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Tenure and forest conditions: community forestry in the Nepal Terai

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SUMMARY

There is a current trend towards decentralization of forest management, particularly among developing nations. Nepal has taken a lead in initiating innovative policies of community forestry. Although these initiatives have been largely deemed successful in the mountains, within the Terai lowlands, there is considerable debate about their outcomes. This research evaluates forest condition within recently declared community forests, national forests and protected areas in the Nepal Terai, using plot mensuration techniques and interviews with local users. The initial condition of forests that were handed over to local communities for use was significantly poorer than those retained as national forests. Protected areas had the highest levels of plant abundance, biomass and biodiversity, which is not surprising, given the level of funds and manpower input to managing these limited areas. In the context of current controversy about the outcome of community forestry in the Nepal Terai, the poor initial condition of forests handed over to local communities is highly significant, and needs to be factored into evaluations of community forest management. This research underscores the need for benchmark studies for evaluating the future outcomes of forest policies in the Terai, provides a valuable addition to the limited information on forest conditions under different management regimes in Nepal, and indicates some of the difficulties that local communities face while dealing with community forestry in practice.

Keywords: community forestry, biodiversity, forest management, land tenure, Nepal

INTRODUCTION

With increasing forest degradation, especially in the developing tropics, there has been a rising interest in developing and evaluating alternative methods of forest management. While the 1950s saw an emphasis on state-centred systems of management, this has now shifted towards encouraging decentralized, local and participatory forms of governance as supposed panaceas (Agrawal *et al*. 1999; Kellert *et al*. 2000; Agrawal & Ostrom 2001). Among developing countries, Nepal has proved an enthusiastic leader in experimenting with participatory systems of forest governance (Thapa & Weber 1995; Brown 1998; Chakraborty 2001). While on paper there is still much enthusiasm for encouraging participation, the devolution of state responsibilities does not quite match the rhetoric in practice (Chaudhary 2000).

A brief look at the history of forest management practices in Nepal can help highlight the variety of perspectives on participatory management. Prior to the mid-1950s, traditional practices of forest management were prevalent in the hills (Messerschmidt 1987; Thapa & Weber 1995). The Nationalization Act of 1957 brought all forested land under government ownership (Shrestha 1998; Varughese 1999). This is believed to have been a major factor resulting in the alienation of local communities (Bajracharya 1983; Neupane 2000). As in many other developing countries, the process of nationalization converted limited-access community-controlled forests to open-access resources (Ostrom 1990). The National Forest Act of 1976 attempted to return some degree of ownership and control to the people. However, this attempt at decentralization was still formally linked to administratively defined government structures or panchayats, and was not notably successful (Thapa & Weber 1995; Shrestha 1998; but see Gilmour & Fisher 1991 for a different perspective). Awareness of these limitations, a growing appreciation for the capacity of local communities to manage common property institutions (Ostrom 1990, 2000) and increasing donor pressure, led to the introduction of the Community Forestry Act in 1993 (Thapa & Weber 1995; Varughese 1999). The major objectives of this policy were to hand over all accessible forests to user groups, provide them the right to manage and protect the forests, and the right to all forest produce and income derived from these forests.

By 1999, over 620 000 ha of forest area had been handed over to 8500 forest user groups (Chaudhary 2000). However, most community forests are located in the mountains, and only 17% of all area under community forests is located in the Terai (lowlands) (Hobley 1996 cited in Chakraborty 2001; Sah & Heinen 2001). Several studies argue that community forestry has been successful in improving the conditions of people and forests in the Nepal middle hills (Agrawal & Ostrom 2001; Chakraborty 2001; Webb &

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Gautam 2001; Gautam *et al.* 2002). However, reservations have been expressed about the feasibility of community forestry in the Terai. This has to do in large part with topography and the history of settlement in this region, which is vastly different from the hills.

The Nepal Terai refers to the southern lowlands of Nepal, and the river valleys located between the Shivalik and Mahabharat ranges (generally referred to as the Inner Terai). While the middle hills of Nepal have supported local populations for centuries, there has been extensive migration into the Terai from the hills after malarial eradication in the 1960s. As a result, there has been far greater recent deforestation in the Terai, compared to the middle hills (Schweik *et al.* 1997; Mathews *et al.* 2000). The low pressure on resources prior to the 1960s obviated the need for traditional systems of forest protection. The challenge for community forestry in the Terai is to support the creation of new institutions of community forest management.

There is much controversy about the success of these programmes. Summarizing this, Chakraborty (2001) states that the increased inequality in the distribution of agrarian resources in the Terai population constitutes an obstacle to community cooperation, as does the increased ethnic diversity resulting from hill migration. Continued migration creates additional pressure on resources, and many forest users live too far from the forests to be involved in monitoring activities. Poudel (2000, 2001) describes additional cited concerns, including incentives for smuggling timber across the country border, and the large and unwieldy size of Terai forest user groups. These concerns have led to proposed amendments by the Nepal government to the Forest Act of 1993, with new subclauses proposing to bring Terai community forestry under partial Forest Department control (Poudel 2000, 2001).

These legislative initiatives to limit Terai community forestry have, understandably, created high levels of concern in the user communities (Neupane 2000; Mahapatra 2001). An often cited reason for the takeover of community forests by the government, is to increase revenue for the forest department (Poudel 2001; Mahapatra 2001). While there has been limited deforestation within protected areas in the Terai including the Royal Chitwan National Park (RCNP), protection in these areas is enforced by the Royal Nepal Army, and park-people conflicts have been well documented. Some efforts at conflict resolution have been made in recent years (Heinen & Mehta 1999; Stræde & Helles 2000), but with concerns about community forestry in the Terai being highlighted, these approaches also now appear to be in retreat (Mahapatra 2001).

The validity of these concerns is questionable (Chakraborty 2001; Poudel 2000, 2001). Increased user group size, increased ethnic diversity and increased inequality of users results in increased heterogeneity, which is here equated with a poor governance system and increased degradation. However, the impact of heterogeneity on forest governance is highly contested (Ostrom 2000; Varughese & Ostrom 2001). Although there have been studies that evaluate the socio-economic effects of forest management strategies, evaluation of these various management regimes in terms of ecological condition and biodiversity has been limited, particularly in the Terai, but also in the Nepal hills (Webb & Gautam 2001; Gautam *et al.* 2002). Part of the debate over the causes of forest degradation in Nepal can be traced to a multiplicity of single locality studies, each employing different methods and data sets (Millette *et al.* 1995).

This paper compares forest conditions within recently declared community forests, national forests, and a protected national park using standardized data from seven forests at three locations within the Chitwan inner Terai district. A broad cross-location analysis first examined whether there were significant differences in forest quality (tree and sapling density, biomass, species richness and diversity) between forest plots located in these three different management regimes. For two locations, each consisting of forests within two management regimes, the variation in forest quality for plots within a management type was compared with the variation in forest quality for plots located in different management types. Results were corroborated with appraisals of forest quality and monitoring by local users and a professional forester. This study thus adds to information on the conditions within which common property management regimes have to function in Nepal, where they are a topic of much current concern and debate.

METHODS

The data used for this study come from part of a larger set of studies in Nepal, conducted using common research protocols developed by the International Forestry Resources and Institutions (IFRI) research programme, and coordinated by Indiana University. Research forms were developed by a team of researchers using a combination of forest mensuration techniques and social science methods (Ostrom 1998). Given the inherent difficulties involved with creating and collecting standardized data sets for monitoring forest conditions in developing countries (Danielsen *et al.* 2000), a data set of this kind provides a valuable basis for analysis. In Nepal, the IFRI research programme is coordinated and conducted by a team of social science and natural science researchers in the Nepal Forest Resources and Institutions research programme, located in Kathmandu (see Varughese 1999, 2000; Varughese & Ostrom 2001 for comparisons of IFRI research sites in the middle hills of Nepal). This data set provides an opportunity to analyse forest conditions in the Nepal Terai using information collected according to a uniform protocol.

Study sites

Three IFRI research sites in the Chitwan district of Nepal were selected for analysis. These study sites were all located

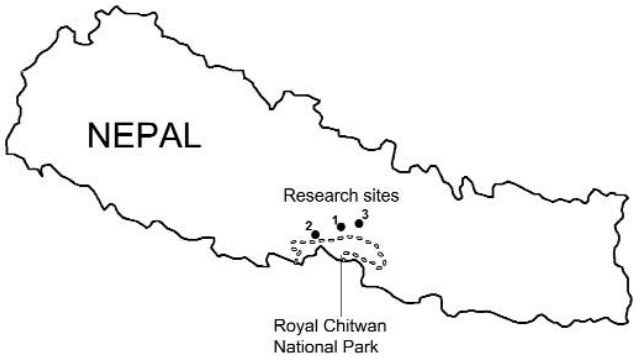

Figure 1 Map of Nepal, with the location of the Royal Chitwan National Park and the three research sites.

relatively close to each other in the same general physiographic zone, the inner Terai or river valley plains (Fig. 1). They were selected so that they covered a range of altitudes, from 195 m to 425 m above sea level (Table 1), yet were covered by relatively similar *Shorea robusta*-dominated, tropical moist deciduous hardwood forests. Sites were also identified to span the east-west range of the Chitwan district (Fig. 1), so that clustering of sites was minimized. These locations represent the variety of physiographic conditions found within the Chitwan inner Terai, and yet remain similar enough to form a basis for cross-site comparisons of forest condition. Site selection was further done so that each site comprised at least two forests that belonged to community forests, national forests or national parks, and were used by a common user group. The sites varied greatly in terms of user:forest ratios, with the maximum number of users per forest hectare in Site 3 almost twice that of Site 1, and four times that of Site 2. These differences will play a major role in determining the pressure on the forest and long term sustainability, an important factor in determining choice of sites, taking into consideration our goals of long-term monitoring.

The forests in this region are tropical moist deciduous, and typically dominated by large tree species: especially by Sal (*Shorea robusta*), the single most valuable and most exploited tree species in the region. Forest plots were laid in a total of seven forests, located in three different sites. The boundaries of the forest patches within which the forest plots were laid were defined based on the areas that were accessed by the user group in question.

Research site 1 is located within the Bharatpur village development committee (VDC, the smallest administrative unit in Nepal), of Chitwan, and includes two forests: a community forest of 157.5 ha and an adjoining national forest of the same area, used by a group of 7400 nearby residents (Table 1). The study area was visited in April 1996, when the process of formally handing over the community forest to the Forest User Committee was in its last stages. Research site 2 is located in Jagatpur VDC of Chitwan. It lies in the vicinity of the RCNP, Nepal's first national park, which was established in 1973. The study area was surveyed in July 1998 and consists of a community forest of 203 ha, located within the park buffer zone, and two patches of forest within the RCNP, 84 ha and 50 ha in size, used by 3980 local residents (Table 1). Data from the two forests within the RCNP was pooled for this analysis. The third research site is located in the Shaktikhor VDC, and includes two national forests of 6 ha each, used by 660 local residents (Table 1). For purposes of confidentiality, the names of the settlements and forests are not provided here.

A total of 69 plots were laid in the community forests, 102 plots in national forests, and 45 plots in the national park. Data from all three research sites was pooled for a comparative analysis of forest condition across these three management regimes. A more detailed analysis of local differences between community and national forests was carried out in research site 1, and between community forests and the national park, in research site 2.

Survey techniques

Analysis included assessment of forest condition through the use of forest plots, evaluation by a professional forester, and interviews with the local communities that use these forests, to establish their perceptions of forest change. Between 1994 and 1998, a four to eight week period of investigation in each site was used to conduct interviews with local residents, and especially with elders in the village, to document oral accounts of forest history. Areas with community forests were visited within the year of formal notification, and this

Table 1 Description of study sites, forest size, numbers of forest plots, management regimes, user group size and the year of community forest notification. VDC = village development committee; msl = metres above sea level.

	Research site 1	*Research site 2*	*Research site 3*
Location (VDC)	Bharatpur	Jagatpur	Shaktikhor
Mean altitude (msl)	195	240	425
Total forest size (ha)	315	337	16
Number of forest plots	74	80	62
Number of forest patches	2	3	2
Forest management regimes	Community forest, national forest	Community forest, national park	National forests
Size of user group	7400	3980	660
Year of community forest notification	1996	1998	Not applicable

study provided a benchmark assessment of forest condition for the areas that were to be handed over to user groups. Rules of forest protection were noted, as well as the degree to which these rules were enforced.

Local residents' perception of changes in forest condition were recorded for each management regime, whether community forest, national forest or national park. The residents' perception of changes in the density of tree cover, shrub and bush cover, and ground cover was recorded separately, according to three possible answers: 'stayed the same', 'increased', or 'decreased'. In addition, the assessment of a professional forester who was also a member of the survey team, was recorded after a comprehensive survey of the forest. This was recorded by ranking the forester's opinion of vegetation density and of species diversity on a qualitative scale of 1 (very sparse) through 5 (very abundant).

Within each forest, 20–40 forest plots were selected for forest mensuration. Plots were selected to sample the entire elevation gradient within the forest: within a particular elevation range, plot locations were randomly selected. Nested circular plots were laid, with the outermost plot being 10 m in radius. Within this, the species, diameter at breast height (dbh) and height were recorded for all trees with dbh greater than 10 cm. A nested sub-plot of 3 m radius was used to record species, dbh and height for all saplings with dbh less than 10 cm, but greater than 1 cm. A further nested sub-plot of 1 m radius was used to record the percentage of ground area covered by each herb-layer species. As the species found in the herb layer are highly season-dependent (Peet *et al.* 1999), and sampling was done during different seasons of the year, only tree and sapling data were used in this analysis for comparative purposes.

RESULTS

Comparisons of forest condition

The assessment of the professional forester who accompanied the team was that, on average, vegetation density and species diversity in the community forests were lower than in the national forests, which were in turn in poorer condition than the forests enclosed within the boundaries of the national park. This was corroborated by the forest plot analysis. Data from all three sites were combined for an analysis of forest condition across different management regimes. A Kruskal-Wallis test indicated significant overall differences in mean tree and sapling species richness, Shannon index of tree and sapling diversity, tree and sapling density per plot, tree and sapling diameter and tree and sapling height, between management regimes ($p < 0.001$).

A Mann-Whitney pair-wise analysis of differences between management regimes indicated that community forests were significantly poorer in species richness and Shannon species diversity, and had significantly lower tree densities per plot, when compared to national forests. However, trees located in community forests were significantly taller than those within national forests. No significant differences in tree size (diameter) were observed for these management regimes (Table 2). Community forests were also significantly poorer in species richness and Shannon species diversity, and had significantly lower tree densities per plot, as well as significantly shorter trees when compared to national parks. However, no significant differences in tree size (diameter) were observed for these management regimes.

Analysis of sapling data indicated if anything, greater differences in forest condition between management regimes (Table 2). Community forests were in significantly poorer condition than national forests across all five parameters of

Table 2 A cross-site comparison of differences between community forests, national forests and national parks in terms of tree and sapling species richness, species diversity, density, dbh and height. A one-tailed Mann-Whitney *U*-test of the significance of differences between forests in different management regimes: $^*p < 0.01$.

	Community forests (CF)	*National forests (NF)*	*National parks (NP)*	*Mann-Whitney test of differences between management regimes*
Number of plots	69	102	45	–
Mean tree species richness per plot	1.19	2.59	2.31	CF < NF *, CF < NP *
Mean tree Shannon diversity per plot	0.16	0.64	0.63	CF < NF *, CF < NP *
Mean tree density per plot	3.84	6.03	5.64	CF < NF *, CF < NP *
Mean tree diameter per plot (cm)	35.10	30.23	32.69	NF < CF, NP < CF
Mean tree height per plot (m)	14.91	12.95	18.78	NF < CF *, CF < NP *
Mean sapling species richness per plot	1.49	3.77	3.00	CF < NF *, CF < NP *
Mean sapling Shannon diversity per plot	0.36	1.04	0.95	CF < NF *, CF < NP *
Mean sapling density per plot	5.25	9.25	4.62	CF < NF *, CF < NP
Mean sapling diameter per plot (cm)	4.23	4.79	4.90	CF < NF *, CF < NP *
Mean sapling height per plot (m)	2.04	2.32	2.44	CF < NF *, CF < NP

Table 3 For research site 1, differences between the patch of community forest and the patch of national forest in terms of tree and sapling species richness, species diversity, density, dbh and height. Results of one-tailed Mann-Whitney *U*-test of the significance of differences between forests in different management regimes: $^{*}p < 0.01$.

	Community forest	*National forest*	*Mann-Whitney test of differences between management regimes*
Forest area (ha)	157.5	157.5	–
Number of plots	34	40	–
Mean tree species richness per plot	0.97	0.98	CF < NF
Mean tree Shannon diversity per plot	0.05	0.08	CF < NF
Mean tree density per plot	2.88	2.20	NF < CF
Mean tree diameter per plot (cm)	56.72	57.97	NF < CF
Mean tree height per plot (m)	22.31	22.35	NF < CF
Mean sapling species richness per plot	1.86	3.00	CF < NF
Mean sapling Shannon diversity per plot	0.45	0.80	CF < NF *
Mean sapling density per plot	8.18	11.20	CF < NF *
Mean sapling diameter per plot (cm)	4.16	5.15	CF < NF *
Mean sapling height per plot (m)	1.93	1.92	NF < CF

forest condition: species richness, Shannon species diversity, sapling density, sapling diameter and sapling height. When compared to national parks, community forests have significantly lower species richness, lower Shannon species diversity, and smaller diameter saplings. However, no significant differences were found in terms of sapling abundance or sapling height.

Within-site analyses of forest condition

The cross-site analysis provides a broad overview of differences in forest condition between community forests, national forests, and national parks. Within-site analyses were also conducted in research sites one and two, to compare forests from two different management regimes that were adjacent to each other, and were used by at least one common user group. This enables a more detailed comparison to be made of forests that are situated in similar microclimatic conditions, and similar social environments.

Research site 1

Interviews established that the driving force behind establishment of this community forest was, interestingly, to keep the forest away from the people, rather than the people from the forest. Wild animals from the nearby forest area had become a threat to the agricultural activity in the nearby villages, which then initiated a motion to declare the western part of the forest a community forest, and demarcate the boundary by fencing it. Restrictions on grazing and harvesting within the community forest were initiated in August 1995.

At the time of study, fencing of the community forest was almost complete. Areas within the community forest showed evidence of a low level of grazing, and some tree lopping. In contrast, the national forest seemed to have very high levels of grazing, significant evidence of tree lopping, shrub and bush harvesting, and signs of fire. The national forest was not fenced, and bordered the adjoining community forest; it supplied the fuelwood, grazing and timber needs of a number of villages that lie as far as ten kilometres away.

A total of 34 plots were laid in the community forest, and 40 plots within the national forest. The two forests did not appear to differ significantly in tree species richness, tree Shannon diversity, tree girth or tree height (Table 3). Mean tree density in the community forest appeared greater than in the national forest, however, this was not significant. In contrast, the sapling layer was markedly different across management regimes (Table 3). The community forest was in significantly poorer condition in terms of sapling species richness, sapling Shannon species diversity, sapling density and sapling girth.

Interviews with the local residents demonstrated a perceived decrease in the density of tree and shrub cover in both the community forest and the national forest over the last five years, though not in the density of ground vegetation cover. However, the residents stated that the driving force for establishment of the community forest in this area was not forest degradation, rather it was to prevent entry of wild animals from the forest into the surrounding agricultural lands.

The professional forester's assessment was that the tree density and species diversity, in both forests, was 'about normal for the ecological zone'. This corroborates the lack of significant differences in forest tree conditions shown by the forest plot data. However, the differences in the sapling layer indicate increased recent disturbance in the community forest. In the past, high levels of grazing, fire and harvesting of saplings in the community forest are likely to have had an

effect on species diversity and sapling biomass. However, interviews with local users indicated that the forest had been fairly well protected from mid-1995 onwards. During the field visits in April 1996, a much higher incidence of grazing, fire and tree lopping was observed in the national forest as compared to the community forest.

Research site 2

A forest user group consisting of 665 households from five settlements managed the community forest. Local users described the community forest as having been in 'good condition' during the 1960s, and prior to establishment of the park. Once the RCNP was formally in place, this led to a sudden decrease in available forest area; as a result, the community forest was heavily overgrazed and over-harvested, resulting in a substantial deterioration of condition. A flood in 1974 caused further damage to the forest.

Following the flood, increased awareness of the degradation in forest condition led to planting of s*issoo* saplings in 15 ha of the forest (*Dalbergia sissoo*, a local tree popular in afforestation programmes). The villagers undertook tree planting, with the assistance of the District Forest Office and the Village Development Committee, in 1974. A community forest or '*panchayat ban*' was established in 1977, and a forest guard appointed to monitor the forest. Grass extraction was regulated and auctioned, and the proceeds used to pay the forest guard. The Timber Corporation of Nepal also planted some sissoo saplings in 1980. The forest is now partially fenced, local residents harvest timber, fuelwood and grazing material from this forest patch.

The other two patches of forest fall within the boundaries of the RCNP. The 84 ha patch of forest selected for study had been subject to resource extraction by the forest user group that manages the community forest, although it lies within the boundaries of the RCNP. During the dry months, November to May, local users extracted fuelwood, fodder and thatch grass from this area. Although dead wood, fallen branches and shrubs are collected, there was no extraction of standing trees (timber) from this forest. The smaller, 50 ha patch was selected within a relatively undisturbed area of the park, for comparison; only thatch grass was extracted from this area, during 10 days of the year when the forest is opened to the communities by the Forest Department. Ample evidence of grazing and tree lopping was observed in the community forest, but not within the national park.

The local people's perception was that the density of tree, shrub and ground vegetation cover had remained essentially unchanged in the two forests within the national park, but actually increased in the community forest over the five years just prior to the survey, i.e. 1993–1998. Nevertheless, based on the forest plot data, the community forest was in poorer overall condition compared to the forests within the RCNP. Plots in the community forest had significantly lower tree and sapling richness and Shannon diversity, and had significantly thinner and shorter trees, and significantly fewer saplings per unit area, compared to the national park (Table 4). The professional forester's assessment corroborated this, with his perception of significantly greater species diversity in the national park as compared to the community forest. However, the two management regimes did not differ across all parameters of forest condition: sapling biomass (diameter and height) in the community forest did not differ significantly from that of the park (Table 4).

Table 4 For research site 2, differences between the patch of community forest and the two patches of forest within the national park in terms of tree and sapling species richness, species diversity, density, dbh and height. Results of one-tailed Mann-Whitney *U*-test of the significance of differences between forests in different management regimes: $^{*}p < 0.01$.

	Community forest	*National park (1)*	*National park (2)*	*Mann-Whitney test of differences between management regimes*
Forest area (ha)	203	84	50	–
Number of plots	35	30	15	–
Mean tree species richness per plot	1.40	1.97	3.00	CF < NP *
Mean tree Shannon diversity per plot	0.27	0.54	0.77	CF < NP *
Mean tree density per plot	4.77	4.13	8.62	CF < NP
Mean tree diameter per plot (cm)	22.47	29.96	35.30	CF < NP *
Mean tree height per plot (m)	10.58	17.13	20.36	CF < NP *
Mean sapling species richness per plot	1.14	2.47	4.07	CF < NP *
Mean sapling Shannon diversity per plot	0.27	0.79	1.27	CF < NP *
Mean sapling density per plot	2.40	3.20	7.47	CF < NP *
Mean sapling diameter per plot (cm)	4.49	5.66	4.25	CF < NP
Mean sapling height per plot (m)	2.43	2.84	2.11	NP < CF

DISCUSSION

The extent of tropical forest habitat in the Himalayas is fast declining, with serious negative consequences in store for ambient temperatures, soil, land stability and biodiversity, as well as issues of ecological sustainability and economic survival of the people dependent on these forests (Zomer *et al*. 2001). Of the countries in the Himalayan belt, Nepal has proved a forerunner in implementing policies of forest management, starting in the early 1970s. Since then, efforts at maintaining forest cover and biodiversity in Nepal have included initiation of a wide variety of programmes, including establishment of a protected area network, and the exploration of alternative methods of management. Since 1993, programmes of community forestry have been initiated in an attempt to decentralize and deregulate previously top-down policies, strengthen local institutions, and ensure greater economic equity (Agrawal *et al*. 1999; Agrawal & Ostrom 2001).

As debate about the effectiveness of these approaches becomes increasingly vocal, it is becoming more and more important to evaluate these various management approaches for their effectiveness. There is a small, but growing body of literature that evaluates the various institutions of management in terms of their stability, equity and other institutional and social parameters of 'success' (see for example Brown 1998; Varughese 1999; Chakraborty 2001; Varughese & Ostrom 2001). There is an equal need for more studies that evaluate the impacts of these policies on forest condition (Varughese 1999; Webb & Gautam 2001; Gautam *et al*. 2002).

Under the current scenario of forest management in Nepal, five categories of forests are recognized, namely protected areas, government-owned (national) forests, community forests, leasehold forests and religious forests (Chaudhary 2000). This research compared forest condition across the three most common categories of forests: community forests, government-owned (national) forests, and national parks in the lowland Terai region of Nepal. The pressure on forests is high, with as much as 75% of the population actively harvesting products from the surrounding forests (Matthews *et al*. 2000). There has been much recent controversy about the outcome of forest policies for forest condition in the lowlands of Nepal, and this study adds to the limited body of knowledge on these issues. The community forests visited in this study were sampled within a year of their official notification, and handing over to the user groups.

One common issue while dealing with forests, and the entire issue of sustainable forestry, is that the whole issue of ecological sustainability is somewhat of an oversimplification. What exactly are we sustaining? This needs to be addressed explicitly, as forests can vary quite markedly along different parameters of 'quality' (Nagendra 2001*a*). Two different methods of forest management may, for instance, result in very different levels of biodiversity, yet both may maintain biomass levels. Would this be considered sustainable use? Part of the debate on what measures to use is also historical, and depends on the context within which various policies were initiated. A recent status paper prepared for the Nepal forestry sector (Chaudhary 2000) states that the protected area network in Nepal was initiated to protect endangered biodiversity. In contrast, community forestry initiatives are often cited as being aimed at improving fuel, timber and fodder levels, to meet the requirements of the local communities. In this study therefore, forests were compared using multiple indices, at the tree and sapling level with respect to species richness, species diversity, abundance, girth and height. Thus evaluation along several axes of forest quality was possible.

In the present study, a cross-site analysis using data from 216 forest plots in seven forests at three separate locations revealed that areas recently declared as community forests appeared to be in poorer condition compared to national forests and national parks. This held true for most indicators of forest quality used in this study. However, trees in the community forest did not differ significantly from those in the national forest in terms of tree girth, and were in fact taller on average in the community forest, as compared with the national forest (though significantly shorter than those in the national park). This is an indication that community forests may be subject to higher levels of non-timber forest produce extraction, grazing, fire or other disturbances leading to losses in biodiversity, but may actually have lower levels of timber extraction; this is evidently the result of previous efforts at forest protection.

At a local scale, while the community forest in Site 1 was in poorer condition than the national forest based on plants in the sapling layer, no significant differences between the two forests were noticed based on the tree data. After protection was initiated in mid-1995, a lower incidence of tree lopping, grazing and fire was observed in the community forests as compared to the national forests: an indication that the protection afforded to the community forest may prove successful at halting its deterioration, given time.

In contrast, the forests within the RCNP were in noticeably better condition compared to the community forest at Site 2. This is no surprise, given the resources and manpower devoted to guarding the park. Like all protected areas in Nepal, these forests are monitored by the Royal Nepal Army, and are thus very well protected indeed, compared to the national forests (Chaudhary 2000). However, protection is provided through strict monitoring of the borders by armed guards, and not participatory in the least, although some efforts at conflict resolution have been made in recent years (Heinen & Mehta 1999; Stræde & Helles 2000).

It is interesting to note that conditions within the two forests inside the national park varied, with the first forest appearing to be in poorer condition. This could be an effect of natural variability in environment, but is more likely due to the variation in degree of protection accorded, as the first forest was subject to higher levels of resource extraction as compared to the second. In the RCNP, local people are

allowed to enter the Park for 10 days every year, to collect grass, reeds, rope bark and rope grass for building material (Stræde & Helles 2000). During the rest of the year, the law strictly prohibits resource extraction by local residents. However, the park is surrounded by 36 VDCs, with a population of nearly 300 000. Many of these residents extract fuelwood, thatch and grazing material from areas of the park, and park authorities have expressed concern about the effect of this illegal extraction on forest condition.

The lack of significant difference between sapling biomass in the community forest and the RCNP is likely to be an outcome of the afforestation programmes carried out in the community forest, and indicates that if the community forest continues to be well protected, the two management regimes may arrive at similar levels of tree biomass in a few years. However, differences in terms of species composition are likely to remain. The national park has what approximates the original 'natural' vegetation of the area, while the community forest represents a once highly degraded forest that is being afforested with specific species. Thus, the community forest is probably not going to return to the species-rich community it once was, at least under current levels of extraction.

Although there is much current controversy on the effectiveness of community forestry in the Nepal Terai, there are few empirical investigations of this issue. It has been previously suggested that a comparison of forest condition between areas that have been under national and community forests can be used to evaluate the success or failure of these alternative policies (Chakraborty 2001). The present research, using quantitative data on the initial state of community forests, indicates that the condition of areas handed over to local communities to be managed as community forests was initially poorer than areas that were retained by the Forest Department as national forest.

This is an important finding. Local communities have claimed in the past that the areas they have been given to manage have been in poorer condition to begin with, and that this needs to be factored into future evaluations of their performance (see for instance Chakraborty 2001). The present research provides an empirical validation of these claims. This must be factored into future evaluations of 'success' or 'failure' of community forestry. Thus these results clearly delineate the need for benchmark studies as the basis for investigations over time to evaluate forest changes in the Nepal Terai. Repeat visits to a site, a few years after its establishment as a community forest, will allow us to monitor changes in user groups, social conditions and forest quality across time and across management regimes.

In a region with high demographic pressures, and where caste and ethnicity have such a major influence on social structures, the underlying demographic and ethnic composition of the communities managing the forest can play a major role in affecting their long-term sustainability (Keohane & Ostrom 1995; Varughese & Ostrom 2001). The population:forest ratio for the user group in Site 3 was almost twice that in Site 1, and four times that in Site 2. This indication of increased pressure on the national forests in Site 3 has long-term implications for their sustainability. The ethnic diversity within these user groups was also very high, with a mix of indigenous Terai and migrant hill castes. In the Terai, owing to the large influx of ethnically different hill migrants in the last four decades, the high ethnic diversity and population densities of user groups can play an especially major role in influencing participation in conservation programmes (Sah & Heinen 2001), and understanding the role of caste heterogeneity is an important factor to consider while planning future research.

While this research represents a substantial amount of data collection and analysis, results need to be examined at a larger scale across the Chitwan, as well as across other districts in the Terai. For instance, in Site 1, the community forest was found to have improved over time as a result of protection. Are these users obtaining their firewood, timber and grazing requirements by increasing their withdrawal from the nearby national forest? It is possible that the community forest is regenerating after protection at the expense of the national forest. Thus, it is essential to broaden the spatial extent of this study, in order to arrive at a complete understanding of the effect of tenure on forest condition not just within a single forest patch, but on the entire region. However, these investigations are time, labour and cost intensive and it is difficult, if not impossible, to carry out such detailed investigations of forest condition across large spatial scales based on just field analysis of forest plots (Nagendra & Gadgil 1999*a*). These results will therefore need to be complemented by a broad-scale assessment of forest extent and condition, using a different set of tools.

Remote sensing is a potentially useful tool for this purpose, providing a spatial synoptic view of changes in forest condition and cover over time (Millette *et al*. 1995; Nagendra & Gadgil 1999*b*; Schweik & Green 1999; Nagendra 2001*b*). Further research plans therefore include the processing of two Landsat TM satellite images of 1989 and 2000, in order to examine forest dynamics between these two time periods. This will allow the analysis of changes in forest extent under different policies of management. Complemented by a local-scale plot-based analysis of changes in forest condition over time, this research will thus provide a comprehensive evaluation of the effect of Nepal's changing forest policies on forest sustainability, along multiple dimensions. Integrated research of this kind, using a combination of field data and remote sensing techniques at multiple scales, will provide a two-pronged approach that is essential for answering a multi-dimensional and complex problem of this nature.

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