood and fodder collections. At a stationary equilibrium, these various measures should be correlated, with residual variations being explained by factors such as the type of soil, natural hazards, exposure to light, or tree species. The problem however stems from the fact that, when fodder and firewood collections increase while timber-felling remains constant, the basal area does not correctly reflect forest degradation, at least in the short run. The other measures are much more sensitive to these changes.[4]

Table 9.1 below shows the mean values and the correlations obtained between these variables. We have also included the firewood collection time, which measures one of the direct impacts of forest degradation on households. Here, collection time corresponds to total collection time, which includes the time it takes to walk to the forest.

This table invites three comments. First, the correlation between the different measures is weak, which justifies paying attention to all three to evaluate

[2] The 90% confidence interval is equal to 48–73%.

[3] This is, in fact, a similar measure to the *crown cover* indicator used by Prabhakar et al. (2006), but as seen from ground level, rather than an aerial view.

[4] In Baland et al. (2010b), we also measured the volume of wood per hectare (basal volume), which is another conventional measure of biomass and regeneration capacity (number

Table 9.1 Correlation coefficients between measures of forest quality in India[5]

	Canopy cover (%)	Basal area (m^2/ha)	Lopping (%)	Collection time (hr)
Canopy cover (%)	1.00			
Basal area (m^2/ha)	0.32	1.00		
Lopping (%)	−0.59	−0.21	1.00	
Collection time (hr)	0.06	0.13	−0.02	1.00
Median (standard errors)	**37.5**	**41.3**	**67.1**	**4**
	(11.1)	(24.6)	(13.2)	(1.2)

Source: Baland et al. (2010b).

the state of a forest. Secondly, there is little correlation between collection time and the other measures. The low correlation is partly explained by the fact that collection times are not a good measure of forest degradation within a village. Indeed, as villagers choose their collecting places on the basis of the time they expect to take, collection times across forests within a village should be equalized, and would therefore be independent of the degree of degradation of a particular forest. Comparisons of collection time across forests adjoining a given village over time would be more informative of differences in degradation.

Finally, the median value of canopy cover is very low while that of lopping is alarmingly high. By comparison, the natural thresholds indicating a completely non-degraded forest have been estimated around 80 percent for canopy cover, 40 m^2/ha for the basal area and 15 percent of tree height for lopping (Thadani 1999). We illustrate the distribution observed for each of these measures in Figures 9.1 to 9.3 below. We also use a vertical broken straight line to show the level corresponding to a *severely degraded* state of the forest, corresponding to thresholds of 40 percent for canopy cover, two-thirds of tree height lopped, and 35 square metres per hectare for basal area (Thadani 1999).

More than half of the forests evidence a severely degraded canopy cover (less than 40 percent) and the extent of lopping exceeds two-thirds of tree height. On the other hand, as shown in Figure 9.3, the tree biomass, measured by the basal area, shows significantly less deterioration. This means that most of the degradation is linked to excessive short-run exploitation, which is not yet visible in terms of a reduction in the volume of standing wood in the forest. In other words, even though the quantity of trees is satisfactory, they are in a particularly poor state: most of their branches have been lopped or torn off and their canopy

of saplings above a height of 0.5 metre per hectare), which declines in the case of illegal felling or frequent grazing. Further measures of biological diversity or quality of tree species could be included. However the main issue here is more the quantity of available wood, which explains our choice of the aforementioned measures.

[5] This table is based on the sub-sample of the forests in Uttarakhand. A similar picture emerges when using the Himachal forests.

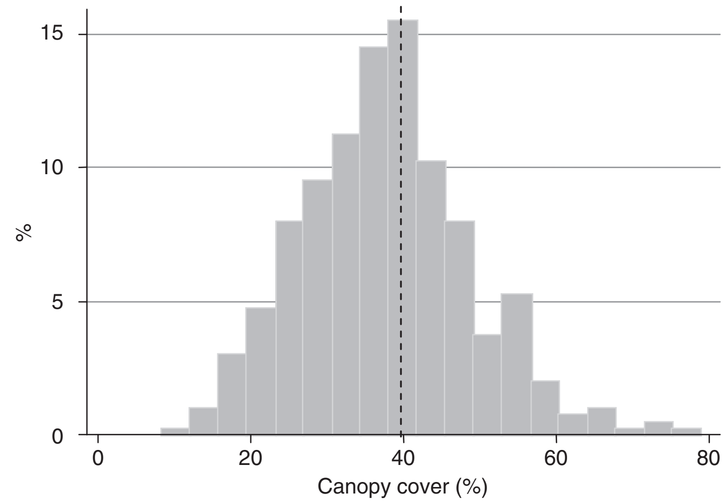

Figure 9.1 Percentage distribution of forests based on their canopy cover (Indian Himalayas, 2002–3)

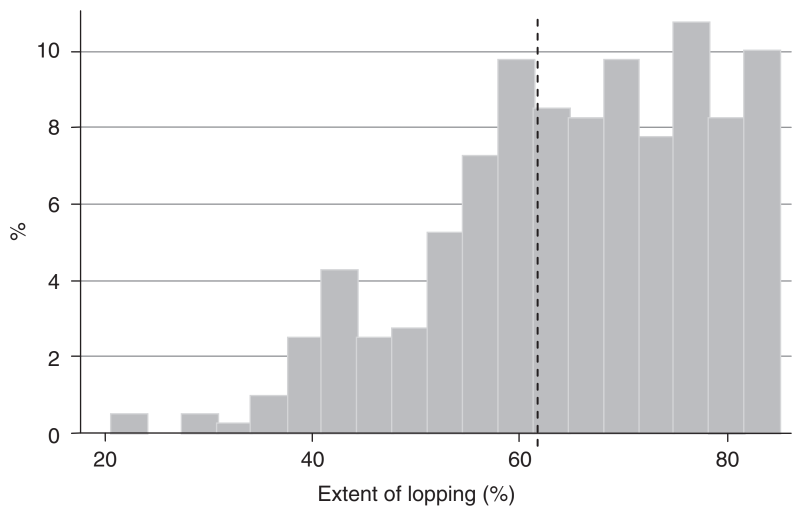

Figure 9.2 Percentage distribution of forests based on the extent of lopping (Indian Himalayas, 2002–3)

density is much too low. The unhealthy quality of trees threatens their growth potential and their resistance to natural calamities (such as frost or drought). It drastically reduces the forest's capacities for future biomass production.

The household surveys conducted confirm these trends. Over the last twenty-five years, the average firewood collection time increased by 60 percent

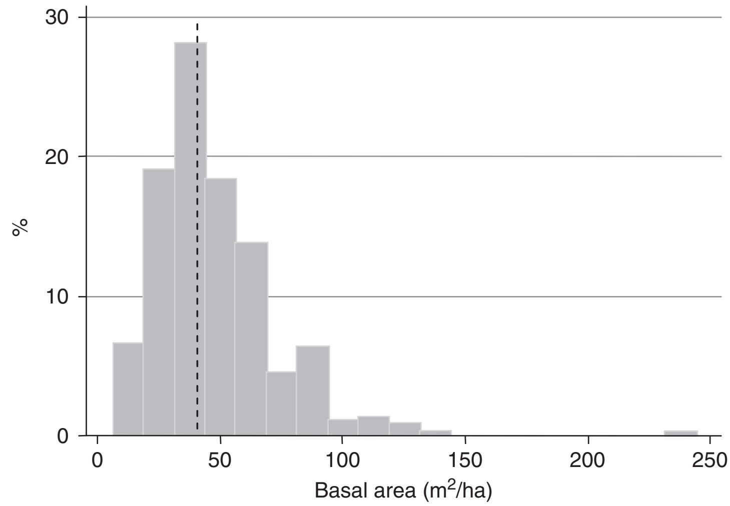

Figure 9.3 Percentage distribution of forests based on basal area (m2/ha) (Indian Himalayas, 2002–3)

(from 2.36 to 3.84 hours per firewood bundle), whereas distance to the forest increased by only 10 percent (from 2.06 to 2.31 kilometres). These differing trends suggest that the cause of increased collection time is not so much the conversion of forest areas into agricultural land or pastureland, as the degradation of forest quality.[6] More than 80 percent of the village respondents said they felt that forest quality was in decline. Forest degradation rather than deforestation thus seems to characterize current changes in the Himalayan forest.

9.2.3 Proximate Causes of Himalayan Forest Degradation

We thus set about examining the causes of this degradation. These can be natural, such as fire- or snowfall-related damage, or anthropogenic. Among the man-related causes, a distinction should be made between those linked to the use of firewood, fodder collection, and grazing, and those relating to tree-felling for commercial purposes or to timber removal. Table 9.2 illustrates the relative importance of these causes in each of the forest plots

[6] The household surveys show that the level of clearance for agricultural purposes is relatively negligible. Moreover, clearance mostly involves non-forested commons (60%). Clearance of forested areas only concerns 5% of cases.

Table 9.2 Extent of degradation of forest lots according to each possible cause (India 2002–3)

Type of degradation (within a plot)	Percent of plots in each category (n = 3512)	
	Low impact %	High impact %
Grazing: low if the only sign of interference is a livestock trail	30	70
Lopping: low if lopping is less than 30%	20	80
Wood-cutting: low if less than 3 tree stumps from wood-cutting	57	43
Forest fires: low if less than 3 tree stumps from burning	62	38
Snowfall: low if less than 3 tree stumps ripped by snow	81	19

visited.[7] Although all the measures are not strictly comparable, anthropogenic pressures, particularly in the context of firewood collection, play a crucial role in the observed degradation.

It is somewhat difficult to obtain reliable data on timber removal, chiefly because this activity is strictly controlled and commercial exploitation is mostly forbidden. This said, our household surveys show the equivalent of one tree of timber is used by a household every five years for construction purposes. Assuming an average three-ton weight per tree, and an average of eighty households per village, this represents forty-eight tons of timber per year per village. This compares with a little over 450 tons of firewood per year per village. In terms of biomass, timber removal for household usage accounts for scarcely 10 percent of the total mass of wood removed from the forest. Lopping for fodder and particularly for firewood is thus the foremost cause of forest degradation.

9.2.4 Forest Ownership and Use Rights

All forests are classified as state forests; with exceptions noted below they are governed by the forest department. The department has a hierarchical administrative structure. The lowest rung is occupied by a forest guard who is responsible for monitoring use on a day-to-day basis. A legacy of the colonial past, the department manages and monitors vast expanses of forests under its control. The main motive behind the forest department's operations is conservation, though some commercialization objectives also exist. For instance,

[7] The size of each plot is equal to $100m^2$.

while there is a ban on green felling, the forest department can sell timber acquired through salvaging operations where the forest stock has been damaged due to natural calamities or alternatively timber acquired through silviculture operations. In some pine forests, the department can extract and sell resin, an important ingredient in the manufacture of turpentine.

Locals have "rights" to access state forests for their livelihood needs. However, they have to abide by rules of extraction and use prescribed by the forest department. Violation of such rules is a legal offence. The forest guard is the main interface between the locals and higher authorities in the department, whose main role is to watch over the forest for detecting violations and imposing penalties on the accused. For historical reasons in the past, state forests have been classified into "un-demarcated" and "demarcated" patches. Un-demarcated forests known as "unclassed forests" in Himachal and "civil soyam" forests in Uttaranchal, are recorded as forests by the forest department but these are not marked by boundary pillars. The department cannot impose prohibitions on these patches as regards rights of access and use. In contrast, a demarcated forest is marked by boundary pillars, an area notified under the Indian Forest Act of 1927. Locals can access such forests unless restrictions are imposed by the forest department. When a forest is declared as a "sanctuary area" all rights are completely denied. Demarcated forests are further categorized into "demarcated protected forests" and "reserved forests." As the name suggests, reserve forests are subject to the most stringent restrictions on use.

However, the forest department faces many obstacles in enforcing these restrictions. Households revealed in the course of their survey responses the ineffectiveness of the forest guard in monitoring violations or imposing penalties. Our ecology surveys indicated no significant differences in degradation between demarcated and un-demarcated forest patches, with regard to canopy cover, lopping, and basal area.

In Uttaranchal the management of some forests have been turned over to local Van Panchayats, or self-governing forest user groups. We discuss these further below.

9.2.5 Local Collective Action Constraining Forest Use

A random sample of four local inhabitants in each village was asked to provide oral histories of local forests on the basis of a structured questionnaire. A large majority of them (88 percent) agreed that there was a general sense in their villages that the forest stock was shrinking. Yet only 45 percent reported that there was any alarm or concern regarding this in their communities. Only in a handful of cases did they report that concrete steps had been taken to arrest the process.[8] This was corroborated in the more detailed anthropological studies of select villages.

Consistent with the lack of spontaneous collective action to control firewood collections within these villages, cross-village analyses of the relationship between land inequality and firewood collections using the Nepal LSMS data for 1995–1996 failed to find any significant correlations, controlling for average holdings of land and other relevant village characteristics (Baland et al. 2007b). As mentioned earlier, a large theoretical literature has speculated that local inequality may be an important determinant of effective collective action; this consideration ceases to be relevant when collective action is absent.

This raises the question of the reasons for failure of local communities to engage in some form of collective action. Could the failure to act collectively to arrest the deforestation process more widely reflect lack of knowledge of appropriate forest management practices? This appears unlikely as villagers seemed well aware of methods of ensuring sustainable forests prescribed by the forest department (collection of dry wood, rotational methods of lopping), but restricted their practice to their own private tree holdings and sacred groves in the village. The collective failure to arrest forest degradation could neither be explained by a lack of capacity for local collective action per se. We found numerous instances of collective action in other areas relevant to current livelihoods, such as agriculture, water management and credit, besides women's groups, youth groups, and temple committees.

Spontaneous collective action with respect to forests therefore seems basically absent. In many villages, however, some of the village forest is managed by a formal forest committee (Van Panchayats, eco-vikas, forest management committees). These have been created and/or recognized by the government. They are more widespread in Uttaranchal where forty-five out of eighty-three villages had a Van Panchayat. However, the actual area under the control of these formal village committees remains limited: according to Sarkar (2008), Van Panchayat forests represent 11 percent of the total forest area in Uttaranchal. The experience of these committees is described as mixed, with some committees functioning effectively and succeeding in protecting the part of the forest under their command. We provide a more systematic analysis of their effectiveness in controlling firewood collections in Section 9.3 below.

[8] In a few villages in Uttaranchal some un-demarcated state forests were reported to have been closed for regeneration. Village inhabitants of Rogi village in Kinnaur district and Gojra in Kullu district of Himachal, closed some local forest patches due to severe threat of landslides that has damaged their fields in the past.

9.3 ANALYZING HOUSEHOLD DEMAND FOR FIREWOOD

9.3.1 Modeling Household Choices

At the beginning of this project we thought that understanding patterns of collective action would be important, and how it interacts with the state of the common property resource as well as with a number of village characteristics, such as leadership and inequality. But with the community surveys and anthropological evidence indicating virtual absence of spontaneous collective action, as well as extremely weak control over firewood use in state forests, it became evident that we needed to model household collections as resulting from self-interested household choices, unconstrained by social norms or penalties for collections. The only relevant costs of collecting firewood and fodder were the opportunity costs of the time spent in these activities. Hence our analytical efforts shifted from modeling collective action in villages to private household production-cum-consumption models where production, energy, and household consumption activities are jointly determined.

The household surveys showed that firewood continues to be the main source of household energy in the Himalayas. In the zone under study, firewood is used for cooking energy in summer by 90 percent of households, and gas by 9 percent. For cooking and heating in winter, firewood is used by 99 percent of households (Baland et al. 2007a). In Nepal, according to 1995–1996 LSMS, villages use firewood as the prime source of energy, when it is available: 82 percent of households in 1995–1996 and 75 percent in 2002–2003. The second source of energy used was gas (in 2002–2003) (Baland et al. 2010a).

In most villages there are no markets for firewood at the village level, though some marginal amounts are commercialized at the nearby market centres. This implies that, for a typical villager, the collection and the production of firewood cannot be separated. Going back to our initial question as to what extent income growth is related to forest degradation in this region, there are two effects at play. The first is the wealth effect, wherein increasing wealth increases consumption of goods and energy, assuming their relative costs are unchanged. The wealth effect can however be negative for firewood if it is an inferior good, for example, if it is associated with less social prestige or if the household seeks to reduce its exposure to pollution by switching to alternate cleaner but more expensive fuels. Hence the direction of the wealth effect in the case of firewood is not clear a priori. The second is the cost effect: insofar as firewood is mainly collected by households, wealthier households have a higher opportunity cost of time spent collecting it, which makes the firewood more expensive. Our surveys indicated negligible use of purchased firewood, hired labor, or technology to substitute for family labor in collection of firewood. Hence the cost channel implies that increasing wealth and income will reduce the demand for firewood. The net effect is therefore ambiguous, if firewood is a normal good, with the wealth and cost effects operating in opposite directions. If it is an inferior good, then both effects would cause firewood consumption to decline in wealth. Hence empirical work is needed to discover the effect of rising wealth on firewood collection, and disentangle the wealth and cost effects.

This task is complicated by the fact that conventional tools of demand analysis that assume exogeneity of income, consumption, and prices are inapplicable. Hence the economic cost of firewood cannot be separated from other household characteristics, incomes, or consumption. In most of the existing literature, there are no attempts to estimate wealth and cost effects associated with increases in income (or the underlying productive assets). Given the lack of longitudinal data (except in our most recent work on this topic), we examine cross-sectional variations in household firewood collections with ownership of different assets. In so doing we confronted a number of formidable methodological problems associated with endogeneity of income, measurement error, omitted variables, and endogenous censoring, which we now discuss.

The most important problem is endogeneity of income or consumption, the most commonly used measures of household living standards. There are many possible unobserved household traits that affect both consumption and firewood collection that could bias estimated Engel elasticities. In addition, both income and consumption are prone to significant measurement errors, especially in a rural society dominated by farming and livestock-related occupations. Reliable instruments for income and consumption that do not affect firewood collections are rarely available. We proceed on the premise that endogeneity and measurement error problems are less acute for underlying household assets (land, livestock, household size, education, etc.) than income or consumption. Based on a model of household decision-making concerning labor supply, fuel choice and consumption for a given composition of assets owned, we develop two estimation strategies. The first (called the semi-structural form (SS) approach) aggregates stocks of different assets into a single scalar measure of wealth (called "potential income"). For this purpose we estimate a household production function, following the approach of Jacoby (1993) to overcome problems with endogeneity of labor supply. Apart from allowing us to estimate household potential income as the measure of wealth, this yields an estimate of household shadow wages, which can be used to value the opportunity cost of time spent collecting firewood. At the second step these are used as measures of household wealth to estimate the wealth effects, while cost effects are estimated using interactions of these estimated shadow wages with reported firewood collection times. Firewood consumption is regressed both on potential income and the interactions of shadow wage with collection time, so that controlling for the other the regression coefficient of these variables can be interpreted as the wealth and cost effects respectively.[9]

The second estimation strategy (which we refer to as the reduced form (RF) approach) relates firewood collection directly to the entire vector of household assets, and their interaction with collection times. While the results of this approach are more complex and harder to interpret than the SS results, they are more reliable owing to avoidance of errors in estimating potential income and shadow wages. Moreover, it avoids the assumption implicit in the aggregation procedure underlying the SS approach that the wealth effects of each asset are proportional to their respective effects on household income. Wealth effects could differ from income effects in a heterogenous fashion if different assets are associated with distinct occupations, locations of work, or networks of coworkers, which affect awareness of household members concerning health effects of firewood vis-à-vis alternate fuels, or accessibility to the latter.

Other econometric problems pertain to omitted variables and endogenous censoring. Geography or climate variations may jointly affect firewood availability, asset ownership and living standards. We control for such village-specific characteristics with village fixed effects, effectively focusing on intra-village variations of firewood collections with household wealth. This also controls for factors such as inequality or social norms that have been argued to be important determinants of common property resources use. In addition we control for various other household characteristics available in the LSMS data, such as household demographics. In the context of Nepal we see a sizeable fraction of households not using firewood at all, so the estimation procedure has to incorporate endogenous censoring. Similar problems arise in the Indian context in studying the role of variations in the cost of LPG gas, since only a small fraction of households use LPG gas.

Problems that we cannot address owing to the nature of the data include the following. The amount of firewood collected is measured in terms of the number of "*bharis*" or headloads that the household report collecting. As the size of a headload varies across individuals, this introduces a potential bias. It is possible that richer households are better fed and tend to carry larger *bharis*, resulting in an underestimate of the impact of living standards on actual firewood collection. Additionally, households confronted with longer walking times carry lighter or smaller headloads. The impact of collection time on the amount of firewood taken may thus be underestimated. Collection time is also based on individual reporting by the household, and may vary with various

[9] To elaborate further, the estimated coefficient with respect to wealth can be interpreted as the effect of increasing wealth of the household in a context where collection times are negligible, as the cost effect would then not come into play. Conversely, the regression coefficient of the interaction of the shadow wage and collection time indicates the effect of rising collection time and how it differentially affects households with varying shadow wages, controlling for their respective wealth levels.

characteristics. To partially address this problem, we compute the average of individual collection times at the village level, and use the latter as a more "objective" measure of collection time. The other advantage of this is that this measure can also be used for villagers that do not collect firewood. This procedure is valid as long as villages are not too dispersed so that all villagers face the same distance to the forests.

Yet other shortcomings of our approach arise from our assumption that all household members are identical with regard to their skills and are thus perfect substitutes in production. In particular, it implies that all members face the same shadow wage in collecting firewood, and share collection tasks equally. This ignores the possibility of specialization of tasks within the household, with resulting disparities in shadow wages across different members.

The hypotheses discussed in the Introduction are all based on a specific assumption as to the predominance that one of the effects has over the other. For example, the environmental Kuznets curve can be interpreted as the claim that the wealth effect is positive and dominates the cost effect at low levels of income, while at higher incomes the wealth effect becomes smaller relative to the cost effect, and may even turn negative. Unfortunately, rigorous studies separating out wealth and cost effects are few and far between: many studies suffer from major methodological weaknesses, owing to their neglect of the issues discussed above.[10]

Among the methodologically rigorous studies, Chaudhury and Pfaff (2003) use a large sample of households in Pakistan to evidence a clear transition from traditional to modern fuels as per capita income rises. It is important to note that they find this transition happening mainly in urban areas, where substitutes to firewood are more readily available. Foster and Rosenzweig (2003) find a small (but statistically significant) negative relationship between firewood consumption and income in a large household sample of rural households in India. However, the Himalayan-village context is different from the all-India context, mainly due to the easy access to firewood, higher levels of poverty and lack of access to alternate energy sources.

9.3.2 Firewood Engel Curves

We start by describing the relationship between income and firewood consumption in Nepal and the Indian Himalayas (Baland et al. 2007a, 2010a)[11] using simple Engel curves. These show the relationship between the amount of firewood collected by the household compared to the village average (in the

[10] A detailed literature review is provided in Baland et al. (2010a).

[11] We use collection and consumption interchangeably, given the virtual absence of firewood markets.

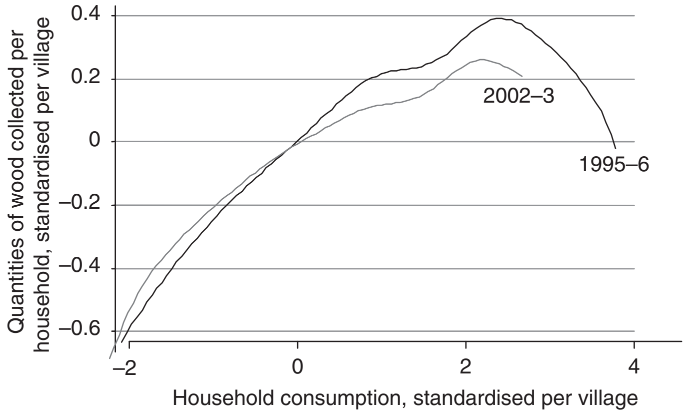

Figure 9.4 Engel curve for firewood collection in Nepal in 1995–6 and 2002–3. Each axis presents deviations from the village mean, divided by the village standard deviation.

Source: Baland et al. (2010a)

number of standard deviations), and household income compared to the village average (in the number of standard deviations, income being measured by consumption expenditures). In this way, we actually compare the amount of firewood collected by different households within the same village (i.e., by comparing with the village average) non-parametrically, with no other controls. Figure 9.4 represents the Engel curve obtained for Nepal in 1995–1996 and 2002–2003, Figure 9.5 the curve obtained for the Indian Himalayan villages.

The Engel curves show an essentially increasing relationship between firewood collection and household income. In the Nepalese villages, this relationship is concave, with the wealthiest households showing a turning point in the tail of the distribution (above the 95 percentile). On average, a 10 percent increase in income is associated with a 4 percent rise in firewood collection. The income effect thus seems to be largely positive and dominates the substitution effect. The results are very similar for India. It should be noted that the concavity of the Engel curves could imply, all other things being equal, that villages in which income disparities are lower consume more wood. The concavity measure in the present instance remains relatively weak, which means that this effect is probably not of great importance. This is corroborated by lack of direct evidence of any significant effect of local land inequality on household firewood collection, in a paper which estimated village fixed effects at the first step and then examined how the estimated village effects varied with measures of inequality (Baland et al. 2007b).

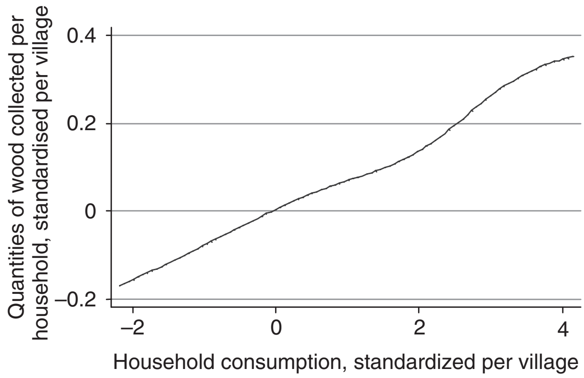

Figure 9.5 Engel curve for firewood collection in the Indian Himalayas (rural zone) in 2002–3. Each axis presents deviations from the village mean, divided by the village standard deviation.

9.3.3 Reduced Form and Semi-Structural Approaches to Estimating Household Demand for Firewood

Households maximize utility by choosing firewood, leisure, and consumption expenditures subject to a time budget constraint. Productive assets, demographics, and the time taken to collect firewood are taken as given. This maximization yields the household demand for firewood as a function of income (or some measure of wealth), collection cost (the product of shadow wage and collection time), and household size.[12] We thus have:

$$F_i = f(W_i, w_i \cdot tc_i, n_i) \quad (1)$$

where F_i represents the amount of firewood collected and consumed, W_i a measure of income or wealth, tc_i the time spent collecting one unit of firewood, w_i the shadow wage and n_i, the labor stock in the family, or family size. It is natural to suppose that collection time depends on occupational patterns, which themselves depend on the composition of assets owned. We therefore assume:

$$tc_i = t(\gamma + \Sigma\gamma_i A_i) \quad (2)$$

where t represents collection time in the village, and A_i represent the assets operated by household i. Linearizing by a first-order Taylor approximation, we obtain:

$$F_i = \alpha_1 W_i + \alpha_2 w_i^* t(\gamma + \Sigma\gamma_i A_i) + \alpha_3 n_i \quad (3).$$

[12] It is relatively immediate to also include the price of the closest substitute source of energy, such as gas (Baland et al. 2010a).

This expression represents the basic regression equation estimated in our semi-structural (SS) approach, controlling for village fixed effects and endogenous censoring. As explained above, the coefficient α_1 is a measure of the wealth effect while α_2 is a measure of the cost effect.

The critical problem here is how to measure wealth and the shadow wage. One possibility is to directly use the level of consumption expenditures as a measure of wealth and as a proxy of the shadow wage. However, both are endogenously determined. Omitted household characteristics such as industriousness, location, or illness could simultaneously affect consumption, shadow wages, and firewood collections, resulting in biased estimates. Measurement error in consumption compounds this problem.

To address these, an alternative strategy is to use an asset-based measure of household wealth, under the assumption that most assets are inherited and less subject to endogeneity and measurement error. So we develop a wealth measure called *potential income*, defined as the self-employment income that the household is expected to earn from its assets if it were to fully utilize its labor stock. We therefore estimate in a first step a Cobb-Douglas production function in which the household income is predicted by its productive assets and the number of labor hours worked. Since labor choices are potentially endogenous, we instrument labor hours by household size (the number of adults available for self-employment), a method used earlier by Jacoby (1993).[13] We then use the estimated elasticities of the household production function from the first stage to estimate its potential income, by calculating the income it would have earned if the entire labor stock in the household were fully utilized. We can also estimate the shadow wage of the household by estimating the marginal product of labor hours from the production function. As it turns out, potential income per head is highly correlated with estimated shadow wages, reflecting underlying variations in asset ownership. At the second step, we then estimate equation (3) using potential income as a proxy for wealth W_i and either potential income or shadow wages as a proxy for w_i.

However, this method of using estimated production function parameters inevitably creates some errors of measurement in potential income and shadow wages, with attendant attenuation biases. They may also involve aggregation biases if the assumption underlying the aggregation (that the wealth effect generated by different assets should be proportional to their respective effects on income) is not valid. These problems can be avoided in the reduced form approach, which relates consumption and shadow wages directly back to household characteristics. Wealth is a function of household assets (which

[13] This strategy ignores the possibility that more productive households might attract relatives to join the household. Moreover, the exclusion restriction rules out the possibility that controlling for total hours employed, a larger household may be more productive, by taking better advantage of the division of labor or complementarity of skills across members.

includes household labor stock). The shadow wage is a function of household assets and collection costs. Combining these, we obtain the (RF) specification in which F is expressed as a function of household assets, household size and collection time interacted with household assets (since the collection cost is the product of collection time with the shadow wage in the household).

The results of these various strategies are given in Tables 9.3, 9.4, and 9.5. Table 9.3 gives the results of the semi-structural approach in the context of the Nepal 1995–1996 LSMS data. The results presented in Table 9.3 separate the effect of rising assets into wealth and cost-of-collection effects. Estimated wealth effects are statistically insignificant at the 10 percent level when potential income is used as the measure of wealth. However, they are significant when consumption and income are used instead. Cost-of-collection effects do not differ much across different measures of wealth. Rising collection time itself (interacted with the shadow wage) has a significant negative effect. The computation of the elasticity of firewood consumption to collection time cannot be directly estimated, as we have to take into account the interaction terms with the household productive assets. We discuss this further below.

We also estimated firewood collection in India using a similar semi-structural approach. The estimated elasticities for an average household are given in the Table 9.4. It shows that in the Indian sample firewood use is inelastic with respect to income growth, irrespective of whether it arises from productivity increases or asset accumulation. For the average household, firewood use per capita falls 0.06 percent following an increase in potential income of 10 percent. The elasticity with respect to growth of any asset is uniformly below 0.02 in absolute value. Compared to our estimates for Nepal, the estimates for the

Table 9.3 Firewood collection: semi-structural estimates for Nepal (1995–6 LSMS)

Dependent variable: firewood collection (log of number of bharis per year)	Using potential income	Consumption	Actual income
Log potential income	**1.961** (1.599)	—	—
Square of log potential income	−0.083 (0.076)	—	—
Log consumption expenditures	—	2.289** (1.138)	—
Square of log consumption Expenditures	—	−0.118** (0.056)	—
Log actual income	—	—	0.959* (0.482)
Square of log actual income	—	—	−0.049* (0.025)
Log(collection time)* Log(shadow wage)	−0.165** (0.079)	−0.150** (0.070)	−0.134* (0.071)

Household size and triple interactions between collection time, shadow wage, and productive assets are included. Village fixed effects are included. Standard errors are given in parentheses. *: significant at 10%, **: significant at 5%, ***: significant at 1%. The number of observations is 2190 households in 201 villages.
Source: Baland et al. (2010a)

Table 9.4 Predicted effects of 10% asset growth on yearly per-capita firewood use of average household in Indian mid-Himalayan region

Predicted % change in firewood collection for an average household resulting from:	
Increase in potential income by 10%	−0.06
Increase in land by 10 %	−0.08
Increase in big livestock by 10%	0.15
Increase in small livestock by 10%	0.01
Increase in education by 10%	−0.19
Increase in non-farm business assets by 10%	−0.01

Source: Baland et al. (2007a)

Table 9.5 Elasticity of firewood collection: reduced form estimates for Nepal, 1995–6 and 2002–3

Productive asset	Wealth effect elasticity		Cost effect elasticity		Total elasticity	
	1995–6	2002–3	1995–6	2002–3	1995–6	2002–3
Land	0.22	0.36	−0.19	−0.25	0.03	0.12
Livestock	N.S.	−0.25	0.50	0.50	0.50	0.25
Education	0.57	N.S.	−0.39	−0.19	0.18	−0.19
Non-farm business Assets	0.18	0.13	N.S.	N.S.	0.18	0.13

NS: not significant at the 10% level.
Source: Baland et al. (2010a)

Indian Himalayan region using the potential income approach yields substantially smaller elasticities.

We also estimated firewood collection using the reduced form approach for Nepal in 1995–1996 and 2002–2003. Table 9.5 shows the results, which distinguish between the wealth and cost effect of changes in various assets.

The reduced form elasticities are generally statistically significant, though of smaller magnitude than indicated by the estimates in Table 9.3 based on the semi-structural form using potential income. The improved statistical significance may owe to the reduction in measurement error associated with using assets directly rather than potential income. The results also indicate substantial mis-specification in the semi-structural form: for example, disparate productive assets do not have a homogenous impact on firewood collection. For example, livestock ownership is associated with a positive cost effect, indicating complementarity between livestock-rearing activities and firewood collection. On the other hand, land, education, and non-farm business assets to some extent are associated with negative cost effects. The wealth effects of different assets are not proportional to their effects on potential income in the first stage regression in the semi-structural approach, as would be required for the latter approach to be valid.

The reduced form estimates are therefore more reliable. The failure of the SS approach has some constructive implications, however. It indicates that the future impact of economic growth for the forest in Nepal crucially depends on the type of asset underpinning this growth. Growth based on modern assets, such as education and non-farm business assets, reduces firewood collection (on the basis of 2002–2003 estimates), with a total net elasticity of –0.06: if these two assets were to double, the demand for firewood is expected to decline by around 6 percent. On the other hand, growth associated with doubling of land and livestock is expected to lead to increased collection of firewood by 37 percent.

Moreover, total elasticity of firewood collection, the sum of the elasticities of all the assets, is relatively high: 0.89 in 1995–1996 and 0.31 in 2002–2003. An overall growth of all the assets, which leads to an equivalent growth in household income (economies of scale proved constant in our estimates), is thus expected to produce a significant increase in the demand for firewood. The Engel curves presented in Figure 9.4 already illustrated this phenomenon.

These results for Nepal indicate the need to estimate firewood demand in India using the reduced form approach rather than the semi-structural approach. This still remains to be done.

To summarize we do *not* find any evidence from within-village variations in support of the Poverty Environment Hypothesis. If anything, we find some evidence for the Environmental Kuznets curve in Nepal, whether one relies on the pure wealth effect or its combined effect including the induced changes in collection costs. But the upward rising portion of the Kuznets curve prevails for over 90 percent of the distribution, with some flattening and decline at the very top end. The impact of wealth or income increases on firewood collection is either negligible (as in our SS estimates for India) or positive (as in the RF estimates for Nepal), except at the very top end of the respective distributions.

Finally, consider the implications of the preceding results for effects of demographic changes, consisting of population growth and changes in household size and composition. The average household size in both India and Nepal indicates that most families are nuclear already and there is little scope for further fragmentation of households. Within villages we also find little variation in household size with per capita potential income. So it is reasonable to assume that household size will remain fixed in the near future, irrespective of economic growth. This implies that population growth will consist mainly of an increase in the number of households. Unless there is substantial out-migration from villages, it is reasonable to suppose that population will grow by at least 10 percent in the next decade. Since our estimates pertained to demand per household, a 10 percent increase in the number of households in the village would give rise to a 10 percent rise in *total* firewood and fodder collections from the neighboring forests. This is a sizeable effect, comparable to the effect of doubling of non-farm business assets in Nepal, and bigger than the effect of doubling of education and non-farm assets with land and livestock remaining unchanged (as implied by the elasticities in Table 9.5). Demographic changes may thus be just important as economic growth in determining the rate of forest degradation over time. Absent significant increases in migration out of these villages, the pressure on forests may be expected to rise approximately in proportion to the rise in population. Hence calculated benefits of policies that reduce fertility rates and encourage migration out of these rural communities should include their effects on forest degradation.

9.3.4 Local Impact of Forest Degradation: Estimating the Local Externality

Continued forest degradation will impact the lives of neighboring villagers primarily by raising the time it takes them to collect firewood and fodder. If trees are more severely lopped, the villagers will take longer to collect a single bundle, either by searching longer for trees that still have branches that can be lopped, or walking further into the forest parts that have not yet been harvested. This is the principal source of the local externality: higher collections today by any single household will raise collection times for all households in surrounding villages in the future.

Precise quantification of the magnitude of this local externality requires knowledge of the rate at which future collection times will rise in response to current collection levels. We have not attempted to estimate this so far. Instead we will try to provide some bounds for the magnitude of the externality by considering the effects of an increase in collection time by one hour per bundle.

The effect of a small increase in collection time on household welfare can be approximated by calculating the shadow cost of additional time required to collect the same number of bundles of firewood selected by the household prior to the increase in collection time. We therefore compute the shadow wage corresponding to the rise in time required to collect the same amount of firewood over a year. In the case of Nepal in 1995–1996, a one-hour increase in the time required to collect on bundle of wood corresponds to an estimated loss of income of around 2 percent.[14] In the case of India, this figure is slightly lower, standing at around 1 percent. The direct impact of the local externality

[14] The data we use is an average firewood collection of seventy-nine bundles per household per year, a median shadow wage of Rs 6.4 per hour, and median consumption expenditure of Rs 30,675.5 per year. The total time spent collecting firewood in Nepal in 1995–6 represented around 400 hours per household per year.

on the villagers' welfare is thus weak, which is certainly part of the factors explaining the lack of collective action at the local level.

Assessments of future degradation would require estimates of the extent to which increased collection times resulting from current degradation would induce a reduction in firewood collections. This requires an estimate of the elasticity of firewood consumption to collection time. The regression specification using village fixed effects makes this difficult, as collection times are partially absorbed by the village fixed effect. We estimated only the extent to which differences in asset ownership interact with collection time at the village level to affect firewood collections. Better data on variations in collection time across households within the same village would be needed to estimate the overall effect of increased collection time, and thus assess the extent to which current degradation patterns would generate a self-correcting tendency for household collections to decrease in the future.

9.3.5 Household Substitution between Alternate Energy Sources

To the extent that policy interventions are deemed desirable to limit firewood collections, it is natural for economists to think of corrective taxes and subsidies. Since monitoring firewood collection by the government does not appear to be feasible option, a natural alternative policy instrument would be subsidies on alternate energy sources (see, for instance, Pitt 1985). We studied this question in the case of India in Baland et al. (2007a).[15] The most commonly found substitute fuel is gas in cylinders (LPG). In the villages where this is available, the elasticity of firewood collection with respect to the price of gas is fairly high. Given an average price of Rs. 300 per cylinder, the estimated impact of a Rs. 100 subsidy on household firewood collection is reported in Table 9.6. As might be expected, the reduction in firewood consumption is larger during the summer than in winter (27 percent and 19 percent respectively), averaging to a 22 percent decrease in annual consumption. The effects are substantial at all income levels: even amongst the poorest households (in the first quartile of the income distribution), demand for firewood drops by 19 percent. Our estimates imply a Rs. 200 subsidy would reduce firewood consumption by 40 percent.

Our household-level estimates also enable us to estimate the fiscal cost of subsidies. As we show in Baland et al. (2007a), this subsidy encourages 37 percent of the households to use an average 1.07 cylinders per person, which represents a subsidy of Rs. 107 per using household. With an average per capita

[15] It was more difficult to design a similar approach for Nepal where the use of gas in 1995–6 was much less common. The 2002–3 data has yet to be analyzed.

Table 9.6 Estimated effect of a Rs. 100 decrease in the price of an LPG cylinder

Season	Income level	% change in the amount of wood collected
All year	Mean	−22%
	First quartile	−19%
	Second quartile	−22%
	Third quartile	−22%
	Fourth quartile	−26%
Summer	Mean	−27%
Winter	Mean	−19%

Source: Baland et al. (2007a)

consumption expenditure of Rs. 8,646 per year, this corresponds to around 1.2 percent of their total consumption expenditure. For the overall consumption expenditures of all the villagers, this subsidy corresponds to an annual tax of 0.4 percent. At a relatively low cost, this policy can thus lead to a significant decrease in firewood consumption, particularly during the summer months.

9.4 DECENTRALIZATION, COMMUNITY MANAGEMENT, AND FOREST QUALITY

9.4.1 Decentralization Movements in India and Nepal

For several years, policies have been adopted in both Nepal and India to transfer part of the rights relating to state forest management and use to local communities. This policy approach is grounded in the idea that degradation of common property resources result from an inadequate institutional framework, which does not provide rural households with suitable incentives for rational and sustainable resource management. While it is true that centralized state management, which often focuses on regulating resources, yields mitigated results in terms of environmental management (Ostrom 1990), the performance of decentralization policies concerning natural resources management by user communities has been called into question by many authors (Baland and Platteau 1996). Whereas local user organizations are often able to develop complex mechanisms for allocating and distributing products from these resources, they often seem to be inadequate when it comes to setting up systems to protect such resources. This is particularly true when market expansion and population pressures come into play. Certain authors also criticize the idealized image of village "communities" put forward by some literature, drawing on case studies. They lay greater emphasis on the shortcomings of community participation programmes, underlining phenomena such as capture by village elites, the absence of accountability and monitoring procedures, or insufficient knowledge and preparation of users (Abraham and Platteau 2001; Mansuri and Rao 2004). In the context of Himalayan forests, an important question thus concerns the relative effectiveness of local community management vis-à-vis centralized state management.

In Nepal, a large-scale programme for forest resources management was launched in 1993. The programme's objective is to transfer the management of all accessible forests to local communities, via Forest User Groups (FUGs). This includes controls on access to the forests, the right to tax forest products, hire forest guards, and launch plantation programmes. Incomes generated by forest-related activities can be used by these groups to finance local projects (such as roads, schools and temples).[16] This programme expanded very swiftly and it was estimated that 38 percent of the population was involved in an FUG by January 2007,

In India, local forest management structures (known as Van Panchayats) were first created in 1931, primarily in Uttaranchal by the colonial British government in order to guarantee local communities the exclusive use of demarcated forest areas. This policy was vigorously pursued after independence, and by 1998, more than one third of the region's villages had their own Van Panchayat. An estimated 10 percent of existing forests are now under Van Panchayat control. Currently, three types of common property management regimes coexist in Uttaranchal. State forests (*Reserve Forest* and *Demarcated Protected Forests*) are forests protected and managed by the state. Access and use of these forests are subject to many restrictions, the Forest Department being responsible for their enforcement. Open access forests (*Civil Soyam*) are forest patches with unrestricted rights of access (except that tree-felling for commercial purposes remains prohibited). They correspond to open access commons. Finally, the forests managed by the Van Panchayats are clearly demarcated forest patches, the use and exploitation (including plantation programmes) of which are defined by the local Van Panchayat, sometimes with state support.

Since 2001, there has been a dramatic increase of Van Panchayats, as shown in Table 9.7. Under pressure from the Indian government, the number of Van Panchayats has almost doubled in five years. New rules were introduced to make it easier to create Van Panchayats (for example, approval by only 1/5 of the population is now required to create a Van Panchayat, instead of the previous 1/3). The programme includes various infrastructure and plantation projects, which are a source of employment for the villagers.

[16] Certain legal restrictions are set for the use of these funds. For example, 25% of revenue must be reinvested in work aimed at developing the forest.

Table 9.7 Number of Van Panchayats in Uttaranchal, India

Number of Van Panchayats in Uttaranchal	
In 1947	429
In 1993	3,635
In 2001	6,777
In 2006	12,089

Source: Sarkar (2008)

Some observers, however, have pointed to the villagers' lack of interest in these recently created community-managed forests, once the casual jobs related to the plantation and infrastructure work disappear. Some of the new Van Panchayats no longer meet and, in fact, only exist on paper (Sarkar 2008). This situation seems to differ from that of the Van Panchayats that were set up much earlier, which involved greater mobilization and active involvement of local communities.

9.4.2 The Impact of Decentralization Policies in India and Nepal

Most existing surveys (Somanathan 1991) that compare state-managed forests with those managed by local communities underline the relative effectiveness of the latter but also the great disparities in their functioning and performance. These studies have three major shortcomings. Firstly, they often only cover very narrow geographical areas (Ostrom 1990; Somanathan 1991; Gibson, McKean, and Ostrom 2000; Jodha 2001; Varughese and Ostrom 2001; Shivakoti and Ostrom 2002). Moreover, they often base their evaluations on how the management councils operate (existence of regulations, penalties, forest guards and so on) or how the villagers perceive the state of the forests, rather than objective indicators of forest quality. Finally, they typically do not take into account problems of selection: a Van Panchayat is formed by villagers' decisions, which gives rise to a potentially significant selection bias. For example, it is possible that villages facing a more deteriorated forest environment have more to gain by creating active Van Panchayats to protect their forests. If forest quality is compared across villages with and without Van Panchayats, a positive correlation would be observed between the existence of a Van Panchayat and forest degradation.

The studies discussed below attempt to get around these problems. In Baland et al. (2010b), we compare different types of forest areas accessed by the same village. Somanathan et al. (2009) compare adjoining forests of different status. Edmonds (2002) compares villages where a community-managed forest is about to be created with villages in which this type of forest has just been created.

Edmonds (2002) followed the implementation of an FUG programme in Nepal. He uses the fact that these groups are gradually set up to compare those villages where the programme was already in place in 1995–1996 with the villages where it had not yet been implemented, in a region with relatively similar ecological conditions. After controlling for a large number of household and village variables, he finds that setting up an FUG causes a 10 to 15 percent reduction in the amount of firewood collected by neighboring households. This estimate is robust to a set of alternative methods and controls. This suggests the programme had a moderating effect on the quantities of firewood used.[17] Tree plantation and timber sales are also a key part of the programme, but a rigorous evaluation of this component is not yet available.[18]

Somanathan et al. (2009) evaluate forest quality using data from satellite images in two regions of Uttaranchal. They compare crown cover of forests across three types of forest management regimes: Van Panchayat forest, open access forest (unregulated), and state forest. They show that on average the crown cover of Van Panchayat forests is significantly higher than open access forests (12 percent for broad-leafed forests), and similar to state-managed forests. This is all the more remarkable as the Van Panchayats do not have the same rights as the Forest Department, especially as far as timber sales are concerned. In their comparisons, the authors take important factors into account such as population density, closeness to the villages and the geographical attributes of the forests, state forests having a better aspect and being further from the villages than the other types of forest. The authors compare these results with forest management costs: the costs of state management are thirteen times higher per hectare of forest than those for Van Panchayat management.[19]

In Uttaranchal we collected detailed information on different types of forest management regimes in the villages surveyed (i.e., 399 forest in eighty-three villages). We were thus able to study how ground-level measures of forest quality varied across different management regimes. We will report here results for three measures: canopy cover, basal area, and lopping (for further details, see Baland et al. 2010b).

Table 9.8 reports the results of the various regressions measuring the impact of the management regime on these three measures of forest quality. These

[17] This is the case, even though the observations were made only three years after the formation of the FUGs. It is therefore likely that the long-run effects are greater.

[18] According to a recent estimate, sale of wood could represent on average two-thirds of overall revenue generated by the FUGs in Nepal (Pokharel 2008).

[19] In 2002–3, management costs per hectare were equal to Rs. 862 for a state-managed forest, as opposed to Rs. 65 for a Van Panchayat-managed forest (Somanathan et al. 2009).

Table 9.8 Impact of management regime on forest quality

Difference between	Canopy cover (%)	Basal area (m^2/ha)	Lopping (%)
Van Panchayat and state forest	5.27	−4.14	−13.18***
Van Panchayat and open-access forest	2.06	−5.20	−4.01
Old Van Panchayat and state forest	9.35**	2.47	−18.26***
New Van Panchayat and state forest	0.06	−12.56**	−6.70**

Note: **: significant at 5%, ***: significant at 1%.
Source: Baland et al. (2010b)

regressions, similar to those of Somanathan et al. (2009), use a large number of control variables (in particular, aspect, distance from the village, or altitude), as well as village fixed effects. What we compare are thus the differences observed between forests patches managed by different regimes but adjoining the same village.

While the results show absence of significant differences between open access forests and state forests, the forests managed by Van Panchayats displayed significantly lower rates of lopping. The collection of firewood and leaf-litter for fodder is less pronounced when the forest is managed by a Van Panchayat.[20]

This more rational use of forests mainly typifies the older Van Panchayats created before 1980. They are also characterized by a higher biomass, measured by canopy cover. On the other hand, the more recently formed Van Panchayats have a smaller basal area. This latter result may indicate that Van Panchayats tend to form when the concerned forests have a poorer quality to start with.[21] The high performance of the older Van Panchayats possibly reflects superior management, being grounded in effective community participation. Reduced rates of lopping over long periods of time also are likely to explain why older Van Panchayat forests achieve superior biomass than state forest.

These findings thus reinforce similar results of Somanathan et al. (2009) based on aerial satellite images. Moreover, they indicate a connection between measures of biomass in the long run and rates of lopping. It is also consistent with the results of Edmonds (2002) for Nepal that creation of an FUG reduces household firewood collection. In our study of firewood collection in India (Baland et al. 2007a) based on household surveys we also observed a

[20] It should also be noted that we did not observe any effect of increased firewood or fodder collection in neighbouring forests.

[21] As in Somanathan et al. (2009), everything seems to indicate that the more degraded forests are more likely to be converted into a Van Panchayat forest.

significant decline in firewood collection in villages with a larger fraction of neighboring forests under Van Panchayat management. These estimates indicate that firewood collection levels would decline by an order of 20 percent if all village forests were converted from state into Van Panchayats forests.

Although setting up a formal community management structure therefore appears effective in terms of improving forest quality, it also has important effects with respect to redistribution, as it changes the rules for using and sharing forest produce. In Nepal, some studies suggest that the local elite often dominate the FUG executive committee and sway its decisions to their own benefit. More particularly, the substantial funds generated by timber sales are invested chiefly in projects that are advantageous to this elite[22] (Banjade et al. 2006; Malla et al. 2003; Pokharel 2008; Timsina 2003). This is reminiscent of the results obtained by Banerjee et al. (2001) in the sugar cooperatives of Maharashtra, in which the richest members secure rents for themselves by manipulating producer prices and using cooperative's profits for their personal benefit (see also Dasgupta 2010, 2012).

In the same vein, in a study of some twenty villages in Gujarat, Agarwal (2007) shows how the creation of a forest management council (similar to the Van Panchayats) has excluded women—who are traditionally users of the forest—from participatory and decision-making structures and deprived them of their access rights to the forest. The women express their feeling of expropriation and exclusion as follows: "If you were to attend meetings, the men will say, oh you haven't cooked my meal on time. What happened to my tea?... The meetings are considered for men only.... No one ever listened to my suggestions.... People don't like it when we speak, they think women are becoming very smart." (Agarwal 2007: 288–9) Agarwal concludes that women bear a large share of the costs linked to community forest management, whereas they only benefit very indirectly from the related advantages, "How will we cook if we don't get wood from the forest? What do they expect us to do?" (Agarwal 2007: 291).

9.5 Summary and Policy Implications

Without some kind of effective government intervention, the future of Himalayan forests appear somewhat bleak. Forest degradation in this region is related to the unregulated extraction of firewood and fodder, which has led to an alarming decline in the quality and resistance of trees in the region. The pressures on the Himalayan forests are increasing due to population

[22] Pokharel (2008) estimates that around three-quarters of the available funds are allocated to projects that benefit wealthier households.

growth: over the last twenty-five years, the average number of households per village has doubled. In addition, the demand for firewood has risen owing to rising standards of living and reduced levels of poverty, though this tends to be moderated if growth is associated with rising education and increasing incidence of non-agricultural activities.

However, it is unclear that local inhabitants perceive this degradation as an important problem, or that they are acting on it to self-regulate local collection activities. Local collective action among local inhabitants is conspicuous by its absence, in the absence of formal efforts by the state to grant rights to local forest user groups. This reason perhaps explains the irrelevance of local land inequality to matter as a determinant of firewood collection levels (e.g., in Baland et al. 2007b), contrary to a large and mainly theoretical literature emphasizing the role of collective action. Part of the reason for lack of spontaneous collective action may be the negligible magnitude of the associated local externality. The relevant externality is therefore essentially non-local in nature, with forest degradation in the Himalayas contributing to landslides, siltation, and floods, and possibly also to global climate change. These necessitate some kind of external state interventions.

Two types of policy interventions can be considered. The first involves encouraging the development of community-based methods of forest management. The experience of Uttaranchal shows that local community management helps ensure a better quality of forest than that obtained through the most protected state forests. The measures for setting up these community management mechanisms nonetheless have a crucial impact on the extent of their success, and it is not clear how state or central governments can encourage genuine grass-roots mobilization and involvement in forest management groups. Moreover, it may take a long time for such groups to become effective in improving the condition of the forest.

The second policy intervention would involve subsidies on LPG, the principal form of alternate energy. Our results on household substitution between firewood and LPG in response to the price paid for LPG are encouraging in this respect, suggesting this to be a cost-effective and reliable method to induce reduced firewood collections.

Third, our analysis indicates that the *composition* of growth matters. To the extent that growth is associated with decline in traditional livestock-based occupations, and rise of education and non-agricultural occupations, pressures on the forest would be ameliorated. Improvements in transport and communication would be likely to raise the value of non-agricultural occupations and expand accessibility to low-cost alternate fuels. Policies encouraging out-migration and reductions in fertility would also be expected to reduce the pressure on the forests.

Many important questions need to be addressed in future research. We need to re-estimate household demand equations in the Indian context using the reduced form approach, and reassess our findings concerning growth projections and elasticities with respect to alternate energy costs. The availability of longitudinal studies of forests and collection behaviour of neighboring communities would represent a big step forward, in allowing for more refined controls and accurate projections for the future. Our recent exploration ((Baland, Libois, and Mookherjee 2011) using a small panel from the Nepal LSMS spanning 1995–1996 and 2002–2003 generates results concerning the effects of changes in levels and composition of household assets that are similar to those obtained from earlier cross-sectional analyses that we have described in this chapter. The availability of larger and more comprehensive longitudinal surveys would enable more detailed examination of the inter-connections between development and forest degradation. Even using the data in hand, there is scope for assessing future sustainability of the Himalayan forests using simulations of a dynamic model of interaction between forest quality and firewood collection patterns, calibrated to fit the observed patterns in the data.

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