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Local Communities' Perceptions of Bamboo Deforestation in Benishangul Gumuz Region, Ethiopia

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Abstract
Households' perception toward deforestation and knowledge on conservation is important for designing suitable management policies. However, more often than not local communities' perceptions do not receive as much attention as they deserve. The study investigated local communities' perception towards the impact of bamboo deforestation and identifies perceived impacts of bamboo deforestation. Data was obtained from a random sample of 384 households. Exploratory factor analysis and seemingly unrelated regression models were used to estimate various relationships. The result shows that 64.06 percent of respondents perceive bamboo forest cover as rapidly declining state. The factor analysis result has identified 3-latent factors (economic, environmental and social perceived impacts). The most perceived impact is economic impact with overall mean score of 3.05.Regression results showed shows that economic, environmental, and social impacts of bamboo deforestation were positivity interdependent, and influenced by some common underlying explanatory variables. These factors included: age of the household head, experience in shifting cultivation, knowledge on the resource condition, and trust among community, membership in social groups, and distance from the forest, farm size, and dependency on bamboo collection.The result recommends the need for quick bamboo forest conservation and rehabilitation activity based on the principles of collective actions and participatory forest management system. Moreover, frequent awareness creation on wildfire protection, modern charcoal preparation, shifting agricultural production system, knowledge on the resource condition were suggested for effective and sustainable use of bamboo resources in the region.
Keywords: Household perception, bamboo deforestation, factor analysis, SUR model, Benishangul Gumuz region, Ethiopia

1. INTRODUCTION

Bamboo deforestation is most significant challenge; where rural people in Benishangul Gumuz region depend on bamboo forest for various economic and environmental goods. The region continues to face the challenge of how best to manage and conserve the bamboo resources. In order for local households to participate with deducing bamboo deforestation, they must have a positive perception toward the adverse impacts of the current bamboo deforestation. This study investigates local communities' perception towards bamboo deforestation and identifies factors affecting their perception on the impacts of bamboo deforestation.

Although Ethiopia took the first place in bamboo potential in Africa comprising 67 percent of the continent's bamboo forest area (Demissew et al., 2011), deforestation particularly massive bamboo depletion has been taking place in many parts of the country, and nowadays is burning issue in Benishangul Gumuz region. The bamboo resources of the region have been quite shrinking from time to time. For instance, in the 1960s, the total area of bamboo in Ethiopia was estimated at 1.5 million hectares (1 million hectares of lowland bamboo and 0.5 million hectares of highland bamboo). According to a study undertaken on Global Forest Resources Assessment (1997), Ethiopia possessed only about 0.8 million hectares of bamboo resources as evidenced by International Network for Bamboo and Rattan (INBAR, 2005), which is supported by Luso Consult (1997). Furthermore, Ensermu *et al*. (2000) estimated the Ethiopian natural bamboo forest about 1 million hectares, which is equivalent to seven percent of the world total and 67 percent of the African bamboo forest area.

In recognition of the problems associated with natural resource degradation, assessing people's perception is vital for effective and sustainable resource management. Despite its imperative roles, most environmental experts were still reluctant to include people's perception and preferences in natural resources management (Keller, 2008). As suggested by Guthiga (2008), understanding local community's perceptions of forest management and factors that influence these perceptions are essential to design effective management policies that are sensitive to their needs. Nevertheless, studies on local people's perception regarding the socio-economic and environmental impacts (benefits or damages) on natural resource are at the margin in the region. Thus, the present study investigated local communities' perception towards the impact of bamboo deforestation and identifies perceived impacts of bamboo deforestation.

2.1. Empirical Studies on Perception of Households on NRM

The attitudes and intention of farmers towards participating in collective management of natural resource and its socio-economic benefit is associated with level of income and dependence on forest income (Yemiru, 2011). In Rwanda, development projects have been undertaken to address the complex issues of deforestation, environmental degradation and rural poverty in Haiti Reserve. Their success was found to depend on an understanding of the social, economic and cultural context within which they operate (Awang, 1994). A study conducted in Botswana showed that communities have a clear perception of the problems of natural resource degradation like land and forest (Khwarae, 2006). There has been substantial awareness about indicators of rangeland degradation in Ethiopia; and knowledge of indigenous management systems are considered as effective means of forest and rangeland management (Fekadu, 2008). In this study it is assumed that integration of communities' perceptions and existing indigenous ecological knowledge is believed to ensure success in forest and rangeland management programmes. Similar research finding in Oromia region, Jimma zone indicated that local farmers are aware about degradation of natural resources such as water, land and forest resources (Kaba, 2003). This study pointed out that respondents perceived forest cover around Jimma areas as rapidly declining, mainly as a result of widely practiced shifting cultivation. The study further showed that farmers recognize the negative effects of deforestation and they are very interested in tree planting and are in favor of private ownership of trees and forests. Examining in a wider perspective, a high proportion of Ethiopian farmers perceived a rapidly declining forest cover and show their intuition in tree planting.

Some scholars suggest environmental education [1] as an important element to raise farmers' perceptions (UNESCO, 1978). Despite the importance of local community involvement for suitable resource management, most planners fail to include the indigenous skill and knowledge of the people at grass root. Practical evidences indicated the different perception status among different households' in many parts of Ethiopia. These differences in perception could also occur among people living in the same location, sharing the same resources (Khwarae, 2006). For example, a study conducted Amhara and Tigray region indicated perception difference on natural resources degradation (Global Mountain Program, 2009).

Regarding the perception of households on factors responsible for deforestation, Tadele (2008) indicated that at house level, farmers' perception to deforestation is positively and significantly associated with sex, household size, marital status, literacy status, farm size, and work status in Sidama Zone, SNNPR. Therefore, assessing farmers' knowledge and their perceptions on the rate of degradation and its impact on their livelihood which could lead to proper planning and designing of appropriate conservation or consumption policy strategy. This, in turn, will have a meaningful effect for research and development strategy of the country.

Previous researches suggest that farmers with secure land tenure exhibit positive attitudes toward forestry activities. Smucker and Timyan (1995) found evidence in Haiti that secure property rights correlated positively with attitudes toward forestry programs. They also realized that insecure property rights are related to environmental degradation. The absence of secure property rights threatens forestry activities by discouraging tree planting, agricultural investments in irrigation, terracing, and soil enrichment, essential elements in tree growing. Characteristics of the farm household may influence the impact of forest activities at the farm level. In many parts of the world, more prosperous farmers, both in terms of material possessions and hector of land owned were found to be better in economic position to adhere to forestry conservation programs (Fiallo and Jacobson, 1995; Nepal and Weber, 1995). According to this finding, farm household income was positively correlated with perceptions toward forestry programms. Farmers who believe that forest activities will have an adverse impact on the farm household exhibit negative attitudes toward the program.

2. Analytical framework for exploratory factor analysis

Despite complex nature of multivariate statistical procedures of exploratory factor analysis (EFA), when properly and systematically applied this approach follows sequential and several linear options which would minimize the tedious procedure and make research work less daunting (Sharma, 1996). Hence factor analysis protocol or decision pathway for potential insight of data analysis was developed. The following is recently recommended 5-step factor analysis protocol developed by Williams et al. (2010) that provides clear decision paths for methodological analysis of households' perception towards the impact of deforestation.

1UNICEF described environmental education as a process of developing a world population to aware of and concerned about the total environment and its associated problems, and which has the knowledge, skills, perceptions, attitudes, motivation and commitment to work individually and collectively toward solutions of current problems and the prevention of new ones.

The 5-step Exploratory Factor Analysis Protocol

Is the data suitable for factor analysis?

↓

How will the factors to be extracted?

↓

What criteria assist in determining factor extraction?

↓

Selection of rotational method

↓

Interpretation and labeling

Source: Williams *et al.* (2012)

Factor analysis technique used in this paper is divided in to five steps. First, literature suggests appropriateness of sample size to decide applications for factor analysis. But there has been lack of agreement regarding the sample size recommendation. The rule of thumb suggests at least 300 samples in using factor analysis. Hair (1995), classify 100 sample as poor, 200 as fair, 300 as good, 500 as very good and 1000 as excellent. MacCallam *et al.* (1999) on their side criticize application of the rule of thumb in determining sample size for factor analysis. They noted that the rule of thumb principle is misleading, especially when the communalities of the factor analysis are high (greater than 0.6) pointing out even 50 sample size as adequate to generate stable factor solution. Sample to variable ratio (N: p) is also important in recommending as to how many respondents to examine for each variables. Scholars also disagree with this recommendation in determining adequate sample to variable ratio. For instance, the rule of thumb recommend a range of ratios 3:1, 6: 1, 10: 1, 15: 1, or 20:1. Despite the debate, Tukey and Mosteller (1977) found the ratio of sample to variable (S:p) to be as large as possible. Following this finding the present study used (S: p) ratio as 25.5:1 also by assuming the larger sample size the better.

The second stepwise procedure in using factor analysis is related to method of factor extraction. Literature indicate several methods of factor analysis which include principal factor analysis (PCA), principal axis factoring (PAF), maximum likelihood, unweighted least square, alph factoring, and image factoring. However, the most and widely used extraction methods in factor analysis are PAC and PAC. In academic research, however, the decision to use either PCA or PAC depends on the interest of the researcher. Pett *et a*l. (2003) suggested the use of PCA for exploratory factor analysis. The present study also uses the same method.

Cumulative percentage of variance and Eigen value >1 rule are the three criteria that assisted the research work in determining factor extraction. Because of complementary and sometimes confusing nature of the factors, no single criteria determine factor extraction and hence this study utilized multiple approaches of factor extraction. Another consideration in using factor analysis is selection of appropriate rotational method that result in maximum loading, and produce a more interpretable and simplified solution. There are two types of rotational methods: Orthogonal rotation and oblique rotation. Orthogonal rotation is the most commonly applied technique in factor analysis in which factor structures are uncorrelated. In contrast, oblique rotation methods produce factors that are correlated. Because of uncorrelated nature of the underlying latent variables the researcher opted for using orthogonal rotational method.

The final step in application of factor analysis is interpretation and labeling of the factors. Interpretation involves examining the nature of variables (which variables are attributed to a factor) and giving a name or them for a factor. Labeling of a factor is subjective, theoretical, and intuitive process (William *et al.* 2012; Henson and Roberts, 2006). They noted that the meaningfulness of a factor actually depends on the researchers' definition. Following these analytical approach the final latent factors were named as economic, social and environmental impacts of bamboo deforestation which are used through this paper.

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

Benishangul-Gumuz National Regional State (BGNRS) is one of the nine regional states established in 1994 by

the new constitution of Ethiopia that created a federal system of governance. Previously the southern part of BGNRS belonged to Wollega while the area above the Abay River to Gojjam. The region is located in the western part of the country between 09.17^0 - 12.06^0 North latitude and 34.10^0-37.04^0 East longitude. The region has international boundary with the Sudan and south Sudan in the West and is bordered by the Amhara region in the North and Northeast, Oromiya in the Southeast and South. The regional capital, Asossa is located at a distance of 687 km west of Addis Ababa, the capital city of Ethiopia. The region has a total area of approximately 50,380 km^2 with altitude ranging from 580 to 2,731 meters above sea level (m.a.s.l.). BGR is divided into 3 administrative zones and 21 '*Woderas*' (administrative unit equivalent to district*)*. Based on CSA (2007) data, the total population of the region is about 670,000 people, and the total population of the region is projected at 711, 702 people in 2009. Population density is sparse with a regional average of 14 people per square kilometer.The smallest population density is estimated at 3 persons per square kilometer and recorded in Guba, Yaso, Dangur and Sirba Abay districts while the largest population density is estimated at 62 people per square kilometers, which are recorded at Assosa, Mandura, Bambasi and Pawi districts (CSA, 2007). Agricultural land is abundant with a mean land holding size of 3.7 hectare.

The average number of family members of a household in the region is 6.7. Of the total population, 92.2 percent lives in the rural areas and 7.8 percent is urban population (BGRFSS, 2004). The population composition of the region has diverse ethnic groups, five of which are indigenous. Based on their languages, "the five indigenous[1]" ethnic groups in their order of population number are Berta (26.7 percent), Gumuz (23.4 percent), Shinasha (7.0 percent), Mao (0.6 percent) and Komo (0.2 percent). Significant numbers of Amhara (22.2 percent), Oromo (12.8 percent) and others (7.1 percent) also reside in the region. The religious affiliation of the population of the region is Muslims (44.1 percent), Orthodox Christian (34.8 percent), traditional religions (13.1 percent), Protestant Christian (5.8 percent), Catholic (0.5 percent) and others (1.5 percent).

Agro-ecologically, it is classified into *Kolla* about 75 percent (lowlands below 1500 m.a.s.l.), *Woina Dega* about 24 percent (midland between 1,500-2,500 m.a.s.l), and *Dega* about 1 percent (highland above 2,500 m.a.s.l.). The region is characterized by a monomodal rainfall. According to the classification of rainfall regimes given by the National Meteorological Service Agency, Benishangul-Gumuz region is characterized by a wet season from April to October. Annual rainfall varies from 800 to 2000 mm. The temperature reaches a daily maximum of 20^0C to 25^0C in the rainy season and rises to 35^0C to 40^0C in the dry season. The minimum daily temperatures range from 12^0C to 20^0C, depending on season and altitude. The hottest period is from February to April.

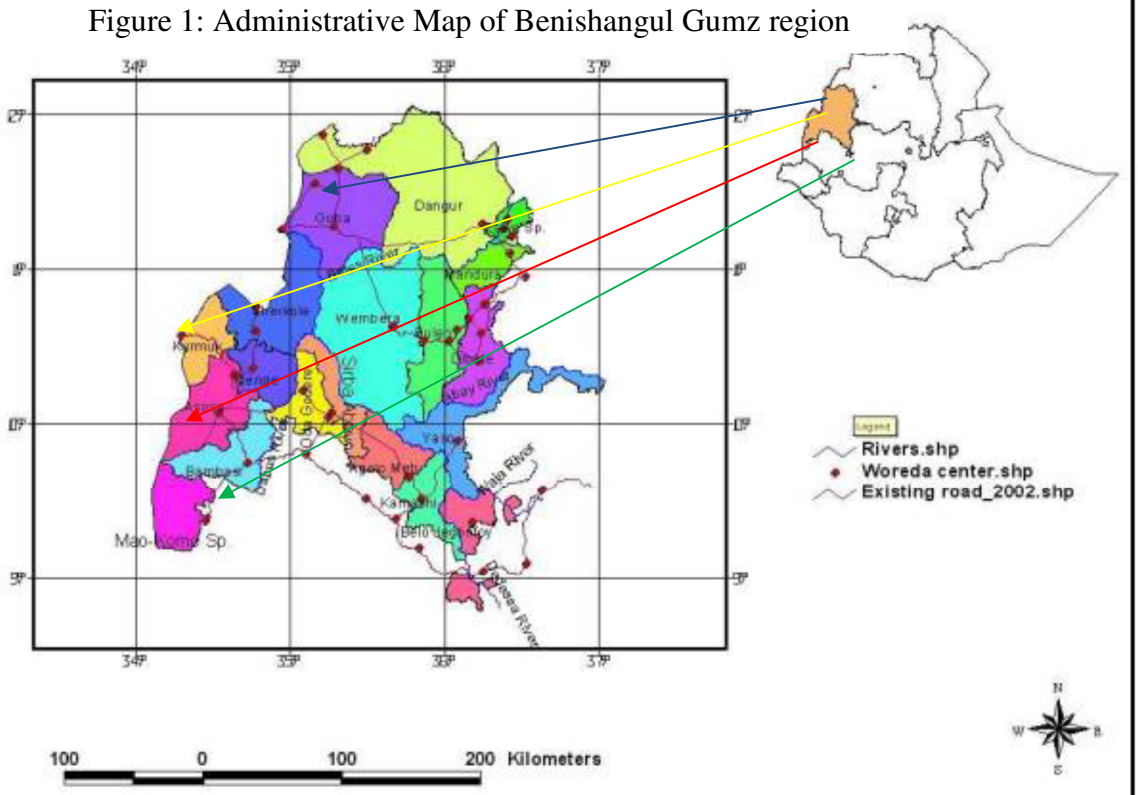
The incidence of poverty in the region is 54 percent (MOFED, 2004) and 93.2 percent of the population depend on shifting-cultivation agriculture for income. However, the incidence of poverty has declined markedly from 54 percent to 28.9 percent in the year 2004/05 to 2010/11 (MoFED, 2012). This source reported that the annual income per household from both agriculture and non-farm activities range from Birr 169 to Birr 1499. Currently, the region is attracting the attentions of the Federal government and other stakeholders' intervention because of the Renaissance Dam of Ethiopia, which is under construction in the region.

Benishagul-Gumz region is endowed with fertile land suitable for high value crops, livestock, apiculture, fishery, minerals like gold and marble, and economically important trees like bamboo and incense. Livestock production is important means of livelihood in the region next to crop production. It is important sources of food, cash income, and assets to buffer against shocks. In general, a mixed farming system, involving both crop production and livestock rearing activities, is the dominant type of production system. According to the CSA (2007) agricultural sample survey, the region had about 0.4 million cattle, 0.3 million goats, 0.1 million sheep, and nearly one million poultry.

In terms of land - use patterns, the region's landmass is predominantly comprised of bushes and shrubs 77.4 percent, while forestland constitutes about 11.4 percent. Further, cultivated land, grazing land and marginal land constitutes about 5.3 percent, 3.2 percent and 2.3 percent, respectively.The vegetation classified into eight types, namely: dense forest, riverine forest, broad-leaved deciduous wood lands, acacia woodland, bush land, shrub lands, boswellia wood land and bamboo thickets (INBAR, 2010). About 0.2 hectare (89 percent) of the total land of the region is covered with vegetation. Evidences in the region revealed that the lowland bamboo forest grows between 1000 and 1800 m.a.s.l and on poor soil in dry vegetation formation (LUSO CONSULT, 1997). It also tolerates poor rocky soil, in erratic annual rainfall even down to about 600 mm and in high temperature of above 35°C. The highland bamboo grows in altitudes from 2.200 -3.500 m.a.s.l and the lowland bamboo between 700-1800 m.a.s.l (Liese, 1989).

2Indigenous ethnic groups mean five ethnic groups in the region. Berta, Gumuz, Shinasha , Mao and Komo people. According to the Ethiopian 1994 new constitutions, the responsibility to manage the region was given to these ethnic groups.

Figure 1: Administrative Map of Benishangul Gumz region



3.2. Sampling technique

This study employed both purposive and stratified multistage random-sampling technique in selecting 384 sample households. In the first stage, all the 21 *woredas* in the region were categorized into two groups: districts with bamboo forest (13 *woredas*) and without bamboo forest (the remaining 8 *woredas*). *Woredas* with bamboo resources were also classified into two as (*woredas* with lowland bamboo and with highland bamboo) based on bamboos species found in their respective *woreas*. Study conducted by INBAR (2010) identified two bamboo species as lowland bamboo (*Oxytenanthera abyssinica*) and highland bamboo (*Arundinaria alpina*) in the region. According to their assessment and my filed observation, lowland bamboo is found in 11 *woredas*. Namely, Assosa, Bambasi, Homosha, Dibate, Bulen, Dangur, Mandura, Guba, Kamashi, Pawe and Sherkole whereas highland bamboo is found in Balo Jiganfoy and Kurmuk *woredas*. Those districts with lowland bamboo resources are situated in two agroecologies (*kolla* and *woynadega*) were stratified in to two. The rational for stratifying *woredas* based agroecology is because of differences in terms of bamboo resource endowments owing to human and natural factors. Therefore, districts with lowland bamboo resources were further categorized into two strata based on their agroecologies. Assosa, Bambasi, Dibate, Bulen and most parts of Dangur *woreas* fall under *woynadega* agroecologies whereas Sherkole, Homosha, Kamashi, Guba, Mandura, and Pawe *woredas* are located in *kolla* agroecologies. After listing all *woredas* in each agroecology, Assosa and Bambasi from first stratum (*woynadega* agroecology); and Homosha and Guba *woredas* from the second stratum (*kolla* agroecology) were randomly selected.

In the second stage, *kebeles* (the lowest administrative unit in Benishangul-Gumuz region) were classified into two groups. These are *kebeles* with and without bamboo resources as some *kebeles* did not possess bamboo resources. Subsequently, a total of 11 *kebeles* that possess bamboo resources were purposively selected. The selection of *kebeles in Assosa and Bambasi* was underpinned by the fact that these sample *kebeles* possess wider bamboo forest, but with high population pressure and high bamboo deforestation. Moreover, experts, NGOs, and regional authoritie opinions were also considered in selecting the *kebeles*. Accordingly three *kebeles* namly Afasisim, Yambasisim and Amba14 from Assosa *woreda* and three *kebeles:* Amba 46, Amba 47 and Amba 48 in Bamabasi *woreda* were purposively selected. Finally, Tumet, Dunga and Angela *kebeles from Homosha woreda,* and Ayicid and Beshat *kebeles* from Guba *woreda* were also purposively selected due to illegal bamboo export to Sundan, and high rate of bamboo depletion. According to the regional official report, bamboo smuggling has been commonly practiced in these five *kebeles* as they share boarder with Sudan and South Sudan. Thus a total of eleven *kebeles* were purposively selected from the four sample *woreda.*

3.3. Method of Data Analysis

3.3.1. Factor analysis

Exploratory factor analysis, which focuses on development theories, was used in this study to reduce 15 perception variables in to meaningful clusters of components using varimax rotation.Household heads' were asked 15 structured questions which can address their perception towards bamboo deforestation. Using a five-point Likert scale with 0, indicating "not important" and 5, indicating "very important", they rate how important each statement in the process of explaining bamboo deforestation and improving their livelihoods. Rating of various types of perception statements help to solicit their perception and preference, in which the low rating indicate low perception and vice versa. Based on the outcomes of the scale, the variable with a low average score indicated negative perception towards a particular perceived impact of bamboo deforestation while a high score have a positive perception as noted by Sharma (1996). The relationship between the observed and latent (underlying variables) is represented by the following structural matrix equation:

$$Z = \lambda F + \varepsilon \quad (1)$$

Where Z is a Px1 vector of variables, λ is a P x M matrix of factor loadings, F is mx1 vector of factors and ε is a px1 vector of error or residual factors (Sharma, 1996). In this particular case, Z's are observed/manifest variables that can be reduced in to manageable size and F is latent variable. These include perceived economic, social and environmental impacts of bamboo deforestation reduced and clustered based on their similarities.

3.3.2. Seemingly unrelated regression model

After factor analysis, seemingly unrelated regression model was also employed due to the fact that this method has three main advantages than using a series of multiple regressions. The first one is to gain efficiency in estimation by combining information on different equations. The second motivation is to impose test restrictions that involve parameters in indifferent equations. The third rationality is that it leads improved tests of hypothesis regarding regression coefficient and other parametric values (Zellner, 1962; Giles, 1987; Fiebg, 2001). This model explains the variation of not just one dependent variable as in multiple regression models, but the variation of m dependent variables. Gauss Markove theorem also positioned that compared to OLS which estimates individual relationships separately, a single estimation using maximum likelihood method would result optimally best linear and unbiased estimates.

Thus using the perception scores (factor scores) as the dependent variables, seemingly unrelated regression (SUR) model was used to estimate each latent variable and determine independent variables that commonly influence respondent's perceived impacts of bamboo deforestation. In order to estimate the interaction effect of the dependent variables and identify the common underlying factors, researchers widely employed seemingly unrelated regression SUR model (Degye *et al.* 2012 a; Degye *et al.* 2012b; Perz, 2002). In this paper, interdependences between the three factors (economic, social and environmental impacts) were assumed. Hence one purpose for applying this model is the need for identifying causal relationships between the three underlying dimensions identified during factor analysis. Theoretical and empirical studies show that such kinds of tivarate correlation between endogamous variables were best estimated by seemingly unrelated regression (SUR) model (Zellner, 1962; Greene, 2012).

Assuming the latent dependent variables were uncorrelated, past research studies used entirely separate multiple regression analysis (Belaineh, 2003; Guthiga, 2008; Dolisca, 2005, Degnet, 2004; Eyduran, 2012). However, actually such types of regression equations are not unrelated because they may at least interrelate through their error terms. Moreover, they are not necessarily simultaneous in nature but bear a close conceptual relationship to one another. The thumb of rule states that when the dependent variables are assumed to be correlated, then joint analysis (set of regression equations) are preferred than equation by equation analysis in order to obtain precise estimates and prediction that lead to better solution.

With respect to this study, households who perceive the economic impact of bamboo deforestation were expected to understand the environmental and social consequence of bamboo deforestation. Previous studies using factor analysis noticed uncorrelated relationships between the newly constructed (clustered) factors. However, practically the three factors were correlated through their common exploratory variables and/or error terms. When the interdependence between the dependent variables was assumed, the common underlying determinates are well estimated using simultaneous equations of seemingly unrelated regression model (Degye *et al.,* 2012a). However, a series of equations in SUR model may not necessarily simultaneous in nature but two or more dependent variables may bear close relationships to one another. Indeed, each equation model applies for different dependent variables and regressors in each equation need not be the same (Zellner, 2006).

Since farmers' perceptions are measured multidimensionaly, their responses toward natural resource degradation are a combination of characteristics of individual farmers (Dolisca, 2005). Given the expected heterogeneous perceptions of farmers' age, sex, income of the households, education level of the households, distance from the forest, farm size, distance forest area, livestock ownership and the level of dependence on forest, and other institutional variables were included to estimate determinants of farmers' perception to impact of bamboo deforestation.

The classic SUR model assumes that for each individual observation i, there are m dependent variables y_{i1}, ..., y_{ij} ,..., $y_i m$ available, each with its own linear regression model:

$$y_{ij} = X'_{ij} B_j + E_{ij}, \quad i = 1..., N \text{ i= 1..., N,} \tag{2}$$

or, with the usual stacking of observations over

$$Y_j = X_j B_j + E_j \tag{3}$$

for $j = 1..., M$, where y_i and E_j are N -vectors and X_j is an $N * K_j$ matrix, where $K_j = \dim(B_j)$ is the number of regressors for the Jth regression.

The standard conditions for the classical regression model are assumed to hold for each j : namely,

$$E(Y_j) = X_j B_j,$$
$$V(Y_j) = \sigma_{JJ} I_N \tag{4}$$

with X_j nonstochastic and rank (X_j) = K_j . Under these conditions, and the additional condition of multinormality of Y_j , the usual inference theory is valid for the classical LS estimator of , β^j applied separately to each equation. However, the SUR model permits nonzero covariance between the error terms E_{ij} and E_{ij} for a given individual i across equations j and k , i.e..,

$$\text{Cov}(E_{ij}, E_{ik}) = \sigma^{ik}$$

while assuming $\text{Cov}(E_{ij}, E_{i'k}) = 0$ (5)

This can be expressed more compactly in matrix form:

$$C(\varepsilon j, E_k) = \sigma_{JJ} I_N$$

Assuming the above homoscedastic, nonzero correlation were fulfilled, the three factor equations were estimated using seemingly unrelated regression (SUR) model specified under.

$$econ_i = X'_1\beta_1 + \varepsilon_{1i}$$
$$envrt_i = X'_2\beta_2 + \varepsilon_{2i} \tag{6}$$
$$social_i = X'_3\beta_3 + \varepsilon_{3i}$$

where $econ_i$, $envrt_i$, and $social_i$ are perceived economic impact, environmental impact and social impact of bamboo deforestation on household i , respectively. The X's are the respective vectors of covariates determining the dependent variables; and the β's are their vectors of parameter coefficients.

3.3.3. Dependent variables

There are three dependent variables considered in the study. These include the factor scores (continuous ratio variables) obtained from factor solution. The three dependent variables were jointly estimated using seemingly unrelated regression model.

Table1: Definition and measurements of each dependent variable was presented as follows.

ECON	Economic impact of bamboo deforestation, continuous measured using factor values
ENVIRNT	Environmental impact of bamboo deforestation, (continuous) measured using factor values
SOCIAL	Social impact of bamboo deforestation, (continuous) measured using factor values

3.3.4. Definitions and Measurements of Explanatory Variables

Based on extensive literature review on farmers' perception, the following socioeconomic, demographic and institutional factors are identified and their relationships hypothesized. Each variable definition, measurement and expected sign is briefly presented below.

Table 2: Variable definition, measurements, and expected sign on perception

Notation	Definition and measurements	Expected sign
sex	Sex of the household head 1/0	+
age	Age of the household head (years)	+
educ	Literacy status of HH, If literate1 ; otherwise,0	+
ethincity	1 if hh head is Berta; 0, otherwise	-
income	Households' annual gross bamboo income (ETB)	+
wealth	Wealfare index (1 if the HH is poor otherwise, 0)	
distance	Proximity to the bamboo forest area (continuous)	+
advise	Access to extension advise on bamboo; if yes 1,otherwise, 0	+
mobile	Proxy to access for information, if a HH have mobile;otherwise, 0	+
factory	HHs' attitude towards establishment of bamboo PLC (dummy)	+/-
firebrk	If HH perception the damage/benefit forest wild fire1totherwse, 0	+
propright	If HH have exclusion right on bamboo forest otherwise,0	+
network	No. of people who have strong social bond (continuous)	+
conflict	if a HH fight over bamboo resource1, otherwise, 0	-
external	If a HH need external (NGOs) support 1 otherwise, 0	+
depndncy	1, if a HH livelihood depend on bamboo collection otherwise, 0	+
setelmt	if a household support resettlement 1; otherwise, 0	-
shifting	A household experience in shifting cultivation 1; otherwise,0	-
resource	if they perceive on changing bamboo resource 1, otherwise, 0	+

4. RESULTS AND DISCUSSIONS

4.1. Household Characteristics

Based on the results of survey data, descriptive statistics are computed to draw information regarding demographic and socio-economic characteristics of the respondents. The result reveals that respondents are predominantly male–headed households accounting for 297 (76.3 percent) and female-headed households comprises 91 (23.7 percent).The minimum and maximum ages for the sample respondents were found to be 16 and 83 years, respectively, with an average of 42.21 year. In terms of their educational back grounds, about half (49.74 percent) of the respondents are illiterate, 30.47 percent had completed primary school, and 19.8 percent had attended elementary school. The result shows literacy level is low among the respondents. This could be due to the occupational nature of the target communities. This is because farming was the primary occupation of the respondents where significant proportions (95.31 percent) engaged in crop and livestock productions, while the remaining 4.69 percent depend on petty trading, traditional gold mining, and trophy hunting as the means of livelihood. Regarding the marital status at the time of survey, the majority of respondents (86.2 percent) were married, (5.47 percent) single, (4.43 percent) widowed/widower, (2.8 percent) divorced, and very few (1.04 percent) separated. Household size ranged from 1 to 22 children with an average of 6.07 people, but the male-headed households had 6.36 while the female-headed household had 5.09 family members.

Agro-ecologically, 160 (41.67 percent) and 224 (58.33 percent) of the respondents were found to live in *Kolla* and *Woynadega*, respectively. In terms of settlement condition, a large number of respondents, 244 (63.54 percent), were migrants (settlers) who came from various regions in Ethiopia and the remaining140 (36.46 percent) were native (mainly Berta community). Almost all Berta ethnic farmers were native to the area, lived for several years in a particular village.

4.2. Perceived Impacts of Bamboo Deforestation

The result of the survey revealed that framers in the study area perceive three impacts of bamboo deforestation. These include economic, social and environmental impacts. The survey result identifies that farmers in Benishangul Gumuz Region have an adequate awareness on the impact of bamboo deforestation with an overall mean score = 3.05 units with the most perceived economic impact. The mean scores of manifest (original) perception variables range from a high mean of 3.54 to a low mean of 2.85.

Respondents rated that increase in agricultural land size (mean = 3.54), the need for income diversification from cleaning operations (mean = 3.29), and decrease in productivity of livestock (mean=3.28) as the most top three perceived indicators of economic impacts of bamboo deforestation. Moreover, environmental related perception statements that mostly influence farmers' perception are found to be an increase in erosion and flood, vulnerability to climate change, and biodiversity loss (destruction of plants and animals habitat). Moreover, increase in demand for cultural and traditional musical instruments, improvement in primary education (enrollment), and decrease in availability of drinking water were perceived as important social indicators of bamboo deforestation.

Table 3: Descriptive statistics on summery of respondents' perception

Statements	Mean rating	Std. Deviation
Decrease livelihood income	3.544	0.704
Expansion of land for agricultural purpose	3.287	0.790
Decrease productivity of livestock	3.279	0.788
Decline supply of timber products	3.260	0.806
Decrease supply of firewood and charcoal	3.257	0.805
Increase time for firewood collection	3.163	0.873
Acerbate flooding and storks	2.930	0.929
Decrease soil fertility due to erosion	2.925	0.937
Increase environmental responsibility	2.914	0.933
Increase in temperature	2.910	0.923
Increase biodiversity loss and destruction of plants and animals	2.899	0.881
Increase vulnerability in global warming	2.896	0.870
Improvement in primary education	2.880	0.936
Increase in demand for cultural instruments	2.875	0.927
Decrease availability of drinking water	2.859	0.933

Source: Computed from survey data, 2014

4.3. Factor Results and Discussions

For the present study, the KMO test of sample adequacy was sufficient enough resulting the value 0.89, confirming validity of the sample selection. Literature shows that the value of KMO should not be less than 0.6, (Sharma, 1968). Moreover, the results of Bartlett test of sphericity (BTS) test are significant at 1 percent level, implying absence of identity matrix correlation. Finally, on the basis of Eigen value, scree-plot graph, and theoretical and conceptual relationships of the factors, the regional variables (original variables) were systematically categorized in to three underlying variables, which are termed as **factors**.

The result reveals that the total variance explained in factor 1, 2 and 3 identify positive eigen values of 7.74, 3.03 and 2.20 for each factors, respectively. Regional variables resulting in <1 eigen value have less effect in explaining variation on the study issue, hence rejected for further analysis. Extraction of sum of square loadings and rotation sum of square loading reveals 86.59 percent of total variance explained. Empirical literature pinpoints the use of two rotation methods in conducting factor analysis (Tukey, 1977). Since there is difference in the two approaches (rotation and unroasted) methods, rotation sum of square method was used in order to generate stable and valid component matrix solution. Rotation sum of square shows 33.8 percent, 30.9 percent and 23 percent total variance explained for the 3-factors retained for further analysis. Hence the 3-factor solutions are briefly discussed therewith:

Factor-1 was related to farmers' perception about economic impact of bamboo deforestation. This factor was named as 'economic impact' because the variables clustered under this factor involve either improvement or deterioration of the welfare of local people. These comprises six interrelated variables (decrease in livelihood income, expansion of land for agricultural purpose, decrease in livestock productivity, decline in supply of timber and non-timber products, decrease in supply of firewood and charcoal, and increase time for wood collection). The values of loading of each variable (decrease in livelihood income, expansion of land for agricultural purpose, decrease in livestock productivity, decline in supply of timber products, decrease in supply of firewood and charcoal, and increase time for wood collection on factor1 were 0.913, 0.717, 0.935, 0.925, 0.923, and 0.666, respectively. The high loading[1] value of decrease in livestock productivity implies that local communities significantly perceive the impact of bamboo degradation in terms of decrease in livestock productivity. The result should not be surprised as the livelihoods of local people in the study area mainly depend on crop and livestock production. Bamboo foliage (leaf and twigs) serves as feed in the area containing sufficient nutrition for body maintenance (Yeshambel *et al*., 2012). The present study shows that farmers perceived decrease in livestock productivity as a result of bamboo deforestation. The decrease in livestock productivity in turn has been decreased in livelihood income of the farmers as livestock is the main source of livelihood income in the study area.

Expansion of agricultural land through shifting cultivation, and illegal means of land acquisition was another perceived economic impact of bamboo deforestation. Despite paramount importance of agriculture for ensuring food self sufficiency, uncontrolled bamboo forestland conversion was perceived as one of the economic cause of bamboo deforestation. Local people also perceive the economic impact of bamboo deforestation as a decrease in supply of timber and non-timber forest products. Because of common-pool nature of bamboo forest, bamboo deforestation causes massive decline in timber and non-timber forest products. This resulted in scarcity of timber

3The Eigen value criterion considers that all factors having eigenvalues greater than 1 should be retained. The rationale is that any factor should account for at least the variance of a single variable.

and non-timber products, and increase in their prices. This finding is consistent with classical demand and supply theories which states that decrease in supply of the products (in this case timber and non- timber) increases the price of commodities assuming all the other variables kept constant. In similar way, farmers also perceive economic impact of bamboo deforestation in the form of shortage of supplies in firewood and charcoal. As a result, apparently local communities walk longer distance to collect firewood than their previous experiences.

Factor-2 was labeled as "environmental impact" of bamboo deforestation which includes acerbate flooding and storm, decrease in soil fertility, increased environmental responsibility, increase in temperature, increase in biodiversity loss), increased vulnerability in global warming with loading value of 0.916, 0.939, 0.932, 0.931, 0.750 and 0.755, respectively.

Factor-3 named 'social impact' represent improvement in enrollment of primary education, increase in the number of cultural (musical) instruments, decrease in availability of clean drinking water accounting for a total of 23 percent total variances explained. Under this factor, a simple question that may be raised is how bamboo forest deforestation leads to improvement education enrollment. The simple explanation is that households cut bamboo culms and sell them in order to generate income for child education.

Table 4: Perception on the impacts of bamboo deforestation and total variance explained

Impacts	Factor loading		
	Economic	Environment	Social
Decrease livelihood income	**0.913***	0.181	0.120
Expansion of land for agricultural purpose	**0.717***	0.102	0.024
Decrease productivity of livestock	**0.935***	0.168	0.099
Decline supply of timber/non-timber products	**0.925***	0.138	0.130
Decrease supply of firewood/charcoal	**0.923***	0.196	0.105
Increase time for firewood collection	**0.666***	0.505	0.025
Acerbate flooding and erosion	0.258	**0.916***	0.077
Increase soil erosion	0.226	**0.939***	0.100
Increase environmental responsibility	0.223	**0.932***	0.086
Increase in temperature	0.202	**0.931***	0.140
Increase in biodiversity loss	0.098	**.750***	0.458
Increase vulnerability in global warming	0.085	**0.755***	0.467
Improvement in primary education	0.107	0.170	**0.959***
Increase in cultural musical instruments	0.107	0.180	**0.963***
Decrease availability of drinking water	0.115	0.178	**0.958***
Total variance explained	33.8	30.9	23
Eigen value	7.912	2.88	2.22
KMO value	0.886		
BTS (Chi-square)	9201.84***		

Numbers in bold carrying * indicate high factor loadings

In sum, the factor analysis result shows that the majority of local communities in the study perceive the three impacts of bamboo deforestation. In all the three factors, households perceive economic impact of bamboo as the main important factor in affecting their welfare. These findings concur with Dolcia's (2005) study who pointed out the same result in Haiti forest reserve. Hence the following paragraph discusses economic benefits of bamboo forest for rural communities in BGR.

4.4. SUR Estimation Results and Discussions

Before estimating the common underlying determinants of the 3-factor variables, existence of interdependences between economic, environmental and social impact of bamboo deforestation were investigated. Their relationships among each other were found to be weak but positive. Pair-wise correlation coefficients were 0.494, 0.384, and 0.268 for economic and environmental impact, economic and social impact, and environmental and social impact variables, respectively. The test result suggested that there were interdependence between economic, environmental and social impacts of bamboo deforestation. This means household framers who perceive economic impacts of bamboo deforestation on their livelihood benefit could also perceive the environmental and social impacts, suggesting reinforcement of each impact with one another. Moreover, correlation matrix of the residuals for the three factors were 0.448 (economic and environment), 0.385 (economic and social), and 0.251 (environmental and economic) impact variables. The breusch-pagan test of independence x^2 (3) =154.309, and (p= 0.000) confirm presence of correlations of the residuals leading us to reject the hypothesis that their correlation is zero. In sum, the seemingly unrelated regression model result for economic, environmental, and social impacts of bamboo deforestation indicated statistically positive links.

Understanding interconnected nature of the three dependent variables, test for normality was carried out. The values of skewness for economic, environmental and social impact variables were found to be 0. 031, -0.378 and

0.013, respectively, signifying no or very low skewed distribution except for environmental impact. Statistical test for normality confirmed that 'economic impact' and 'social impact' appear to be significantly normal in skewness with (P=0.798) and (P=0.915) values while 'environmental impact' appears to be slightly non-normal in skewness (P=0.003), which shows left skewed distribution. Overall, the test result attests that SUR model is quite appropriate. Hence, the effects of socio-economic and institutional variables on the three dependent variables were estimated as follows.

Thirteen explanatory variables, were included in the SUR model to identify the separate and underlying factors of perceived impacts of bamboo deforestation : sex of household head, age of household head, ethnicity of the respondents, educational status, agro-ecologies, settlement condition, access to extension contact (not advise on bamboo), access to advise on bamboo, annual bamboo income, experience in shifting cultivation, knowledge on the resource condition, trust among community members, and property rights. The regression result identifies nine factors that are found to be significant with various degrees of influence and signs. Of the total environmental impact model variables, sex of household head, age of household head, ethnicity of the respondents, educational status of the household head, access to advise on bamboo, settlement condition, and experience in shifting cultivation showed significant and positive association with the dependent variables while agro-ecologies of the respondents, access to extension, annual bamboo income, knowledge on the resource condition, and trust among community members exhibited significant and negative correlation with environmental impacts of bamboo deforestation.

The model result shows that four variables namely: age of the household head, experience in shifting cultivation, knowledge on the resource condition, and trust among community members to have substantial effect. Male-headed households perceive economic and social impacts of bamboo deforestation more than their female counterparts. The coefficient is significant at 10 percent and 1 percent for economic and social impacts, respectively. However, sample respondents perceive social impacts better than they economic ones. The coefficient for respondents' age is significant for all the three impacts (economic, environmental and social).This suggests that older respondents tend to better perceive the impact of bamboo deforestation than younger respondents. Moreover, old people may have ample experience with bamboo for its economic or social and environmental protection.

Education is correlated with environmental impacts of bamboo deforestation. Literate respondents perceive environmental impacts of bamboo deforestation than illiterate respondents do. This finding is consistent with a previous study conducted by Dolisca (2005) where respondents with a high-school degree favor environmental impacts less than do middle-school respondents. Perceived impact of bamboo deforestation also varies depending on whether or not respondents belong to Berta ethnic group. Respondents who are members of Berta ethnic group better perceive environmental impact than the rest of ethnic groups. Proximity, (i.e. distance from respondents' village to bamboo forest area) has strong significant and negative association with perceived social impacts. This implies that respondents who live near bamboo area better perceive the social consequences of bamboo deforestation than those who live at distant area. Similarly, agro-ecologies of the respondents have significant and negative effect on perceived environmental impact of bamboo deforestation. Respondents from *Woynadega (Assosa* and *Bambasi woredas)* better perceive the environmental impacts than those respondents who live in *Kolla* agroecologies *(Guba* and *Homosha woredas).*

Relocating people to fertile and moisture sufficient areas has been one of the policy principles that Ethiopia has introduced with the intention of offering adequate physical and social infrastructures. The influence of resettlement on bamboo deforestation was extensively analyzed. Moreover, anecdotal report from regional policy advisors, local administrators and local people suggest that bamboo forest suffer from the current and previous resettlement programs. In light of this view, the relationship between the dummy variable 'settlement' and perceived impacts of bamboo deforestation was assessed. The finding attested that resettlement has positive and significant association with environmental impact but significant negative correlation with perceived social impacts. This implies that 'settlers', respondents who came from different parts of the country as the result of the government resettlement policy (specially during the *Derg* regime), where the majority of settlers are from Amahara region, show concern for environmental consequences as compared with the native local people. On the other hand, the indigenous (mainly the Berta and Gumuz) respondents have high concern for social values of bamboo relative to the settlers. The same ideas have been reflected by the elders during the group discussion in Assosa and Bambasi *woredas.*

Extension contact showed significant and negative relationship with environmental impact but insignificant effect on social impacts. With the view to ensuring food self sufficiency of the societies, Ethiopia has given more focus for agricultural extension service and increased crop and livestock production and productivities (MOA, 2012). However, an overemphasis towards ensuring food security, thought with reason, may hinder environmental protection and rehabilitation activities. This is because most development agents in each *kebele* often spent much of their time for agricultural extension service (i.e.. crop and livestock), except during one month national natural resource conservation campaign. However, specific extension contact on natural resource

management, in this case, advice on bamboo cultivation, management and utilization has positive and significant role in influencing environmental impact of bamboo deforestation. This reveals that respondents who get access to advice on bamboo either in formal or informal ways better perceive the environmental impacts.

Examination of respondents' land holdings shows negative and significant correlation with economic impact. This implies that households with higher land size negatively perceive the economic impact of bamboo deforestation compared with small land holders. The notion for this is that farmers with higher land size do not dedicate to care about the adverse impacts of the bamboo deforestation as far as they earn more output from larger land size. As a result, they may expand their agricultural land size by operating at full capacity of their total land. However, respondents' annual bamboo income was found to have positive association. Respondents who generate more income from collecting bamboo perceive economic impact more than the social values of bamboo. In terms of poverty status, richer households perceive social impacts of bamboo deforestation than the poor farmers, and accordingly these groups have more concern for bamboo conservation. This result is consistent with Scrieciu's finding in tropical deforestation where poor farm households or commercial loggers have little incentive to care about the environmental effects of their actions (Scrieciu, 2006). Experiences in shifting cultivation influenced households' perception about the three impacts of bamboo deforestation significantly and negatively. Farmers in BGR who practice shifting cultivation have less perception for the three impacts.

The REED+ policy document outlined human activities and actions that directly impact forest cover in certain area as proximate or direct drivers of deforestation and forest degradation (Kissinger *et al*., 2012). Following this argument, in this study, the effects of shifting cultivation and wildfire incidence on bamboo forest were considered as proximate drivers of bamboo deforestation in BGR, and the result was in line with the hypothesis set up, indicating positive and significant association between the two variables. Farmers who understand the adverse impact of uncontrolled wildfire on bamboo deforestation better perceive its consequence on their social values and act accordingly.

Like other common-pool resources, bamboo is subtractable natural resource. Knowledge on bamboo condition shows positive and significant association with impact of the three factors. Farmers who understand deductibility of the resource perceive economic, environmental and social impacts of bamboo deforestation, thereby harm their livelihoods. However, as explained on the previous descriptive statistics, the proportion of sample households who recognize the rival nature of the resource condition are found to be low, suggesting the need for continuous awareness creation to the farmers regarding non-executable and rival resource condition of bamboo forest.

Society's norms, culture and social capital are the central elements for efficient and sustainable natural resource management (Francois and Zabojnik, 2004). The role of 'social capital' on perceived impacts of bamboo deforestation was investigated. The model result indicated positive impacts of social capital on perception towards social impacts of bamboo deforestation. As the number of social networking, such as cooperative membership or membership in formal or informal associations increase, so do the respondents' perception on social impacts. A unite increase in the number of social networking increase the perceived social impacts of bamboo deforestation by 1.083 percent.

The need for rapid transformation of agricultural based development strategy to industrialization, which demands establishment of various private companies and factories in the country, is the current government policy intention in Ethiopia (MOFED, 2010). In the case of BGR, household perception towards establishment of bamboo industry was evaluated. The survey result indicates that 82.81 percent of households had favorable attitudes towards establishment of bamboo factories in their localities. Statistically, household perception on establishment of factory was positively and significantly associated with social impacts of bamboo deforestation. This implies household heads who support establishment of bamboo factory in their localities better perceive the social impacts of bamboo deforestation.

Various nongovernmental organizations like INBAR and Farm Africa have been assisting farmers in BGR by providing several awareness creation trainings on sustainable utilization and management of bamboo resources. Framers' access to external support was positively and significantly connected with social impacts of bamboo deforestation. This indicates that those households, who get access to technical support, better perceive the social consequences of bamboo deforestation.

Table 5: Estimations of impacts of bamboo deforestation using SUR model

Variable	Coefficients of SUR model		
	Economic	Environmental	Social
Sex of household head	0.829*	1.819***	-
Age of household head (log)	2.901***	1.567**	2.312**
Educational status	-	0.903**	-
Ethnicity of the respondents	0.005	0.171**	-
Ecology (dummy)	-	-1.444***	-
Desistance to the bamboo forest	-	-	-0.242***
Settlement condition (dummy)	-	0.750*	-0.836*
Access to extension	-	-0.793*	-0.393
Access to advise on bamboo	0.649	0.703*	-
Annual bamboo income in birr (log)	0.265*	-0.001	-
Current land holding in hector	-0.342*	-	-
Wealth status	-	-	1.502*
Experience in shifting cultivation	-0.775*	-1.086**	-0.44
Perception on wildfire incidence	-	-	1.262**
Knowledge on the resource condition	1.820**	1.846****	0.559
Number of social people in networks (log)	-	-	1.083**
Perception for establishment of factory	-	-	2.369***
Access to external support	-	-	0.886*
Access to secure property rights	-1.472**	-	-
R^2	0.15	0.22	0.18
x^2	66.10	92.44	85.30

***, ** and * indicate the level of significance at 1 percent, 5 percent and 10 percent, respectively.

It is commonly argued that open access resources are typically subject to a more than optimal extraction rate, which also leads to a well known problem of "the tragedy of the commons". In this study, the empirical evidence suggests that access to secure property rights have influenced perceived economic impacts of bamboo deforestation adversely, despite the positive influence in the literature.

5. CONCLUSION

Current conservation debates place high emphasis on the need to integrate the views and needs of local communities in conservation process and rehabilitation strategies of common pool-sources. Understanding local community perceptions of forest management and the factors that influence these perceptions is important for designing management policies that are sensitive to their needs. However, more often than not local communities' perceptions do not receive as much attention as they deserve. This study investigated perceptions of household farmers towards the impacts of bamboo deforestation in the in BGR and further analyses factors that influenced perceived impacts of deforestation.

Findings from this study shows that the majority (64.06 percent) of farmers perceive declining state of bamboo forest in the study area. This study also found statistical difference between households who perceive and who don't perceive with respect the socioeconomic variables and perceived impacts of bamboo deforestation. Empirical study on analysis of farmers' perception on the impact of bamboo deforestation was not documented. The study found that combination of different factors shape local communities attitudes and perceptions towards the impact of bamboo deforestation. The results of factor analysis have identified three perceived impacts of bamboo deforestation in the study area: Economic, social and environmental impacts. The mean preference ratings suggest economic impacts of bamboo deforestation as the highest perceived impact. The study has also demonstrated that economic impacts such as decrease in livelihood income, expansion of land for agricultural purpose, decrease in livestock productivity, decline in supply of timber and non-timber products, decrease in supply of firewood and charcoal, and increase time for wood collection as the most important perceived consequences of bamboo deforestation. Hence, particular attention should be given by policy makers for economic impacts of bamboo deforestation than environmental and social impacts. Moreover, future research should focus on studies that empirically estimate economic benefits of bamboo forest and factors that influence households' perception towards economic impacts of bamboo deforestation in the study area.

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