Forests to the People: Decentralization and Forest Degradation in the Indian Himalayas

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Summary

This paper assesses degradation of forests managed by local communities (Van Panchayats (VPs)), relative to state protected and open access forests in the Indian state of Uttaranchal. It is based on ground-level ecological measures of forest quality (including canopy cover, biomass, lopping and regeneration) in forest areas adjoining a random sample of villages, and controls for unobserved village heterogeneity, possible endogeneity of management regimes and cross-forest spillovers. Controlling for these factors, VP forests are found to be 20—30% less lopped, and similar on other dimensions. The lopping differences are greater the longer the forest has been under a VP.

Keywords: Asia, India, Himalayan forests, community management

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1. INTRODUCTION

Property rights and management of common property resources such as forests, fisheries and irrigation systems has become a central issue in development economics and policy. This owes both to the high degree of reliance of lives of the poor in rural communities in developing countries on these resources, as well as concerns for environmental sustainability.[1] While there are many plausible causes of degradation of such resources such as population pressure, economic growth, commercial exploitation, socio-economic heterogeneity and government policies, an important determinant that has received much attention is the nature of property rights and control mechanisms. It is frequently argued that excessive state control and management of such resources has been associated with adverse incentive and monitoring systems, which have contributed to degradation of common property resources (Ostrom (1990), Somanathan (1991), Gibson, McKean and Ostrom (2000), Jodha (2001), Shivakoti and Ostrom (2002)). This suggests the need for policies that allow local communities to own and manage these resources themselves.

While questioning the performance of centralized states in managing common property resources, the literature on environmental resource management has also pointed out a number of possible shortcomings of community management mechanisms that may restrict their success. In their comprehensive analysis of various case studies Baland and Platteau (1996) argue that while local communities are fairly deft in developing rules of allocation and distribution of the resource output across users (such as those described by Wade (1987) for South Indian irrigation collective schemes), these distribution measures succeed in protecting the resource only in stationary environments. They argue that the case-study-based evidence shows that local communities tend to be much less successful in devising conservation measures in the face of rising population and market pressures. Likewise, Ballabh, Balooni and Dave (2002) describe case studies of forest management institutions in India whose effectiveness have been undermined over time by administrative interference by upper-level bodies, local conflicts and weaknesses in enforcement of local regulations.

Other concerns have been voiced in the broader context of community-based development programs. In their recent critical review of such programs, Mansuri and Rao (2004) describe a range of possible weaknesses of community participation programs arising from lack of accountability of community leaders, local elite capture, deficiencies in local training, poor design and implementation. They also lament the lack of empirical studies that establish causal relationships between participatory elements and relevant outcomes. They argue this results frequently from lack of availability of suitable data-sets with large samples with objective measures of resource stocks, and identification problems arising from endogenous treatment and unobserved heterogeneity.

The literature on community forest management (reviewed in detail in Section 2) with a few exceptions is subject to these methodological criticisms. Most assessments are based on case studies in narrow geographical areas, and reliance is placed on subjective perceptions of interviewed subjects. While these studies provide rich institutional descriptions in particular settings, the reliability and representativeness of their findings over a larger regional area is questionable. Even in cases where larger samples are selected and objective measures of forest conditions are used, inferences are frequently made on the basis of cross-sectional comparisons of different areas. This ignores possible biases arising from omission of unobserved characteristics of local geography or community characteristics which are correlated with both forest conditions and the nature of local management institution. In particular, these ignore the question of why a particular management institution arose in a particular area, and the possibility that this was partly in response to historical forest conditions (correlated in turn with their current state). There is also the possibility that unobserved characteristics of local communities, such as social capital or traditions of cooperation or participation, may jointly affect the choice of regulatory institution and forest conditions. Inferences regarding the *causal* impact of management institutions on forest condition therefore need to control for these confounding possibilities. Yet another problem arises if local residents respond to local community management by shifting their extraction from community managed forests to other adjoining forest areas. In that case the superior quality of community managed forests may conceal the adverse spill-over effect they exercise on non-community-managed forests.

This paper focuses on the impact of Van Panchayats (VPs, or local forest councils) on forest degradation in Uttaranchal, the only Indian state characterized by such a village community management system. These were first created in 1931 by the colonial British government, following large-scale protests by local populations at previous attempts of the government to convert forests to state property and impose restrictions on local use. A 1931 Act allowed a Van Panchayat to be formed following a collective application by at least one-third of the local community. Forest areas were subsequently transferred out of state control to the local council, which became responsible for regulating and monitoring use of the forest by members of the local community. Since Independence, the Indian government has continued to encourage the formation of Van Panchayats, based on the idea that community management can improve governance and prevent degradation of the forest stock. Despite these measures, only one-third of villages in the mid-Himalayan region of Uttaranchal have been transferred to VPs. Forests governed by VPs thus co-exist with state forests, often adjacent to one another. In this context, as with most others involving common property resources, it is thus evident that the management institution has evolved endogenously. Moreover, spillovers may arise between different kinds of contiguous forest areas.

Our main contribution is to overcome many of the methodological weaknesses of existing literature in attempting a comparative assessment of VP-managed forests and other forests. First, we rely on a random sample of relatively large size and geographic coverage, in contrast to many papers relying on case studies, non-random or small samples, or a restricted geographical area. Second, we utilize detailed ground-level measures of forest quality conducted by trained ecologists, in contrast to subjective perception-based measurements of forest stocks by local community members. Third, we explore possible biases associated with the self-formation of Van Panchayats, problems of unobserved heterogeneity and possible cross-forest spillovers, to the extent feasible with a cross-sectional dataset. Our strategy is to compare conditions in multiple forest patches adjoining a particular village, some of which are VP-managed and others are not. Comparing forest conditions *across* these various patches in the same local area then provides an estimate of the effect of the management institution on forest condition, while controlling for common characteristics of local geography, climate and communities. Cross-forest spillovers can be estimated by examining how the conditions of one kind of forest patch depend on the composition of other forest patches adjoining it. Comparisons of these estimates with those that do not correct for unobserved local characteristics provide an indication of the nature of bias that arises in the latter method, and accordingly the extent to which local forest institutions have endogenously evolved in response to historical forest conditions, or the extent to which community management has merely resulted in shifting of extraction activities across different kinds of forests.

While the details of our results will be presented within the paper, we find evidence of substantial endogeneity bias which tend to *understate* the impact of local community management (when it does emerge). Briefly, the evidence is consistent with the hypothesis that such institutions tend to emerge when local forests become degraded, and that they tend to improve the condition of the forest thereafter in one major dimension: the extent to which trees are lopped (i.e., as a result of firewood collection by neighboring villages). Hence the current differences in lopping between community managed forest patches and other forest patches conceal the improvement that these community management institutions have brought about. Moreover, we find no evidence of any adverse spillovers on adjacent non-VP-managed forests.

Nevertheless, the evidence does *not* indicate improvements on other measures of forest quality, such as canopy cover, basal volumes, forest regeneration or time taken by villagers to collect firewood from the forest (after controlling for distance to the village). This indicates that the van panchayats have been successful mainly in regulating firewood and fodder extraction of local residents, rather than tree-cutting, timber extraction, forest grazing or encroachment activities.

As discussed further in Section 2, these results are consistent with the few papers assessing the effectiveness of community management of the Himalayan forests using large sample surveys. Edmonds (2002) and our own work (Baland *et al* (2006, 2008)) has examined the effect of existence of community management institutions in the Himalayan forests of Nepal and Uttaranchal respectively on household-reported collections of firewood and fodder. Somanathan, Prabhakar and Mehta (2005) have evaluated local management institutions in the context of Uttaranchal using aerial satellite based measures of forest quality, and have subjected their estimates to similar robustness checks with respect to endogeneity of local management mode.

Section 2 provides a detailed review of existing literature, and explains the methodological problems that afflicts most of it. Section 3 then explains the methods we use to overcome these problems. Section 4 provides background information concerning forest management institutions in Uttaranchal. Section 5 presents the detailed results, while Section 6 concludes with a summary, principal implications and avenues of further research.

2. METHODOLOGICAL ISSUES

Much of the evidence in existing literature is based on case-studies, small samples or surveys of geographically narrow areas (e.g., Gibson, McKean and Ostrom (2000), Jodha (2001), Ostrom (1990), Shivakoti and Ostrom (2002), Somanathan (1991), Varughese and Ostrom (2001)). Some case studies of Uttaranchal forests support the view that VPs perform relatively well compared to the state forest department in protecting local forests (e.g., Somanathan (1991)). However, other case studies often report that VP performance varies widely across villages, with indications of serious degradation for a significant number of local forests. There is also a view that decentralized management mechanisms, where they exist, are eroding under population pressure and market integration (Britt-Kapoor, 1994; Singh, 1999; Ballabh et al, 2002; Agarwal, 2006). Apart from the narrow geographical area and small sample coverage, these studies are usually based on villagers' perceptions of local forests and VP operations. Therefore the results of these studies are potentially prone to biases resulting from selective choice of locations and of local community institutions that are distinctive in some way, and of the subjective perceptions of local residents concerning the way that local institutions perform.

Some studies of forest governance utilize data from larger samples drawn from larger geographical areas, but are based on non-random samples and on qualitative perceptions-based data concerning the state of the forest stock (e.g., Agrawal and Yadama (1997), Agrawal and Chhatre (2006)). Agrawal and Yadama, for instance, examine 279 VP forests in the Kumaon region of Uttaranchal, and compare a dichotomous response of local residents concerning their perception of the state of the forest across various aspects of the VP, such as size of the user group, VP age, number of months it hired a forest guard and number of annual meetings, after controlling for population pressure and distance to the forest from a paved road. They find that older VPs and those hiring more guards were associated with a better forest stock. Agrawal and

Chhatre examine local perceptions of forest condition in a non-random sample of 95 forests in the neighboring state of Himachal Pradesh that were managed by local communities. After controlling for geographic, demographic and socio-economic village characteristics, they find a better forest condition in those areas where community management has been in existence for a longer time, and is subject to greater internal competition for official positions, but a poorer condition in those that hire guards or impose more fines.[2]

Reliance on subjective perceptions of local villagers to measure forest quality is fraught with a number of possible biases. Those participating actively in a local user group council may be pre-disposed to view the forest condition in a favorable light. Moreover, respondents often tend to mix means with the ends, depending on whether they focus on VP activities (e.g. the existence of explicit rules) or its impact on the forest (e.g. forest degradation). If the VP forest is well managed informally, the VP does not need to impose many rules and may appear as relatively inactive. Conversely, if the forest is badly degraded, the VP may be very active in strictly enforcing rules. In these two situations, the VP can be considered as 'effective' or 'ineffective' depending on the respondent's point of view. In this sense, the 'effectiveness' of the VP is very hard to assess without an independent, objective survey of the forest. This highlights the importance of using ecological measures of forest quality, collected by an outside team of trained ecologists.

The other major problem with cross-sectional comparisons of forests across different management types is possible bias resulting from unobserved cross-village heterogeneity and endogenous selection. The local community is required to organize itself and apply to form a VP, and work in collaboration with the government forest department to draw up boundaries between state forests and VP forests. Little is known about how the selection process actually operates on the ground and what biases it might give rise to. It is possible that villages with superior `social capital' organize to form VPs: these village communities could be more successful in devising informal means of inducing greater restraint among households with respect to their extraction practices. In that case the differences between VP forests and non-VP forests proxy partly the effect of differences in local `social capital', resulting in an over-estimate of the benefits of VP management *per se*. Alternatively, villages neighboring more degraded forests may have a stronger incentive to form a VP, and the concerned VP may be motivated to monitor and enforce rules more actively. This would impart a negative correlation between forest condition and measures of VP existence or operation (analogous to those found by Agrawal and Chhatre (2006)). Similar biases would obtain if the government Forest Department has a vested interest in keeping better forests under its own control, and deny help to VPs.

3. OUR APPROACH

We now explain the methods we use to address the problems discussed in the preceding section. We discuss the design of the surveys, the measures of forest quality used, and the analytical methodology.

3.1 Survey Design

On the basis of the 2001 Census of India data, we selected a stratified random sample of 83 villages in Uttaranchal in the altitude-zone between 1800 and 3000 meters. The stratification was based on three criteria: altitude, household density, and distance to the nearest town. Household, community and ecology studies were conducted within these villages; this paper utilizes the data collected from the ecology studies to measure the condition of the neighboring forests.

For conducting the ecology surveys we employed trained ecologists from the local region but outsiders to the villages in question. The ecologists identified and mapped local forest zones on the basis of local interactions. Each village typically has a number of distinct forest patches adjoining it that are accessed by local residents for firewood, fodder, livestock grazing, timber and other needs. Some of these forest areas are managed by VPs. Others are either state protected forests, or unprotected (*civil soyam*) forests. On average there were 5.6 forest areas adjoining each village, of which 2.6 were state protected (which we shall hereforth refer to simply as state forests) forests, 1.4 were VP forests, and the rest were unprotected.

In each of the adjoining forest areas, 3 to 6 (depending on the area) random transects (100 meters in length) were laid in the forest and measurements at three equidistant plots (of 5.63 meters radius) on the transect were recorded on various dimensions that we explain below. The design of the survey thus ensures geographical representativeness, lack of bias in selection of locations, and reliance on direct measurements of forest condition by trained ecologists who are not residents of the local village.

3.2 Measures of Forest Condition

Forest degradation has various dimensions that are difficult to represent by a single measure. Canopy cover (crown cover) is the principal measure used by the Forest Survey of India (FSI), as well as by Somanathan et al (2005, 2006) on the basis of aerial satellite images. Our study is based instead on direct ground-level measures of forest quality on five different dimensions of forest quality: canopy cover, height, girth and species of trees, lopping and regeneration rates. We describe these below.

Canopy cover is defined as the amount of ground area covered by the spread of tree branches and leaves, as viewed from above. A mirror with grids of equal size was used to determine the canopy cover from the ground-level, so as to record the proportion of grids covered by tree canopies within each plot. FSI uses a threshold of 40% to denote a severely degraded forest, while Somanathan et al (2005) take canopy cover above 80% as an indicator of a well-stocked forest. Accordingly we may distinguish between severely degraded, degraded and healthy forests, using 40% and 80% as the corresponding cutoffs. There appears to be more consensus among ecologists concerning the latter cutoff, i.e., that long-term growth of the forest is not hampered by canopy covers in the range 80—100%. For this reason, the tables below will provide proportions of forests that lie below the 80% cutoff.

Basal area and *volume* represent tree biomass, a second important dimension of tree quality. Basal area is defined as the sectional area at breast height of all trees put together per unit area.[3] Basal area estimates above 40 mts^2 per hectare are considered by forestry experts to be indicative of good bio-mass potential of a forest (Thadani and Ashton (1995)). We augment this measure by multiplying the height of each tree with its basal area to obtain a measure of basal volume, which is a more accurate measure of tree biomass as it incorporates possible loss of height due to excessive lopping. As we will see in Table 3 below, these two measures are highly correlated.

Lopping is the third dimension of degradation. To measure lopping, a visual scale was constructed: each tree encountered in the sample plots was classified into grade-1 if the extent of lopping was less than 30% (mid value 15%) of the tree height, grade-2 if the tree was 30-70% (mid value 50%) lopped and grade-3 if the tree height was over 70% (mid value is 85%) lopped. Grade 1 does not affect long-term growth while grade 3 negatively affects survival of the tree. Grade 2 is the middle range where growth is affected negatively (height and girth of trees get stunted) but the effect on sustainability is uncertain (Thadani (1999) [4,5].

Regeneration is another indicator of sustainability of forest stock. The regeneration rate is measured by the number of saplings per hectare above the height of 0.50cm. A value of 500 indicates abnormally low regeneration, while above 2000 indicates healthy regeneration (Thadani and Ashton (1995)).

Collection Time is a final measure of degradation is the amount of time taken by neighboring villagers to gather a bundle of firewood normally carried by adults (approximately 35 kilograms) from within the forest. More time is spent gathering a given amount of firewood within a more degraded forest, as villagers have to search more to find good trees, or have to climb to a higher level of each tree in order to lop off branches. This data was compiled from village questionnaires which included collection times per bundle reported for each forest patch accessed by a sample of surveyed villagers. These collection times include time to walk to the forest. Controlling for distance of each forest to the village, variations in reported collection times provide a measure of variations in within-forest gathering times. However, there are no sustainability benchmarks available from forestry scientists concerning gathering times.

Our data additionally includes the percentage of broad-leaf species in the forest, based on the trees inspected by the ecologists in the areas inspected around each transect. This is a useful control used in the regressions, since broad-leaved forests tend to be more useful and therefore more degraded than coniferous forests.[7]

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 by the ecologists at each plot in terms of a predetermined qualitative scale.

3.3 Analytical Approach

At a first step one can compare the differences in forest condition between VP, state and civil soyam forests, using different dimensions of forest condition described above. If the nature of forest management were randomly assigned across different forest areas, this would provide an unbiased estimate of their relative effectiveness in preserving forest quality. However, VPs were formed on the basis of a process by which local residents succeeded in organizing themselves and applying to form a VP, and in their subsequent negotiations with the state Forest department. This is a process which involves the motivations of local residents to form a VP, as well as that of state Forest Department officials to hand over a forest area to the VP. It is also conditioned on the capacity of the local residents to organize successfully, to arrive at a consensus concerning the governance and functioning of the VP. The demarcation between the three kinds of forest areas is a result of interaction between local residents and state Forest Department officials. Therefore the determination of the status of a given forest area is not random. It is determined by a complex process which is conditioned by historical, geographical, social, economic and political factors. Forest areas that are assigned to VPs may be systematically different from other forests in ways that affect their forest condition.

For instance, forests that are more degraded historically and more useful for local residents to access may be more likely to be a VP forest, as local residents would have stronger incentive to organize and seek to have it transferred to their community to manage locally. Then VP forests are more likely to be degraded, and the simple average difference between VP and state forests will understate the benefits of VP management. A VP may be successful in improving the condition of a historically degraded forest, which reduces the gap between its condition with other adjoining non-VP forests and yet ends up with an inferior condition.

It is also possible that the historical process of creation of VPs was the opposite of that described above: the `better' forests were sought to be managed by the local community, and VP management has subsequently been unsuccessful in eroding the quality of the forest. In that case the simple difference between VP and state forests would overstate the benefits of VP management. The absence of historical data concerning the evolution of forest quality implies that it is not possible to gauge the extent to which the status of the forest has changed since being transferred to the VP.

The first step in attempting to overcome the biases resulting from endogeneity of management status, is to compare VP forests with non-VP forests that happen to have the same kinds of underlying ecological, geographic or local community characteristics that are likely to have affected historical forest quality. Accordingly, we can control for the following sets of characteristics: (a) *ecological:* proportion of the forest that is broad-leaved, and distance of the forest to the village, which affect the `usefulness' of the forest to village residents; (b) *geographical:* altitude, slope and aspect which affect innate forest quality, regenerative capacity and usefulness to local residents; (c) *community:* population density and proximity to roads which are measures of demographic and commercialization pressures that affect demand for forest products. Our first set of regressions (reported in Table 5 in the next section) will then regress alternative measures of forest quality, on dummy variables representing the type of forest (VP, state or civil soyam), while controlling for these characteristics.

Such an approach would still be vulnerable to concerns that various unobserved characteristics of the forests, local geography, demography or commercialization pressures could bias the estimates of forest management type. It is undeniable that there are many other detailed characteristics that are not captured by the controls that we are able to incorporate. Moreover, there are many aspects of the `social capital' of the village community --- extent of social cohesion, traditions of participation and representation, extent to which peers can monitor and sanction each other --- which both jointly affect forest quality as well as whether or not there is a VP managing them. The presence of such community characteristics would bias inferences concerning the causal impact of local community management on the condition of the forest. The effects of VP management would then be overestimated, the result of a spurious correlation resulting from failure to control adequately for local `social capital'. Yet this variable is intrinsically difficult to measure.

One way to overcome these biases is to compare VP-forest areas with other types of forest areas *adjoining the same village*. This automatically controls for all those factors that are common to the village, including all unobservable characteristics such as `social capital', as well as unmeasured attributes of ecology, geography, demographics and commercialization. This will be our second set of regression estimates, reported from Table 6 onwards in the next section. These regressions include village dummies, one for each village (save a particular village which serves as a control). Controlling for these village dummies, as well as geographical and ecological characteristics of the concerned forest areas (such as distance to the village and species composition), the regression coefficient of forest condition on dummy variables representing the type of management of the forest area then provides an estimate of the differential effectiveness of VPs and state protection on forest quality which is no longer subject to biases arising from spurious correlation with unobserved local characteristics.

A third set of concerns may still arise from the possibility that VP regulations reduce the extent to which local residents access VP-forests by inducing them to switch their dependence to non-VP forests. In that case the gains from VP management on sustainability of the neighboring forests would be illusory: the difference between forest quality of neighboring VP and non-VP forests would overstate the underlying differences in management effectiveness. The extent to which this is so can be assessed by estimating cross-forest-type spillovers. For instance if there were substantial spillovers of extraction from VP to state forests, the condition of state forests across different villages would vary depending on their proximity to VP forests in the same local area. One would have to add controls for the percentage of adjoining forest area that happen to be VP-forests. This will allow direct estimation of the nature and magnitude of cross-forest-type spillovers, which can then be used to `correct' the estimate of effectiveness of VPs. Table 8 in the next Section will provide estimates of these spillovers.

As a final check for endogeneity concerns, we shall use a number of indirect ways to assess these, such as determinants of the likelihood that a given forest area will be a VP forest (Table 7), and comparisons of forest quality between VPs varying in age (Table 10). These will be explained further in the next Section.

Before concluding this Section, we would like to mention that we are not the first to use the methodology sketched above, even in the context of management of common property resources in the South Asian region. In the context of local infrastructure projects in northern Pakistan, Khwaja (2006) used physical measurements of infrastructure and its maintenance by an external team of engineers. He controlled for unobserved community characteristics by using community fixed effects, and compared projects within the same community but with differing extents of community participation. In the context of forest degradation in Nepal, Edmonds (2002) and (2008) use data from household responses to questions concerning firewood extraction, and relate these to existence of self-governing forest user groups, controlling for a range of household and community characteristics.[8] A companion study of ours (Baland et al (2006)) extends this approach to the mid-Himalayan ranges of Uttaranchal and Himachal Pradesh, using data which overlaps with that used in this paper. All these papers estimate a 10-15% reduction in firewood extraction associated with the existence of a self-governing user group. Nevertheless, the dependent variable in these papers is the extent of firewood extraction by neighboring households, rather than direct measures of the forest stock. Firewood collection by neighboring villagers is one possible source of forest degradation among many others (such as natural calamities, logging, timber removal); there is no firm evidence of its relative significance. This paper complements Baland et al (2006) by examining evidence directly on forest quality rather than on firewood collection levels of residents.

The paper most closely related to ours is Somanathan, Prabhakar and Mehta (2005) which also focuses on forest stock measurement. They use satellite-based measures of vegetation indices (commonly used to predict canopy cover of forests) over geographical regions spanning VP and non-VP forests, from a large random sample covering a wide area in Uttaranchal. This enables them to avoid subjective perception-based measures of local forest quality, and problems of narrow geographic coverage. Moreover, they control for a number of geographical attributes (such as slope, aspect, altitude and distance from the village) that affect forest quality, and unobserved village characteristics by using village fixed effects. The principal difference from their paper is that we utilize ground-level measures of forest quality on a larger number of dimensions, and apply a larger variety of controls for endogenous selection. The satellite-based vegetation index they use is a predictor of canopy cover of the forest, whereas we measure canopy cover directly. Apart from this, the regeneration potential of the forest depends on many other dimensions that cannot be captured by satellite data. Lower branches of trees can be severely lopped, while trunks and tree crowns are left intact. Such trees have few chances of survival in the medium term, yet will not be reflected in current canopy cover estimates. The collection of leaf-litter for fodder or grazing often restricts the growth of saplings at the foot of the tree, ultimately restricting the future growth of the tree, and making forests vulnerable to invasion by inferior species. Effects of severe lopping or leaf-litter collection today are likely to persist for many decades due to likely regeneration failure of the stable forest species (Thadani (1999), Thadani and Ashton (1995), Singh and Singh (1987)). Our ability to measure lopping and regeneration enables us to compare VP and non-VP forests on these dimensions in addition to canopy cover and tree biomass, and we do find significant differences with regard to these dimensions. These findings reinforce the view expressed in their paper, concerning the effectiveness of VP management.

4. CONTEXT: FOREST INSTITUTIONS IN UTTARANCHAL

This section provides institutional details of forest management in Uttaranchal. Readers already familiar with this may skip to the results presented in the next Section.

State forests are governed by the forest department. The department has a hierarchical administrative structure. The lowest rung is occupied by the "forest guard" responsible for field operations 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 department's operations is conservation, though some commercialization objectives also exist. For instance, while there is a ban on green felling, the forest department can sell timber acquired through silviculture operations or through salvaging operations where the forest stock has been damaged due to natural calamities. 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 the higher authorities in the department. His main role is to watch over the forest for detecting violations and imposing penalties on the accused.

For historical reasons, state forests have been classified into ‘un-demarcated’ and ‘demarcated’ patches.[11] Un-demarcated forests are known as ‘civil soyam’ forests in Uttaranchal and are not marked by boundary pillars. The department cannot impose prohibitions on these patches as regards rights of access and use. In the course of our fieldwork we found that these were usually patches of forests between the village boundary and the demarcated state forest patches. A demarcated forest, which is marked by boundary pillars, is an area notified under the Indian Forest Act of 1927. Locals can access such forests unless prohibited. For instance, the forest department can close plantation zones from use or stop the granting of timber rights from a degraded forest to promote regeneration.[12] Demarcated forests are further categorized into ‘demarcated protected forests’ and ‘reserved forests’.[13] As the name suggests, reserved forests have more restrictions on access and use and the forest department has the authority, if it wishes, to exercise maximum control on them but it can relax these norms. In Uttaranchal, most demarcated forest patches are ‘reserved forests’. We use the term `state forests’ to depict demarcated forests.

Van Panchayat forests were first formed under the Van Panchayat act of 1931. The British had started intruding into local forest patches in large parts of Kumaon and parts of Garhwal areas of Uttaranchal, to cater to their imperial needs of timber and charcoal. They started demarcating forests for their own use. This sparked off a series of agitations by the local inhabitants who set forests on fire in protest. In a bid to pacify the villagers, the British set up a Grievance Committee which passed the Van Panchayat Act in 1931. Under this act, villagers can create community managed forests from forests controlled by the revenue department. The act entitles the villagers to demarcate the boundary of their panchayat forests, protect it from illegal tree felling, fires, encroachments and cultivation. Daily operations are chiefly governed by rules that village forest council have themselves crafted, often aided by government officials. The rules appear designed to ensure sustainable use of forest resources. In the case of firewood, extraction is restricted to ‘dry-wood’ only and, in the case of timber, only ‘dried-trees’ can be felled upon payment of a stipulated fee. There are quantitative restrictions on the extraction of firewood, fodder and leaf-litter. In some cases, the forest is divided into compartments and extraction is permitted on a rotational basis across these compartments after the declaration of a pre-determined date so as to ensure sufficient time for regeneration of closed-compartments. Penalties are imposed in case of rule violations. A vigilance mechanism is usually required to make these rules fool-proof. For this purpose, either a guard is hired or there is informal monitoring by villagers. The local guard is usually hired through contributions made by local inhabitants or resources diverted from van-panchayat earnings.

Van Panchayats are typically created in civil soyam forests in the vicinity of the villages. While a major objective is to rejuvenate and manage patches of civil-soyam forests for local use, it also prevents neighbouring villages from intruding into this zone, once formally demarcated as a ‘van panchayat’ forest. Most of the van panchayats are fairly old and have been in existence for over 35 years, even though a significant number of them were created over the past decade as part of the Indian government policies to promote community participation in forest management.[14] Interactions with the local inhabitants revealed that most of these ‘van panchayats’ were formed by the villagers only after being motivated by the forest department. In our sample, 39 out of 45 van panchayats have been initiated in this manner.

5. RESULTS

5.1 Descriptive Statistics Table 1 provides details of the number and nature of forests surveyed.

(TABLE 1 HERE)

On average there were 4.8 forest areas accessed by each village, of which 2.6 were state forests, 1.4 were VP forests, and the rest were civil soyam forests. About two-thirds of the forest species were broad-leaf rather than coniferous forests, the former providing greater utility to neighboring villagers owing to the superior quality of firewood and fodder from broad-leaf species. The forests were located on an average altitude of 2200 metres above sea-level, at an average slope of 32 degrees, and an average aspect of 0.58 (where an aspect of 1 is most conducive to vegetation growth, representing a direction between east and north).[15]

Our household and community questionnaires provide a useful perspective on the extent to which village households rely on the forests, though such data is not used in this paper. Data from our household questionnaires reported in Baland et al (2006) show that households in these villages were overwhelmingly involved in farming activities, with only 8% of household time allocated to non-agricultural occupations. Households were highly dependent on local forests for firewood, grazing and leaf-fodder. Firewood was the only source of energy used for heating, and the major source for cooking. LPG was the main cooking fuel alternative, with 11% of the household using it as a primary source of cooking energy in summer (3% in winter). Over 90% of firewood and timber and 62% of leaf fodder were collected from local forests. In terms of biomass, timber extraction was less important, accounting for only one tenth the wood removed for firewood.[16] Despite the fact that these areas are fairly disaster-prone, with half the villages experiencing natural disasters in the last five years, the latter played a relatively minor role in forest degradation.[17] Hence firewood and fodder collection seemed to be the most important sources of forest degradation.

From our community-representative interviews, 91% of respondents in Uttaranchal agreed that ‘in their villages the forest stock was depleting’, and 30% described forest degradation over the past quarter century as ‘drastic’. Collection levels per household declined on average by about 36% and mean collection times for firewood increased by over 60%. Distance to the forest increased by less than 10% in the meantime. Increased collection times were accounted for mainly by households spending more time within the forest to collect a given amount of firewood. Hence forest degradation (declining forest quality) was far more serious than deforestation (shrinking forest area). [18]

Table 2 provides averages of the six measures of forest quality in our sample.

(TABLE 2 HERE)

The average canopy cover was lower than 40%, indicating severe degradation. Every forest fell below the 80% threshold defining a healthy forest. In terms of basal area, the forests appear relatively healthy, with the mean basal area above the threshold of 40 square meters per hectare level. More than half the forests were above this threshold. Sustainability thresholds for basal volume are not available from forestry specialists, so we cannot assess degradation in terms of basal volume. However, basal area and basal volume are highly correlated (see Table 3 below), indicating that with regard to biomass the Uttaranchal forests are comparatively less degraded. With regard to lopping, the average tree was 65% lopped, with almost all forests lopped more than 30%. The extent of degradation therefore seems severe on this dimension. It is also severe with regard to regeneration rates, the average lying below the 500 threshold for severe degradation, and no forest crossing the threshold of 2000 indicating healthy regeneration. Finally, the average time to collect a bundle of firewood (approximately 35 kgs) is close to 4 hours.

In summary, we have substantial evidence of degradation of trees, judged by canopy cover, lopping and regeneration. In contrast, in terms of biomass the extent of degradation seems less severe. This indicates that degradation measures based on forest biomass alone miss significant dimensions of forest quality. Moreover, the measures used here are not strongly correlated with one another, indicating the need to measure them separately in order to evaluate VP management. Table 3 reports the correlation coefficients across the different measures used. Basal area and basal volume have a correlation of 0.90, and lopping and canopy cover have a correlation of -0.59. Apart from these pairs, all others have substantially lower correlations.

(TABLE 3 HERE)

5.2 Simple Comparison of Average Measures of Forest Quality Across Forest Types

Table 4 displays differences between the three principal types of forests with regard to the various degradation measures, without controlling for any other forest attributes. The differences on most dimensions appear marginal and are not statistically significant. VP forests have marginally lower canopy cover than state forests, are slightly less lopped and have a higher regeneration rate.

(TABLE 4 HERE)

These raw differences reflect the joint effects of forest geography, forest management, household extraction activities and related community characteristics. As explained in Section 3, they may conceal important differences in geographic characteristics across VP and non-VP forests. The last four rows of Table 4 indicate that VP and Civil Soyam forests are significantly more broad-leaved and closer to the village than state forests. With respect to aspect, altitude and slope, they are similar. Hence VP and Civil Soyam forests are likely to be more highly valued by local villagers, which is likely to translate into greater degradation. Hence we need to control for differences in underlying geographical attributes in assessing the effectiveness of VPs.

5.3 Regressions Assessing Comparative Forest Quality Across Forest Types, Controlling for Relevant Ecological, Geographic and Demographic Characteristics. Table 5 shows simple OLS regressions of the six different quality measures of forest patches on forest type, controlling for species composition, distance to the village, aspect, altitude, slope, village population density, and proximity to motorable roads.

(TABLE 5 HERE)

The different forest types considered are van panchayat forests and civil soyam forests, with state protected forests constituting the control type. These regressions also provide estimates of the effect of geographical attributes on forest degradation. Controlling for all the other attributes, broad-leaved forests are significantly more likely to be lopped and have lower biomass, while exhibiting higher regeneration rates. Superior aspect is associated with higher bio-mass and higher regeneration rates. Higher altitude forests have greater canopy cover, biomass, and are lopped more, and regenerate better. More distant forests have superior biomass.

Controlling for these geographic attributes, Table 5 shows that VP forests are significantly less lopped than state protected forests, and are statistically indistinguishable on all other dimensions. The lopping rate is lower by 4.2 percentage points, against an average lopping rate of 65%, which amounts to a 6% difference. Hence if we compare a state protected forest and a VP forest of similar geographical attributes, the VP forest exhibits less extraction of firewood and fodder. Comparing VP and civil soyam forests with a paired-t test (not reported in the table), we find that the two types of forests are similar with respect to all the measures of degradation.

5.3 Controlling for Unobservable Village Characteristics. As explained in Section 3, the regression results in Table 5 are subject to at least three potential sources of bias. First, it is possible that villages with lower forest quality (for instance due to the unmeasured pressure of neighboring villages, or inability of the community to restrict extraction activities via informal means) or with superior `social capital' tend to have more VP forests. Second, even within a given village area, more degraded patches may be more likely to be converted into VP forests. Third, there may be spillovers from VP forests to other forests in the neighboring area: regulations concerning use of a given VP forests may cause villagers to switch their collections to the other forests in the vicinity. We address each of these possible biases below.[25]

In this subsection we control for the first source of bias associated with unobserved heterogeneity in village characteristics by including village fixed effects in the regression. A dummy variable for every village is included in the regression (with the exception of one village which serves as a control), with coefficients not reported in the table. Hence all variables which are village-specific are dropped from the regression; only variables that are forest-area-specific (such as altitude, slope, aspect and distance to the village) are included. Table 6 reports the results obtained under this new specification, which effectively compares different forest patches of similar attributes adjoining the same village area.

(TABLE 6 HERE)

The estimated difference in lopping between VP patches and state protected patches now increases to 10.17 percentage points, and collection times are lower by 0.4 hours. On other dimensions the differences are statistically insignificant. Our estimates also imply that, in the vicinity of any given village, VP forests are superior to civil soyam forests with regard to canopy cover by 14.27% (p-value= .07) and are 12.45% less lopped (p-value=.02). Since crown cover and canopy cover are closely related, these results are similar to the findings of Somanathan et al (2005). In addition, we find significant improvements on the lopping dimension compared to both state demarcated and civil soyam forests.

The differences in results between Table 5 and 6 indicate the importance of unobserved village characteristics. Hence, from now on, we focus on the village fixed effect specification. It is also worth noticing that Table 6 shows no significant difference between civil soyams and state reserved forests. This finding is consistent with many of our survey interviews. Our field investigators came away with the impression that there was little distinction made by villagers between different types of state forests. They seemed aware of the administrative status of the forest but not particularly of the underlying restrictions associated with each type. Thus, a forest official remarked: “for a villager, a forest is a forest!” Moreover, monitoring by the forest guards appointed by the forest department was reported to be weak. The proportion of villages in which monitoring of firewood extraction in state forests was perceived by villagers as `poor' was as high as 98%. With respect to timber extraction and medicinal herbs collection, monitoring was reported `poor' in 68% and 78% of the forests respectively.

5.4 Endogeneity of Forest Boundaries. The second source of possible bias is endogeneity of forest boundaries between VP and non-VP patches within a given village. A VP once formed may wish to draw boundaries so as to appropriate the better part of the forest for themselves, leaving the poorer quality parts in the state forest. Or the Forest Department which actually draws the boundaries may willfully create the opposite pattern. Somanathan et al (2005) argue that if there was a systematic tendency for forest boundaries to be drawn to include or exclude high quality forests from VP areas, this would tend to be manifested in systematic differences in those attributes strongly correlated with forest quality, such as aspect or altitude. They found that state protected forests tended to exhibit better aspect (i.e., were more north-facing), indicating that selection bias associated with endogenous local boundaries resulted in an underestimate of the benefits of VP management.

Table 4 showed little differences in raw averages of aspect or altitude between VP and non-VP forests. Table 7 explores these differences more carefully, using a conditional logit with village fixed effects, which predicts the likelihood of a forest being a VP patch on the basis of observed geographical attributes.[26] It shows no significant association with aspect, slope or altitude, unlike the findings of Somanathan et al (2005).

(TABLE 7 HERE)

we do find a strong correlation with the distance from the village.

However, it does show a significant negative correlation with distance from the village. Recall from Table 4 that VP patches are on average 1.3 km closer to the village than the state forests and about the same distance as civil soyam forests. Since human pressures on the forest tend to increase in proximity of the villages, this indicates a tendency for more degraded patches to be converted to van panchayat forests. Of course, Tables 5 and 6 already controlled for distance to the village from the forest patches and hence reduced the bias due to the possible endogeneity of forest boundaries. This result therefore says something about the direction of the bias, which is likely to cause the benefits of VP management to be underestimated.[27]

5.5 Cross-Forest Spillovers. Next, we address the concern that the superior quality of VP forests relative to other forests in the same vicinity may reflect negative spillovers. If villagers respond to restrictions on firewood and fodder collection in VP forests by switching their extraction to other forests, previous estimates of benefits of VP management are upward biased. Table 8 augments the regressions in Table 7 to include composition of *other* forest area in the same village between van panchayat, civil soyam and protected state forests. We also control for relative distances to the village, by controlling for the average distance of all the local patches to the village.

(TABLE 8 HERE)

Table 8 shows that these additional controls further increase the estimated coefficient of the VP dummy on lopping reduction to 13 percentage points relative to state forests. But there is no statistically significant difference between civil soyam and VP forests. Moreover, VP forests have no significant spillovers on the other forests except in case of basal area. The superiority of VP over state forests with regard to lopping thus cannot be attributed to negative externalities. Protected state forests on the other hand have strong negative spillovers with regard to canopy cover and lopping on neighboring forests, which can perhaps be attributed to better enforcement of protective measures in those forests. This reinforces the positive impact of VPs on forest degradation relative to the state protected forests. Conversion of a state-protected forest into a VP forest will enable the negative spillovers of the former to be avoided. However the magnitude of these spillovers are small relative to the direct effects.

5.6 Old Versus New VPs. As a final check for the importance of selection effects, we examine an important source of possible heterogeneity of the effect of VP management: the length of time that a VP has been in existence. We have noted above that some VPs have been in existence since the 1930s, while others have been started under the active encouragement of the Indian government since the 1970s. Table 9 displays the distribution over years of starting of the VPs. More than half were started before 1970, and every decade since then has witnessed creation of some new ones. Hence there is considerable heterogeneity in ages of VPs.

(TABLE 9 HERE)

The effect of management type in restricting firewood and fodder collection of local villagers is likely to take some time to manifest itself in measures of forest quality. As more time goes by, these effects should become more important, while selection effects operating on construction of forest boundaries should become less important. Hence one way to gauge the relative effects of forest selection and VP management is to separate old and new VPs, *vis-à-vis* other types of forest management.

Table 10 shows the effects of separating effects of old and new VPs, where `old' is defined as having been in existence for over 25 years.

(TABLE 10 HERE)

The differences in effects are more pronounced for old VPs, with regard to canopy cover and lopping. The difference in lopping between old VPs and state protected forests now expands to 18 percentage points, amounting to a 28% difference relative to the mean lopping rate. In comparison to civil soyams, the difference is not statistically significant, but the point estimate for lopping reduction is 8.5 percentage points. In contrast, the lopping difference between new VPs and state protected forests is much smaller (6.7 percentage points, contrasted to 18 percentage points for old VPs). Basal area in the new VP forests is significantly lower than state protected forests. These results are consistent with the hypothesis that more degraded forests are more likely to be converted to VP forests, and VP management subsequently improves forest quality, bringing them back on par with other forests. They are not consistent with the opposite hypothesis that better forests tend to be converted to VP forests and VP management subsequently causes them to become more degraded.

6. CONCLUDING COMMENTS

In this paper, we investigated the comparative qualities of forests managed respectively by local communities and by the state forest department in Uttaranchal. Methodologically our approach can be contrasted with most existing literature on this topic which is based on case studies, small or non-randomly selected samples, narrow geographic area and subjective perceptions of local residents. We based our analysis on forest measurements by trained ecologists in 399 forest areas adjoining a stratified random sample of 83 villages covering the entire mid-Himalayan region in the state of Uttaranchal. Controls for ecological, geographic and demographic characteristics showed forests managed by VPs to be significantly less lopped by about ten percentage points than state forests, and similar on all other dimensions. Additional controls for unobserved village heterogeneity and for cross-forest-type spillovers raised the lopping difference to over 20%, while on other dimensions of forest quality the two types of forests continued to be statistically indistinguishable. These differences were more pronounced for older VPs that were better more with respect to lopping and canopy cover, consistent with the view that they reflect management differences *per se* rather than selection effects.

The results are consistent with the hypothesis that more degraded forests are more likely to be converted to a VP forest, which accounts for the increase in lopping differences as we add controls for ecological, geographic and unobserved village characteristics. Indirect evidence for this is also available: forests that are closer to the village and composed of species more useful to local residents are more likely to be VP forests. These results indicate the importance of recognizing the potential endogeneity of forest type, and attempting to understand the process by which forests come to be managed by VPs. The evidence suggests that local communities are more motivated to form a VP and manage forest areas under their control more effectively when these forests are more valuable to them and become degraded. The bias that results from failing to incorporate this source of endogeneity involves significant underestimation of the benefits of VP management when forest quality is compared across VP and non-VP forest areas without controlling for relevant characteristics of these forests and the local community.

These results are consistent with those in a complementary study of firewood and fodder collection by neighboring households from a household questionnaire administered to a random sample of households in the same set of villages (Baland et al (2006)). There, we found that proximity to VP forests was associated with significantly lower use of firewood compared with state forests, after controlling for household, village and forest characteristics. Those estimates imply that conversion of state protected forests to VP forests would be associated with a 20% reduction in firewood collections. This is roughly the same order of magnitude of the estimated difference in extent of lopping that we found here. Edmonds (2002) found an 11% reduction in household firewood extraction in forest user groups in the Arun Valley in Nepal.

The results have obvious implications for policy seeking ways to moderate firewood and fodder extraction from the Himalayan forests, a key source of degradation of these forests. Our evidence (reported in Table 2) shows alarmingly high levels of degradation on three dimensions: canopy cover, lopping and regeneration. Excessive lopping results in stunted growth of trees and reduction in regenerative capacity; it also implies villagers have to spend more time within the forest in the future in seeking firewood and fodder. Ensuring sustainability of the forests and local livelihoods is thus a key policy issue. In this respect transfer of forests to local communities is an important policy option, and the results of this paper inform us of their likely effects. On average we do see van panchayats in Uttaranchal are able to reduce the incidence of lopping by about 20 percentage points, which is significant compared with the average rate of lopping of 66 percent.

Nevertheless, a number of cautionary remarks are in order. First, we see no significant differences on other dimensions of forest quality such as canopy cover, biomass or regeneration. This indicates that the VPs are not able to make a significant difference to other kinds of activities such as tree cutting, timber extraction or livestock grazing. This could be either because such activities are harder to monitor than extraction of firewood and fodder, or the possibility that VPs lay disproportionate stress on firewood and fodder extraction to the exclusion of other activities. Second, the process of creation of VPs involves collective action by local communities, which is uneven across different communities and local areas. Even after 80 years of a policy allowing and encouraging formation of VPs, only one third of all forest areas have been transferred to VPs. The formation and successful functioning of a VP requires a certain degree of social cohesion and coordination, something that cannot be decreed by legislation or efforts by higher level government bodies. Hence policy-makers can only encourage the formation and effective functioning of VPs; in areas where this does not happen policies to improve the effectiveness of state protection or reduce the dependence of local communities on firewood and fodder are needed. Our work based on household surveys in these communities (Baland et al (2006)) shows that subsidies for LPG, the main substitute to firewood as a source of cooking energy in Uttaranchal households, would be highly effective in reducing household use of firewood. Policies increasing educational access and enhancing shift from pastoral to agricultural or non-agricultural occupations would also reduce household need for firewood and fodder.

A final caution is suggested by our results concerning the relative effectiveness of old versus new VPs, which show VPs that have been in existence for more than a quarter century are three times as effective in reducing lopping compared with those that came into existence within the past quarter century. The benefits of community management may therefore take a long time to achieve. To the extent that pressures on the Himalayan forests need to be reduced fairly quickly, policies that encourage households to switch to LPG gas may be more important.

There are many directions for future research. In-depth studies of VPs can throw more light into how they come into being, and how they function. This would be useful in enabling policy-makers to predict the kind of circumstances where successful community management initiatives can and cannot be expected to emerge. They would help explain why VPs have been successful only in reducing lopping but not in increasing canopy cover or regenerative capacity of the forests. Proper attention needs to be devoted to the methodology for such studies, issues such as size and representativeness of the samples taken, and ways in which measurements are taken.

Finally, the use of cross-sectional data will always leave room for possible biases resulting from unobserved heterogeneity. We have controlled for unobserved village level characteristics with the use of village fixed effects, and for endogenous selection of forest types by a variety of indirect methods. Panel data or use of randomized treatments would be needed to reduce these biases even further. However, the effects of community management may take a long time to manifest themselves, and may exhibit considerable heterogeneity across regions, so the scope for randomized treatment evaluations are limited unless the experiments are conducted over a wide geographic area and over long spans of time.

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Table 1: Forest Characteristics

	Mean	Standard deviation
Forests per village	4.81	1.93
State forests per village	2.57	1.99
Civil Soyam forests per village	0.84	1.66
Van Panchayat forests per village	1.4	1.64
% Broad-leaf species in a forests	64.4	40.47
Aspect*	0.58	0.4
Altitude (meters)	2200.49	301.78
Slope (degree)	32.4	4.95
Distance to village centre (km)	2.21	1.54
Number of villages	83	
Number of observations	399	

*: Aspect equals 1 if it is most conducive to vegetation growth (from east to north), zero if it is least conducive to growth (south to west) and 0.5 for combinations of the two (SE or NW).

Table 2: Descriptive Measures of Forest Degradation

	Mean	Median	Proportion degraded forest*
% Canopy Cover	37.79 (11.11)	37.5	100
Basal Area (m^2/ha)	46.79 (24.61)	41.31	47.12
Basal Volume (m^3/ha)	904.59 (867.49)	671.58	na
% Lopped	65.39 (13.17)	67.11	99
Regeneration rate (number of saplings above 0.5m/ha)	440.75 (317.42)	383.33	100
Collection Time (hours)	3.89 (1.23)	4	na

Number of Observations: 399.

*:Degradation thresholds: Canopy cover below 80%, Basal area below 40 m^2/ha, Lopping above 30%, Regeneration rate below 2000/ha.

Table 3: Correlation coefficients between the measures of forest quality.

	Canopy Cover	Basal Area	Basal Volume	Lopping	Regeneration	Collection Time
% Canopy Cover	1.00					
Basal Area (m^2/ha)	0.32	1.00				
Basal Volume (m^3/ha)	0.25	0.90	1.00			
% Lopped	-0.59	-0.21	-0.16	1.00		
Regeneration (number of saplings above 0.5m/ha)	0.04	-0.12	-0.23	-0.10	1.00	
Collection Time (hours)	0.06	0.13	0.09	-0.02	0.05	1.00

Table 4: Characteristics of Forests by Forest Status

	Demarcated protected forests	Civil Soyam forests	Van panchayat forests
	Mean (stand. dev.)	Mean (stand. dev.)	Mean (stand. dev.)
Canopy cover (%)	39.4 (10.6)	34.6 (11.2)	36.8 (11.6)
Basal area (m^2/ha)	52.4 (26.4)	37.8 (20.3)	41.9 (20.8)
Basal Volume (m^3/ha)	1162.5 (1011.9)	502.3 (514.5)	673.7 (580.9)
% Lopped	65.4 (12.7)	68.4 (13.8)	63.6 (13.5)
Regeneration rate (saplings above 0.5m/ha.)	386.5 (316.2)	486.4 (357.2)	512.8 (275.4)
Collection Time (hours)	4.1 (1.3)	3.6 (1.0)	3.6 (1.2)
% Broad leaf trees	50.02 (41.5)	85.6 (27.9)	78.0 (34.5)
Aspect	0.59 (0.50)	0.60 (0.50)	0.60 (0.5)
Slope (degrees)	33.6 (4.9)	30.7 (5.1)	31.1 (4.4)
Altitude (m)	2224.9 (322.0)	2119.7 (273.9)	2204.3 (272.0)
Distance from the village center (kms)	2.71 (1.7)	1.7 (0.9)	1.6 (1.1)
Number of forests*	213 (178)	70 (64)	116 (104)

* Parentheses: number of forests for which collection time is available

Table 5: Forest Quality OLS regressions: Pooled Sample

	Canopy cover	Basal area	Basal Volume	Lopping	Regeneration	Collection time
Dummy van panchayat forest	-1.47 (1.31)	-3.65 (2.68)	-115.81 (85.67)	-4.16*** (1.60)	60.71 (37.06)	0.03 (.14)
Dummy civil soyam forest	-2.78* (1.60)	-5.79* (3.03)	-168.02** (79.39)	-0.08 (2.05)	27.48 (50.04)	0.03 (.14)
Distance to the forest	1.08*** (.34)	2.76*** (.98)	95.38*** (32.91)	-.97* (.50)	0.63 (9.45)	.58*** (.06)
Percentage Broad-leaf	0.01 (.01)	-.13*** (.02)	-9.27*** (.93)	.05*** (.01)	2.23*** (.40)	0.00 (.00)
Aspect	2.04 (1.44)	7.74*** (2.55)	220.91*** (75.81)	-0.30 (1.62)	83.15** (36.43)	0.12 (.13)
Altitude	.01*** (.00)	.03*** (.00)	.73*** (.19)	-.004* (.00)	-.10* (.05)	0.00 (.00)
Slope	0.00 (.11)	-0.19 (.24)	-5.50 (7.29)	0.03 (.15)	-0.43 (3.48)	0.01 (.01)
Population density per ha	-0.28 (2.05)	-1.92 (4.36)	4.87 (170.12)	-1.99 (2.57)	8.07 (59.25)	0.11 (.20)
Square of population density	0.35 (.55)	0.81 (1.20)	17.17 (53.46)	0.16 (.74)	-0.96 (16.97)	-0.08 (.04)
Hours to jeepable road	-0.77 (1.17)	5.62** (2.43)	219.68*** (78.20)	0.01 (1.43)	-25.98 (32.00)	0.21 (.13)
Hours square to jeepable road	0.05 (.22)	-0.76 (.46)	-35.63** (14.74)	-0.06 (.27)	-0.90 (6.38)	-0.03 (.02)
Number of observations	399	399	399	399	399	346
Number of Villages	83	83	83	83	83	83
R-squared	0.12	0.28	0.38	0.06	0.13	0.39

Parentheses: robust standard errors, clustered at village level
***, **, *: significant at 1,5,10% respectively

Table 6: Forest Quality regressions with Village Fixed Effects

	Canopy cover	Basal area	Basal Volume	Lopping	Regeneration	Collection time
Dummy van panchayat forest	3.01 (2.55)	0.63 (4.05)	53.90 (126.71)	-10.17*** (2.77)	-30.15 (57.31)	-.40* (.21)
Dummy civil soyam forest	-1.99 (1.96)	-5.01 (3.58)	-10.45 (94.42)	-2.89 (2.66)	-36.35 (49.81)	-.37** (.18)
Distance to the forest	.99* (.53)	3.44*** (1.12)	112.38*** (33.00)	-1.23* (.72)	-15.20 (12.28)	.50*** (.08)
Percentage Broad-leaf	0.03 (.02)	-.21*** (.04)	-11.21*** (1.44)	.07** (.03)	.71* (.42)	0.00 (.00)
Aspect	2.65 (1.61)	7.26*** (2.66)	231.94*** (87.22)	-1.00 (2.47)	114.33** (50.09)	-0.10 (.16)
Altitude	0.00 (.00)	.03*** (.01)	.87** (.42)	-.01** (.00)	.25** (.10)	0.00 (.00)
Slope	0.12 (.17)	-0.01 (.40)	0.69 (11.32)	-0.23 (.22)	10.29* (6.08)	0.02 (.02)
Number of observations	399	399	399	399	399	346
Number of Villages	83	83	83	83	83	83
R-squared	0.09	0.24	0.28	0.09	0.08	0.43

Parentheses: robust standard errors, clustered at village level
***, **, *: significant at 1,5,10% respectively

Table 7: Conditional Village Fixed Effect Logit for Likelihood of being a Van Panchayat forest

	Van Panchayat dummy
Percentage Broad-leaf	.01** (.01)
Aspect	0.45 (.74)
Slope	-0.005 (.05)
Altitude	-0.001 (.00)
Distance to the forest	-.67*** (.17)
Number of observations#	184
Number of Villages&	35
Pseudo R-square	0.22

#: Observations located in villages with both VP and Non-VP forests coexisting
& Number of Villages with both VP and Non-VP forests coexisting

Parentheses: robust standard errors, clustered at village level
***, **, *: significant at 1,5,10% respectively

Table 8: Forest Quality Regressions with Village Fixed Effects, with Controls for Composition of Neighbouring Forests

	Canopy cover	Basal area	Basal Volume	Lopping	Regeneration	Collection time
Dummy van panchayat forest	5.27 (3.42)	-4.14 (4.32)	-18.09 (133.98)	-13.18*** (3.98)	20.92 (81.11)	-0.19 (.24)
Dummy civil soyam forest	3.21 (3.60)	0.96 (6.39)	69.39 (146.65)	-9.17* (4.73)	172.03* (100.46)	-0.33 (.28)
Distance to the forest	.92* (.51)	3.48*** (1.10)	111.00*** (33.61)	-1.09 (.69)	-13.34 (11.81)	.48*** (.08)
Percentage Broad-leaf	.04* (.02)	-.20*** (.04)	-11.11*** (1.46)	.06* (.03)	.87* (.45)	0.00 (.00)
Aspect	2.55 (1.60)	7.08** (2.70)	227.48** (88.12)	-0.82 (2.45)	113.94** (50.09)	-0.10 (.15)
Altitude	0.00 (.00)	.03*** (.01)	.87** (.41)	-.01* (.01)	.26** (.11)	0.00 (.00)
Slope	0.15 (.14)	0.07 (.35)	1.76 (11.16)	-0.26 (.17)	11.97** (4.63)	0.02 (.02)
Competing Van Panchayat forest area (ha)	0.00 (.02)	-.06** (.03)	-1.17 (.94)	0.01 (.03)	0.27 (.40)	0.00 (.00)
Competing State protected forest area (ha)	-.04* (.02)	0.03 (.04)	0.14 (1.20)	.06** (.03)	-0.61 (.57)	-.005** (.00)
Competing Civil Soyam forest area (ha)	0.15 (.15)	0.33 (.28)	3.56 (5.42)	-0.14 (.20)	8.64* (4.98)	-0.01 (.01)
Number of observations	399	399	399	399	399	346
Number of Villages	83	83	83	83	83	83
R-squared	0.11	0.25	0.29	0.11	0.12	0.45

Parentheses: robust standard errors, clustered at village level; ***, **, *: significant at 1,5,10% respectively

Table 9: Distribution of Year of Starting of Van Panchayats

	Number	Percentage (%)
After 2000	4	9
1990s	6	13
1980s	3	7
1970s	7	16
Before 1970	25	56

Total	45	100

Table 10: Forest Quality Regressions with Village Fixed Effects, and Separate Effect of Old and New Van Panchayats

	Canopy cover	Basal area	Basal Volume	Lopping	Regeneration	Collection time
New Van Panchayat	0.06 (2.86)	-12.56** (5.68)	-288.75 (227.27)	-6.70* (3.55)	-8.34 (66.83)	-0.12 (.23)
Old Van Panchayat	9.35** (4.30)	2.47 (5.24)	194.33 (141.72)	-18.26*** (4.56)	43.89 (116.12)	-0.25 (.30)
Dummy civil soyam forest	3.68 (3.50)	1.72 (6.39)	93.80 (151.65)	-9.76** (4.58)	174.67* (100.90)	-0.34 (.28)
Distance to the forest	1.04** (.48)	3.67*** (1.11)	117.25*** (33.45)	-1.24* (.65)	-12.67 (11.88)	.47*** (.08)
Percentage Broad-leaf	.04* (.02)	-.20*** (.04)	-11.15*** (1.44)	.06* (.03)	.86* (.45)	0.00 (.00)
Aspect	2.38 (1.53)	6.82** (2.64)	218.97** (87.14)	-0.61 (2.36)	113.02** (50.78)	-0.09 (.15)
Altitude	0.00 (.00)	.03*** (.01)	.81** (.39)	-0.01 (.01)	.26** (.11)	0.00 (.00)
Slope	0.14 (.14)	0.05 (.35)	1.09 (11.01)	-0.25 (.17)	11.90** (4.60)	0.02 (.02)
Competing Van Panchayat forest area (ha)	0.01 (.02)	-0.04 (.03)	-0.65 (.81)	0.00 (.03)	0.33 (.48)	0.00 (.00)
Competing State protected forest area (ha)	-.04* (.02)	0.03 (.04)	0.19 (1.23)	.06** (.03)	-0.60 (.56)	-.004** (.00)
Competing Civil Soyam forest area (ha)	0.14 (.15)	0.32 (.28)	3.36 (5.50)	-0.14 (.20)	8.61* (5.02)	-0.01 (.01)
Number of observations	399	399	399	399	399	346
Number of Villages	83	83	83	83	83	83
R-squared	0.13	0.26	0.30	0.13	0.12	0.45

Note: robust standard errors, clustered at village level
***, **, *: significant at 1,5,10% respectively

ENDNOTES

[1] See Dasgupta (1996) and Dasgupta et al (2000) for an overview of these concerns. Jodha (1986, 2001) presents evidence that between 15-25% of the incomes of the rural poor in India depend on these resources. Beck and Nesmith (2001) survey evidence from various parts of India and West Africa, which indicate a similar range of dependence.

[2] They explain the latter result in terms of possible endogeneity of monitoring and fines: better forests are in better condition because of lower levels of extraction of firewood and fodder, which in turn necessitate less monitoring and enforcement activities.

[3] During field work, we measured the girth at breast height of all trees above three meters in height, thereby ignoring smaller trees.

[4] See for instance, Kumar and Shahabuddin (2005), who show high grazing and firewood extraction are associated with low canopy cover, low height and girth of trees in the Sariska Tiger Reserve forests in northern India.

[5] Scientific work on what values of these measures indicate lack of sustainability in our area of study is limited. Our survey and the cutoffs used for measures indicative of degradation in our area have used the field experience of Dr. R. Thadani.

[7] Coniferous species have lower calorific value, burn more quickly owing to presence of resin, and produce sparks. They are also a poor source of leaf fodder and litter, with a lower nutrient content, and a lower rate of decomposition.

[8] Edmonds uses a number of methods to control for endogeneity bias, such as a comparison between communities forming user groups at different points of time, and instruments (such as distance to a forest range post) for user group formation.

[11] Forests were demarcated by the British to facilitate their timber felling operations in order to cater to their imperial needs of ship-building and construction of railways.

[12] Collective plantation programs initiated by the forest department for rejuvenating degraded patches of forests do not appear to have been successful. 72% of the villages reported no such programs. In those villages that reported the existence of these programs, 69% of respondents were of the opinion that they were marginally effective, and 20% believed they were ineffective. Such programs seem to have failed due to weak mobilization of the local community, poor post-plantation care and interference with villagers' grazing zones and cattle-paths.

[13] When the Indian Forest Act of 1927 was promulgated, the basic objective was first to establish control over forests by notifying them as "protected". Thereafter settlement operations were carried out that defined people's rights on forests. Boundary pillars were put up and these were classified as 'demarcated protected forests'. Thereafter, well stocked forests with least human interference were identified and were classified as 'reserved'. Forests were all rights of use are denied are declared a 'sanctuary area'. This information is based on discussions with Dr Pankaj Khullar, additional principal conservator of forests in Himachal Pradesh.

[14] The 1976 and 2001 amendments make van panchayat formation much easier, and ensure greater control on the incomes generated and their uses for local development purposes (for more details, see Sarkar, 2007).

[15] The lowest value of aspect is 0, corresponding to a direction of south to west. Such directions correspond to greater sunlight exposure, which lowers moisture content of the soil. See Singh and Singh (1987) for further geographic details concerning vegetation in Himalayan forests.

[16] The household responses indicated one tree equivalent of timber used by a household every five years. Based on an assumption of three ton weight per tree, and 80 households per village, timber use accounted for biomass removal of 48 tons per village per year, compared with 456 tons for firewood removal.

[17]The ecologists visually estimated different sources of tree degradation, using a qualitative scale from categories 0 to 3 (with 0 denoting no degradation, 1 denoting low degradation, 2 denoting moderate degradation, and 3 denoting high degradation). Categories of sources considered were grazing, leaf litter removal, lopping, timber removal, natural calamity (fire and snowfall). The average score for grazing was 1.86, for lopping was 2.19, and timber was 1.35. The average scores for degradation resulting from fire and snow were well below 1.

[18] From the household surveys, only 8% of households could not account for plots acquired or expanded by purchase, inheritance or gift. The area that can thus be residually attributed to encroachment represents 10 hectares per village. Moreover, 60% of the household voluntarily reported encroachment occurred with respect to the village commons, and only 5% with respect to forests. While these data may well understate the extent of encroachment, they suggest that it was a comparatively insignificant source of shrinking forest area.

[25] Finally, it is possible that some types of forests are more susceptible to be used by residents from neighboring villages. We also ran the regressions displayed in Tables 4-12 by also including the number of neighboring villages having access to the same forest. For the sake of brevity, these results are not reported here, but they closely parallel those presented below.

[26] In our data, aspect is measured on average across the forest, not at the boundaries. This is because our unit of observation is the village and the forests to which it has access .

[27] One might for instance argue that the state had a vested interest in showing that decentralization works, and therefore selected better forests for conversion.