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Deforestation, Reforestation and Community Forest Management in Nepal

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森林の破壊と再生：ネパールの森林共同体管理の事例

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Abstract

Forest resources are considered as an integral part of the livelihood of the citizens in developing countries. However, deforestation has been taking place in these countries for several decades. Owing to the limited capacity of governments, there is a high likelihood that the governments cannot ensure the efficiency in protection and allocation of the natural resources such as forests in developing countries. An alternative management regime, community management, is introduced to combat the problems associated with natural resource degradation in recent decades. There is broad agreement that the community management regime has brought positive outcomes in terms of protection and sustainable use of forest products in many developing countries.

Most of the researches ever conducted in Nepal are concentrated in the Hilly region of the country where copse forests are existed. The causes of deforestation and the effect of community management on forest condition in Tarai region are seldom analyzed specially using community forest level data. Furthermore, even among few researches, there is no consensus about the effect on the Community Forestry on forest rehabilitation. These researches often did not use ground level data set and robust econometric methodology. This paper aims to fulfill these gaps. This paper explores the determinants of deforestation and the effects of community management regime on forest condition in Tarai region. The analysis is based on the ground level data of forest conditions using the robust econometric methods and capturing the wider set of control variables. Possible endogeneity problem in selecting the management regime is addressed using a two stage least square estimation technique. It is found that scarcity of the forest land and the distance to market towns from the forests are the major drivers of deforestation. Scarcity of the forest is measured by the number of households relative to the area of forest. The forests, which were handed over earlier to the

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community groups, consist of more medium sized trees per hectare. Similarly, the forests, which were handed over recently, consist of more small sized trees per hectare compared to other sized trees. This result indicates the positive effect of community management on reforestation.

1. Introduction

Land use changes issue due to deforestation has become a highly debated issue in the field of natural resource management for several decades. State controlled natural resources such as forests are considered as “common pool resources”. When common pool resources are used, every user generally imposes the external cost on other user. In addition, there is a chance of emergence of free rider problems. This ultimately leads to the situation of “The Tragedy of the Commons” as Hardin explained in “Ma naging the Commons” (1977). When the markets are imperfect, the role of government is necessary to correct the market failure. However, in the case of developing countries there is a high likelihood that the governments cannot ensure the efficiency in protection and allocation of the natural resources. By handing over the property rights to the local users, the problem of “common pool” resource management can be solved. An important aspect of the property rights is the right to exclude others from using the resources.

There is accumulating evidence showing that community management, as opposed to either public management or individualized private management, could be an effective alternative for managing the commons, but the question of under what conditions it works and under what conditions it does not, is not yet well understood (Baland et al., 2010). In their influential study, “Efficiency of timber production in the community and private forestry in Nepal” Sakurai et al. (2001) found that community mechanism was more efficient than private management to protect the natural resources since a higher transaction cost is required for the individual entity than the community mechanism to protect the forests. Several studies reveal that the community forestry has brought positive results in the form of better forests (Gautam et al., 2002). Therefore, the community based forest management has been introduced to combat the problem of massive deforestation in developing countries (Baland and Platteau, 1996).

There is widespread agreement that the community management regime has brought positive outcomes to stop deforestation and to enhance reforestation in the Hill regions of Nepal (Gilmour and Fisher, 1991). In the Hill region, copse forests are existed, and the population density is low. In the Tarai region, forests are prone to deforestation mainly due to two reasons. First, the population of the Tarai region has

been increasing since few decades due to constant in-migration from the Hill region. High in-migration rate may create pressure on forests by clearing forest land into other land such as land for settlement and agriculture. Second, Tarai forests produce high value timber trees such as Sal (Shorea robusta). These types of forests are prone to market over exploitation. Controversy exists on the success of community forestry in the Tarai region of Nepal. Some researchers argue that community management regime is feasible in the Tarai region. They claimed that community forests in the Tarai region are successful in terms of enhancing forest condition (Chakraborty, 2000). On the other hand, others claim that it is infeasible to conserve the forest resources in the Tarai region due to some specific factors such as high-value timber trees, and high population pressure (Hobley, 1996; Ojha, 2009). Therefore, feasibility of community management regime and its impact on reforestation in the Tarai region needs to be further analyzed. In addition, previous studies have been criticized for methodological issues such as lack of robust econometric analysis (e.g. Chakraborty, 2000). In addition, these studies are based on qualitative perception of the local users and cross sectional non-random samples (e.g. Chakraborty, 2000; Agrawal and Chhatre, 2006; Agrawal and Yadama (1997). Moreover, some studies did not use ground level data (Bhattarai and Conway, 2008) to assess the forest condition and effects of management regime. Such cross-sectional non-random samples and subjective perception based studies are prone to a number of possible biases such as endogenous selection of samples and individual subjectivity biases. Each person may have a different perception on the forests condition based on their relation with committee members.

For the sustainability of the forest condition, mainly we need to focus on two issues. First, we need to stop deforestation or forest degradation. Second, we need to foster reforestation process. Therefore, this paper mainly focuses on these two issues using community forestry level data. First, it explores the determinants of deforestation in Tarai forests. Second, the paper assesses the effects of community management on reforestation. In addressing the above issues, this paper tries to solve some of the methodological shortcomings of the existing studies indicated above by considering wider control variables. Possible endogeneity issue is addressed using a two stage least squares estimation technique.

This paper is structured as follows. Section 2 reviews the existing literature on deforestation and reforestation. Section 3 briefly highlights evolution of Nepal's forest policy. Section 4 postulates the hypotheses guiding this study. Section 5 presents information about study side, data and methodological issues used in the analysis. Section 6 reports the result, and Section 7 concludes the paper.

2. Literature review

Forestry plays a vital role in ecological and economic domains by sustaining environmental balance and contributing to economic activities respectively. However, massive deforestation is taking place in developing countries, resulting in greater scarcity of the forest products (Otsuka and Place, 2001). Large numbers of studies, mostly focusing on the tropical regions, have been carried out to explore the factors responsible for the deforestation (Paff, 1999, Geist and Lambin, 2001). Some studies have found that human settlement and road access are the causes of deforestation (Pfaff, 1999) while others have suggested that increasing demand of fuel wood due to population pressure and weak forest protection practices contributes to the deforestation (Brown and Pearce, 1994). Geist and Lambin (2001) identified the various causes of deforestation and categorized them into three broad themes; 1) proximate causes, 2) underlining cause (social) and 3) other causes. According to them, proximate causes arise due to human activities that directly affect the forest such as wood extraction, expansion of agriculture land and extension of infrastructure. Underlining causes comprises demographic (e.g. Population pressure), economic (e.g. Market, price of wood), technological (e.g. Agricultural productivity), institutional (e.g. Property rights on forests) and cultural factors (e.g. Attitude, Value). Other factors comprise environmental factors (e.g. Soil quality, Slope), biophysical factors (e.g. Droughts, Pest), and social factors (e.g. Wars and Economic shock).

Using the satellite data of the forest condition and combine them with the demographic data, Bhattarai (2009) found that population pressure, elevation of the forest land and road access to market from the forests are the factors which accelerates deforestation in the Bara district (Tarai region) of Nepal. In highlighting the causes of deforestation, there have been observations that Nepalese government policy is also responsible for contributing to deforestation. Government policies, in particular Forest Nationalization Act 1957 and the government resettlement program in the Tarai region, have resulted in high population growth, urbanization practices and infrastructure development activities. These factors are seen as factors causing deforestation in Nepal (New ERA, 1997).

As forest cover decreased rapidly because of the state's inability to control deforestation, forest products became increasingly scarce, and as a result, the need for effective policy in promoting reforestation was increasingly felt. Literature on reforestation is relatively weak than that of the deforestation. Few studies have been carried out to find the determinants of reforestation and collective action. According to Nagendra (2009), land tenure or range of management regimes are associated with forest rehabilitation. Focusing on the case of Nepal, Nagendra found that community forests, leasehold forests and buffer zone forests have been actively managed and have shown

significant reforestation. Other studies found that resource scarcity as measured by population pressure relative to the forest area has had a positive relationship with the collective action of the group (Wade, 1987). In addition, it was found that population growth is negatively associated (Dasgupta, 1995), and prior experience of co-operational activity is positively associated (Baland and Platteau, 1996) with the collective action. It is expected that better collective action fosters the process of reforestation.

Conducting a case study of community forestry in the middle Hill region of Nepal, Dev et al. (2003) revealed that the community management regime has been successful in terms of forest protection and regeneration. The community forestry program should address the twin goal of forest conservation and efficient benefit allocation among users to uplift the livelihood of the citizens. Therefore, those community forests are tend to be success which are able to conserve the forest (i.e. reduce the rate of forest degradation and increase the rate of reforestation) and increase the household income of the users. Many studies conducted in the Hill region have suggested that forest condition is improving (Acharya, 2002; Dev et al., 2003; Yadav et al. 2003). For example, tree density and regeneration rate is increasing in degraded forests, and illegal harvesting rate is decreasing in the Hill region. A study conducted in the eastern Hill of Nepal found that the average annual household income of the forest user members increased by 113 percent over a period from 2003 to 2008 (Chapagain et al., 2009). Such quantitative evidences of success and failure are not available in the Tarai cases.

There is no consensus among researchers about the success and failure of the CFUGs in Tarai region. Some researcher argued that community management regime is feasible in the Tarai region (Chakraborty, 2000). Chakraborty (2000) found that traditional systems of authority in the villages, monitoring and enforcement mechanisms and external support from other institutions are some key factors which help to flourish the community management system in the Tarai region. In contrast, Ojha et al. (2009) argued that Tarai forests create greater conflict over the forest resource access, benefit distribution and overall community forestry programs implementation because of high commercial value of the forest product. Similarly, other studies found that community forestry in the Tarai region is infeasible to conserve the forest resources due to diverse ethnic composition, a high immigration rate, spatial distribution of the forests and human settlement program (Hobley, 1996). In addition, Gautam (2004) argued that a conservative approach of the government office in handing over the forests to the local people is the main factor behind the lower number of community forests in the Tarai region compared to the Hill region. Summarizing the findings from the different studies, Gautam (2004) stated that various forms of misconduct by CFUG, forest characteristics (high valued trees) and socio-economic context of the Tarai

region such as greater ethnic heterogeneity, better access to market, and high migration into the region leads to mismanagement by CFUG. However, literature on the causes of deforestation and the effects of community management on forest conditions in the Tarai region is relatively weaker than that of Hill region of Nepal.

Few studies ever been conducted are also fraught with the number of methodological issues. For example, while assessing the forest condition and stability of the community forestry of the Banke and Dhanusha districts of Nepal (Tarai region), Chakraborty (2000) used the non random sample of forests to conduct qualitative analysis. Bhattarai (2009) used the remote sensing data to assess the forest condition in Bara district (Tarai region) of Nepal. This is not a community forestry level analysis. This paper aims to address these limitations on existing literature. In this paper, the determinants of deforestation as well as the effects of community management regime on reforestation are explored based on the ground level data of forest conditions using the robust econometric method. A possible bias due to endogenous selection of samples is addressed by deploying instrumental variable approach.

3. An Overview of Forest Policy in Nepal

Forest resources are the main natural resources in Nepal because citizens are heavily dependent on the forestry products for their livelihood. Indeed, the significance of forestry in Nepal's economy is aptly reflected in the national slogan; "Green Forest-Nepal's Wealth". However, forest resources in Nepal have been depleting especially in the Tarai region for several decades. Various factors such as an ever increasing population and market overexploitation are identified as the causes of deforestation. In addition, Nepalese government policy is also regarded as the major factor of deforestation (Regmi, 1994). Nepalese forestry policy can be categorized into three regimes; 1) privatization regime before the1950s, 2) nationalization regime between the 1950s and the 1970s and 3) decentralization regime after the 1970s.

Most of the forest lands were under private control before the 1950s. Government encourages people to convert the forests land into agricultural land to increase tax revenue before 1950s. (Mahat et al.,1986). The government of Nepal promulgated the Forest Nationalization Act in 1957 which shifted all forest lands to government control from citizens (Hobley, 1985). This Act accelerated the deforestation process since the forest resources became "common pool resources". Besides these, government resettlement programmes and massive migration into Terai from the Hill region generated strong pressure on the Terai forest leading to massive deforestation after the 1950s (Gautam, 2004). In the 1970s, the government of Nepal realized that only the state itself could not control the forest degradation. In response, the government promulgated Panchayat Forest Rules and Panchayat Protected Forest rules in 1978. These rules

devolved the authority of managing the degraded forest land to the locally elected body. Government enacted the Decentralization Act in 1982. This Act introduced and promoted user group concept as an effective means to foster the collective action and to reduce the pace of forest degradation. The current Forest Act was first enacted in 1993 after the restoration of multi party democracy in 1990. In this Act, community forestry was given the highest priority and considered it is an effective institution to combat the problem of deforestation. The revision of Forest Act of 1999 devised a number of provisions regarding investment of income and control mechanism for Community Forest User Group (CFUG). According to this Act, CFUGs should invest 25% of forest income for forest development. There is widespread agreement that the community forest management system is successful to attain the efficient use of forest resources (Baland and Platteau, 1996; Bromley, 1992). Therefore, policy intervention after the 1970s has drastically helped to flourish the community forestry in Nepal.

4. Hypothesis

Forests are important natural resources which directly affect the livelihood of the poor people and are crucial for maintaining the environmental balance. Higher population density due to migration and natural growth, create higher demand of land for agricultural, settlement and grazing purpose leading to massive deforestation (Pfaff, 1999; Geist and Lambin, 2001; Bhattarai, 2009). Higher population pressure also creates higher demand for forestry products such as timber, firewood, grass fodder and leaf litter (Shafik, 1994). Over extraction of such products causes severe forest degradation. Similarly, better access to the forests from market causes forest degradation due to market exploitation of forest products (Panayoutou, 1994). Based on this evidence, the following hypothesis is postulated.

Hypothesis 1: Higher population density and better access to the forests from market leads to greater deforestation[1].

The property rights regime on the natural resource management has been heavily debated in the literature for the past several decades. It is argued that property rights should be handed over to the local community people to solve the problem of common pool resources. Property rights increase the local participation in the resource management, and it provides the ownership of resources to the people (Aggarwal and Elbow, 2006). Therefore, handing over the property rights encourage the local people to preserve and promote the forests condition effectively and efficiently. Based on this observation, the following hypothesis is postulated.

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1 This hypothesis is already tested in many places but new area of study and new methodology is adopted to test this hypothesis in this paper

Hypothesis 2: Community management has a positive effect on reforestation after the forest use right has been handed over.

5. Study site, Data and Methodology

Dang district is one of the pioneer districts in implementing community forestry program in the Tarai region. More than 50 percent of the national forests are already handed over to the community user groups in this district. This district is located in the western part of Nepal. It extends east to west at an average length of 90 km and north to south on an average width of 72 km. The District consists of two valleys called Dang and Deukahri which are separated by the mid Churia Hills. Sal (Shorea robusta) is the predominant tree species in the forests in Churia Hills and valleys.

Among 447 community forests in the Dang district, 200 community forests are randomly selected. Community forests and community forest user group's data are partly collected from the constitutions[2] and operational plans[3] of the community forest user groups which are mandatorily submitted to the district forest office by the community groups. Other data such as % of deforested area and managed area are collected from the survey. The descriptive statistics, presented in table 2, provide basic characteristics of dependent as well as explanatory variables. The samples are divided into two groups by valleys (Dang and Deukhuri) depending on the sample location.

Forest degradation has various dimensions. I use two types of measurements for the forest conditions. The first measure is the extent of deforestation which is measured by the proportion of various forms of the severely degraded land, which is the area where trees were planted, the area of barren land and the area of encroachments for agriculture and human settlements purposes. The second measure of the forest conditions is the average number of small, medium and large trees per hectare[4]. Higher average number of tree per hectare implies that condition of the forest is better. Regeneration takes place either from seed or root of the tree. If the trees are cut down, many coppices are regenerated. Small categories of trees include seedlings and saplings, as well as medium categories include smaller sized poles and medium sized poles. Larger trees are comprised of large poles and mature trees. From table 1, it can

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2 Every community group submits their constitutions in the time of hand over and they can revise it later. The constitutions contains the information about the number of user households, population of the user group, functions, duties and power of the user group and user committees, financial regulations and etc.

3 The community forest user groups should submit the operational plan in a regular interval, usually within a 5 year gap. In this report they have the information regarding the objective of the forest management, forest development activities which must be carried out in the planned period, forest characteristics such as trees in the forest by size and type, slope, soil type etc. The operational plan is prepared by the user groups with the technical support of the district forest office and other supporters such as NGO/INGOs.

4 Rational number of trees may be better than higher number of trees especially for commercial forests. However, since the forests were degraded severely in the past, I assume that tree density also can be used to measure the forest condition.

Table 1: Descriptive statistics of the variable used in the analysis by valley

Variables used	Deukhuri Valley		Dang Valley	
	Mean	N	Mean	N
% of planted /encroach /barren area	1.365022	61	1.327516	139
Small number of trees/h	14377.81	60	11010.07	129
Medium number of trees/h	572.5664	60	796.8209	128
Large number of trees/ha	225.4668	49	325.1939	114
Year of handover	1998.639	61	1997.229	140
Household density(hh/area)	0.873841	61	1.609768	140
Distance to market town	8.688525	61	10.14643	140
Distance to village	0.502459	61	0.597543	140
Slope of the forest land	11.12024	56	13.73497	127
Cast diversity index	0.416696	56	0.395021	121
Ratio of the Brahmin / chettri	0.259576	56	0.432215	121
Soil dummy (clay/loam)	0.716981	53	0.75	124
Soil dummy (stony/ gravel)	0.283019	53	0.25	124

Source: Dang Forest survey, 2010 (Own Survey)

be seen that household density is higher in the Dang valley than in the Deukhuri valley. Similarly, average numbers of small trees are more prevalent in the Deukhuri valley than in the Dang valley, but there are more medium sized and larger sized trees in the Dang valley. The forests, which are located in the Dang valley, were handed over earlier to the community people than in the Deukhari valley.

Table 2 shows the size of the trees of different categories. The growth rate of the trees depends on various factors such as climate, distance between trees, soil type, seed type, species type and management practices. In addition, the growth rate of the trees of different age group differs significantly. Therefore, it is hard to predict the age of the trees by analyzing the size of the trees. Under normal conditions, it is estimated that the diameter of the sapling size of a Sal tree is increased by 1 cm per year (According to Forester). Since, most of the community management systems restrict grazing and harvesting of fodder except for certain periods, the regeneration of trees must have taken place after the forest is handed over to the community people. Therefore, we can expect that the forests, which were handed over earlier, have more medium sized trees. Similarly, the forests, which were handed over recently, have more small sized trees. The maximum time elapsed since the hand over is 19 years, so we cannot expect the larger sized trees in community managed forests from the regeneration.

Table 2: Size of trees by different categories

Seedling	Sapling	Small pole	Medium pole	Large Pole	Large Tree
Less than 1 m height	More than 1 m height and less than 10 cm diameter	10 to <15 cm diameter	15 to < 20 cm diameter	20 to < 30 cm diameter	>30 cm diameter

In order to test the hypotheses, the following econometric models are developed. Hypothesis 1 and 2 suggests that population pressure and better market access directly lead to deforestation but could potentially also improve tree conditions, by inducing its nearby communities to better manage the forest through the process of induced institutional innovation. Thus, forest conditions are determined by population pressure, market access and forest management, as well as other community characteristics. In this study, institutional innovation in forest management is captured by the timing of community hand-over of each forest to the community, which evolves endogenously. The econometric specifications' expressing the determinants of forest conditions takes the following form:

$$\text{Forest\_Condition}_i = \beta_0 + \beta_1 \text{Population\_Pressure}_i + \beta_2 \text{Market\_Access}_i + \beta_3 \text{Hand\_Over}_i + \boldsymbol{\delta X_i} + \upsilon_l \quad (1)$$

The determinants of the timing of forest handover, in turn, take the following form:

$$\text{Hand\_Over}_i = \phi_0 + \phi_1 \text{Population\_Pressure}_i + \phi_2 \text{Market\_Access}_i + \phi_3 \boldsymbol{Z_i} + \boldsymbol{\eta X_i} + \xi_i \quad (2)$$

Where Hand_Over_i is the year when forest management was handed over to the community i, υ_l and ξ_l are error terms, and $\text{Population\_Pressure}_i$ is measured by the number of households per hectare of forest area. Similarly, Market_Access_i is measured by the distance from the nearest market town to border of the community forest i, $\boldsymbol{X_i}$ is a vector of other characteristics of the community forest i, and ε_l is an error-term. $\boldsymbol{X_i}$ vector include physical characteristics of the forest (represented by the distance of the forest to village center, the slope of the forest, soil type) and social characteristics of the community (represented by herfindhal index of caste composition, the share of Brahmin Chettri households). The dependent variable in equation (1), $\text{Forest\_Condition}_i$, is proxied by a set of variables measuring the number (or density) of trees of different sizes per hectare and the area of the forest (%) where severe deforestation took place.

Hypothesis 2 suggests that forest conditions improve as a result of community forest management and that the earlier the timing of hand over the better the forest conditions are likely to be once other direct causes of deforestation, such as population pressure and market access are controlled. The expected sign of the coefficients on

Hand_over$_i$ (i.e., β_3) in equation (1) depends on the type of tree size, as discussed below. Hypothesis 1 further suggests that, while the sign of the coefficients on population pressure and market access (β_2 and β_2) is ambiguous *without* controlling for forest management, once the extent of forest management (as proxied by Hand_over$_i$) is controlled for, both population pressure and market access lead to deforestation.

Identification of the coefficient on Handover (β_3) requires instrumental variables ($\boldsymbol{Z}_i$) that are correlated with the timing of forest handover but do not directly affect forest conditions. The identification assumption is that the timing of hand over is affected by the location of forest communities. Dang district can be divided into two parts, Dang valley and Deukhuri valley, separated by mid Churia Hills, and district headquarters and forest head offices are located in Dang valley. As a result, forest communities in Dang valley tended to be handed over earlier than those in Deukhuri valley mainly due to the difference in accessibility to the forest offices. As Edmonds (2002) documents, forest officers in Nepal play vital roles in the process of hand over to community forest but do *not* manage forests themselves, and thus accessibility to the forest headquarters is likely to be a crucial determinant of the timing of hand over. I further assume that forest conditions are not different between the two valleys once observable physical (such as slope, soil conditions) and social (such as caste composition) characteristics are controlled. With this identification assumption, I use a dummy variable taking value one for those communities located in Dang valley as the instrumental variable. Equation (1) and (2) are estimated by 2SLS.

6. Results and Discussions

Analysis of deforestation

The table 3(column 2) shows that the population pressure measured by the number of households to the area of the forest is positively significant when the % of deforested area is the dependent variable. This indicates that the population pressure is a key determinant of severe deforestation in the Tarai region. The population pressure in the Tarai region has been increasing for several decades due to high migration from the Hill region. Pull factors of migration in Tarai comprise eradication of malaria, the availability of fertile land, better opportunities in terms of schooling, health, transportation and better agriculture wage (Regmi, 1994). Since the livelihood of the people depends heavily on the forest products, high population density ultimately increases pressure on the forest products resulting in severe deforestation. Most of the rural people have small houses with small parcels of land and some cattle. Timber is used to construct the housing and shades for the livestock. Fuel wood is a main source of energy for cooking. Forest land is also used as a grazing land for the cattle people own. Population pressure, either due to migration or natural growth, affects the forest

condition negatively by over extracting the forest products. More importantly, if the population pressure increases, more land is required for agriculture and settlement to maintains livelihoods of the people leading to the encroachment of the forests. From table 3, we can also see that slope of the forests is negatively related to the deforested land. Higher the slopes of the forest lower the deforestation has taken place. This evidence supports the fact that forests are more prone to deforestation in plain areas where the population pressure has been increasing in the recent decades.

Forest condition can be measured by accounting different categories of trees. Higher the number of trees per hectare, better the condition of the forest is. From table 3(column 5), it can be seen that the number of large trees is positively related to the distance to the market town. This shows that there are more large trees per hector in the remote places. This indicates that the forest degradation took place in a nearby location from the market place. This type of degradation is caused by the commercial extraction of the large tree. Tarai forests produce valuable timber such as Sal (Shorea robusta) and the demand of Sal timber is very high in the country.

Table 3: Forest condition: 2SLS regression[5,6,7]

1	2	3	4	5
	Deforested area(%)	Small trees	Medium trees	Large trees
Year of hand over	0.331683 (1.09)	3447.1** (2.12)	-131.73* (-1.77)	-53.5784 (-1.06)
Household density (HH/area)	0.345642*** (3.05)	-70.6787 (-0.11)	-32.0189 (-1.09)	1.057426 (0.06)
Distance to market town from forest	0.004215 (0.12)	-110.603 (-0.56)	-12.2877 (-1.33)	10.579** (2.04)
Walking time to village from forest	-0.07614 (-0.28)	-2183.37 (-1.46)	79.59601 (1.13)	48.44516 (1.23)
Slope of the forest	-0.06839** (-2.1)	-271.105 (-1.47)	15.1353* (1.75)	7.0194 (1.27)
Cast diversity index (Herfindhal)	-0.31204 (-0.24)	-10378.5 (-1.43)	578.103* (1.67)	274.208 (1.33)
Ratio of Brahmin/ Chettri	1.048368 (0.94)	6176.005 (1.04)	15.92558 (0.06)	25.9952 (0.16)
Soil dummy(Clay loam)	-0.12598 (-0.29)	534.2876 (0.22)	-23.4957 (-0.21)	60.4846 (0.92)
Constant	-660.892 (-0.29)	-68657** (-2.12)	263551* (-1.77)	106920 (1.06)
N	154	148	147	144
F	2.13	1.15	0.79	1.93
Prob>F	0.0363	0.3316	0.6158	0.0609

*, **, and *** signify statistical significance at 0.1, .05 and .01 levels, respectively. t- Statistics are presented in the parenthesis

5 OLS and first stage regression are reported in the appendix. First stage regressions results show that population density and market access are not significant when the dependent variables are forest condition. This evidence needs further scrutiny.

6 The regression analysis below reports a test of the null hypothesis that all slope coefficients' are jointly equal to zero.

7 Variables forest area and number of household in CFUGs are also tried as explanatory variables while conducting the regression analysis. These variables are not significant in all models, but they reduce the overall significance of the model such as reduce the coefficient of other variables and reduce the F- value in the first stage regression. Therefore, these variables are excluded from the analysis.

However, the year of handover is not significant when the dependent variable is the number of large trees per hectare. This shows that age of the community forest does not affect the number of large trees. The average age of the community forests in Dang is around 12 years. Therefore, a regenerated tree, after the forests is handed over, could not mature as large trees in 12 years. Another reason for the non significance of the year of hand over may be that the communities are interested in the forests which provide them minor forests products, rather than timber trees.

Analysis of reforestation

In table 3(column 3 & 4), we can see that population pressure and distance to market have negative coefficients but not significant when the dependent variables are a number of small and medium sized trees, and the year of hand over is controlled. One possibility for this evidence is that the rate of regeneration of new trees in places where massive deforestation took place is higher than in other places. From column 2 and 5 of table 3, we can see that deforestation took place in those areas where the population pressure is higher, and the forests are nearer to market places. Regeneration effects after massive cutting down of the trees and the effect of population pressure and market on small sized trees equate to each other. However, this needs further scrutiny. We can see, on the other hand, that the year of hand over is significant when the dependent variables are an average number of small and medium sized trees per hectare, but the sign of the coefficients are different. This shows that if the forests were handed over earlier, medium sized trees are dominant in the forest. Similarly, if the forests were handed over recently, smaller sized trees are dominant, compared to other trees. This indicates the positive effect of the community management regime in the reforestation process. The average time elapsed since handover to the latest operational plan is 9.25. If the growth rate of the diameter of the small tree is about 1 cm per year, the mature time of trees from small categories to medium categories is about 10 years, which is almost the same as the average time elapsed since handover. Therefore, below the average year of time elapsed, small categories of trees are dominant and above the average year of time elapsed medium sized trees are dominant. It is important to note that the regeneration process is the natural process for the Sal trees either from seed or from the coppice. Under the community management regime, grazing and harvesting the fodder is restricted in most of the forests. Therefore, regeneration can easily take place in the forests under the community management regime.

7. Conclusion

Considerable number of studies explained the success of community forestry in

the Hill region of Nepal (Gilmour and Fisher, 1991; Hobley, 1996). However, controversy exists about its success in the Tarai region. Very few quantitative analyses were conducted using the community forest level data in the Tarai Forests. Few studies ever been conducted are also fraught with the number of methodological issues and quality of data. This paper has used ground level data which is collected using simple random sampling technique. 2SLS technique is used to solve the problem of endogeneity of the age of the CFUGs variables.

This article highlights two issues on the existing forest condition and management regime based on a comprehensive and detailed cross-sectional dataset from the Nepal inner Tarai forests. First, the determinants of deforestation are investigated empirically. I found that population pressure and distance to market towns are major causes of deforestation. Population pressure measured by the number of households relative to the area of the forest is highly significant in the regression analysis when the dependent variable is percentage of planted, barren and encroached area, indicating the severe deforestation. Similarly, I found that market access is correlated with the number of the larger trees which are more vulnerable to over extraction when they are close to market towns. These evidences on forest degradation are also consistent with other studies (Pfaff, 1999).

Second, I assess the effect of community management regime on reforestation. I use different sizes of trees and community management durations to find the effects of management regime. I found that small trees are dominant in the forest which were under shorter community management duration and medium sized trees are dominant in the forests which were under the longer management duration. Since, the age of smaller sized trees is approximately equal to the shorter management duration and age of medium sized trees is approximately equal to longer management duration, it can be claimed that this is the effect of the community management regime. It is important to note that the large trees are not significant with the time of handover. Generation of new plants without diminishing the larger ones confirms the sustainability of the forest condition in the Tarai forest under the Community Forestry.

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Appendix 1

Forest Condition (OLS results)

Dependent Variables → / Independent Variables ↓	% of plantation / barren / encroach area	Small categories of trees	Medium categories of trees	Large categories of trees
Year of hand over	0.023 (0.34)	180.753 (0.61)	-5.092 (-0.32)	3.320 (0.33)
Household density (HH/area)	0.296*** (3.08)	-621.630 (-1.52)	-9.588 (-0.44)	9.666 (0.72)
Distance to market town from forest	-0.006 (-0.2)	-239.463* (-1.76)	-7.432 (-1.02)	12.244*** (2.73)
Walking time to village from forest	0.001 (0)	-1378.059 (-1.31)	48.205 (0.86)	36.793 (1.07)
Slope of the forest	-0.046* (-2.02)	-6.130 (-0.06)	4.753 (0.91)	2.193 (0.68)
Cast diversity index (Herfindhal)	0.260 (0.23)	-4152.801 (-0.86)	321.142 (1.24)	152.056 (0.96)
Ratio of Brahmin/ Chettri	0.338 (0.41)	-969.572 (-0.27)	284.634 (1.5)	140.645 (1.21)
Soil dummy(Clay loam)	-0.028 (-0.07)	1253.504 (0.73)	-48.342 (-0.52)	44.486 (0.77)
Constant	-44.518 (-0.33)	-343495.100 (-0.58)	10687.640 (0.34)	-6672.961 (-0.33)
N	154	148	147	144
R2	0.1118	0.0624	0.0322	0.1167
F	0.0250	1.16	0.59	2.23
Prob>F	.0250	0.3301	0.7835	0.0289

*, **, and *** signify statistical significance at 0.1, .05 and .01 levels, respectively. t- Statistics are presented in the parenthesis

Appendix 2

First Stage Regression (Forest Condition)

Dependent Variables → / Independent Variables ↓	% of plantation / barren / encroach area	Small categories of trees	Medium categories of trees	Large categories of trees
Household density (HH/area)	-0.092 (-.80)	-0.099 (-0.86)	-0.107 (-0.93)	-0.091 (-0.8)
Distance to market town from forest	-0.025 (-0.67)	-0.030 (-0.79)	-0.028 (-0.75)	-0.021 (-0.56)
Walking time to village from forest	0.378 (1.30)	0.396 (1.34)	0.402 (1.36)	0.340 (1.16)
Slope of the forest	0.087*** (3.28)	0.095*** (3.56)	0.097*** (3.62)	0.096 (3.61)
Cast diversity index (Herfindhal)	1.979 (1.50)	2.094 (1.57)	2.257* (1.69)	2.315 (1.75)
Ratio of Brahmin/ Chettri	-1.332 (-1.31)	-1.169 (-1.14)	-1.053 (-1.02)	-1.177 (-1.16)
Soil dummy(Clay loam)	0.323 (0.68)	0.224 (0.47)	0.194 (0.41)	0.243 (0.5)
Valley Dummy	-1.389*** (-2.92)	-1.437*** (-3.04)	-1.483*** (-3.13)	-1.246 (-2.62)
Constant	1996.936 (2253.52)	1996.919 (2218.65)	1996.815 (2211.22)	1996.534 (2218.95)
N	154.000	148	147	144
R2	0.1845	0.2007	0.2070	0.0002
F	4.100	4.36	4.5	4.12
Prob>F	0.0002	0.0001	0.0001	-0.091

*, **, and *** signify statistical significance at 0.1, .05 and .01 levels, respectively. t- Statistics are presented in the parenthesis

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