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Original Paper

Demand and Supply of Forest Products in Bandevi Buffer Zone Community Forest, Chitwan National Park, Nepal

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Abstract

Buffer Zone Community Forestry (BZCF) in the Chitwan National Park (CNP) started with an objective to engage locals and fulfill their resource needs without jeopardizing conservation. This study estimates the forest product demand and supply of fuelwood, fodder, and timber in Bandevi BZCF user group. Data was collected using stratified random sampling and forest inventory using the quadrate method. Results indicated Bandevi BZCF conditions improved since its handover to the community. However, the study estimated a deficit of 26173 cubic meters per year of timber, 3.21 million tonnes per year (Mt/yr) of fodder, and 0.12 Mt/yr of fuelwood. Deficits were fulfilled from agricultural lands outside BZCF and illegal collection from the Bharandavar corridor forest and CNP. BZCF program is a success in improving forest conditions and needs continuation. Policy and programs must focus primarily on livelihood improvement and income generations to reduce the dependency of local people on the forest.

Keywords

buffer zone, fodder, fuelwood, livelihoods, resource deficiency

1. Introduction

Population growth has led to the rapid depletion of natural resources and has accelerated land use change towards agriculture. The establishment and management of Protected Areas (PAs) have become one of the most important ways of ensuring that the world's natural resources are utilized sustainably and conserved for the future generations (Berkmuller & Monroe, 1986; Adhikari et al., 2017). Initially, species-level conservation was of primary concern with top-down conservation approach. The model with the exclusion of people in the early seventies was heavily criticized for restricting local level usury rights and debarring local people (Heinen & Shrestha, 2006). Nepal and Weber (1995) have identified major issues of park-people conflicts prevailing in the park including illegal transactions of forest products, livestock grazing, illegal hunting and fishing, crop damage, and threats to human from wild animals. Likewise, Shrestha (1994), Nepal and Weber (1995), Heinen and Mehta (2000), and Budhathoki (2003) studied about the resource conflict between park conservation and adjoining settlements and found a serious threat to the survival of endangered animals and plants because of poaching and illegal use of park resources. To achieve socially favorable and ecological sound conservation, it is imperative to address local livelihood needs (Gurung, 2005). Fines and fences measures faded with increased park-people conflict and established the notion that local peoples' needs, and aspirations hold priority for the better conservation of biodiversity. Natural resources professionals had recognized the need to work beyond PAs if they are to sustain viable populations of wildlife species and large-scale ecological process (Heinen & Mehta, 2000). This irrefutable conservation thought led to amendment in National Parks and Wildlife Conservation Act of Nepal in 1993 that had facilitated the legal foundation for biodiversity conservation to establish and manage the buffer zone areas outside the PAs (GoN, 1973; Heinen & Kattel, 1992). Since then, the buffer zone has been institutionalized as an operational approach and large-scale ecological process to ensure the ecological integrity of PAs and enabling of local communities to sustain their livelihood through active management of natural resources outside the park (Heinen & Mehta 2000; Wells & McShane 2004; Stræde & Treue, 2006).

The buffer zone development program is designed to address the local communities' needs through active participation in Buffer Zone Community Forest (BZCF) and other community development activities. In 1996, 750 square kilometers (Km^2) of adjacent areas in Chitwan National Park (CNP) was declared as a buffer zone which encompasses 35 Village Development Committees (VDCs) and two municipalities that have 510 settlements (DNPWC, 2000). The buffer zone area comprises a mosaic of forests, agricultural lands, settlements, cultural heritage areas, village open spaces and many other types of land use (Budhathoki, 2005). CNP had released the budget of approximately Nepali Rupees (NRs.) 0.19 billion (approximately US$ 2.8 million) by 2005 to buffer zone to facilitate community-based conservation initiatives (DNPWC, 2005). The concept behind the buffer zones was to engage the local community in conservation through active management of community forest outside the park to fulfill their resource needs. This would reduce the dependency of locals on national parks for fodder, fuelwood, and other resources, and is expected to alleviate theft of park resources. Community forestry appears to be quite successful regarding forest protection and management (Thoms, 2008). However, the introduction of BZCF dictates adjustment to livestock numbers and reliance on the forest, and the success heavily depends on forest resource availability, equitable allocation and positive impact on people's livelihoods from the community forestry (Adhikari et al., 2007). Straede and Helles (2000) have also raised a question over the capability of the BZCF to supply resources. However, the strategy of a buffer zone in the PA is ambitious, and many anticipated it to resolve the much-contested linkages diminishing societal support for PAs (Sanderson & Redford, 2003).

Several studies have been conducted on BZCF in Nepal with a discussion on forest management and resource allocation. On a brighter side, BZCF has helped improve livelihood through plantations and agroforestry that has created additional natural resource base for firewood and fodder and generated household income (Maskey & Bajimaya, 2005). Such community-based forest management has a potential of income-equalizing among the rural households (Mamo et al., 2007). Strade and Trene (2006) demonstrated the economic importance of forest product of CNP to the livelihood of people in Bacchauli VDC and revealed the pressure correlated with the economic value of the product. Poudyal (2007) detailed the socio-economic characteristics of CNP buffer zone residents and concluded that local residents heavily depend on national park and surrounding forests to meet their forest product demand. Mulepati (2009) concluded that about 62% claimed decreasing availability of forest products and 68% complained that there Baghauda BZCF is not fulfilling their demand. Dangol (2009) reported that only about 17% of the fuelwood and 8.4% of the fodder could be sustainably supplied from Bacchauli BZCF. Also, in Piple and Bandevi BZCF, as estimates of annual forest yield and household demand for forest products do not fulfill the needs, deficits are met through park resources and other nearby community forests outside the buffer zone (Poudyal, 2007; Pokharel, 2009). Straede et al. (2002) concluded that non-timber forest products, fuelwood, and timbers are not always compatible with what the locals want, and the pressure of resource theft is still on the PAs. People near to national park sneak inside to meet their requirements illegally thereby compromising conservation. Nyaupane and Poudel (2011) also reported that people of the BZCF user group exerted pressure on resources in the national forest and national parks. Although BZCF has been a better conservation model than restricting local level usury rights and debarring local people, the reality had been festering with little success for biodiversity conservation as well as adequate forest resources supply (Nepal & Spiteri, 2011).

Poudyal (2007) concluded that all buffer zone households, irrespective of their land holding size, need forest products for fodder and fuelwood, and have not yet been able to sustain demand despite the establishment of BZCF and restoration of adjoining areas of CNP to present forest size. Although everyone wants fuelwood and fodder, the quaintly demanded mostly depends on household economic conditions. In general, socioeconomic factors such as land and livestock holdings, caste, education, household income, societal status exerts a strong influence on the benefits from common resources (Adhikari et al., 2004; Pokharel et al., 2017, 2018). Large agricultural households demand larger quantities of grasses and leaf litter for subsistence uses since they hold more livestock. However, due to the lack of land and/or livestock, the poor use lesser quantities of these products (Adhikari et al., 2004). Therefore, there is need of investigating the success of BZCF in Nepal not only in terms of improved forest conditions, but also in terms of socioeconomic condition, the livelihood of the surrounding communities, and resource availability. There are few questions that need answering to validate the success of buffer zone management paradigm: (i) Has it or has it not met the positive outcomes for active engagement of the community in forestry to fulfill their demand for forest resources? (ii) What are the resources available from BZCFs, and (iii) Was it able to reduce dependency and theft of park resources? In this study, Bandevi BZCF User Group of CNP, Bharatpur is examined as a case study to understand the linkages between natural resource availability, sustainability, and demand. The objective of this study is to estimate the supply of forest resources in Bandevi BZCF and demand, of the BZCF user group.

2. Method

2.1 Study Area

Bandevi BZCF is located between the Bharandabhar corridor forest and Bharatpur municipality with an area of approximately 168 hectares (ha) (Dhakal & Yadava, 2011). There is no observable boundary between the BZCF and the Bharandabhar corridor forest in the East. Bandevi BZCF is located 300 meters inside from the forest edge into the Bharandabhar corridor forest. The Mahendra East-West highway borders Bandevi BZCF in the north, Navajyoti BZCF in the south, and Bharatpur municipality in the west. The Barandabhar corridor forest links the Mahabharat and Chure regions facilitating seasonal movements of the wild animals and migration to suitable breeding grounds, habitat, and food supply. Bandevi BZCF is located in the Central Northern side of CNP (Figure 1). The Forest is predominantly Sal forest (*Shorea robusta*) along with Saj (*Terminalia alata*), and Sisso (*Dalbergia sisso*). The BZCF and the adjacent corridor forest hosts endangered wildlife species including *Rhinoceros unicornis, Cervus sps, Axix axis, Panthera pardus, Felis chaus*, and *Sus scorfa*. The Bishajari Tal, a wetland enlisted in the Ramsar Site, is within a few hundred meters from Bandevi BZCF (Siwakoti & Karki, 2010). The reservoirs provide suitable habitat for migratory and local birds, and therefore, has high avian diversity. More than 250 different bird species have been reported in these forests of the buffer zone (Baral & Upadhyay, 1998; BES, 2007). The Bandevi BZCF user group includes 10,583 people in 1,872 households (BMC, 2006). The user group includes ward No. 8 with a population of 5,664 and Ward No. 9 with a population of 4,919 of Bharatpur municipality. Anyone not in the BZCF user group doesn't get access to use the forest's resources. For fodder and litter collection, members are allowed to enter every day inside the forest. However, timber collection is strictly conducted only once a year.

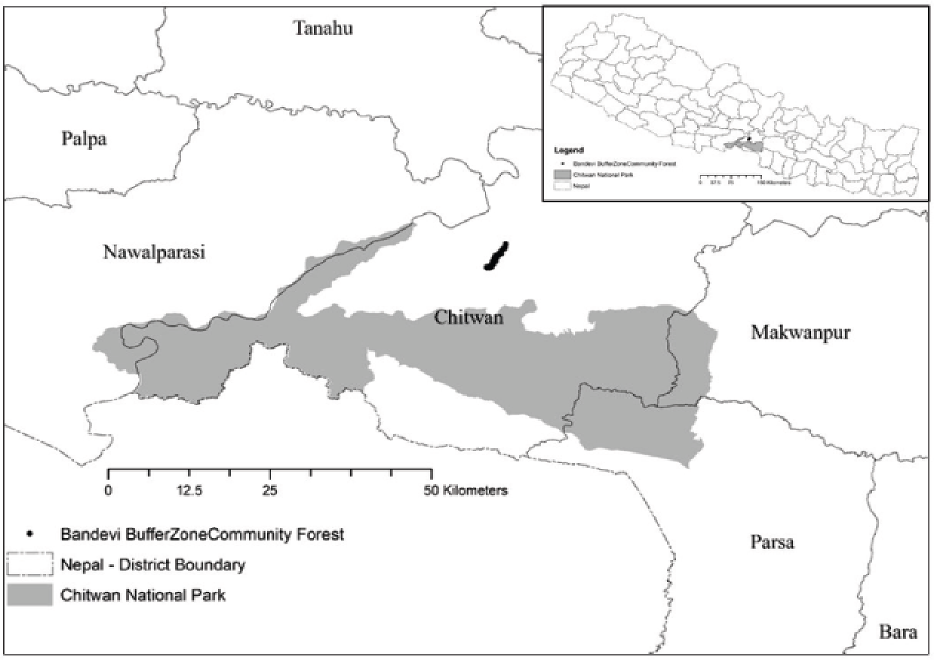

Figure 1. Chitwan National Park and Bandevi Buffer Zone Community Forest of Nepal

2.2 Local Demand Estimation

The in-person household survey was conducted in September 2007 to collect information on demand of three primary forest resources-fodder, fuelwood, and timber and socioeconomic attributes. Stratified random sampling was applied to the survey by the settlement size with two parameters: a) land holding size, and b) settlement size by population. Data on land holding and settlement size of User Group was obtained from the office of Bandevi BZCF user group (BMC, 2006). The survey sample size (n) was determined using Equation 1 (Arkin & Colton, 1963; Poudyal, 2007).

$$n=[N\ Z^2\ P\ (1-P)]/[N\ e^2+Z^2\ P\ (1-P)] \quad (1)$$

where N is a total number of households, Z is the standard critical value of normal distribution at 95% confidence level (Z=1.96), and P is the estimated population proportion (0.05, this maximizes the sample size), and e is the error limit (±0.05). This calculated sample size was then stratified by settlement size and land holding by drawing random lottery without replacement. A random sampling of 71 households stratified across seven settlement sizes (villages) and four land holding sizes were conducted as specified in Table 1. Before conducting the formal questionnaire survey, focus group discussion and pre-testing of the questionnaire was conducted in some households. Modifications were made to make the questionnaire easier to understand for the respondent and surveyor and eliminate misunderstanding and misinformation. Although the data is a decade old, we believe that it provides relevant information on demand and supply gap of the BZCF.

Table 1. Stratified Sampling Numbers by Settlement Size and Land Holding Category Bandevi Buffer Zone Community Forest User Group

Settlement Name	Land Holding Category in hectares (ha)					
(Population)	Landless	Small (<0.68)	Medium (0.68-1.36)	Medium (1.36-2.72)	Very large (>2.72)	Total
Katsikari (>200)	1	1	1	1	0	4
Salyani (<600)	3	2	1	2	0	8
Gaurigung (<600)	3	4	1	7	0	15
Baruwa (<600)	1	6	2	1	0	10
Parasnagar(<600)	1	5	2	3	0	11
Saradpur (<600)	0	5	1	9	0	15
Godran (200-600)	2	4	0	2	0	8
Total	11	27	8	25	0	71

The demand for green fodder (D_{fd}) and fuelwood (D_{fw}) per household was calculated as specified in Equations 2 and 3. The survey questionnaire asked respondents to report their demand for fodder and fuelwood in addition to their farm supply in local units per month. The demand for the timber (D_t) was collected from the Bandevi BZCF management office based on the application for timber supply (BMC 2006).

$$D_{fw}=12 * \tau_{fw} * Q_{fw} \quad (2)$$

$$D_{fd}=12 * \tau_{fd} * Q_{fd} \quad (3)$$

where Q_{fw} and Q_{fd} are the quantities of fuelwood and fodder demanded in local units per month, τ_{fw} and τ_{fd} are the conversion factors to convert local units to International System of Units (abbreviated as SI, from the French Système International) (Table 2). The total fodder and fuelwood demand for Bandevi BZCF were obtained by multiplying fodder and fuelwood demand per household by total household in the User Group, respectively.

Table 2. Conversion of Local Units into SI Units

Local unit of land, fodder, and fuelwood	Conversion factor
1 Biga (20 Kattha) land	0.68 ha
1 Kattha land	0.034 ha
1 Bhari* Fodder (τ_{fd})	50 kg
1 Bhari* Fuelwood (τ_{fw})	40 kg

Source: Nepal and Weber (1992).

2.3 Annual Yield and Sustainable Supply of Forest Products

The sustainable yield and supply of fodder, fuelwood, and timber from the Bandevi BZCF were estimated using forest inventory method developed by the Forest Survey and Statistics Division, Ministry of Forest and Soil Conservation, Nepal (Sharma & Pukkla, 1990), now restructured as Forest Research and Training Center, Ministry of Forest and Environment, Nepal. The forest inventory was carried out between September and November of 2007. The Bandevi BZCF map was divided into 30 minutes by 30 minutes (longitude and latitude) grids, and 25 random locations were selected. At each location, a quadrate plot of 20 m by 20 m (400 m^2) was laid to measure trees. Within the tree plot, in two opposite corners (southeast and northwest) nested sub-plots of 5m by 5m (25 m^2) and 1m by 1m (1 m^2) were laid to study shrub and herb species, respectively. Diameter at breast height (dbh) was measured with the help of D-tape for different stand sizes as specified in Table 3.

Table 3. Stand Size Classification in the Terai Region of Nepal

Stand Size	Diameter at breast height (cm)
Sapling	<12.5
Poles	12.5–25
Small Saw Timber	25–50
Large Saw Timber	>50

Source: FSSD (1989).

Height (h) of the tree was calculated using simple trigonometry as specified in Equation 4 using the angle (θ) measured with clinometers 6 m away from the base of the tree. Thus, the calculated h in meters and dbh measured in centimeters were used to calculate the volume and biomass of the tree. The standing volume of the tree (V), was calculated using Equation 5 (Sharma & Pukkla, 1990). The volume measured using Equation 5 is corrected by dividing V by 1000 such that the reported volumes are in cubic meters. The total dry weight of the stem is estimated using Equation 6, and the total weight in kilograms of the tree is estimated using equation 7.

$$h=6 * \tan(\theta)+1.6 \tag{4}$$

$$\ln(V)=\alpha+\beta * \ln(dbh)+\gamma * \ln(h) \tag{5}$$

$$W_s=\rho * (V/1000) \tag{6}$$

$$W=W_s+x * W_s+y * W_s \tag{7}$$

where ln(.) refers to the logarithm, α, β, and γ are the volume parameters, ρ is the wood density that is constant for each species but differs between species (Table 4), x and y are the branches to stem and foliage ratios for tree species. x=0.300 and y=0.0620 were used to calculate branch and foliage biomass since almost all trees had dbh <28 cm (Sharma & Pukkla, 1990). We used the same ratio for all tree species due to lack of data and comparable stem and foliage compositions. The volume parameters and wood density were obtained from the Forest Survey and Statistical Division, now known as Forest Research and Training Center (Sharma & Pukkla, 1990) are reported in Table 4.

Table 4. Volume Parameters and Wood Density for Tree Species in the Terai region of Nepal

Species	Volume Parameters			Wood Density
	α	β	γ	ρ
Shorea robusta (Sal)	-2.4554	1.9026	0.8352	880
Terminalia alata (Saj)	-2.4616	1.8497	0.8800	950
Dalbergia sisso (Sisau)	2.1959	1.6567	0.9899	780
Adina cordifolia (Tik)	-2.5026	1.8598	0.8783	670

Source: FSSD (1989), Sharma and Pukkla (1990).

The annual yield of the Terai mixed hardwood forest was used for the annual yield of tree species. The annual forest product yield of annual stem biomass (Y_s), annual branch biomass (Y_b), and annual leaf biomass (Y_l) were estimated using ratios of branch and foliage with total biomass (Table 5) as specified in Equations 8, and 9, and 10 respectively.

$$Y_s = a * W \quad (8)$$

$$Y_b = b * W \quad (9)$$

$$Y_l = c * W \quad (10)$$

where *a*, *b*, and *c* are the annual yield parameters (Table 5) on Mean Annual Increment (MAI) for the Terai region of Nepal, reported by Forest Survey and Statistical Division, now known as Forest Research and Training Center (FSSD, 1989).

Table 5. Annual Yield of the Stem, Branches, and Leaves in the Terai region of Nepal

	Percentage Yield		
Forest Type	Stem (a)	Branch (b)	Leaf (c)
Terai Mixed Hardwood forest	4.88	4.92	5.41
Khair Sissoo Forest	5.13	5.13	5.41

Source: FSSD (1989).

The sustainable wood harvest was calculated as the sum of stem and branch growth, and stem and branch mortality with only 15% of stem growth allocated for timber and rest should be left for the healthy forest (FSSD, 1989). The annual accumulation of deadwood in Sal forest in the Terai region of Nepal is 4.9% (FSSD, 1989). Therefore, 4.9 % of the wood was considered as allowable fuelwood that can be extracted out of forests. Sal trees are not allowed to be harvested for fuelwood. The annual yield from leaf biomass (foliage) can be used as fodder if the tree is fodder species. The fodder yield was calculated based on Total Digestible Nutrient (TND) yields for hardwood forest with grazing reported by Forest Survey and Statistical Division (FSSD, 1989). The TND yields for hardwood forest with grazing is 34% of the annual foliage biomass. Sustainable timber supply (S_s), Sustainable fuelwood supply (S_{fw}), and sustainable fodder supply (S_{fd}) per hectare of forest were calculated as specified in Equations 11, 12, and 13. The total annual yield of the forest was calculated by multiplying annual yields per hectare with the total area of the BZCF area.

$$S_s=0.15 * Y_s \quad (11)$$

$$S_{fw}=0.049 * (Y_s+Y_b) \quad (12)$$

$$S_{fd}=0.34 * Y_l \quad (13)$$

Also, ecological indices were calculated for all tree, shrub, and herb species. These indices provide insight into forest types, habitat types, and the value of forest to the local community (Odum et al., 1971).

$$\text{Density of a species (Di) } (N_i/A) * 1000 \quad (14)$$

$$\text{Relative Density (\%) } (RD_i)=(D_i/\sum D_i) * 100 \quad (15)$$

$$\text{Frequency } (f_i)=(q_i /Q) * 100 \quad (16)$$

$$\text{Relative Frequency (\%) } (RF_i)=(f_i/\sum f_i) * 100 \quad (17)$$

$$\text{Basal Area } (BA_i)=(\pi * dbh^2)/4 \quad (18)$$

$$\text{Relative Basal Area } (RBA)=BA_i/\sum BA_i \quad (19)$$

$$\text{Important Value Index } (IVI_i)=RD_i+RF_i+RBA_i \quad (20)$$

where N_i is the total number of i species recorded in the study area, A is the total area of the study plots, D_i is the density of i^{th} species in number per hectare, $\sum D_i$ is the sum of all density of all species, f_i is the frequency of i^{th} species, q_i is the number of quadrate with species i, Q is the total number of quadrats, $\sum f_i$ is the sum of frequencies of all species, dbh is the diameter at breast height, π is a constant, BA_i is the basal area of species i, $\sum BA_i$ is the total basal area of all species in the study area, and IVI_i is the important value index of species i.

3. Result

3.1 Socioeconomic Status of the User Group

The socioeconomic status of the User Group surveyed is presented in Table 6. The sex composition of the survey was 38% female and 62% male. Approximately, 79% of the population was working population (Figure 2). This comprises of 52% male and 27% female working population. About 21% of the population was dependent on others. The female dependent population was slightly higher than the male.

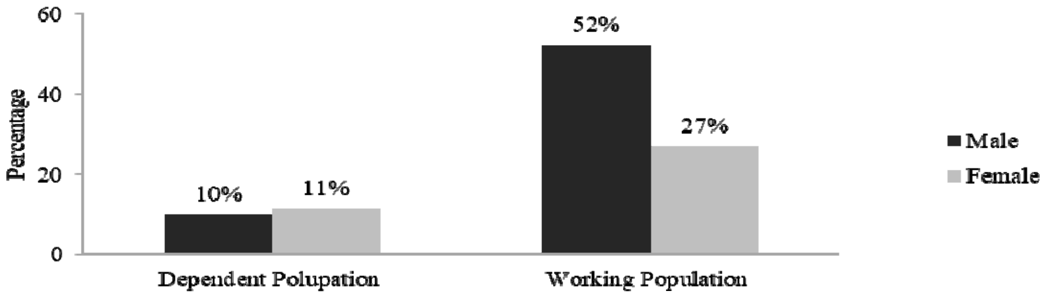

Figure 2. Distribution of the Working Population of Bandevi BZCF User Group

Table 6. General Characteristics of Bandevi BZCF User Group

Categories	Male	Female	Total	%
1. Age				
14-25	3	8	11	15.5
26-39	10	14	24	33.8
40-59	27	5	32	45.1
=>60	4	0	4	5.6
2. Caste/Ethnicity				
Bramin-Chettri	25	22	47	66.2
Tharu	4	4	8	11.3
Dalits	9	0	9	12.7
Janjati	6	1	7	9.9
3. Education				
Illiterate	18	9	27	38
General	15	7	22	31
Primary	1	0	1	1.4
Secondary	5	6	11	15.5
College/University	5	5	10	14.1
4. Occupation				
Agriculture	17	9	26	36.6
Politics	1	0	1	1.4
Service	5	5	10	14.1
Wage Labor	5	0	5	7.0
Business	9	8	17	23.9
Student	1	0	1	1.4
Housework	0	3	3	4.2
Others	3	0	3	4.2

Agriculture and Business	3	2	5	7.0
5. Family Income Source				
Agriculture	3	2	5	7
Business and Remittance	1	2	3	4.2
Agriculture, Livestock, and Remittance	2	2	4	5.6
Agriculture and Remittance	0	2	2	2.8
Service	3	0	3	4.2
Agriculture, Service, and Livestock	1	3	4	5.6
Agriculture, Livestock, and Business	10	6	16	22.5
Agriculture and Wage labor	4	5	9	12.7
Agriculture, Business, and Remittance	2	1	3	4.2
Livestock, Service, and Remittance	2	0	2	2.8
Agriculture, Business, and Service	2	1	3	4.2
Business	4	2	6	8.5
Wage Labor	10	1	11	15.5
6. Farm Size				
Landless	10	1	11	15.5
Small (>0.68 ha)	12	15	27	38
Medium (0.68 to 1.36 ha)	4	4	8	11.3
Large (<1.36 ha)	18	7	25	35.2
7. Land Holding Type				
Own	26	19	45	63.4
Rented in/out	8	1	9	12.7
Own and Rented in/out	8	7	15	21.1
Government land	2	0	2	2.8
Total	44	27	71	100

Bandevi BZCF User Group had 16% of 14-25, 34% of 26-39, 45% of 40-59, and 7% of above 60 age group. Four ethnicities: Bramins-Chettri, Tharus, Dalits, and Janjati were reported in Bandevi BZCF User Group. Brahmin-Chettri makes up 66% of the population followed by 11% of Tharu, 13% of Dalits, and 10% of Janajati (ethnic people). Approximately, 15% of the people were landless, 38% had 0.68 ha or less, 35% had 0.68 to 1.36 ha, and 35.2% had more than 1.36 ha of farmland. None of the respondents had big farms (above 2.72 ha). Brahmin-Chettri occupied most of the land (62%, 4% of them were landless), livestock (7 or more per household) and consumed the highest amount of fodder and energy. Tharus had less land (11%, 0 landless) and livestock (7 or less per household) and consumed less fodder and energy. Dalits (4%, 9% of them were landless) had the least land holdings, a handful of livestock (4 or less per household) and very little access to energy and forest resources. Janajati also shares a very small portion of land (7%; 3% of them were landless), energy and forest products. For BZCF management, Brahmins/Chettris were more active than the other ethnic groups. The representation of the Dalit was very poor. Regarding education, 38% of the respondents were illiterate, 31% can read and write but lack formal education, 2% had completed primary school, 16% had completed secondary level, and 14% had a college degree. Highest literacy was observed in Brahmin-Chettri. Tharus, Dalits, and Janajati rarely had a college degree. About 37% of the respondents worked in agriculture, 14% in service and 24% in the business sector. Approximately, 7% of the respondents worked as wage laborers. Rest of the respondents were involved in politics, housework, and/or other occupations (Table 6). Majority of the respondents reported multiple sources of income. Agriculture along with other income sources such as remittance, livestock, business, etc., made up the major income source of the BZCF User Group. For agriculture and other purposes, 63% used their land, 13% rented others' land on top of their landholding, and 3% used the government-owned land. This 3% government land was occupied by landless near the community forests for settlement since they have no land to build houses.

3.2 Demand and Supply of the Forest Products

The Largest Livestock Unit (LSU) per household was observed among medium landholdings followed by landless. One LSU is equal to two goats or one and a half cows or one buffalo (Poudyal, 2000; Poudyal, 2007; Mulepati, 2009). Households with large land holdings had lesser livestock units. Therefore, the demand for resources was higher in a household with medium land holdings (Table 7). The demand for timber, fodder, and fuelwood in one BZCF User Group household was 14 m^3/yr, 1725 t/ha/yr, 64 t/ha/yr, respectively (Table 7). The total demand was 3.23 Mt/yr for fodder, 0.12 Mt/yr for fuelwood and 26,208 m^3/yr for timber in Bandevi BZCF user group (Table 9).

Table 7. Demand for Fodder and Fuelwood of the Bandevi BZCF User Group

Demand	Landless	Small (<0.68)	Medium (0.68-1.36)	Large (1.36-2.72)	Average
Livestock per Household	3.01	1.38	8.64	1.97	3.51
Fodder (Bhari)	325	2917	8255	3381	2874
Fodder (t/yr per household)	195	1750	4953	2029	1725
Fuel wood (Bhari)	82	231	83	368	107
Fuel wood (t//ha/per household)	39	111	40	176	64
Timber (m^3/yr per household)	-	-	-	-	14

The sustainable annual yield of Bandevi BZCF was 0.21 m^3/ha/year of timber, 96775 kg//ha/year of fuelwood, and 3001 kg/ha/year of fodder (Table 8). The total sustainable supply was 16258 t/year for fodder, 504 t/year for fuelwood and 35 m^3/year for timber in Bandevi BZCF (Table 8), mainly contributed by two species of trees. *Terminalia alata* (Saj) and *Shorea robusta* (Sal) (Table 8). In total, only four tree species were reported in the Bandevi BZCF. *Shorea robusta* (Sal, V=0.547 m^3/ha, W=656 kg/ha) had the largest standing volume and biomass followed by *Terminalia alata* (Saj, V= 0.451 m^3/ha, W=584 kg/ha). *Terminalia alata* (Saj, RD=51%, RF=32%) were present in largest number and density but were less frequent compared to *Shorea robusta* (Sal, RD=41%, RF=62%) (Table 10). *Shorea robusta* (Sal) had the highest basal area (18.36 m^2/ha), and Important Value Index (164.45) indicating that it is the most valuable and dominant species (Table 10). *Adina cordifolia* (Karma) and *Dalbergia sisso* (Sisso) were reported with about 2% relative frequency in the Bandevi BZCF. Both were planted species with few numbers found at the edge of the forest.

Table 8. Volume, Biomass and Sustainable Supply of Tree Species of Bandevi BZCF

	Tree Species (Local Name)				
	Shorea robusta (Sal)	*Terminalia alata* (Saj)	*Dalbergia sisso* (Sisso)	*Adina cordifolia* (Tik)	Total
Number	360	425	5	61	878
Basal Area (m^2/ha)	18.36	10.51	0.93	0.17	29.96
Important Value Index (IVI)	164.45	118.97	6.37	10.21	300
Standing Volume (m3/ha)	0.547	0.451	0.227	0.164	1.390
Percent by Volume	39.37	32.48	16.34	11.82	100.00
Total Tree Biomass (kg/ha)	656	584	241	150	1631
Percent by Biomass	40.21	35.81	14.79	9.19	100.00
Annual Stem Yield (kg/ha/year)	3201	2851	1209484	751352	1966888
Annual Branch Biomass yield (kg/ha/year)	3228	2874	1238	769	8108
Annual Foliage Biomass yield (kg/ha/year)	3549	3160	1305	811	8825
Sustainable yield timber (m3/ha/year)	0.082	0.068	0.034	0.025	0.209
Sustainable fodder yield (kg/ha/year)	315	280	59325	36854	96775
Sustainable fuel wood yield (kg/ha/year)	1207	1074	444	276	3001

There was a deficit of 26173 m^3/year of timber, 3212105 t/year of fodder, and 119697 t/year of fuelwood in the Bandevi BZCF User Group (Table 9). About 23% of the respondents reported that they did not have any deficiency in forest products. About 48% of the respondents said they buy their deficit from other sources like sawmills, local markets and even from the landless peoples who illegally get the resources from the Bharandavar Corridor forest, BZCF, and/or the national park. Approximately, 27% of the respondents said that their deficit is fulfilled from their farms (Figure 4). About 1% of the people fulfill their deficit from their farm as well as buy from the local market (others farm), and 1% of the respondents do not use any forest products. Thus, the deficiency and its management are very important in the study area as 48% of people buy or borrow it, which may encourage sellers to get it from protected forests illegally. The usual sellers are landless who get the resources illegally from corridor forest or the BZCF.

Table 9. Demand-Supply of the Forest Products in the Bandevi BZCF User Group

Forest Products	Total Demand	Total Supply	Deficit
Fodder (t/year)	3228363	16258	3212105
Fuel wood (t/year)	120201	504	119697
Timber (m^3/year)	26208	35	26173
Area of Bandevi BZCF=168 ha and total Households=1872			

3.3 Vegetation Analysis

The total number, species, density, relative density, the frequency of occurrence, and relative frequency of all reported species are also reported in Table 10. This study identified 65 plant species in the Bandevi BZCF. *Imperata cylindrica* was the densest (21,620/ha) and most frequent (30.8/ha) herb species. In Shrubs, *Eupatorium adenophorum* had the highest density (1,481/ha) and frequency of occurrence (19.46/ha). *Shorea robusta* (Sal, RD=41%, RF=62%) and *Terminalia alata* (Saj, RD=51, RF=32%) were the two main tree species found in Bandevi BZCF. Bandevi BZCF is a tropical forest with the very high percentage of saplings (83%) in the sampled plot indicating regenerating forest (Figure 3). Only 6.15% of the stand was large saw timber.

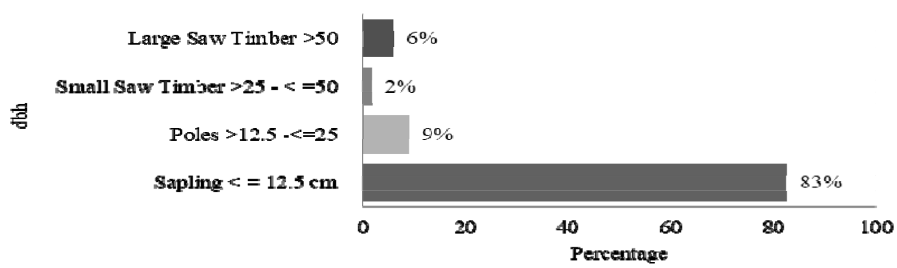

Figure 3. Stand Size of Trees in Bandevi BZCF of Nepal

Table 10. Plant Identified in Bandevi BZCF

Name of the Species	Number	Density	Relative Density	Frequency	Relative Frequency
1. **Herbs**					
Achyranthes aspera Linnaeus	4	80	0.1	1	0.27
Ageratum conyzoides Linnaeus	319	6380	8.23	17	4.62
Arisaema tortuosum (Wallish) Schott	13	260	0.34	4	1.09
Bidens pilosa Linneaus Var Minor (Blume) Sherff	6	120	0.15	1	0.27
Borreria alata (Aublet) De Candolle	60	1200	1.55	3	0.82
Brachiaria romosa (Linneaus) Stapf	21	420	0.54	1	0.27
Canjanus scarabaeoide (Linneaus) Thouars	7	140	0.18	2	0.54
Catunaregam spinosa (Thunberg) Tirvengadum	3	60	0.08	2	0.54
Cissampelos pareira Linneaus	13	260	0.34	7	1.9
Clerodendrum vicosum Ventenat	140	2800	3.61	28	7.61
Clerodendrum vicosum Ventenat	11	220	0.28	3	0.82
Commelina benghalensis Linneaus	100	2000	2.58	17	4.62
Compositae (Family)	11	220	0.28	4	1.09
Costus speciosus (Koeing) Smith	3	60	0.08	2	0.54
Cynodon dactylon Linneaus Persoon	181	3620	4.67	6	1.63
Cyperus rotundus Linnaeus	35	700	0.9	12	3.26
Cypreus distans Linnaeus Fil	40	800	1.03	6	1.63
Desmodium laxiflorum De Candolle	6	120	0.15	1	0.27
Desmodium multiflorum Buchanan-Hamilton Ex D. Don	4	80	0.1	1	0.27
Desmodium multiflorum De Candolle	8	160	0.21	1	0.27
Digitaria ciliaris (Retzius) Koeler-Gram	219	4380	5.65	10	2.72
Dioscorea bulbifera Linnaeus	21	420	0.54	8	2.17
Elsholtzia stachodes (Link) Raizada And Saxena	16	320	0.41	3	0.82
Equisetum Sps	15	300	0.39	1	0.27
Erysimum hieraciifolium Linnaeus	2	40	0.05	1	0.27
Eupatorium adenophorum Sprengel	49	980	1.26	18	4.89

Evolvulus nummularius (Linneaus) Linnaeus	130	2600	3.35	16	4.35
Fern (unidentified)	3	60	0.08	1	0.27
Gonostegia Sps	13	260	0.34	2	0.54
Hedyotis lineata Roxburg	294	5880	7.58	22	5.98
Hedyotis scandens Roxburg	3	60	0.08	1	0.27
Hemigraphis hista (Vahl) T. Anderson	25	500	0.64	1	0.27
Hemiphragma heterophyllum Wallich	190	3800	4.9	10	2.72
Holorrhea Pubescens	12	240	0.31	3	0.82
Imperata cylindrica (Linnaeus) Palisot De Beavios	1081	21620	27.88	36	9.78
Labiateae (Family)	4	80	0.1	1	0.27
Murrayana koenigii (Linnaeus) Sprengle	3	60	0.08	1	0.27
Ophioglossium reticulatum Linneaus	8	160	0.21	2	0.54
Oxalis latifolia Kunth	13	260	0.34	1	0.27
Phyllanthus parvifolius Buchanan-Hamilton Ex D. Don	214	4280	5.52	12	3.26
Rungia parviflora (Retzius) Nees	12	240	0.31	2	0.54
Saccharum spontaneum	10	200	0.26	1	0.27
Saussurea Sps	13	260	0.34	3	0.82
Shorea robusta Gaertner	144	2880	3.71	31	8.42
Solena Heterophylla Loureiro	11	220	0.28	7	1.9
Sporobolous fertilis (Steudel) W. D. Clayton	11	220	0.28	3	0.82
Stellaaria vestita Kurz	15	300	0.39	1	0.27
Stephania japonica (Thunberg) Miers	16	320	0.41	5	1.36
Torinea cordifolia Roxburg	3	60	0.08	1	0.27
Trifolium repens Linneaus	188	3760	4.85	17	4.62
Triumfetta rhomboides Jacquin	4	80	0.1	3	0.82
Vigna mungo (Linneaus) Hepper	138	2760	3.56	23	6.25
Viola pilosa Blume	13	260	0.34	2	0.54
2. **Shrubs**					
Achyranthes aspera Linnaeus	31	24.8	0.52	4	1.08
Arisaema tortuosum (Wallish) Schott	166	132.8	2.79	28	7.57

Chenopodium sps	14	11.2	0.24	2	0.54
Cirsium verutum (D Don) Sprengel	17	13.6	0.29	4	1.08
Clerodendrum vicosum Ventenat	1112	889.6	18.71	64	17.3
Costus speciosus (Koeing) Smith	72	57.6	1.21	14	3.78
Dalbergia Dalbergia sisso Roxburgh Roxburgh	15	12	0.25	6	1.62
Desmodium Multiflorum De Candolle	1	0.8	0.02	2	0.54
Elsholtzia stachodes (Link) Raizada And Saxena	269	215.2	4.53	8	2.16
Eugenia formosa Wallich	90	72	1.51	10	2.7
Eupatorium adenophorum Sprengel	1481	1184.8	24.92	72	19.46
Flemingia marcophylla Willtenow Merrill	120	96	2.02	10	2.7
Helicteres isora Linnaeus	118	94.4	1.99	26	7.03
Holarrhea pubescens (Buchaan-Hamilton)	4	3.2	0.07	2	0.54
Imperata cylindrica (Linnaeus) Palisot De Beavios	783	626.4	13.18	12	3.24
Ipomea sps	52	41.6	0.87	8	2.16
Murrayana koenigii (Linnaeus) Sprengle	19	15.2	0.32	12	3.24
Phyllanthus parviflora Buchanan-Hamilton Ex D. Don	3	2.4	0.05	4	1.08
Saccharum spontaneum	75	60	1.26	2	0.54
Shorea robusta Gaertner	1463	1170.4	24.62	70	18.92
Uncaria sps	1	0.8	0.02	2	0.54
Urena lobuta Linnaeus	37	29.6	0.62	8	2.16
3. **Trees** (local name)					
Adina cordifolia (Karma)	61	6.1	6.95	4	2.7
Dalbergia sisso (Sisso)	5	0.5	0.57	4	2.7
Shorea robusta (Sal)	360	36	41	92	62.16
Terminalia alata (Saj)	452	45.2	51.48	48	32.43

4. Discussion

Bandevi BZCF is a habitat conservation and management model involving local people designed to preserve the Corridor forest linking the Mahabharat range, and CNP or Chure region allowing wild animals seasonal movements and migrations for suitable breeding grounds, habitat, and food supply

(Dhakal & Yadava, 2011; Aryal et al., 2012). Bandevi BZCF also borders Bharatpur municipality, one of the fastest growing urban centers of Nepal (Dhakal & Yadava, 2011). Therefore, Bandevi BZCF User Group is a mixed community depending every day on resources of the BZCF and people who earn their living through other activities in the city and do not depend on the forest for livelihood. There is a growing pressure of urbanization and land use change on the forest. With development and urbanization, the majority of the population becomes indifferent towards resources of adjoining BZCF, but the marginal people who cannot meet the challenge of urban sprawl are becoming more and more dependent on the BZCF for their livelihood (Nepal & Spiteri, 2011). Bandevi BZCF served as a buffer between the wildlife corridor forest and the surging urban community delivering powers and authority to the locals in the User Group to make decisions and protect the forest against encroachment and illegal activity. On the other hand, the marginally poor people out of the user group are deprived of resource allocation and opportunity and has been reported to be involved in illegal activities in the BZCF and corridor forest. This has also given rise to conflicts in the community. This challenge has made Bandevi BZCF a unique and interesting natural resource conservation practice with an urban-wildland interface. The CNP, District Forest Office and BZCF User Group have to work together to maintain park-people relation and allocation of resources while keeping off illegal activities such as poaching, theft, and land encroachment.

Bandevi BZCF User Group comprises populations from various ethnic groups and social status. The Brahmin/Chettri's were a dominant ethnic group with larger land holdings and higher levels of education in BZCF User Group followed by Dalits, Tharus, and Janajati. Tharus, Dalits, and Janajati depend largely on community forest for their fodder and fuelwood demand. About 38% of the population were illiterate, mostly from marginalized groups. Such disparity indicated there were still a lot of people who depended on manual labor for a livelihood. They were more likely to depend on forest resources for livelihood and least aware of sustainability and conservation issues (Nepal & Spiteri, 2011). A major source of income for the User Group was agriculture, wage labor, and small businesses. Livelihood improvement and active participation of backward ethnic groups must be the focal point of people park relations and effective buffer zone management strategy. We don't recommend sidelining the major ethnic group. However, we strongly suggest higher participation of the marginal ethnic groups and landless people for the better success of buffer zone since they are the most dependent people on BZCF. The park system should focus its extension programs on conservation issues and conduct training(s) on income generating programs to reduce the pressure on community forest. These programs should also include people outside the user group to reduce the illegal poaching, encroachment, and forest product theft.

The results based on the household landholding, livestock unit per household and green fodder and fuelwood supply options indicated the demand for green fodder and fuelwood had not been supplied sufficiently from Bandevi BZCF. The highest demand was observed among small and medium landholders since they have limited land to supply fodder and fuelwood from their farms. A household with a medium farm required more green fodder as they had large number of livestock compared to others. However, the fuelwood demand was the highest amongst the households with small landholdings. They were more dependent on fuelwood from the BZCF as they have less land to substitute resources from their farms. Large landowners were less dependent on community forest for their fodder and fuelwood demand. Households with larger land holding were limited and had the least number of livestock, therefore, supplied their fodder demand from their lands and were less dependent on BZCF. Households with larger landholdings were richer families who could afford other forms of energy and opt out of the tedious process to collect fuelwood from the forest. Households with medium landholding had more livestock and were more likely to get biogas, which is incentivized through the government. Without the land and few LSU, the landless and households with small land holdings are the most dependent on BZCF for resources.

There was a very high demand for timber but very limited supply among all socioeconomic groups of Bandevi BZCF User Group. Sal (*Shorea robusta*) is one of the best timbers used for housing purposes in Nepal and are expensive to buy from the market. Stræde and Treue (2006) demonstrated the economic importance of forest products of CNP to the livelihood of people and also revealed the pressure correlated with the economic value of the product. Due to high-value Sal timber, all the members must have asked for higher volumes of Sal timber (higher allowed) although they did not need it right away. This might have made deficiency seem enormous. Another reason could be that the available Sal timber is allocated based on first come first serve basis and put in a queue for next year if demand is not met in the current year. Therefore, people might have asked for timber even if they do not need it now but might need it in future. Also, the area is adjacent Bharatpur municipality and therefore, the demand is much higher compared to other BZCF User Group due to ongoing urbanization.

Although there is a deficit in available resource and the demand of the local community, the quality of Bandevi BZCF has improved since its handover to the local people in 2006. The very high number and density of saplings suggests regenerating forest. It might increase the available forest resources and lessen the deficit in recent future. However, the impact of deficit might have simply spilled over to the Bharandabhar Corridor Forest and the National Park. An earlier study reported that 37.1 % of fuelwood and 55.5 % of fodder were collected from National Park (DNPWC, 2000). This study reported that half of the deficit was being bought from others, especially landless and poor locals, who were believed to obtain it illegally out of BZCF and Corridor forest. The pressing issue was essential for livelihood in the poorer household who dwell near the BZCF. The culture dichotomy fueled by the local community's urgency to illegally use forests in BZCF, Corridor forest, and the national park for cattle grazing, thatch and fodder grass cutting, firewood collection, timber cutting, hunting and fishing are the frontline issues to challenge the protected area management through buffer zone management programs (Stræde & Treue, 2006; Poudyal, 2007; Nyaupane & Poudel, 2011; Thapa, 2013; Stone & Nyaupane, 2016; Bhattarai et al., 2017).

Many recommendations have been put forward to solve the forest product deficiency and control illegal activities to meet the societal demand. The extension of the Bandevi BZCF beyond 300m from the boundary into the corridor forest was the major priority felt by the locals. This might help the User Group to increase their available resources as well as protect the corridor forest. Paudyal (2008) argued that economic and political structures and social institutions set the context for individual and group behavior. Therefore, park and other conservation authorities must focus on behavior and livelihood uplifting program to reduce the pressure on natural resources. The buffer zone approach has been successful in improving the forest conditions with local involvement. Therefore, it must be continued with other programs to reduce the dependency of local people in forests. For example, promoting agroforestry, farm-based high-quality fodder production, and other animal feedstock to lessen the demand for the fodder can help reduce fodder demand on BZCF. Alternative energy promotions, incentives for biogas, and solar energy installment can reduce the demand for fuel woods. Similarly, the deficit for timber can be mitigated with alternative building materials such as concrete, iron, etc. Therefore, newer policy and programs must focus primarily on livelihood improvement and income generations to reduce the dependency of local people on the forest.

5. Conclusions

All buffer zone households irrespective of their land holding size need forest produce for fodder and fuelwood. The Bandevi BZCF conditions have improved since its hand over to the local community. However, the BZCF has not been able to sustainably supply the demanded amount of fodder, fuelwood, and timber to the local community. The deficit is met by the products of private farms and/or buying from others, sometimes illegally obtained from the BZCF, Bharandabhar Corridor Forest, and/or CNP. This has jeopardized the conservation efforts of the protected areas. The extension of the forest was the major priority felt by the locals to increase their available resources as well as protect the corridor forest. However, improving the livelihood of local people through income-generating activities, promoting alternative energy, and conservation education might be a better strategy in conservation issues of the buffer zone.

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References

Adhikari, B., Di Falco, S., & Lovett, J. C. (2004). Household characteristics & forest dependency: Evidence from common property forest management in Nepal. *Ecological Economics*, *48*(2), 245-257. https://doi.org/10.1016/j.ecolecon.2003.08.008

Adhikari, B., Williams, F., & Lovett, J. C. (2007). Local benefits from community forests in the middle hills of Nepal. *Forest Policy and Economics*, *9*(5), 464-478. https://doi.org/10.1016/j.forpol.2005.11.002

Adhikari, R. K., Kindu, M., Pokharel, R., Castro, L. M., & Knoke, T. (2017). Financial compensation for biodiversity conservation in Ba Be National Park of Northern Vietnam. *Journal for Nature Conservation*, *35*, 92-100. https://doi.org/10.1016/j.jnc.2016.12.003

Arkin, H., & Colton, R. R. (1963). *Tables for Statisticians*. New York, NY: Barnes & Noble Books.

Aryal, A., Brunton, D., Pandit, R., Shrestha, T. K., Lord, J., Koirala, R. K., … Raubenheimer, D. (2012). Biological diversity and management regimes of the northern Barandabhar Forest Corridor: An essential habitat for ecological connectivity in Nepal. *Tropical Conservation Science*, *5*(1), 38-49. https://doi.org/10.1177/194008291200500105

Bandevi Buffer Zone Community Forest Management Committee (BMC). (2006). *Bandevi Buffer Zone Community Forest Five Year Management Plan*. Chitwan, Nepal.

Baral, H. S., & Upadhyay, G. P. (1998). *Birds of Chitwan*. Kathmandu, Nepal: Bird Conservation Nepal.

Berkmuller, K., & Monroe, M. C. (1986). World Conservation Strategy: A Programme for Youth. Manual for Youth Environmental Projects. *Education Training and Awareness Series* (No. 1). Cambridge, UK: IUCN Publications Services.

Bhattarai, B. R., Wright, W., Poudel, B. S., Aryal, A., Yadav, B. P., & Wagle, R. (2017). Shifting paradigms for Nepal's protected areas: History, challenges, and relationships. *Journal of Mountain Science*, *14*(5), 964-979. https://doi.org/10.1007/s11629-016-3980-9

Bird Education Society (BES). (2007). *Birds of Chitwan*. Chitwan, Nepal: Bird Education Society.

Budhathoki, P. (2003). Nepal's conservation in crisis: Empowering people to secure natural resources. *Journal of Forest and Livelihood*, *2*(2), 72-75.

Budhathoki, P. (2005). *Royal Chitwan National Park: A World Heritage Site with Buffer Zone*. Kathmandu, Nepal: IUCN World Commission on Protected Areas and Resources Himalaya Foundation, Kathmandu, Nepal.

Dangol, Y. (2007). *Biodiversity Conservation in Bacchauli Buffer zone Village Development Committee of Chitwan National Park* (Master's thesis). Tribhuvan University, Kathmandu, Nepal.

Department of National Park and Wildlife Conservation (DNPWC). (2005). *Annual Report.* Kathmandu, Nepal: Department of National Park and Wildlife Conservation, Ministry of Forests and Soil Conservation.

Department of National Park and Wildlife Conservation (DNPWC). (2000). *Royal Chitwan National*

Park-Resource Profile. Kathmandu, Nepal: Department of National Park and Wildlife Conservation, Ministry of Forests and Soil Conservation.

Dhakal, R. R., & Yadava, J. N. (2011). Comparative assessment of floristic diversity in a buffer zone community forest and a community forest of Barandabhar corridor, Chitwan, Nepal. *Journal of Horticulture and Forestry*, *3*(8), 244-250.

Forest Survey and Statistical Division (FSSD). (1989). *Master Plan for the Forestry Sector of Nepal: Forest resources information and status and development plan*. Kathmandu, Nepal: Forest Survey and Statistical Division. Ministry of Forest and Soil Conservation.

Government of Nepal (GoN). (1973). *National Parks and Wildlife Conservation Act*, *2029*(1973). Kathmandu, Nepal: Ministry of Law and Justice, Government of Nepal.

Gurung, G. S. (2005). *Reconciling Conservation and Livelihood Needs in Protected Areas of Nepal: A Case Study of Kangchanjunga conservation Area*. Kathmandu, Nepal: Conservation Biology in Asia, Society for Conservation Biology Asia Section and Resources Himalaya Foundation.

Heinen, J. T., & Kattel, B. (1992). A review of conservation legislation in Nepal: Past progress and future needs. *Environmental Management*, *16*(6), 723-733. https://doi.org/10.1007/BF02645662

Heinen, J. T., & Mehta, J. N. (2000). Emerging issues in legal and procedural aspects of buffer zone management with case studies from Nepal. *The Journal of Environment and Development*, *9*(1), 45-67. https://doi.org/10.1177/107049650000900103

Heinen, J. T., & Shrestha, S. K. (2006). Evolving policies for conservation: a historical profile of the protected area system of Nepal. *Journal of Environmental Planning and Management*, *49*(1), 41-58. https://doi.org/10.1080/09640560500373048

Mamo, G., Sjaastad, E., & Vedeld, P. (2007). Economic dependence on forest resources: A case from Dendi District, Ethiopia. *Forest Policy and Economics*, *9*(8), 916-927. https://doi.org/10.1016/j.forpol.2006.08.001

Maskey, T., & Bajimaya, S. (2005). Participatory management of Buffer zones for matural resource conservation. *Banko Jankari*, *15*(1), 3-10. https://doi.org/10.3126/banko.v15i1.17036

Mulepati, A. (2009). *Investigating Buffer Zone Issues in Baghauda Buffer Zone Village Development Committee, Chitwan National Park* (Master's thesis). Tribhuvan University, Kathmandu, Nepal.

National Trust for Nature Conservation (NTNC). (1998). *Buffer Zone Policy Analysis of Royal Chitwan Nationa Park*. Technical Report. Kathmandu, Nepal: National Trust for Nature Conservation.

Nepal, S. K., & Weber, K. E. (1995). The quandary of local people-Park relations in Nepal's Royal Chitwan National Park. *Environmental Management*, *19*(6), 853-866. https://doi.org/10.1007/BF02471937

Nepal, S., & Spiteri, A. (2011). Linking livelihoods and conservation: An examination of residents' perceived linkages between conservation and livelihood benefits around Nepal's Chitwan National Park. *Environmental Management*, *47*(5), 727-738. https://doi.org/10.1007/s00267-011-9631-6

Nyaupane, G. P., & Poudel, S. (2011). Linkages among biodiversity, livelihood, and tourism. *Annals of*

Tourism Research, *38*(4), 1344-1366. https://doi.org/10.1016/j.annals.2011.03.006

Odum, E. P., Odum, H. T., & Andrews, J. (1971). *Fundamentals of Ecology*. Saunders, Philadelphia, PA.

Paudyal, B. R. (2008). *Agrarian structures and distributive outcomes: A study of community forestry in Nepal* (Ph.D. dissertation). Leiden University, Leiden, Netherlands.

Pokharel, R. (2009). *People, Pressure & Conservation Issues of Bandevi Barandavar Community Forest, Chitwan National Park, Nepal* (Master's thesis). Tribhuvan University, Kathmandu, Nepal.

Pokharel, R., Poudel, J., & Grala, R. K. (2018). Impact of economic factors and a political conflict on international tourism demand in Nepal: A vector error correction model. *International Journal of Tourism Policy*, *8*(1), 18-41. https://doi.org/10.1504/IJTP.2018.090319

Pokharel, R., Poudel, J., Sharma, A. R., & Grala, R. K. (2017). A study of climate variability and socioeconomic impact on tourism industry of Nepal. *Sustainability in Environment*, *2*(1), 20-34. https://doi.org/10.22158/se.v2n1p20

Poudyal, A. (2007). *Buffer Zone Resources and Community Conservation: A Case Study of Piple Buffer Zone VDC, Chitwan National Park* (Master's thesis). Tribhuvan University, Kathmandu, Nepal.

Poudyal, A. S. (2000). *Wildlife Corridor Management: Analysis of Biodiversity and Socio-economic in Buffer Zone of Royal Chitwan National Park, Nepal* (Master's thesis). Asian Institute of Technology, School of Environment, Resources and Development, Thailand.

Rampur Weather Station. (2003). *Weather Report*. Chitwan, Nepal: Rampur Weather Station.

Regmi, B. R. (1999). *Interaction between park and people: Forest resources use patterns in Jankauli Village of Chitwan District* (Master's thesis). Tribhuvan University. Nepal.

Sanderson, S. E., & Redford, K. H. (2003). Contested relationships between biodiversity conservation and poverty alleviation. *Oryx*, *37*(4), 389. https://doi.org/10.1017/S003060530300070X

Sharma, E. R., & Pukkla, T. (1990). *Volume equation and biomass prediction of forest types of Nepal*. Kathmandu, Nepal: Forest Survey and Statistical Division. Ministry of Forest and Soil Conservation.

Shrestha, B. (1994). *Studies on Park and People Conflict: Investigation on resolving responses conflicts between park conservation and adjoining settlements in RCNP* (Master's thesis). Tribhuvan University, Kathmandu, Nepal.

Siwakoti, M., & Karki, J. B. (2010). Conservation status of Ramsar sites of Nepal Tarai: An overview. *Botanica Orientalis: Journal of Plant Science*, *6*, 76-84. https://doi.org/10.3126/botor.v6i0.2914

Stone, M. T., & Nyaupane, G. P. (2016). Protected areas, tourism and community livelihoods linkages: A comprehensive analysis approach. *Journal of Sustainable Tourism*, *24*(5), 673-693. https://doi.org/10.1080/09669582.2015.1072207

Stræde, S., & Treue, T. (2006). Beyond buffer zone protection: A comparative study of park and buffer zone products' importance to villagers living inside Royal Chitwan National Park and to villagers living in its buffer zone. *Journal of Environmental Management*, *78*(3), 251-267.

https://doi.org/10.1016/j.jenvman.2005.03.017

Straede, S., Nobel, G., & Rijal, A. (2002). Structure and Floristic Composition of Community Forests and their Compatibility with Villagers' Traditional Needs for Forest Products. *Biodiversity and Conservation*, *11*, 487-508. https://doi.org/10.1023/A:1014808600514

Thapa, S. (2013). Do protected areas, and conservation incentives contribute to sustainable livelihoods? A case study of Bardia National Park, Nepal. *Journal of Environmental Management*, *128*, 988-999. https://doi.org/10.1016/j.jenvman.2013.06.054

Thoms, C. A. (2008). Community control of resources and the challenge of improving local livelihoods: A critical examination of community forestry in Nepal. *Geoforum*, *39*(3), 1452-1465. https://doi.org/10.1016/j.geoforum.2008.01.006

Wells M. P., & McShane, T. O. (2004). Integrating protected area management with local needs and aspirations. *AMBIO: A Journal of the Human Environment*, *33*(8), 513-519. https://doi.org/10.1579/0044-7447-33.8.513