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ANALYSIS

# Gender and forest conservation: The impact of women's participation in community forest governance

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ABSTRACT

Would enhancing women's presence in community institutions of forest governance improve resource conservation and regeneration? This paper focuses on this little addressed question. Based on the author's primary data on communities managing their local forests in parts of India and Nepal, it statistically assesses whether the gender composition of a local forest management group affects forest conservation outcomes, after controlling for other characteristics of the management group, aspects of institutional functioning, forest and population characteristics, and related factors. It is found that groups with a high proportion of women in their executive committee (EC)—the principal decision-making body—show significantly greater improvements in forest condition in both regions. Moreover, groups with all-women ECs in the Nepal sample have better forest regeneration and canopy growth than other groups, despite receiving much smaller and more degraded forests. Older EC members, especially older women, also make a particular difference, as does employing a guard. The beneficial impact of women's presence on conservation outcomes is attributable especially to women's contributions to improved forest protection and rule compliance. More opportunity for women to use their knowledge of plant species and methods of product extraction, as well as greater cooperation among women, are also likely contributory factors.



## 1. Introduction

> At night men can go and protect. But men alone cannot protect the forest effectively. Just as we need both sexes to run the house so we need both sexes to protect the forest (village women to author, Sabarkantha district, Gujarat, 1998).

> A good forest will bring more rain and help us control soil erosion. Our children will get fruits and berries to eat (woman EC member, CFI in Bharuch district, Gujarat, author's survey, 2000–01).

Can the gender composition of a local forest management group affect forest conservation and regeneration? This manifestly simple question remains largely unaddressed, despite the substantial literature on women's representation in public decision-making, as well as the growing research on local environmental governance.

It is now widely accepted that our ability to regenerate and conserve forests can depend in critical ways on the local collective action of innumerable rural communities scattered across the globe.[1] Communities are, however, far from homogenous units. Typically embodying socio-economic inequalities and differences, their relationship to the forests on which they depend is characterized by complex interests which can vary especially by gender and class. Women and men, the landed and landless, differ in the nature and extent of their dependence on and use of local forests, predicated especially on the gender division of labor and economic endowments. Rural women's dependence is typically for products such as firewood, fodder and non-timber items. Firewood, in particular, is a daily need and is largely non-monetized and gathered.[2] Men's dependence is typically for products such as timber which are needed occasionally and can also be purchased. In both cases, such dependence is greater among the landless than the landed. Forest products such as firewood, fodder and non-timber items which fall mainly in women's domain also have a shorter gestation period and greater potential for extraction than timber which falls mainly in men's domain. Such gender and class differences in forest dependence and use, in turn, impinge on the stakes women and men, the poor and the well-off have in conservation and extraction. They also shape their preferences for particular forest products, and their knowledge of forest

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[1] This was also recognized by the Brundtland Report (1987).

[2] In the 1990s, 80% of the households using firewood as cooking fuel in rural India gathered it from the commons and private sources (NCAER 2000–01). Similarly, in rural Nepal, 82% of the households using firewood as their primary cooking fuel gathered it (Loughran and Pritchett 1997).

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species and processes of regeneration.[3] Moreover, gender norms that separate male and female domains of work and interaction make for differences and complementarities in their ability to protect forests. For these and related reasons, women's presence in institutions of forest governance could make a significant difference to conservation outcomes. Yet in the growing literature on collective action for natural resource management there are striking lacunae from a gender perspective.[4] For instance, research on environmental governance, especially that by economists studying collective action, which focuses on what makes for successful cooperation among people managing a common pool resource, the issue of group heterogeneity is typically limited to class or caste/ethnicity and seldom covers gender.[5]

At the same time, a growing body of work on gender and environmental governance—mostly relating to forests—focuses almost entirely on women's limited presence and participation in management bodies and on gender equity effects.[6] It largely neglects questions of efficiency, in particular the gender impact on forest condition. There is an implicit assumption (rather than verification) that once women are included in decision-making, many benefits will follow.[7] The focus on women's relative absence from management also misses the potential effect of women's greater presence. Moreover, there is little statistical testing of propositions, [8] barring a few exceptions.[9]

This paper seeks to fill many of these gaps. It focuses on communities managing their local forests in South Asia to statistically assess how women's presence in these community forestry institutions (CFIs) might contribute to forest conservation. In particular, it examines if the gender composition of the executive committee (EC)—the principal decision-making body of a CFI—has an impact on forest condition. A systematic primary survey of CFIs with varying gender composition that I undertook in 2000–01, in parts of India and Nepal, provides a unique data set to test this. Several indicators are used to measure forest condition. Methodologically the use of both quantitative and qualitative data helps trace processes as well as outcomes.

## 2. Context, data, and forest profiles

### 2.1. Context and data

India and Nepal are the two South Asian countries with country-wide community forestry programmes. CFIs in these two countries, which provide the context of this study, manage forest land owned by the government but transferred to local communities/user groups to protect and govern, with a sharing of responsibilities and benefits. Most such groups (whether promoted by forest officials, communities or non-governmental organizations—NGOs), are registered under the Joint Forest Management (JFM) Programme launched in India in 1990, and a somewhat similar initiative in Nepal in 1993.[10] In most states of India (including in Gujarat where my study was undertaken) only degraded forests can be transferred to communities, but in Nepal better forests can also be transferred. By the early 2000s, India had around 84,000 JFM groups involving 8.4 million households and 22.5% of its forest land, and Nepal had around 10,000 groups involving about 1 million households and 11.4% of its forest land.[11]

In both India and Nepal the broadly similar, two-tier organizational structure of the CFI consists of a general body (GB) with members drawn from the whole village or community of users, and an executive committee (EC) of around 9–15 members. The EC, as the core decision-making body, in interaction with the GB (and in varying degree with the forest department), defines the rules for forest use and benefit-sharing, decides on methods of protection, draws up plans for forest development, and so on. Some communities plant trees in the more degraded patches, others simply depend on natural regeneration. In India, CFIs have rights to extract non-timber products and to a share of any mature timber that the forest department allows to be harvested. In Nepal, although in principle the CFIs can extract all products and keep the full share, in practice timber cutting is again restricted according to how the forest department defines "sustainable harvest levels" (Ojha and Timsina, 2008, 216).

To enable regeneration, communities usually begin protection by closing off the forest (forest closure) and restricting forest use. Restrictions can range from a complete ban on the entry of people and animals to allowing limited extraction of selected items such as firewood, fodder and non-timber products (as detailed in Agarwal, 2009). Timber felling is seldom allowed except for special need and usually requires the forest department's permission. Protection is done through various methods, such as employing a guard (usually paid by the community), forming patrol groups, or both, while also keeping an informal lookout as people go about their daily tasks. Such protection can notably improve overall forest canopy and biodiversity, even if it does not fully restore the forest. Our interest is in examining if improvement is more likely with higher proportions of women in forest management bodies.

I address this question based on my primary data relating to 135 CFIs, of which 65 are located in three districts of Gujarat in west India and 70 are located mainly in three districts of Nepal's middle hills. The Gujarat sample districts are Narmada/Bharuch,[12] Panchmahals and Sabarkantha. Each district has a major NGO working on community forest management. All three NGOs have broadly similar aims in terms of participatory development, environmental protection and social inclusion. The choice of Gujarat (rather than another Indian state) was dictated mainly by the fact that the three district-level NGOs had

[3] In other words, I locate gender differences in dependence on and knowledge of forests in social norms and material conditions and not, as argued by many ecofeminists, in some ideological or intrinsic connection between women and nature (see also Agarwal, 1992).

[4] See e.g. Baland and Platteau's (1996) review of an extensive literature. See also, Bromley (1992), Ostrom (1990), Poffenberger and McGean (1996), Wade (1988), and Baland et al. (2006).

[5] See e.g. Bardhan (1993, 2001), Seabright (1997a,b), Baland and Platteau (1999), and several articles in Baland et al. (2006).

[6] See, as a sample, Ahmed (1994), Bingeman (2001), Britt (1993), Buchy and Subba (2003), Correa (1997), Dahal (1994), Davidson-Hunt (1995), Ghimire-Bastakoti and Bastakoti (2006), Guhathakurta and Bhatia (1992), Gururani (1996), Hobley (1990, 1996), ISO/Swedfest (1993), Kant et al. (1991), Lama and Buchy (2002), Mansingh (1991), Moffatt (1998), Mukerjee and Roy (1993), Pandey (1990), Roy et al. (c.1992,1993), Sarin (1995, 1998), Sarin and Khanna (1993), Seeley (1996), Shah and Shah (1995), Sharma and Sinha (1993), Singh (2001), Singh and Kumar (1993), TERI (1995), Viegas and Menon (1993), and Venkateshwaran (1992).

[7] Although many of these studies provide valuable insights on the constraints women face in participation and some provide early warnings of women's lengthening firewood collection time amidst regenerating forests—see especially Sarin (1998) for India, and Hobley (1996) for Nepal—we know rather little about the likely impact of women's presence on conservation outcomes.

[8] See, for instance, references in Agarwal (2000, 2001, 2006) and recent papers under the Capri/CGIAR project (http://www.capri.cgiar.org/pubs.asp). With rare exceptions, these too are largely descriptive.

[9] Exceptions include my paper—Agarwal (2006)—a prelude to my current analysis; and Agarwal and Chhatre (2006) who test the impact of several variables (including gender) on forest condition in Himachal Pradesh. There are, however, problems of definition and interpretation in Agrawal and Chattre's gender variables—gender conflict and gender relations—neither of which is linked with forest governance. Gender is also not the focus of their study. Prokopy's (2004) study, although on water, is also of interest here, in that she examines the impact of women's participation on the effectiveness of rural water supply projects and finds no significant effect.

[10] There is a vast literature on community forestry in India and Nepal—its origins, functioning and performance—which it is not possible to reference here, but see among others Agarwal (2001, 2006, 2009, in press-a,b), Jeffrey and Sundar (1999), Sundar et al. (2001), Poffenberger and McGean (1996), Hobley (1996), Springate-Baginski and Blaiki (2007), and references therein.

[11] For India see Bahuguna (2004); for Nepal I computed the figures from forest department data (GoN, 2000).

[12] Earlier Narmada district was a part of Bharuch. The sample CFIs fall mainly in Narmada with some spillover into present-day Bharuch district.

information on the gender composition of CFIs. This information, which was essential for sample selection, was not available for other states. In contrast, the Nepal forest department does collect regularly updated information on the gender composition of CFIs, which could be used for district identification, subject to security constraints in the survey years (see Agarwal, in press-b, for details). The Nepal sample districts are Baglung, Parbat and Gorkha, with a small spillover into Dhading district when replacement CFIs were needed for Gorkha.[13]

Ecologically, the Gujarat sample falls in a semi-arid zone with dry deciduous forests. The villages are populated by communities that are mainly tribal and poor, and a fair number migrate seasonally for work. Socially, tribal women are subject to fewer restrictions than Hindu women, although even among them conservative social practices are spreading. In Nepal, ecologically the districts fall in a sub-tropical zone characterized mainly by deciduous forests, a significant ethnic population and considerable poverty. Landlessness, however, is low both in the districts (6–13% of the households: GoN, 2001) and in the sample population. Socially, there is greater caste/community heterogeneity here (relative to the Gujarat sample), but the study's location in the middle hills makes for less sharp differences in social norms between women of different communities than found in the plains (Bennett and Gujurel, 2006).

The CFIs were selected through stratified random sampling from the population of CFIs in the identified districts. The main criterion for sample selection was the EC's gender composition. In Gujarat, the population of CFIs was stratified into two mutually exclusive categories: ECs with ≤2 EC women and those with >2 women in each of the three districts (the three districts were sampled separately). The two-woman marker stemmed from the fact that including at least two women in the EC is required in Gujarat (as in several other Indian states). Although, in practice, many CFIs fail to reach this minimum and some exceed it, this is a relevant criterion since including only two women is a nominal way of following the rule, and including more than two women is a departure from the minimum requirement. The state has very few CFIs with all-women ECs. In Nepal, at the time of the survey there was no mandate for ECs to include a certain number or proportion of women, although there were broad "guidelines" recommending inclusive practices.[14] For comparability with Gujarat, however, I used the two-woman marker for selecting Nepal's sample as well, in addition to all-women groups of which there are a fair number here. The Nepal ECs were thus stratified into three mutually exclusive categories: ECs with all-women, with ≤2 EC women and with >2 women (but not all-women). The all-women groups are those whose ECs are constituted only of women, but the membership of the CFI itself (which makes up the general body) contains both men and women, as is the case with other CFIs. Baglung and Parbat districts were clubbed for sampling due to a limited universe of all-women groups in each, and Gorkha was sampled separately.[15]

In the Gujarat sample, 48% of the ECs have ≤2 women (including 5 all-male ECs) while 52% have >2 women (including 3 all-women ECs), with a typical EC containing 11 members in all. In Nepal the typical EC has 11–13 members, and 39% of the groups are all-women, 28% have ≤2 EC women (including 5 all-male ECs), and 33% have >2 EC women. These distributions are not representative of the universe, since the sample was purposively selected, given that my main interest was in assessing the impact of women's proportional strength on forest condition and not in why some ECs had few women and others many. Nevertheless, as discussed further below, I probed what factors underlay differences between CFIs in their EC's gender composition and found a variety of context-specific, non-systematic factors which differed across villages.

**Table 1**
Gujarat and Nepal: forest area protected by CFI gender composition.

| Region | Forest area by CFI gender composition (mean hectares) | | |
|---|---|---|---|
| Gujarat | ≤2 EC women<br>173.3 ($N=31$) | >2 EC women<br>157.3 ($N=34$) | All CFIs<br>164.9 ($N=65$) |
| Nepal | All-women CFIs<br>20.9 ($N=27$) | Other CFIs<br>41.6 ($N=43$) | All CFIs<br>33.6 ($N=70$) |

Source: Author's 2000–01 survey.
$N$ = Number of CFIs.

A combination of quantitative and qualitative information was obtained on the characteristics of the EC, the CFI, the forest, and the forest-using population, through focused group discussions and semi-structured interviews with EC members, as well as focused group discussions with male and female villagers separately, drawn from across the village settlements, and individual interviews with key informants.[16] In Gujarat, information on forest condition was obtained through several sources (detailed further below): assessments by a forestry expert in the research team, by the villagers, and by a forest institution using satellite imagery. In Nepal, apart from villagers' assessments, forest officials also fielded questionnaires on forest condition as recorded when the forest was transferred to communities and at the time of the survey. In Gujarat, each CFI is linked with a specific village and information was obtained on population characteristics, migration, land ownership and other aspects for every household in all 65 villages. In Nepal, a CFI can have members from several toles (a tole is between a hamlet and a village in size), and a single forest can have more than one CFI protecting non-overlapping sections. Here it was not possible to identify a clear set of "village characteristics". Also given this difference, the Gujarat and Nepal cannot be clubbed together for analysis without losing information available for Gujarat but not for Nepal. They were thus analyzed separately.

### 2.2. Forest profiles

The Gujarat and Nepal samples differ not only ecologically but also in the size and quality of their forests (Tables 1 and 2). Gujarat's forests are substantially larger on average, but all the CFIs described their condition as degraded or very degraded when they began protection. Located in a semi-arid climatic zone and hilly terrain, many barely had even rootstock intact. In Panchmahals, with many community-initiated CFIs, the protected sites were mostly left to regenerate naturally. In the other two districts, gap-filling tree planting was undertaken.[17] On average, the forests protected are also substantially smaller in Narmada/Bharuch (58 ha) relative to Sabarkantha (181 ha) and Panchmahals (225 ha). CFIs with >2 EC women, compared with ≤2 EC women, have somewhat smaller forests.

In Nepal, the average forest size (34 ha) is much smaller than in Gujarat, but the CFIs received richer, more biodiverse natural forests, both because Nepal's forests are generally less depleted and because

[13] Four of the originally-selected Gorkha CFIs became inaccessible due to the Maoist insurgency. These were replaced by CFIs with the same gender composition from a contiguous part of the adjacent Dhading district.

[14] Subsequent to my survey, there have been further national-level discussions in Nepal on how to promote gender and social equity in community forestry.

[15] Baglung and Parbat are contiguous districts with similar ecological and social profiles. Since each had only 14 all-women CFIs—insufficient to take each district on its own—the two districts were clubbed for sample selection. Gorkha, with 42 all-women groups, was treated as a separate unit.

[16] The information was obtained through six researchers in Nepal and six in Gujarat who knew the local dialect. Teams of two spent on average three and a half days in the field for every CFI. In Gujarat there were also subsequent revisits. In both regions, most and sometimes all of the EC members were present for discussions on the EC-related questionnaire, and a fairly wide cross-section of villagers/forest users attended the focused group discussions. See Agarwal (in press-b) for further details.

[17] Such 'enrichment planting', as it is termed, is done for increasing plant density (i.e. the number of plants per hectare) in an already growing forest stand (Watson et al., 2000). In highly degraded forests, the entire area may take the shape of a plantation.

its community forestry policy (as noted) allows the transfer of even good forest land to communities. Most received natural forests, but some had supplementary plantations or only plantations. Nepal's forest department records show that three-fourths of the sample forests, when given to communities, had thin or patchy canopies and a quarter had good or very good canopies (Table 2).

In addition, there is a striking difference between Nepal's all-women groups and its 'other' groups (namely groups with mixed gender ECs plus the 5 all-male groups). All-women groups in the sample received on average half the forest area (21 ha),[18] and more degraded plots than given to other groups (Tables 1 and 2).[19] By the forest department's recorded assessment, 90% of the sample all-women groups received forests with thin or patchy canopy relative to 69% of the other groups; and according to the villagers' reports, a substantially larger percentage of all-women groups compared with other groups received a young forest (under 15 years of age), with fewer species of firewood, fodder and timber. Local forest officials justify giving all-women CFIs smaller and poorer plots on the plea that women alone may be unable to protect the forests effectively, and their management capabilities first needed to be tested via small plots. The account of an all-women's group in Gorkha (Nepal) which received only 7.06 ha, is illustrative:

> We first formed a group in 1994 on the advice of a female ranger and prepared the necessary papers. But when we submitted the documents to the district forest officer (DFO), he was skeptical and said, "How can you women protect the forest? You don't know the rules or how to manage, and nobody will accept your decisions". We said, "please give us the forest, we will try our best and demonstrate to you within a year that we can do it. We are ready to accept any kind of penalty if we fail." The community men and the local ranger supported us, which is why we were able to speak so boldly to the DFO. Finally he relented and gave us a small area to protect (author's survey, 2000-01).

The actual performance of all-women groups (empirically measured below) in terms of improving forest condition belies this official skepticism. Indeed as we will see, the enthusiasm and commitment that many such groups bring to their work more than makes up for their lesser experience in institutional management.

**Table 2**
Gujarat and Nepal: forest condition when protection began.

| Region and forest condition | Percent CFIs | | |
|---|---|---|---|
| GUJARAT | ≤2 EC women | >2 EC women | All CFIs |
| Forest condition when protection began (village assessment)[a] | $N=31$ | $N=33$ | $N=64$ |
| • Very degraded | 51.6 | 51.5 | 51.6 |
| • Degraded | 48.4 | 48.5 | 48.4 |
| NEPAL | All-women CFIs | Other CFIs | All CFIs |
| Forest condition when CFI formed (villager assessment) | $N=27$ | $N=43$ | $N=70$ |
| • Very degraded | 22.2 | 11.6 | 15.7 |
| • Degraded | 51.9 | 62.8 | 58.6 |
| • Good | 25.9 | 20.9 | 22.9 |
| • Very good | 0.0 | 4.7 | 2.9 |
| Forest canopy when CFI formed (forest department assessment) | $N=21$ | $N=39$ | $N=60$ |
| • Thin canopy | 57.1 | 30.8 | 40.0 |
| • Patchy canopy | 33.3 | 38.5 | 36.7 |
| • Medium canopy | 4.8 | 2.6 | 3.3 |
| • Thick canopy | 4.8 | 28.2 | 20.0 |

Source: Author's 2000–01 survey.
$N$ = Number of CFIs. Information was not available for some CFIs.
[a] Some villages began informal protection a few years prior to CFI formalization.

## 3. Some hypotheses

### 3.1. Gender, and other EC characteristics

Why would we expect a group's gender composition to affect conservation outcomes? The most important reason is the likelihood of substantially improving the quality of protection if there are more women on the EC. In addition, women's presence would provide an opportunity of drawing upon their knowledge of forest-use practices and species, and registering their preferences if trees are planted.

Protection, for instance, has both a preventive and a proactive component. In preventive terms, women when inducted into the EC are more likely to follow the rules themselves (involvement in rule formulation tends to enhance rule compliance[20]), and be able to persuade other village women to comply. They can also bring village women's concerns, say about firewood or fodder needs, to the attention of male EC members. Such persuasion and interaction are important, given the disproportionately high cost of forest closure that women bear in terms of time expended in finding alternative sites for firewood and fodder, and the negative health effects of shifting to inferior fuels such as cropwaste (Agarwal, 2001, in press-b). Women's involvement in the making and enforcement of rules would also help spread awareness of the rules among village women who persistently complain that even their husbands do not usually inform them about what takes place in village meetings. Women EC members would be in a better position to reach them.

The proactive component of protection arises from women's participation in the actual process of protection. If included in the EC, women are likely to be more motivated and better placed to actively participate in protection themselves, by forming a patrol or keeping an informal lookout as they work in the fields. They could also motivate other village women to join or form a patrol group, or simply be more vigilant. The account below, by an all-women's group in Gorkha district, is illustrative:

> We do not have a formal patrol group. It is an informal one. By this we mean we look after the forest when we go to our fields to work…. Once we caught a non-member in the forest. We seized his knife and basket and sent him back (author's survey, 2000–01).

Often women describe with pride their success in preventing timber smuggling or other theft. In the current survey, 37% of Gujarat's CFIs and 72% of Nepal's CFIs that had patrols reported that women also participated in patrolling, typically by substituting for an absent male family member but sometimes by joining a mixed patrol on a regular basis. These and other informal ways in which EC women can make a difference to forest protection cannot all be quantified directly but would be subsumed within the gender composition variable. Simply focusing on their participation in formal patrolling would substantially underestimate that contribution.

Another important contribution (although again difficult to quantify) that women inducted into the EC can make to forest improvement is through their knowledge of how certain forest products should be extracted when the forest is opened periodically, or which products to promote in planting efforts. In many regions (albeit not universally), knowledge of forest ecology is gendered: women are found to be better informed about firewood and fodder

[18] If we take the 'other' CFIs on their own, and compare the ≤2 EC women groups with the >2 EC women groups, the latter received a smaller total forest area to protect, but are not notably disadvantaged on other counts.
[19] The all-Nepal picture is similar: for instance, Buchy and Rai (2008) found from 2004 data that 50% of the all-women CFIs relative to 25% of mixed-gender CFIs across Nepal received forests in poor condition.
[20] See also Bardhan (2001).

species and non-timber forest products, and men about timber species (Gaul, 1994; Pandey, 1990). Their knowledge about the products that they typically collect and which require particular skills, such as how tree fodder should be plucked (excessive plucking can reduce growth) and at what stage of its development—some fodder leaves are best when young, others are poisonous when young (Carter, 1992)—or how ground grass should be cut, or medicinal herbs and wild vegetables procured, can also prove significant in forest conservation efforts (Agarwal, 2000).[21] Moreover, for forest development and enrichment planting, it is useful to know the attributes of different firewood species (some are smokier than others) or different tree fodder species (some help milch cattle produce more milk than others). All this provides yet another reason why women's greater presence on the EC (as a proxy for their overall involvement) could improve forest condition.

The presence of women's associations in the forest protecting community could also strengthen the hands of women EC members who could draw upon these associations to improve protection. Several studies in India have noted the contribution of these associations to forest protection.[22]

Women's age could also matter in conservation. Older women, and older people in general, are likely to carry more authority in prevailing on villagers to follow the rules of forest closure. Age also adds to experience and to social networks which the EC can draw upon in case of conflicts with neighbours over intrusions. Moreover, many older people I met on my field visits in 1998–99 and in the current survey expressed conservationist ideas, emphasizing the importance of forest protection for leaving a legacy for their children and grandchildren.[23] A snippet of my conversation with an elderly woman EC member in the Uttarakhand hills (then in Uttar Pradesh, India) in 1998, is illustrative:

> Author: why do you protect the jungle given that you are now old and may not reap the benefits of protection?
>
> Elderly woman EC member: For my grandchildren. The jungle will keep growing. Every home now has a small [tree] nursery, so we all join and ensure that all the households participate.

Overall, therefore we would expect older EC members to be more committed to rule compliance themselves, and to be able to persuade others to do the same.

Gender and age apart, other social characteristics of the EC, in particular its caste composition, could impinge on forest condition. The Gujarat sample, dominated by tribal communities, is relatively homogenous in this regard, but the Nepal sites contain a fair proportion of both ethnic groups and caste-Hindu groups. Brahmins, the upper-most caste, in particular, tend to carry traditional authority and command respect from those lower down the social hierarchy—their presence on the EC could thus benefit protection. Literacy among EC members could similarly improve their ability to manage the institution and increase the respect they command from their own and neighbouring communities, thus making for better protection. In other words, not only the fact of protection but perceptions about those managing the CFIs and their relationships within and outside the village can impinge on the effectiveness of governance.

### 3.2. Additional relevant factors

In addition to the variables discussed above, six types of factors could affect forest condition: the method of protection, the period of protection, the characteristics of the resource, features of the forest-dependent community, infrastructural development, and technical inputs.

First the overall method of protection could matter. Rule compliance is likely to be better in CFIs employing guards, since guards carry more formal authority than patrol groups or individual villagers, and also reflect the community's commitment to ensuring good protection since the community pays for them. Protection can improve further if the guard's efforts are supplemented by village patrolling and informal vigilance. Although, in Gujarat, CFIs with different gender compositions differ rather little in their protection methods, in Nepal all-women's groups depend more on informal protection than on guards, partly due to financial constraints and partly because their smaller forest plots are easier to protect informally than the much larger forests received by other groups. Second, the period of protection could affect forest condition—the longer the community has protected the forest, the better we would expect forest condition to be.

Third, the characteristics of the resource—the size, initial quality and contiguity of the protected forest—could affect how well it regenerates. A large forest faces less population pressure but is also more difficult to guard effectively. The net effect on realized forest improvement could go either way. The condition of the forest when protection starts could, likewise, impinge on its resilience. Groups that receive a more degraded area begin with an initial disadvantage. Although the impact of this initial condition could not be tested for Gujarat, since all the CFIs said their land was degraded to begin with, it could be tested for Nepal based on the forest department's data. In addition, the districts serve as proxies for differences in overall ecological conditions under which regeneration takes place. Contiguity of the forest area measured by the number of forest segments can also make a difference—non-contiguous plots are more difficult to protect formally and we would expect this to negatively affect forest regeneration. This again was tested only for Gujarat, since in Nepal there were data gaps in some cases and rather little forest segmentation in other cases.

Fourth, the demographic and economic features of the forest-dependent population could impinge on forest condition, although not always in obvious ways. The more the population settlements (hamlets for Gujarat, toles for Nepal) that use a forest, the more difficult it would be to protect, with potentially negative effects on conservation. Similarly high landlessness and/or male out-migration would pull toward poorer forest condition.[24] Landless and migrant households (which too are often landless) are more likely to break rules, given their greater dependence on forests.[25] Both migrants and landless households would also be less able to contribute to protection either financially (toward the guard's pay) or in patrolling time, due to the increased work burden on members left behind in migrant families, and the lack of flexible time in landless families dependent on wage-work.

Fifth, village development measured through an infrastructure index (arrived at by aggregating village electrification, and education and health facilities) can affect forest condition in complex ways. On the one hand the availability of alternative energy sources, such as electricity (and also LPG in more developed villages), could help conservation by reducing dependence on the forest for fuelwood; on the other hand the index is a proxy for modernization which can be linked with less conservationist attitudes. The two aspects could thus have divergent effects on forest condition.

[21] See also http://www.fao.org/docrep/005/y2328e/y2328e07.htm on the importance of using the correct techniques for procuring fodder and pruning fodder trees for sustainable growth.

[22] See Davidson-Hunt's (1995) research in Himachal Pradesh, and Raju's (1997) work in Gujarat.

[23] On people imbibing conservation values over time, see also Agarwal (2005), and Buchy and Rai (2008).

[24] Given a notable overlap between migration and landlessness only one or other was included at a time in the Gujarat regressions.

[25] The issue of dependence is a complex one—greater dependence gives a local population a stake in protection but can also lead to over-exploitation of the forest.

Sixth, the technical aspects of forest management can affect regeneration prospects: for instance, clearing forest undergrowth and weeding allows new shoots to breathe and reduces the risk of fires. Also young trees need careful pruning to allow the best shoots to grow. Biomass growth can thus be critically affected by the expertise with which such periodic cut-back/clearing operations are performed. Although villagers can gain technical knowledge through learning-by-doing; this expertise can be enhanced by technical inputs from forest officials. We would thus expect CFIs with greater forest department inputs to have better forest regeneration.[26] Indirectly forest department involvement would also indicate to villagers that the EC has the backing of state authority and might induce better rule compliance. On the negative side the top–down character of forest department involvement can lower village motivation and sense of autonomy. The net effect would depend on these opposing tendencies. The forest department's involvement in CFI rule formulation is used as a proxy for the department's overall inputs in the Nepal sites. In the Gujarat analysis this variable was not included since the department's involvement in rule making was very limited.

## 4. Measurement

### 4.1. Indicators of forest condition

Any empirical assessment of forest condition and changes thereof faces the challenge of defining relevant indicators and finding the data to measure them. Forest condition can be assessed in many ways, such as density of canopy cover, regeneration, the variety of species, the height and girth of trees, or some mix of these. Aggregating these aspects is not easy. It is also difficult to arrive at an overall average assessment for a large forest, since some parts may be dense, other parts degraded or patchy. Given these complexities, no single measure can give a full picture. I have therefore defined several indicators to measure different aspects.

Four sources of information are used to define the indicators: the researcher's assessment (limited to Gujarat) based on visits by the same expert researcher to all the forest sites; the community's assessment of their protected forest at the time they began protection *and* at the time of the survey (for both Gujarat and Nepal); satellite data-based assessments (for Gujarat); and the forest department's recorded assessment of the protected forest at the time of handover and changes therein (for Nepal). Described below, these indicators would be of methodological interest for other regions as well.

#### 4.1.1. Gujarat

I have used five indicators for Gujarat—the first three are based on the field survey, and the last two on satellite data.

*4.1.1.1. Researcher's index.* For computing this, one of my research assistants with a degree in forestry visited all 65 forest sites in the sample, and I accompanied him to most of the 21 Panchmahals fieldsites. We graded each site on a scale of 1 to 5, at intervals of 0.25, with the value 1 representing the worst condition and 5 representing the best. We arrived at the grade based on a visual assessment of the height and girth of the trees, forest density, signs of regeneration, signs of cutting or other damage, and so on. Different parts of the forest were visited, notes taken, and an overall grade given. Admittedly this was subjective in nature, but since the same person visited all the sites, any personal bias is uniform, and our purpose was to arrive at relative ranking rather than absolute values. This index is treated as a continuous dependent variable in the regression analysis.

*4.1.1.2. Forest canopy (village assessment).* During the field survey, the EC was asked whether the canopy of the protected forest was thick, medium, patchy or thin. This information was used to construct a binary variable for the logistic analysis: CFIs reporting forests with thick or medium canopy were given a value of 1 and those with thin/patchy canopy a value of 0. About 59% of CFIs reported medium or thick canopy.

*4.1.1.3. Change in forest condition since protection began (village assessment).* In the survey, EC members were asked to describe their forest condition (in terms of levels of degradation) when they began formal protection, and at the time of the survey, by choosing one of the following options: very degraded, degraded, good and very good. Comparing information for the two time periods, I assessed whether there was a worsening, no change, some improvement, or substantial improvement. CFIs that moved one category down from where they were when protection began were listed as worsening; those that moved up one category (e.g. from degraded to good, or good to very good) had "some improvement in category", and those that moved up more than one category (e.g. from very degraded to good or degraded to very good) had "substantial improvement in category". Except for one case of worsening with unreliable data (and omitted from the analysis), all others reported either no improvement or (some or substantial) improvement. In the regressions, "no improvement in category" is compared with "some or substantial improvement in category" using logistic analysis.

Notably, this assessment of change is based on a comparison of the broad categories into which the villagers placed the forest when protection began and at the time of the survey, and not on their assessment of whether the forest was "improving" in condition. In fact all the CFIs said their forest was improving, but not all felt it had shifted category from say "degraded" to "good". In other words, forest condition can improve within a given category even if it does not qualify for a category shift.[27]

*4.1.1.4. Geer indices.* The remaining two indices for Gujarat are based on satellite data for 1999–2000 (close to my survey period) provided by the GEER Foundation in Gandhinagar, Gujarat. These indices are *Geer degraded forest* (percent forest area classified as degraded) and *Geer dense forest* (percent forest area classified as dense). Given their conceptual similarity, only Geer degraded forest is used in the regressions. The GEER Foundation's technical team synchronized the village forest area with satellite imagery to establish the percentage of forest area that was degraded or dense. The imagery covers total forest area in the village, which, in some villages, exceeds the protected area. In these cases there could be some underestimation of forest improvement with protection.

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Some of the above indicators are assessments of forest condition at the time of the survey in 2000–01 and some explicitly measure changes over time. Normally, differences between CFIs in the current state of their forest cannot all be attributed to the governance institution, since they would have started with different levels of initial forest condition. However, in the Gujarat sample, since all the CFIs reported they had either degraded or very degraded forest when protection began, it can be assumed that cross-sectional differences in the current state of the forest broadly reflect differences in the efficiency of governance. In this sense, all the Gujarat measures can be seen as measures of change. I am not depending, however, only on the current forest condition indices.

[26] I have in mind specific aspects of technical support from the forest department. This does not contradict the broader criticism of 'scientific forestry' that was promoted by the colonial administrators and used to divest local communities of their traditional rights to forest produce (see e.g. Guha, 1989).

[27] Also, as Lele (1994) emphasizes, villagers' assessments of a good or degraded forest can be affected by the products it provides, and different segments of the population may value different products. My survey, however, did not capture such differences, possibly because the initial degradation was so high that any regeneration was equally welcomed across the community.

There is also one indicator (village assessment) which explicitly measures change. Moreover, there is consistency between indices, the signs of the correlation coefficients between different indicators are in the expected direction, and in some cases the correlation coefficient is notably high (e.g. it is 0.71 between the researcher's index and villagers' assessment of canopy cover).

Table 3 gives the forest condition profile for Gujarat, by district and gender composition. Most of the indices (taking all districts together) show a considerable variation across CFIs, but on average almost all the forests show improvement, even though there is still considerable scope for going further. By the GEER Foundation's satellite-based assessment, in 1999 although a third of the forest area on average was still degraded, a third was also dense. By the villagers' assessment, 41% of the sites had thin or patchy canopies but the rest had medium to thick canopies at the time of the survey. Also, in 83% of the CFIs there was some or substantial category improvement in forest condition from the pre-protection situation. A somewhat higher percentage of the CFIs with >2 EC women compared to those with ≤2 EC women showed a category improvement.

*4.1.2. Nepal*

For Nepal I use two indicators of forest condition, one based on my field survey, the other on the forest department's records. Both measure change. In Nepal, it was necessary to use direct change measures for assessing the impact of institutional governance, since here, unlike in Gujarat, some CFIs received degraded forests and others received forests in fairly good condition.

The first indicator is villagers' assessment in 2000–01 of forest regeneration since protection began. The EC members categorized regeneration as poor, good and very good. The second indicator is change in canopy cover, based on the forest department's assessment at the time of handover (and found in their written records) and a forest officer's assessment at the time of my survey. On both occasions, the forest was described in terms of whether the canopy cover was thin, patchy, medium or thick. Forests that had moved since handover from an upper to a lower category (e.g. from thick to patchy) were seen as "worsening". Those remaining either thin, patchy or medium at both times were identified as remaining the "same", and those moving upwards (say from thin to patchy or patchy to medium or thick) were categorized as "better". Those that were thick both at the time of handover and in 2000–01 were treated as maintaining their good condition. They were clubbed with "better". Since there were only two cases of worsening they were clubbed with "same". Change by this second indicator therefore involves comparing "same or worsening" canopy cover with "better or maintaining thick canopy".

**Table 3**
Gujarat forest condition indicators.

| Forest condition indicators | ≤2 EC women | >2 EC women | All CFIs |
|---|---|---|---|
| | $N=30$ | $N=33$ | $N=63$ |
| 1. Researcher's Index (mean) | 3.2 | 3.7 | 3.5 |
| 2a. Geer % degraded forest, 1999 (mean) | 34.5 | 30.8 | 32.6 |
| 2b. Geer % dense forest, 1999 (mean) | 31.3 | 29.9 | 30.6 |
| 3. Density of forest canopy at time of survey (village assessment) (% of CFIs) | | | |
| • Thin or patchy canopy | 40.0 | 42.4 | 41.3 |
| • Thick or medium canopy | 60.0 | 57.6 | 58.7 |
| 4. Improvement in forest condition category since protection began (computed from village assessments) (% CFIs) | $N=31$ | $N=33$ | $N=64$ |
| • No improvement in category | 22.6 | 12.1 | 17.2 |
| • Some improvement in category | 38.7 | 54.6 | 46.9 |
| • Substantial improvement in category | 38.7 | 33.3 | 35.9 |

Source: Author's 2000–01 survey.
Notes: $N$ = number of CFIs.

**Table 4**
Nepal: forest condition indicators (% CFIs).

| Forest condition indicators | All-women CFIs | Other CFIs[a] | All CFIs |
|---|---|---|---|
| 1. All forest regeneration in 2000–01 (village assessment) | $N=27$ | $N=43$ | $N=70$ |
| • Poor regeneration | 18.5 | 11.6 | 14.3 |
| • Good regeneration | 51.8 | 69.8 | 62.9 |
| • Very good regeneration | 29.6 | 18.6 | 22.8 |
| 2. Change in forest canopy (forest department assessment)[b] | $N=21$ | $N=37$ | $N=58$ |
| • No change from thin or patchy[c] | 33.3 | 32.4 | 32.8 |
| • No change from thick canopy | 4.8 | 24.3 | 17.2 |
| • Improvement from thin upwards | 61.9 | 43.3 | 50.0 |

Source: Author's 2000–01 survey.
Notes: $N$ = Number of CFIs.
[a] 'Other' contains mixed gender CFIs and 5 all-male CFIs.
[b] The Original canopy cover could be thin, patchy, medium or thick.
[c] Contains 2 cases of worsening.

By both indicators most CFIs registered an improvement in forest condition (Table 4). Eighty-six percent reported good or very good forest regeneration and about half (table not given) also reported an increase in species. Even by the forest department's (somewhat more conservative) assessment, 50% of the CFIs improved their canopy cover and another 17% maintained their thick canopies. Even maintaining a dense forest implies that community management has proved beneficial.

Although, gender-wise, on average, Nepal's all-women CFIs began with poorer forests than the other groups, today the picture is a mixed one. By the villagers' assessment, although a somewhat larger percentage of the all-women groups relative to other groups reported "poor" regeneration, a substantially larger percentage of them also reported "very good" forest regeneration. Also by the forest department's assessment of a change in forest canopy, a substantially larger percentage of all-women groups than other groups had improved canopy cover, while about the same percentage of both types of groups showed no change from thin or patchy cover. In the regression analysis (further below), we examine whether all-women groups outperform other groups, despite their initial disadvantage, after controlling for other factors.

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In the regression analysis, I use four indicators of forest condition/change for Gujarat and two for Nepal. The explanatory variables conceptually fall into four categories: Gender and EC-related, CFI-related, resource-related and location/village-related. All the models consistently test for the impact of the EC's gender composition, which is our primary interest. Most models also have several other explanatory variables in common, but in a few equations some variables are not included due to sample size constraints or hidden collinearity (in logistic analysis).[28] Also some explanatory variables which capture rather similar dimensions serve as substitutes in particular equations, such as the gender dummy and the percent women in the EC; or the average age of the female EC members and the average age of all EC members.

Apart from the all-district analysis, separate analysis is presented for Panchmahals (Gujarat) because the district has some distinct

[28] Hidden collinearity can occur, for instance, in logistic models when several explanatory variables are dummies, leading to missing standard errors for one or more of the estimated coefficients. The solution is usually to drop the variable due to which this occurs.

**Table 5**
Gujarat: factors affecting forest condition (all districts).

| Dependent variables | Researcher's index | Forest canopy: dummy[a] village assessment | | Geer index: % degraded forest | | Forest condition change[b] (village assessment) | |
|---|---|---|---|---|---|---|---|
| Statistical method | OLS (r) | Logit | | OLS (r) | OLS (r) | Logit | |
| Equation no. | 1 | 2 | | 3 | 4 | 5 | |
| No. of observations | 57 | 57 | | 57 | 60 | 57 | |
| $R^2$ or pseudo $R^2$ as relevant | 0.59 | 0.31 | | 0.20 | 0.29 | 0.61 | |
| Explanatory variables | Coeff. | Coeff. | M.E | Coeff. | Coeff. | Coeff. | M.E. |
| GenComp1: dummy (>2 EC women = 1) | 0.32* (0.065) | −0.06 (0.940) | −0.01 (0.940) | −1.12 (0.810) | | 2.44† (0.104) | 0.02 (0.547) |
| GenComp2: % EC women | | | | | −0.13* (0.090) | | |
| Women's association: dummy (assoc. exists = 1) | | 1.27* (0.092) | 0.30* (0.079) | 4.34 (0.336) | 5.76 (0.178) | 1.55 (0.280) | 0.01 (0.570) |
| Average age of women EC members | 0.03** (0.028) | 0.03 (0.547) | 0.01 (0.548) | −0.70* (0.055) | | 0.41** (0.037) | 0.00 (0.535) |
| Average age of all EC members | | | | | −0.95*** (0.009) | | |
| Protection method: dummy (Guard = 1) | 0.61*** (0.002) | 1.70* (0.060) | 0.35** (0.022) | −3.38 (0.470) | −3.96 (0.361) | −1.15 (0.606) | −0.01 (0.712) |
| Forest area protected (ha) | 0.00** (0.040) | 0.00 (0.346) | 0.00 (0.339) | −0.01 (0.464) | −0.01 (0.373) | 0.01 (0.129) | 0.00 (0.556) |
| Forest segments | −0.16* (0.082) | −0.29 (0.438) | −0.07 (0.436) | −0.05 (0.981) | −0.69 (0.733) | −2.27* (0.078) | −0.01 (0.545) |
| No. of hamlets in village | −0.14*** (0.002) | −0.34** (0.030) | −0.08** (0.029) | 0.76 (0.484) | 0.19 (0.854) | −0.35 (0.345) | −0.00 (0.589) |
| % Village households with migrant males | −0.02** (0.016) | −0.09** (0.037) | −0.02** (0.039) | 0.05 (0.825) | 0.15 (0.265) | −0.13* (0.074) | −0.00 (0.528) |
| District2: dummy (Panchmahals = 1) | −0.44 (0.226) | −3.16 (0.108) | −0.66** (0.016) | −6.21 (0.498) | | −4.85 (0.150) | −0.13 (0.578) |
| District3: dummy (Sabarkantha = 1) | −1.03*** (0.004) | −3.42* (0.080) | −0.67*** (0.009) | −4.20 (0.644) | | −1.43 (0.536) | −0.01 (0.662) |
| Constant | 3.74 | 3.55 | | 58.64 | 74.35 | −5.44 | |

OLS (r) = regression with robust standard errors.
M.E = Marginal Effect. The M.E. is for a discrete change from 0 to 1 for dummy variables, and for a one unit change for continuous variables.
Numbers in parenthesis are *p*-values. Significance: *** at 1%, ** at 5%, * at 10%, † at close to 10%.
[a] Forest canopy: Thick or medium density = 1; thin or patchy = 0.
[b] Forest condition change: some or substantial improvement in category = 1; no improvement in category = 0.

features, such as the community-initiated nature of many of its CFIs compared with the more NGO-initiated groups in the other Gujarat districts, and the disproportionately high percentage of landless women in many of Panchmahals ECs compared with both other Gujarat districts as well as Nepal. The latter aspect also impinges on extraction rules where again Panchmahals differs from other regions. In Agarwal (2009, in press-a), for instance, I explored the impact of the EC's gender composition on the strictness of extraction rules, and found (unexpectedly) that ECs with more women tended to make stricter rules, except in Panchmahals where such CFIs made less strict rules. One important factor identified as underlying the difference between Panchmahals and other areas was the high presence of landless women among many of Panchmahals' ECs and their low presence elsewhere. The Panchmahals case would thus also help us examine whether leniency in rules can impact negatively on conservation.

The estimation procedure used is variously ordinary least square regressions (corrected for heteroskedasticity to give robust standard errors) for continuous dependent variables, binomial logistic regressions for binary dependent variables, and a multinomial logistic regression in the one case where the dependent variable takes three discrete values.

### 4.2. Potential econometric concerns

Survey analysis can raise some econometric concerns, in particular omitted variable bias and reverse causality. However, I do not expect potential problems on either count in relation to the EC's gender composition, which is the explanatory variable we are most interested in. For instance, a potential argument could be that the EC's gender composition and improved forest condition are both a result of an omitted factor, such as culture: communities with a positive gender attitude might also be more conservation-minded. Culture could thus explain both high female presence on the EC and improvement in forest condition. This is unlikely to hold in my study area, however. For example, one popular cultural marker (even stereotype) of gender friendliness and environmental friendliness is caste or ethnicity. Tribal communities are popularly assumed to be less patriarchal and more conservationist. In my study area, however, community social norms do not vary much across the samples. In the Gujarat sites, most villages are dominated by tribal communities and there is no systematic difference on this count by CFI gender composition. In Nepal, as noted earlier, there is greater caste/community heterogeneity, but all the sample CFIs are located in the middle hills where differences in social norms governing upper-caste Hindu women and ethnic women tend to be less sharp than in the plains, and social restrictions on Hindu women have also been declining overall.[29] Similarly, there is no evidence in the study sites of systematic differences between communities in attitudes to forest conservation. In any case, in Nepal I have taken the EC's caste/ethnic composition into account as an explanatory variable. Another potential factor which could be argued to affect both gender composition and forest condition is NGO presence. But an NGO would uniformly affect all CFIs in its area of operation, and differences between NGOs are assessed through the district dummies. Although it cannot be fully guaranteed that no variable is omitted, no obvious variable comes to mind that may have been omitted which could simultaneously affect both EC gender composition and forest condition in this region.

Also, I explored and found that the factors associated with the EC's gender composition were diverse and highly context-specific (often varying from CFI to CFI), and none appeared to be linked to observed forest condition.[30] Some factors which facilitated greater female

[29] Although, traditionally, Hindu women tended to face more social restrictions than ethnic women in Nepal, this was less the case for Hindu women in the hills even in the late 1970s (Acharya and Bennett, 1983); and in recent years social restrictions on Hindu women in general have declined substantially (Bennett and Gujurel, 2006).
[30] See Agarwal (in press-b) for a detailed discussion of this exploration.

**Table 6**
Gujarat: factors affecting forest condition (Panchmahals district).

| Dependent variables | Researcher's index | Forest canopy: dummy[a] (village assessment) | | Geer index: % degraded forest | Forest condition change: dummy[b] (village assessment) | |
|---|---|---|---|---|---|---|
| Statistical method | OLS (r) | Logit | | OLS (r) | Logit | |
| Equation no. | 1 | 2 | | 3 | 4 | |
| No. of observations | 18 | 18 | | 19 | 19 | |
| $R^2$ or pseudo $R^2$ as relevant | 0.84 | 0.30 | | 0.68 | 0.55 | |
| Explanatory variables | Coeff. | Coeff. | M.E. | Coeff. | Coeff. | M.E. |
| GenComp1: dummy (>2 EC women = 1) | 0.98*** (0.001) | 3.86* (0.067) | 0.75*** (0.001) | −12.60* (0.078) | 3.56* (0.094) | 0.57** (0.031) |
| Average age of women EC members | 0.01 (0.479) | −0.02 (0.870) | −0.01 (0.870) | −1.20*** (0.003) | 0.12 (0.441) | 0.02 (0.445) |
| Protection method: dummy (guard = 1) | 0.94** (0.013) | 1.41 (0.488) | 0.34 (0.444) | 0.81 (0.908) | | |
| Forest area protected (ha) | 0.00 (0.284) | 0.01 (0.326) | 0.00 (0.315) | 0.07*** (0.002) | 0.01* (0.099) | 0.00 (0.137) |
| Forest segments | −0.03 (0.742) | 0.08 (0.884) | 0.02 (0.884) | −0.73 (0.720) | −1.29 (0.173) | −0.25 (0.189) |
| % Landless households in village | −0.05 (0.107) | −0.18 (0.400) | −0.04 (0.400) | 0.42 (0.664) | −0.62** (0.047) | −0.12* (0.055) |
| Infrastructure index | −0.07 (0.558) | 0.32 (0.771) | 0.08 (0.772) | −9.62** (0.024) | | |
| Constant | 2.57 | −3.71 | | 101.68 | −3.39 | |

OLS (r) = regression with robust standard errors.
M.E. = Marginal Effect. The M.E. is for a discrete change from 0 to 1 for dummy variables, and for a one unit change for continuous variables.
Numbers in parenthesis are *p*-values. Significance: *** at 1%, ** at 5%, * at 10%.
[a] Forest canopy: Thick or medium density = 1, Thin or patchy = 0.
[b] Forest condition change: Some or substantial improvement in category = 1; no improvement in category = 0.

presence were historical (a history of women's prior group activity unrelated to forestry); some were linked with ad hoc interventions by a dynamic and gender-sensitive NGO staff member or village leader; some stemmed from the availability of forest products of particular interest to women; and some were linked with the absence of disabling gender norms. NGO staff or village leaders encouraging women's inclusion were driven primarily by considerations of gender justice and women's empowerment, rather than by the idea that women might have a different impact on forests than men. Occasionally village leaders mentioned that including women in the EC could reduce rule violations by women. But all these considerations impinged on the formation of ECs *prior to* any visible impact on forest condition.

Especially because of this time sequencing, I also do not expect a reverse causality bias. EC formation precedes the impact on forest condition. Once formed, most ECs tend to remain largely unchanged for several years, with an occasional member being replaced if s/he wants to discontinue or is suspected of corruption. The causality would thus run from EC formation in time 't' to forest condition in time 't + k'. In other words, while the EC's gender composition could have a bearing on changes in forest condition, the reverse does not appear to be very likely. In Nepal the noted link between EC composition and forest condition again has a time sequence. Although all-women's groups tend to get poorer forests, such groups are not formed because there is degraded forest available. Rather all women's groups *once formed* tend to be given more degraded forest.

## 5. Regression results

Tables 5 to 8 give the regression results, and the tables in Appendix A provide definitions and descriptive statistics.

### 5.1. Effect of gender and EC characteristics

In both Gujarat and Nepal, the results show that gender matters in a number of ways. The most important gender variable is the EC's gender composition. Several indicators show that in CFIs where ECs had more women the forests were in better overall condition at the time of the survey, and showed greater improvement in condition over the protection period. The positive gender effect is especially strong in the all-district results for Nepal, and for Panchmahals district

**Table 7**
Nepal: factors affecting forest regeneration (all districts).

| Dependent variable | Forest regeneration[a] (change reported by villagers at time of survey) | | | |
|---|---|---|---|---|
| Statistical method | MLogit | | | |
| No. of observations | 70 | | | |
| Pseudo $R^2$ | 0.21 | | | |
| Explanatory variables | Coeff | M.E | Coeff | M.E. |
| Categories compared | 1 (Poor) Compared with 2 (Good) | Outcome (1) | 3 (Very good) Compared with 2 (Good) | Outcome (3) |
| GenComp: dummy (All-women EC = 1) | 1.48 (0.195) | 0.04 (0.498) | 1.58* (0.083) | 0.29* (0.095) |
| Women's association: dummy (assoc. exists = 1) | −1.92* (0.064) | −0.08 (0.278) | −0.20 (0.784) | −0.01 (0.909) |
| Average age of all EC members | −0.03 (0.805) | −0.001 (0.723) | 0.06 (0.437) | 0.01 (0.416) |
| % Brahmins in EC | 0.02 (0.194) | 0.001 (0.308) | 0.01 (0.417) | 0.001 (0.465) |
| Who made forest-use rules: dummy (without FD help = 1)[b] | 2.73** (0.021) | 0.11 (0.287) | 1.36 (0.122) | 0.22 (0.202) |
| Forest area protected (ha) | −0.08* (0.053) | −0.003* (0.071) | 0.01 (0.442) | 0.002 (0.271) |
| No of toles | 0.01 (0.955) | 0.002 (0.816) | −0.15 (0.334) | −0.03 (0.320) |
| District: dummy (Baglung/Parbat = 1) | −0.16 (0.894) | −0.005 (0.902) | −0.06 (0.936) | −0.01 (0.943) |
| Constant | −0.30 | | −4.34 | |

M.E. = Marginal Effect. The M.E. is for a discrete change from 0 to 1 for dummy variables, and for a one unit change for continuous variables.
For GenComp, I also calculated predicated probabilities at value 1 and value 0 and the difference. The predicted probability for forest condition being very good came to 0.44 with GenComp = 1 and 0.15 with GenComp = 0, giving a difference of 0.29, which is the same as the marginal effect for outcome (3).
Numbers in parenthesis are *p*-values. Significance: ** at 5%, * at 10%.
In the equation, the Hausman's test indicates that the assumption of 'independence of irrelevant alternatives' (IIA) holds.
[a] Forest regeneration: poor = 1; good = 2; very good = 3.
[b] The M.E. for outcome (2), not presented here, was negatively significant at 10%.

**Table 8**
Nepal: factors affecting forest canopy change (all districts).

| Dependent variable | Change in forest canopy: dummy[a] (canopy assessed by the forest department at two points in time) | |
|---|---|---|
| Statistical method | Logit | |
| No. of observations | 58 | |
| Pseudo $R^2$ | 0.38 | |
| Explanatory variables | Coeff. | M.E. |
| GenComp: dummy (All-women EC = 1) | 4.18** (0.010) | 0.51*** (0.000) |
| Women's association: dummy (Assoc. exists = 1) | −1.43 (0.142) | −0.21 (0.130) |
| Average age of all EC members | 0.40*** (0.006) | 0.06*** (0.001) |
| % Illiterate EC members | −0.03* (0.067) | −0.01* (0.050) |
| % Brahmins in EC | 0.03** (0.045) | 0.004** (0.034) |
| Who made forest-use rules: dummy (without FD help = 1) | −0.43 (0.660) | −0.07 (0.668) |
| Forest area protected (ha) | 0.02 (0.352) | 0.003 (0.353) |
| Forest canopy at time of handover: dummy (Thick or medium = 1) | 2.97** (0.027) | 0.29*** (0.004) |
| No. of toles | −0.17 (0.302) | −0.03 (0.306) |
| District: dummy (Baglung/Parbat = 1) | −2.34** (0.047) | −0.38** (0.035) |
| Constant | −15.30 | |

M.E. = Marginal Effect. The M.E. is for a discrete change from 0 to 1 for dummy variables, and for a one unit change for continuous variables.
Numbers in parenthesis are *p*-values. Significance: *** at 1%, ** at 5%, * at 10%.
[a]Change in forest canopy: Canopy improvement or thick canopy maintained = 1; same canopy (thin, patchy or medium) or worsening canopy = 0.

in Gujarat. Gujarat's all-district results are less strong but still significant for two indicators, and suggestive for a third.

In Gujarat, ECs with >2 women relative to those with ≤2 women are found to rank significantly higher in overall forest condition by the researcher's index (Table 5: Eq. 1). Also the higher the percentage of women on the EC, the lower the percentage of degraded forest area (Table 5: Eq. 4). Given that all the forests were degraded when protection began, we can take the overall better forest condition, and a lower percentage of degraded area at the time of the survey, as signs of improvement. In this sense, as noted earlier, all of Gujarat's indicators are indicators of change, either implicitly or explicitly. The direct change indicator—based on the villagers' assessment—also shows that ECs with >2 women are more likely to show a category improvement in forest condition than those with ≤2 women, but this result is only indicative since the marginal effect is not significant.

The Panchmahals gender results, however, are consistently strong and striking (Table 6). CFIs with more EC women tend to have better forests and show a greater improvement in forest condition by every single indicator: CFIs with >2 EC women compared with those with ≤2 women perform better by the researcher's index; tend to have a thicker forest canopy and a lower percentage of degraded forest area; and are more likely to show an improvement in forest condition since protection began. The probability of forest category improvement is 57% higher in CFIs with >2 EC women than in those with ≤2 EC women (Table 6, Eq. 4). Similarly the probability of the forest canopy being medium or thick as vs. thin or patchy is 75% higher in CFIs with >2 EC women than in those with ≤2 EC women (Table 6, Eq. 2). One possible reason why the gender variable does especially well in Panchmahals could be the more inclusive nature of its ECs, many of which tend to have a substantially larger presence of landless women members, relative to other districts. Inducting landless women into the EC and involving them in the conservation project would enhance rule compliance among landless families, who otherwise tend to remain marginalized and, not infrequently, hostile to forest closure.

The Nepal results are again consistently strong on the gender effects: both indicators explicitly measure change and by both indicators the forests of all-women CFIs relative to other groups show significantly greater improvement. For instance, there is a 29% greater probability of forest regeneration being very good with CFIs that have all-women ECs than other CFIs (Table 7). Similarly, there is a 51% higher probability of an improvement in forest canopy with CFIs that have all-women ECs relative to other CFIs (Table 8). The positive effect of women's participation on forest canopy is especially notable, since this is a measure derived from the forest department's assessment of canopy cover recorded at two points in time, and not from the villagers' own assessment of change recorded at the time of the survey. There is consistency, however, in the overall direction of change between the assessment of villagers and that of the forest department.

In both Gujarat and Nepal, the presence of more women on the EC impinges on forest condition in various ways, which I touched upon when framing the hypotheses and elaborate here. The most important effect is through improved protection. Village women tend to participate in patrolling much more if they are on the EC. This makes for more effective patrolling than when men alone patrol. Women are also found more likely to be in patrols where ECs have more than just one or two women, and some all-women CFIs in Nepal even have formal women-only patrols. More commonly, however, all-women patrols are informal, consisting of a few women doing a daytime round. Women in patrols are better able to apprehend female intruders while men face cultural constraints in physically catching women intruders and risk being charged with molestation if they do so.[31]

Women are also found to comply more with the rules when they are themselves on the EC. Some EC women in a Baglung CFI (author's survey, 2000–01) put it clearly:

> W 1: We feel the forest is ours. When I was only a CFI member, I used to steal grass from the forest, but after taking responsibility as an EC member I have stopped stealing and feel that the forest should be protected.
>
> W 2: We labor hard for this forest. I feel it is like my own baby.

EC women tend to spread information about rules among other women, persuade them to follow the rules, and may even motivate them to be vigilant and report intruders. Observations by some women EC members on their contributions to protection are illustrative:

> One year, EC women did not go for protection, only the men went. But women sneaked in for cutting firewood. So men said to me,

[31] During my fieldwork in India both in 2001-01 and earlier in 1998–99, I came across many instances where such charges had been made against all-male patrol groups (see also Agarwal 2001).

> you should stop women from cutting since the women don't listen to us when we request them not to cut. So I called a meeting of the women. We decided that ten women would go together every day for patrolling (woman EC member and leader to author, CFI in Narmada district, Gujarat, 1998).

> Having women on the EC helps in protection. Often village women would cut firewood from the protected forest in times of need. We held a meeting and they stopped cutting. We were even able to persuade women from the neighbouring village to stop cutting our forest (woman EC President to author, CFI in Sabarkantha district, Gujarat, 1999).

Especially but not only among all-women CFIs, I found that village women often expressed a strong sense of ownership of the protected forest, and kept an informal vigil when going about their daily work. Sometimes women's alertness alone prevented forest fires from spreading. All-women groups compared to other Nepal groups also have significantly fewer violations per year of CFI functioning; and in Gujarat I found that violations by women and for firewood declined while violations by men and for timber increased, as the years of protection increased (Agarwal, in press-b). The collection of firewood, fodder and non-timber items done mainly by women is also less likely to be harmful compared with the lopping or clear felling of trees for timber by men (see also Lele, 1994).

Moreover, the Panchmahals results demonstrate that lenient rules which allow some procurement of firewood and related products do the forest no harm. Here women's greater presence in the EC is linked with improved forest condition even though, as noted earlier, such groups make less strict rules. In fact, some extraction can even be beneficial, as elaborated further below, by helping to clear undergrowth and providing the community in general, and women in particular, more incentive to cooperate, resulting in a positive net effect on forest condition. Another advantage that groups with more women compared with groups with few or no women are found to have in other studies (although not directly tested by me) is better collaboration, solidarity and conflict resolution.[32] This can greatly benefit institutional functioning and forest condition outcomes. Moreover, although difficult to quantify, women's presence on the EC tends to benefit forest condition through their knowledge of plants and correct extraction practices, and through better account being taken of women's preferences in plant species, thus enhancing their cooperation.

Gender effects in the regression results are apparent too through village women's associations and the age of female EC members. An active women's association is significantly associated with thick rather than thin forest canopy in Gujarat (Table 5: Eq. 2), and with good forest regeneration as vs. poor regeneration in Nepal. The statistical results, however, are not a full measure of this variable's importance which is revealed more in women's qualitative responses. In some Gujarat villages, EC women told us that women's associations helped them spread the message of forest conservation and encouraged village women to watch out for intruders.

Age has both a gender dimension and a general dimension and, as hypothesized, is found significant in both Gujarat and Nepal for most forest condition indicators. CFIs that have ECs with older women members and older members in general show greater improvement in forest condition. In Gujarat, age is positively associated with better current forest (researcher's index), a smaller percentage of degraded forest area (Geer index), and an improvement in forest condition (Table 5). In Nepal, ECs with older members (including women) are found more likely to show an improvement in forest canopy (Table 8). Older EC members (as elaborated earlier) embody greater experience in CFI functioning, carry more authority and respect within the village and are more likely to be listened to, making it easier for them to enforce rule compliance. They also often tend to be more committed to protection, to have lower time preferences, and are more likely to express explicitly conservationist values. The region's environmental histories (recorded in my survey), especially those from Gujarat, for instance, suggest that many older people (men and women) initiated forest protection because they had personally seen the degradation of once-lush forests. The elderly also bear fewer costs in enforcing the rules, since they often have younger family members, especially daughters-in-law to search for firewood and fodder—a support of particular importance for female EC members. And older women are more able to attend EC meetings, and face fewer social restrictions in talking to both male and female villagers and persuading them to adhere to the rules.

The EC's caste and literacy are also found to make a difference. Improvement in forest condition in Nepal is greater in ECs which have a higher percentage of Brahmins and a lower incidence of illiteracy among their members (Table 8).

### 5.2. Other relevant factors

A number of factors linked with CFI functioning and the characteristics of the forest, the population, and the location also affect forest condition. Some of these factors are significant in Gujarat, others in Nepal. First, in Gujarat, protection by a guard is significantly associated with better overall forest condition (higher researcher's index, denser canopy: see Tables 5 and 6).[33] Guards matter not only in what they themselves can do (being paid by the community, they bear more responsibility and carry more authority than village patrols), but also their presence reflects the community's interest in good protection and rule enforcement.[34] Villagers themselves recognize this:

> When we began protection, the forests also began to grow. With that thefts increased. It was difficult for us to control this. So we decided to keep two or three watchmen. People used to feel that they had a right over the forest, and who are we to stop them? Now everybody knows that we are serious about protection, that is why the thefts have decreased, almost stopped (EC members in a CFI in Panchmahals district, author's survey, 2000–01).

Even when the community cannot afford a guard throughout the year, they employ one during marriage or festival seasons when the forest is particularly at risk. The period of protection, however, is found to have an insignificant effect in all the equations for both Gujarat and Nepal and the variable is not included in the final equations presented here.

Second, forest condition is significantly affected by the population served by the CFI, which in turn impinges on its ability to protect. Both the all-district and Panchmahals equations for Gujarat bring this out. In the all-district results (Table 5), the larger the incidence of migrant households in the village, the poorer is the condition of the forest. Migration reduces a household's ability to contribute to protection and other forest management work. Landlessness, except insofar as it overlaps with migration, makes no additional difference. In Panchmahals, however, landlessness on its own (here migration per se is less important), does have a negative

[32] Westerman et al (2005) empirically establish this in their study of 46 groups with varying gender composition (all-men, mixed, and all-women) managing natural resources across 20 countries of Latin America, Africa and Asia.

[33] In the Nepal equations, the forest protection method was not included because of hidden collinearity (see also footnote 28).

[34] There is a difference between a forest department beatguard who may be imposed top–down on the villagers and likely to face hostility from them, and a guard appointed by the villagers themselves.

impact on forest condition (Table 6: Eq. 4). Landlessness, we had noted, makes for higher forest dependence (which could increase the proclivity to break rules), and a lesser ability to contribute to protection, time-wise or financially.

Third, as hypothesized, resource characteristics and the constraints they pose affect forest condition and its likelihood of improvement—the fewer the constraints the better the conservation. Larger forests show a greater improvement in forest condition in some equations for both Gujarat and Nepal, but the coefficients are very small so that the effect is limited (Tables 5, 6 and 7). Panchmahals deviates from this pattern for one indicator, in that large forest size is linked with a larger percentage of degraded area (Geer index). This could imply that monitoring difficulties outweigh the advantage of size; but more likely what underlies this result is the fact that in several Panchmahals villages with large forests some of the forest area in the Geer index falls outside the protection boundary (since, as noted, the satellite data do not distinguish between protected and unprotected village forest land).

Relatedly, the Gujarat results bear out that the more the settlements (hamlets) dependent on the forest the poorer the forest condition and the less the chances of improvement. A larger number of settlements indicate not just population pressure but also social heterogeneity, since hamlets are often formed around caste groups. Such heterogeneity enhances the potential for conflict in the community and can reduce institutional cooperation and so negatively affect conservation outcomes. In Nepal, the effect of toles is not significant, possibly because pressure on any one protected site is somewhat eased since villagers can join more than one CFI: in 75% of the CFIs the villagers were members of at least one other CFI (although such membership when measured directly was not a significant predictor of forest improvement). Other aspects of initial resource disadvantage that are found to have an adverse impact on forest condition include the number of forest segments (Gujarat). Non-continuous forest areas are difficult to effectively watch either by a patrol or a guard—in fact CFIs with highly segmented forests do not even bother to keep guards. The district dummies also capture the overall impact of location which includes ecology and population aspects. In Gujarat, CFIs in Narmada/Bharuch do better by several indicators than those located in the other two districts, and in Nepal, CFIs in Gorkha/Dhading do better in terms of canopy increase than CFIs in Baglung/Parbat.

What about resilience? Does the extent of degradation when protection started matter in the forest's ability to regenerate naturally? The Nepal results support this. We find that forests that started with an initial advantage (e.g. had medium to thick canopy) had a 29% greater probability of showing an improvement in canopy or maintaining a thick canopy, compared with forests which were thin or patchy at the time of handover (Table 8). It is therefore especially creditable that all-women groups, most of which started with thin and patchy forests, have done so well in improving their forest condition.

Fourth, the impact of the infrastructure index (a proxy for modernization and lower forest dependence) is weak and is found significant in only one equation (see Table 6 for Panchmahals).[35] A higher index is linked with a lower percentage of degraded forest.

Fifth, there is a positive albeit weak indication that forest department involvement adds to forest improvement: Nepal's CFIs in which the forest department provided inputs in framing forest-use rules are found more likely to have good regeneration (Table 7). Forest department involvement can, as noted, improve forest condition by the technical inputs the department can provide—in Nepal they are especially involved in the CFI's forest cleaning and pruning operations—and because the authority they carry could induce people to comply better with forest closure rules.

[35] The index was found to be consistently insignificant in the all-district Gujarat regressions and was not included in the final equations, given sample size constraints.

It needs mention though that strict forest-use rules (that is, little or no extraction) may or may not improve forest condition. On the one hand, it is possible that some of the improvement in forest condition associated with women's greater presence on the EC is attributable to the stricter rules that CFIs with more women make in most of the study districts, with the exception of Panchmahals (Agarwal, 2009). On the other hand, the results for Panchmahals, where CFIs with more EC women show better forest regeneration, despite making relatively lenient rules, indicate that less strict rules which allow some extraction do no harm.[36] Indeed, very strict rules, such as a total ban on entry, could be counterproductive, both because the rules can prove socially non-viable and increase the tendency of those in acute need to break them, and because ecologically they may leave the forests more vulnerable to fires. Allowing cattle to graze, for instance, helps remove potentially incendiary undergrowth, while totally banning grazing can cause biomass to accumulate and prove susceptible to fires set off by a careless cigarette or by someone resentful of the rules.[37] This does not of course imply that open access will benefit conservation. Rather, within the overall regime of protection and regulation, context-specific leniency could benefit forest condition, or at least do no harm, while leading to more equitable gender outcomes in terms of women's access to firewood and other non-timber products.

## 6. Concluding comments

This paper has statistically examined whether women's greater participation in the governance structure of an institution protecting a common pool resource, such as a forest, leads to better resource conservation and regeneration. We find that this is indeed the case. As argued here, there can be many reasons for this. Involving women in the EC's decisions enlarges the pool of citizens committed to forest conservation. Including women in the EC also improves the spread of information about forest closure rules and the need for conservation among a wider cross-section of people. It increases the numbers of those keeping watch for transgressors from within and outside the community of members. And it creates conditions for taking better account of women's knowledge of plants and species. It can also help instill a conservation ethic in children and so contribute to sustainable conservation. Measures that help enhance women's presence in the governance institutions would thus be beneficial not only because women's participation is important in itself, as a constituent element of successful functioning, but also in an instrumental sense of better fulfilling the conservation objectives of such institutions. A related enabling factor can be the presence of a woman's association in the community. Although captured only limitedly in the statistical analysis, women's associations (especially if inclusive of poor women) could improve forest protection and enhance women's collective strength and public presence.

Another dimension, not captured in the statistical analysis but which could prove important, is having more landless women and generally more landless members represented on the EC. Landless EC members could better persuade village landless households to follow the rules set by the CFI. Landless *women* on the EC could have a particularly positive effect since they are the most forest dependent and their reaching other landless village women could make a marked difference to protection. In other words, unlike the effect of *village* landlessness, which we found was detrimental to

[36] When I directly tested the effect of strictness in forest use rules on improvements in forest condition, the variable was consistently insignificant (see Agarwal, 2009, for details on the nature of rules).

[37] For historical evidence on this, see Bhattacharya (1992) and Sivaramakrishnan (1999).

conservation, the effect of including the landless on the EC could prove beneficial.

Our finding that older female EC members and an older EC overall are more effective, also points to the positive effect of inducting older people into governance. Another policy pointer is the benefit of employing a guard to supplement village patrolling. The forest department's technical support (including training in pruning and clearing operations) could also enhance the effectiveness of the community's conservation efforts, although gender barriers in access to training would need to be overcome, since such training is usually confined to a few male office bearers. Finally, it appears important to give the community a larger sized forest in a contiguous patch and in a condition that still allows regeneration, rather than giving it a forest that is so small or so segmented as to provide little resource support, or so degraded as to have lost its resilience.

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## Appendix A

**Table A1**
Gujarat: regression variable definitions and descriptive statistics.

| | All districts | | | | | Panchmahals | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dependent variables names and definitions | *N* | Mean | CV | Min | Max | *N* | Mean | CV | Min | Max |
| Researcher's Index: Forest quality assessed by forest specialist/ researcher, graded on a scale of 1 to 5, at intervals of 0.25 | 63 | 3.5 | 0.25 | 1.50 | 4.75 | 19 | 3.4 | 0.20 | 2.50 | 4.75 |
| Forest canopy: Dummy for canopy of protected natural forest and plantation: Thick or medium density = 1; Thin or patchy = 0 | 63 | 37 | n.a. | 0 | 1 | 19 | 9 | n.a. | 0 | 1 |
| Geer: % degraded forest: % forest area with degraded canopy in 1999, assessed by the GEER Foundation, based on satellite data | 63 | 32.6 | 0.48 | 0 | 74.6 | 19 | 29.6 | 0.52 | 0 | 56.0 |
| Forest condition change (all districts): Change in natural forest and plantation condition since protection began (villagers' assessment): Some or substantial improvement in category = 1; No improvement in category = 0 | 64 | 53 | n.a. | 0 | 1 | 20 | 13 | n.a. | 0 | 1 |
| Explanatory variables | | | | | | | | | | |
| GenComp1: Dummy: If EC has >2 women = 1; If EC has ≤2 women = 0 | 65 | 34 | n.a. | 0 | 1 | 21 | 10 | n.a. | 0 | 1 |
| GenComp2: % women in the EC | 65 | 27.3 | 0.72 | 0 | 100 | | | | | |
| Women's association: Dummy: Association exists = 1; If not = 0 | 65 | 44 | n.a. | 0 | 1 | | | | | |
| Average age of women EC members, 2000–01 | 59 | 40.9 | 0.16 | 23 | 59.5 | 20 | 41.8 | 0.14 | 23 | 54 |
| Average age of all EC members, 2000–01 | 64 | 43.6 | 0.14 | 28.1 | 55.6 | | | | | |
| Protection method: Dummy: Protected by guard = 1; Without guard but using other methods = 0 | 65 | 22 | n.a. | 0 | 1 | 21 | 6 | n.a. | 0 | 1 |
| Forest area protected in 2000–01 (ha) | 65 | 164.9 | 1.3 | 15 | 1536.8 | 21 | 224.6 | 0.72 | 15.3 | 546 |
| Forest segments: no. of non-contiguous parts of protected forest | 65 | 1.9 | 0.61 | 1 | 6 | 21 | 2.7 | 0.52 | 1 | 6 |
| No. of hamlets in village | 65 | 6.0 | 0.47 | 2 | 13 | | | | | |
| % households in village with migrant males | 64 | 12.7 | 1.33 | 0 | 59.5 | | | | | |
| % Landless households in village | | | | | | 21 | 2.0 | 1.85 | 0 | 12.4 |
| Infrastructure index: this aggregates village facilities (if they exist) for four levels of education, two levels of health care, & village electrification. Each type of facility gets equal weight | | | | | | 21 | 3.3 | 0.27 | 2 | 5 |
| District1: Dummy: Narmada/Bharuch = 1 (reference category) | 65 | 16 | n.a. | 0 | 1 | | | | | |
| District2: Dummy: Panchmahals = 1; other districts = 0 | 65 | 21 | n.a. | 0 | 1 | | | | | |
| District3: Dummy: Sabarkantha = 1; other districts = 0 | 65 | 28 | n.a. | 0 | 1 | | | | | |

For the dummy variables the means give the number of positive values. n.a. = not applicable.

**Table A2**
Nepal: regression variable definitions and descriptive statistics.

| Dependent variables | *N* | Mean | CV | Min | Max |
|---|---|---|---|---|---|
| Forest regeneration (villagers assessment): Poor = 1; Good = 2; Very good = 3 | 70 | 10/44/16 | n.a. | 1 | 3 |
| Change in forest canopy: Dummy (forest dept. assessment): Improvement in canopy or thick canopy maintained = 1; No change in canopy (thin, patchy or medium) or worsening canopy = 0 | 58 | 39 | n.a. | 0 | 1 |
| Explanatory variables | | | | | |
| GenComp: Dummy: All-women EC = 1; Other ECs = 0 | 70 | 27 | n.a. | 0 | 1 |
| Women's association: Dummy: If active women's association exists in user toles = 1; If not = 0 | 70 | 42 | n.a. | 0 | 1 |
| Average age of all EC members in 2000–01 | 70 | 41.5 | 0.12 | 30.4 | 54.5 |
| % Brahmins in EC | 70 | 48.6 | 0.77 | 0 | 100 |
| Who made forest-use rules: Dummy: If rules made without forest department (FD) help = 1; If rules made with FD help = 0 | 70 | 25 | n.a. | 0 | 1 |
| Forest area protected in 2000–01 (ha) | 70 | 33.6 | 0.89 | 3.9 | 160 |
| Forest canopy at time of handover: Dummy (forest department assessment) If thick or medium canopy = 1; if thin or patchy canopy = 0 | 60 | 14 | n.a. | 0 | 1 |
| No. of toles | 70 | 5.2 | 0.47 | 1 | 13 |
| District: Dummy: Baglung/Parbat = 1; Gorkha/Dhading = 0 | 70 | 34 | n.a. | 0 | 1 |

For the dummy variables the means give the number of positive values. n.a. = not applicable.

## References


Acharya, M., Bennett, L., 1983. Women and the subsistence sector: economic participation and household decentralization in Nepal. World Bank Staff Working Paper No. 526. World Bank, Washington DC.

Agarwal, B., 1992. The gender and environment debate: lessons from India. Feminist Studies 18 (1), 119–158.

Agarwal, B., 2000. Conceptualizing environmental collective action: why gender matters. Cambridge Journal of Economics 24 (3), 283–310.

Agarwal, B., 2001. Participatory exclusions, community forestry and gender: an analysis and conceptual framework. World Development 29 (10), 1623–1648.

Agarwal, A., 2005. Environmentality: Technologies of Government and the Making of Subjects. Duke University Press, Durham.

Agarwal, B., 2006. Gender inequality, cooperation and environmental sustainability. In: Baland, J.-M., Bowles, S., Bardhan, P. (Eds.), Inequality, Cooperation, and Environmental Sustainability. InPrinceton University Press, Princeton, pp. 274–313.

Agarwal, B., 2009. Rule making in community forestry institutions: the difference women make. Ecological Economics 68, 2296–2308.

Agarwal, B. in press-a. Does women's proportionate strength affect their participation? Governing local forests in South Asia, World Development.

Agarwal, B. in press-b. Gender and Green Governance: The Political Economy of Women's Presence in Community Forestry and Beyond. Oxford University Press, Oxford.

Agarwal, A., Chhatre, A., 2006. Explaining success on the commons: community forest governance in the Indian Himalayas. World Development 34 (1), 149–166.

Ahmed, S., 1994. The rhetoric and reality of women's participation in Joint Forest Management: the case of an NGO in western India. Paper presented for an international seminar on women, poverty and demographic change, Oaxaca, Mexico, Oct.

Bahuguna, V.K. 2004. Root to canopy: an overview. In: Bahuguna, V.K., Mitra, K., Capistrano, D. and Saigal, S. (Eds.), Root to Canopy. New Delhi, Commonwealth Forestry Association and Winrock International, pp. 15–24.

Baland, J.M., Platteau, J.P., 1996. Halting Degradation of Natural Resources: Is there a Role for Rural Communities? Clarendon Press, Oxford.

Baland, J.M., Platteau, J.P., 1999. The ambiguous impact of inequality on local resource management. World Development 27 (5), 773–788.

Baland, J.M., Bowles, S., Bardhan, P. (Eds.), 2006. Inequality, Collective Action and Environmental Sustainability. Princeton University Press, Princeton.

Bardhan, P., 1993. Analytics of the institutions of informal cooperation in rural development. World Development 21 (4), 633–639.

Bardhan, P., 2001. Water community: an empirical analysis of cooperation on irrigation in South India. In: Aoki, M., Hayami, Y. (Eds.), Community and Market in Economic Development. Oxford University Press, Oxford.

Bennett, L., Gujurel, K., 2006. Negotiating social change: gender, caste and ethnic dimensions of empowerment and social inclusion in rural Nepal. In: Alsop, R., Bertelsen, M., Holland, J. (Eds.), Empowerment in Practice: from Analysis to Implementation. The World Bank, Washington DC.

Bhattacharya, N., 1992. Colonial state and agrarian society. In: Stein, B. (Ed.), The Making of Agrarian Policy in British India 1770–1900. Oxford University Press, Delhi.

Bingeman, K. 2001. Policy, gender and institutions: a journey though forest management issues in the Kullu Valley, Himachal Pradesh, India. Masters thesis in Natural Resource Management, University of Manitoba, Winnipeg.

Britt, C. 1993. Out of the wood? Local institutions and community forest management in two central Himalayan villages, Cornell University, Ithaca, draft monograph.

Bromley, D.W. (Ed.), 1992. Making the Commons Work: Theory, Practice, and Policy. InInstitute for Contemporary Studies Press, San Francisco.

Brundtland Report, 1987. Our Common Future. World Commission on Environment and Development. Oxford University Press, Oxford.

Buchy, M., Subba, S., 2003. Why is community forestry a social- and gender-blind technology? The case of Nepal. Gender, Technology and Development 7 (3), 313–332.

Buchy, M., Rai, B., 2008. Do women-only approaches to natural resource management help women? The case of community forestry in Nepal. In: Resurreccion, B.P., Elmhirst, R. (Eds.), Gender and Natural Resource Management: Livelihoods, Mobility and Interventions. Earthscan, London, pp. 127–149.

Carter, F.J., 1992. Tree cultivation on private land in the middle hills of Nepal: lessons from some villagers of Dolakia. Mountain Research and Development 12 (3), 241–255.

Correa, M., 1997. Gender and Joint Forest Planning and Management: a Research Study in Uttara Kannada District, Karnataka. India Development Service, Dharwad.

Dahal, D.R., 1994. A Review of Forest User Groups: Case Studies from Eastern Nepal. International Center for Integrated Mountain Development (ICIMOD), Kathmandu.

Davidson-Hunt, K. 1995. Engendering the commons: a case study in gender, difference and common property in Himachal Pradesh, India. Masters thesis, Dept of Anthropology, University of Manitoba, Winnipeg.

Gaul, K.K. 1994. Negotiated positions and shifting terrains: apprehension of forest resources in the Western Himalaya, PhD dissertation, Department of Anthropology, University of Massachusetts, Amherst.

Ghimire-Bastakoti, K., Bastakoti, R.R., 2006. Social exclusion in community forestry: why women are frequently excluded from decision-making and leadership in Nepal. Proceedings of the Women's Global Connection Conference on Affirming diversity: women making a difference, University of the Incarnate Word, San Antonio, Texas, USA, May 18–20.

GoN, 2000. FUG Database. Community and Private Forestry Division. Dept. of Forests, Government of Nepal, Kathmandu.

GoN, 2001. Census of Nepal 2001. National Planning Commission, Government of Nepal. InCentral Bureau of Statistics, Kathmandu.

Guhathakurta, P., Bhatia, K.S., 1992. A Case Study on Gender and Forest Resources in West Bengal. World Bank, Delhi. June 16.

Gururani, S. 1996. Fuel, fodder and forests: politics of forest use and abuse in Uttarakhand Himalaya, India. Doctoral thesis in cultural anthropology, Syracuse University.

Guha, R., 1989. The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalaya. Oxford University Press, Delhi.

Hobley, M. 1990. Social reality, social forestry: the case of two Nepalese panchayats. Doctoral dissertation, Department of Forestry, Australian National University.

Hobley, M., 1996. Participatory Forestry: the Process of Change in India and Nepal. Overseas Development Institute, London.

ISO/Swedforest, 1993. Forests, People and Protection: Case Studies of Voluntary Forest Protection by Communities in Orissa. Swedish International Development Agency (SIDA), Delhi.

Jeffery, R., Sundar, N. (Eds.), 1999. A New Moral Economy for India's Forests: Discourses of Community and Participation. Sage Publications, New Delhi.

Kant, S., Singh, N., Singh, K.K. 1991. Community-based forest management systems: case studies from Orissa. SIDA, New Delhi; Indian Institute of Forest Management, Bhopal; and ISO/Swedforest, New Delhi.

Lama, A., Buchy, M., 2002. Gender, class, caste and participation: the case of community forestry in Nepal. Indian Journal of Gender Studies 9 (1), 27–41.

Lele, S., 1994. Sustainable use of biomass resources: a note on definitions, criteria and practical applications. Energy for Sustainable Development 1 (4), 42–46.

Loughran, D., Pritchett, L., 1997. Environmental scarcity, resource collection, and the demand for children in Nepal. Policy Research Working Paper. World Bank, Washington, DC.

Mansingh, O. 1991. Community organization and ecological restoration: an analysis of strategic options for NGOs in central Himalaya, with particular reference to the Community Forestry Programme of the NGO Chirag, MA dissertation in Rural Development, AFRAS, University of Sussex.

Moffatt, M. 1998. A gender analysis of community forestry and community leasehold forestry in Nepal with a macro-meso-micro framework. M.A. dissertation in Development Policy Analysis, Department of Economics and Social Studies, University of Manchester.

Mukerjee, R., Roy, S.B., 1993. Influence of social institutions on women's participation in JFM: a case study from Sarugarh, North Bengal. Working Paper No. 17, IBRAD, Calcutta.

NCAER, 2000–01. Evaluation survey of the national programme on improved chulha. Report. National Council for Applied Economic Research, Delhi.

Ojha, H.R., Timsina, N.P., 2008. Community-based forest management programmes in Nepal: lessons and policy implications. In: Ojha, H.R., Timsina, N.P., Kumar, C., Banjade, M.R. (Eds.), Communities, Forests and Governance. Adroit Publishers, New Delhi.

Ostrom, E., 1990. Governing the Commons. Cambridge University Press, Cambridge.

Pandey, S., 1990. Women in Hattidunde forest management in Dhading District, Nepal. MPE Series No. 9. ICIMOD, Kathmandu.

Poffenberger, M., McGean, B. (Eds.), 1996. Village Voices, Forest Choices: Joint Forest Management in India. Oxford University Press, Delhi.

Prokopy, L.S., 2004. Women's participation in rural water supply projects in India. Water Supply 6, 103–116.

Raju, M., 1997. Seeking Niches in Forest Canopy: An Enquiry into Women's Participation, Report. Ford Foundation, New Delhi.

Roy, S.B., Mukerjee, R., Chatterjee, M.C., 1992. Endogenous Development, Gender Role in Participatory Forest Management. IBRAD, Calcutta.

Roy, S.B., Mukerjee, R., Roy, D.S., Bhattacharya, P., Bhadra, R.K., 1993. Profile of Joint Forest Protection Committee at Sarugarh Range. West Bengal, IBRAD Working Paper No. 16, Calcutta.

Sarin, M., 1995. Regenerating India's forests: reconciling gender equity and Joint Forest Management. IDS Bulletin 26 (1), 83–91.

Sarin, M., 1998. Who is Gaining? Who is Losing? Gender and Equality Concerns in Joint Forest Management. Society for Promotion of Wastelands Development, New Delhi.

Sarin, M., Khanna, R., 1993. Women organize for wasteland development: a case study of SARTHI in Gujarat. In: Singh, A., Burra, N. (Eds.), Women and Wasteland Development in India. Sage publications, Delhi, pp. 129–169.

Seabright, P., 1997a. Is cooperation habit-forming? In: Dasgupta, P., Maler, K.-G. (Eds.), The Environment and Emerging Development Issues. InClarendon Press, Oxford, pp. 283–307.

Seabright, P., 1997b. The Effect of Inequality on Collective Action. Draft Paper. Dept. of Applied Economics, University of Cambridge, UK.

Seeley, J., 1996. Who benefits from participatory forest management. Banko Janakari 6 (1), 38–39.

Shah, M.K., Shah, P., 1995. Gender, environment and livelihood security: an alternative viewpoint from India. IDS Bulletin 26 (1), 75–82.

Sharma, A., Sinha, A., 1993. A study of the common property resources in the project area of the central Himalaya rural action group. Report, Indian Institute of Forest Management, Bhopal, Madhya Pradesh.

Singh, N., 2001. Women and community forests in Orissa: rights and management. Indian Journal of Gender Studies 8 (2), 257–269.

Singh, N., Kumar, K., 1993. Community Initiatives to Protect and Manage Forests in Balangir and Sambalpur Districts, Report. SIDA, New Delhi.

Sivaramakrishnan, K., 1999. Modern Forests: State Making and Environmental Change in Colonial Eastern India. Stanford University Press, Stanford.

Springate-Baginski, O., Blaiki, P. (Eds.), 2007. Forests, People and Power: the Political Ecology of Reform in South Asia. Earthscan, London.

Sundar, N., Jeffrey, R., Thin, N., 2001. Branching Out: Joint Forest Management in India. Oxford University Press, Delhi.

TERI, 1995. Community Participation in Van Panchayats of Kumaon Region of Uttar Pradesh, Paper No.1, Part I. Tata Energy Research Institute, Delhi.
Viegas, P., Menon, G., 1993. Bringing government and people together: forest protection committees of West Bengal — role and participation of women. In: Singh, A., Burra, N. (Eds.), Women and Wasteland Development in India. Sage Publications, New Delhi, pp. 171–210.
Venkateshwaran, S., 1992. Living on the Edge: Women, Environment and Development. Friedrich Ebert Stiftun, New Delhi.
Wade, R., 1988. Village Republics: Economic Conditions for Collective Action in South India. Cambridge University Press, Cambridge.
Westerman, O., Ashby, J., Pretty, J., 2005. Gender and social capital: the importance of gender differences for the maturity and effectiveness of natural resource management groups. World Development 33 (11), 1783–1799.
Watson, R.T., Noble, I.R., Bolin, B., Ravindranath, N.H., Verardo, D.J., Dokken, D.J. (Eds.), 2000. Land Use, Land Use Change and Forestry: a Special Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, New York.