FOREST ECOSYSTEM SERVICE VALUATION: A CASE OF THE KALIKA COMMUNITY FOREST, DHADING, CENTRAL NEPAL

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ABSTRACT

The mid hill of Nepal is also known as the hub of community forestry and Dhading district alone has 681. Valuating ecosystem goods and services is expected to raise public attention to their importance and may trigger support for a suitable conservation strategy. This paper assesses how the community forest ecosystem functioning connected to human wellbeing and what is their monetary value. To answer these questions Kalika community forest of Dhading district, central Nepal was selected since it was rewarded by DFO as the best CFUG in Dhading in 2014. This study presents the results of an attempt to estimate the economic value of goods and service provided by the community forest. Market price method was used for estimation of provisioning goods, productivity method for supporting services, religious value through donation collection from the temple as cultural services and avoided damage cost for the regulating services and secondary data from the community forestry operational plan provided by DFO was also used for the estimation of provisioning goods. The economic value from the ecosystem functioning of the forest was approximate $441,739 per year with an average of $2265 per hector per year. The value of carbon sequestration was estimated high as $1342 per hector per year and the economic value of the cultural services was very low as compared to other but have a greater role in forest conservation. At last this study discusses the importance of outcome for sustainable forest management strategy and suggests some way forward.

Contribution/Originality: This study is one of very few studies which have investigated the economic value of the specific community forest of Dhading district, Nepal. The paper documents the important information of the quantified monetary value of community forest resource that is paramount for the sustainable conservation and management of forest.

1. INTRODUCTION

In the context of Nepal forest has always been a source of livelihood resources for the people living near the mountain and rural communities [1]. One cannot say the value of this precious forest so it is facing numerous conservation and development challenges. Many research work focused on regulating service especially 'carbon stock measurement' has been published [2, 3] by highlighting their role in the carbon sequestration. Furthermore, Dangal, et al. [4] had studied the effectiveness on management intervention on forest carbon stock in four different planted community forests, Karky and Skutsch [5] also considered the biological carbon sequestrations and estimated the economic value in returns to carbon abatement. Other scholarly article can be found with the similar

theme [6, 7] most of them are related to the REDD pilot project. Certainly, a forest has an important role in carbon sequestration, but its role is also equally important for other ecosystem services as provisioning, cultural etc. which is significant for the improvement of livelihoods of local people as well as the national capital. There would be justice if people evaluate the total ecosystem service of the forest as much as possible. In Nepal, community forests have created natural capital and improved existing forests conditions and biodiversity, forest conditions have improved overall since the handover to CFUGs, with 86 percent showing improvements in forests conditions, where CFUGs have significantly increased the area of forested land thus reducing landslide and soil erosion, protecting watersheds and increasing the agricultural output [8, 9]. CF is considered as the highly successful participatory forestry program to enhance the forest productivity, increase the forest condition and coverage, increase the support for community development and livelihood of local peoples [10, 11]. Forestry is extensive land use system in Nepal and provides basic commodities such as timber, fuelwood, fodder, medicinal herbs and serves as ecological function. Nearly 80 percent of Nepalese rural households derive some or all of their livelihoods from the forest sector [12, 13]. For some, their livelihoods are totally dependent on access to forest products for others forests provide important household products, inputs to agriculture, income and environmental services. The MEA [14] documented that 60-70% of ecosystem services are deteriorating faster than the can recover. Payment for ecosystem services (PES) plays a vital role in the developing country, as the poor households and communities could get benefit by controlling the environmental services [15]. Estimating the value of ecosystem services and identifying the importance of conservation can facilitate and create awareness amongst decision-makers leading to suitable conservation policy [16]. So, this can be helpful to estimate the relative importance of ecosystem with justifying specific conservations in particular place, similarly, it helps to identify the potential sources of sustainable financing. In this context, this study aims to quantify the forest ecosystem value with comprising different ecosystem service as much as possible.

Dhading district is known as the hub of community forestry and it holds total of 681 CFUG with highest in Nepal [17]. The forest quality as well as the people perception toward the community based conservation is positive. After the establishment of community forestry, the forest cover, quality and their service were increased, and it was awarded by DFO Dhading in 2015 as the 1st prize for its best management practices [18]. In this background this study tries to estimate the economic value of provisioning, supporting, cultural and regulating services and their total.

2. METHODOLOGY

2.1. Study Site

Dhading district is one of the 75 districts of Nepal lies in Bagmati zone of Central Development Region and new constitution places the district in 3 no. province. The elevation ranges from 300m (Jogimara) to 7110m (Pawil Himal) results in the climatic variation, including the subtropical to arctic climates [19]. Hills (72%) and mountains (28%) are the two distinct landscape types and having an area of 192,600 hectares with forest 48.23% [18]. Community Forest Development Program plays an important role in the conservation of existing forest and poverty eradication in this District. The total area of 29,724.34 hectares of the forest is managed by the community in which 71,638 households are directly engaged [20]. This study was carried out in the Kalika community forest (Fig. 1), of the same district, that is located about 20 km southeast from district headquarter, which covers an area of 195 hectares. The forest elevation ranges from 464m to 1264m and separated in the east by confluence of Khanikhola and Koshikhola; Sadikhola and Badahare Ban in west; Khanikholain north and west by Koshikhola. Forest mainly dominated by *Pinus roxburghii*and *Shorearobusta*, besides these, other species such as *Lagerstroemia parviflora, Schimawallichii, Phyllanthus emblica, Semecarpusanacardium, Sapium insigne, Syzygium cumini* etc. are also found.
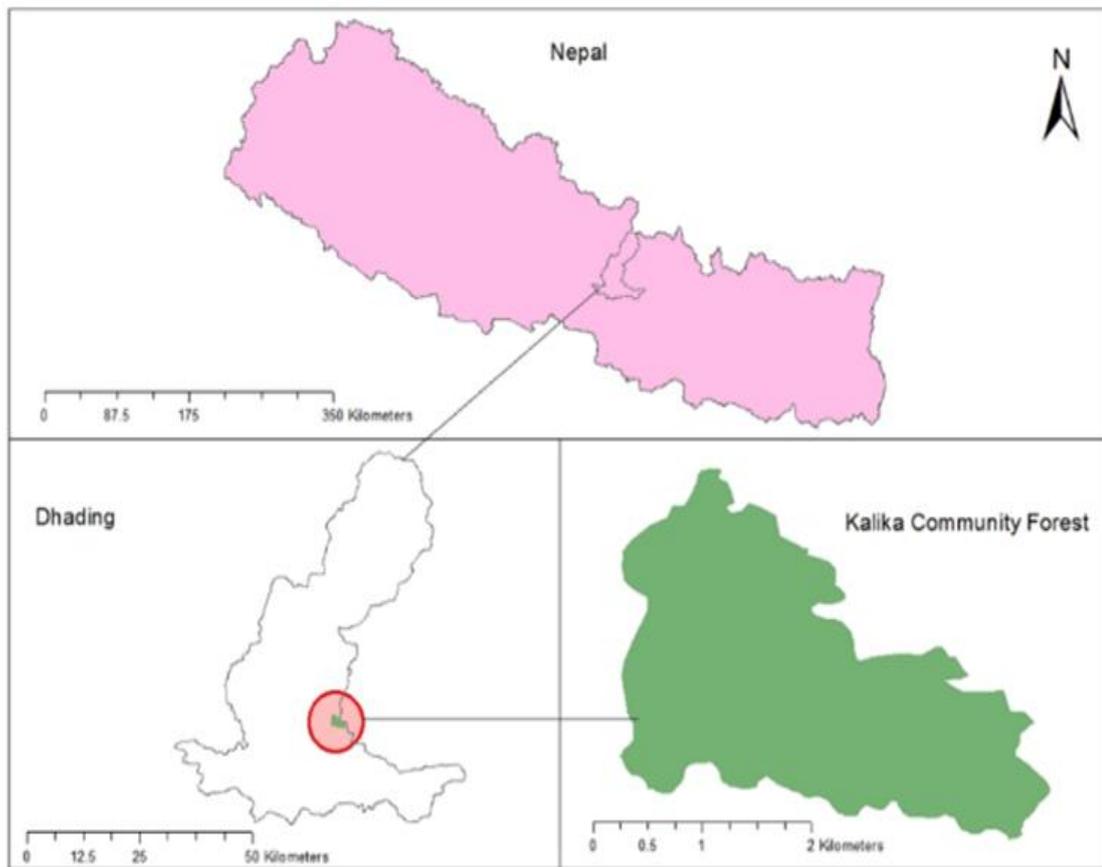
Figure-1. Map of study area

Source: With the help of Google earth and ArcGIS 10.2 software

2.2. Valuation of ES

We considered revenue collection from the water supply, wood, fuelwood, leaf litter, floor grass and other kinds of biomass (Syaula and Sotar) as provisioning services; carbon stock of the forest as regulating services; revenue collection from the temple as cultural services and nutrient recycling and soil formation as supporting services. These ES were chosen for this study as they were flagged by local people as being of particular importance.

2.2.1. Provisioning Services

People in the village adjacent to the Kalika community forest collect wood, fuelwood, fodder, and other NTFPs. Data regarding the value of provisioning services were collected by interviewing 59 households selected at random. Qualitative and quantitative data were collected from key informant interview and village older. Direct market valuation method and the replacement cost method was used to estimate the value of these services of the forest. The economic value of the harvested goods was calculated through the relevant market price and the rate mentioned in the operational plan of the community forest. The price of fodder was calculated through the replacement cost of rice straw; equivalent to one kg of fodder cost NPR 5.7.

2.2.2. Cultural Services

Only the revenue collected from the Kalika temple was considered as the cultural service of the forest.

2.2.3. Regulating Services

To determine the regulating services of the forest carbon stock density was determined. At first, forest boundary survey was carried by using GPS and map was prepared by through Google earth and ArcGIS 10.2. Then the required number of sample plots was estimated by taking 0.5% sampling intensity accordance to the

Department of Forest, community forest inventory guidelines, 2003 and the total possible number of sample plots was calculated as Area of all sample plots = sampling intensity × area of all forest, =0.5% × 195 = 0.975 ha. The number of sample plots= (Area of all sample plots)/ (Area of one sample plot) =0.975/0.025=39 So, in total 39 sample plots were required which was selected randomly through the ArcGIS 10.2. Then carbon stock of the forest was calculated according to the method mentioned in "Forest Carbon Stock Measurement: Guideline for measuring carbon stock in community-managed forests" jointly developed by Subedi, et al. [21]. Previous carbon stock density of the forest is not available so it was assumed that the age of the trees of the forest is 40 years and the tree growth rate is equal till this time and the average carbon sequestration value was determined by dividing the total carbon stock of the forest by 40 years. After calculating the carbon stock density, the carbon value was determined by using the Social Cost of Carbon (SCC) $43/tCO2 value given by Yohe, et al. [22] was applied.

2.2.4. Supporting Services

The value of the supporting services of the forest ecosystem was determined by estimating the effects of nutrient recycling and soil formation on crop production and thus on people's wellbeing. The effects of the forest and agro ecosystem services were estimated using an econometric model and sample statistics. The supporting services from forest biodiversity were estimated econometrically from the contribution of the forest ecosystem to the crop income of the households. Linear regression model was used to estimate the contribution of the agro ecosystem and forest ecosystem to household wellbeing. Income from the crop was considered as dependent variable and other attribute (sex, education, operated agricultural land etc.) as independent variables. The regression model was adopted from Pant, et al. [23].

Incrop=α+β1gen+β2age+β3eth+β4edu+β5fsize+β6Livestock+β7road+β8opag+β9irrag+β10innongfo+β11Spp_variety+β12ecoextent+ε.

The coefficients α and $\beta 11$ were determined by econometrically and ε is an error that is expected to be zero

and constant standard deviation, the $\beta 11$ is the contribution of agro ecosystem to the crop income whereas $\beta 12$ is

the contribution of forest ecosystem to the crop income and the variables were defined in Table 1. The value generated by forest ecosystem service was applied for all household.

Table-1. Variable used in supporting service and their descriptions

Variable	Unit	Description
incrop	NPR	income from the major crops
gen	dummy	male respondent =1, female = 0
age	number	age of the respondent
eth	dummy	0 = bramhan,1= kshetry, 2 = newar, 3 = magar
edu	dummy	0=illiterate, 1= primary, 2= others
fsize	number	family size of the respondent
livestock	number	number of livestock of the respondent
road	dummy	access to road or not, 0 = no, 1 =yes
opag	ha	operated agricultural land of HHs
irrag	%	Percentage of irrigated agricultural land
innonagfo	NPR 1000	Income of HHs from non-agricultural and non-forest
Spp_variety	number	species variety as measured by the number of major crops cultivated
eco_extent	ha	ecosystem extent measured by the total area of the community forest

Source: Pant, et al. [23]

3. RESULTS

3.1. Provisioning Services

Villagers living near the forest harvest woods, poles, fuel woods, fodder, grass, leaf litter medicinal herbs from the community forest. Wood harvesting is not allowed, however, CFUG gives permission to cut the tree for the construction of the house damaged by the earthquake. After aggregating all harvested forest products, it is multiplied by the total household of the community forest and the resulting economic value was calculated as $54,454 per year (Table 2). People also harvest roofing stones, Red and white mud for painting. Different kinds of medicinal plants and fruits (Rittha (*Sapindusmukorossi*), Tatelo (O*roxylumindicum*), Ban kurilo (*Asparagus racemosus*), Babiyo (*Eulaliopsis binate)* for making ropes, Thakal (*Phoenix humili*), Amili (*Tamarindusindica*), Phalits (*Syzygiumcumini*), Amala (*Phyllanthus emblica*), Lapsi (*Choerospondiasaxillaris*), Amaro (*Spondiaspinnata*), Harro (*Terminalia chebula*), Bel (*Aegle marmelos*), Gittha (*Dioscoreabulbifera*), Bayer (*Zizypusmauritiana*), Chiuri (*Aesandrabutyracea*), Bhalayo (*Semecarpusanacardium*), Tindu (*Diospyros embryopteris*) etc. Similarly, Shilajit (Mineral wax) is also collected seasonally from the community forest and the monetary values of these varieties were not quantified in this study.

Table-2. Economic value of provisioning goods

Provisioning goods	Local unit	standard unit equivalent	Annual average quantity	Rate	Annual average (NPR)	No. of HHs	Total value (NPR)	Total value ($) (1$=101)
Annually harvested goods and their market price								
Wood	cu.ft.	cu. ft	10	400	4000			
Fuelwood	Bhari	45 kg	26	175	4550			54,454
Poles	No.	No.	4	200	800			
Biomass for animal husbandry								
Fodder	Bhari	35 kg	27	200	5400			
Floor Grass	Bhari	35 Kg	29	100	2900		18965 *290	
leaf litter	Bhari	15kg	25	15	175	290		
Biomass (syaula, sotar)	Bhari	35kg	27	20	540		5,499,850	
Agricultural tools (Halo, Haris, Juwa)	No.		2	300	600			
Total					18,965			

Field survey: 2017

3.1.1. Annually Extractable Quantity of Resources

From the report of community forest operational plan 2014, the annually extractable quantity of resource without degrading the quality of the forest is given in the following table. In which 2435.37 cubics. ft of wood, 614.57 tons of fuelwood 823 poles, 1377.46 tons of floor grass can be harvested annually. The resulting price of the goods was estimated by multiplying the per unit value (Table 3).

Table-3. Annually extractable quantity of resources

Forest products	Unit	Standard unit equivalent	Quantity extractable	price per unit (NPR)	Total Value (NPR)	Total value ($)
Wood	Cubic feet	Cubic feet	2435.37	400	974148	9645.03
Fuelwood	Bhari	45 kg	13657	175	2389975	23663.12
Biomass (Syaua,Sotar)	Bhari	35 kg	33734	20	674680	6680
leaf litter	Bhari	15 kg	19678	15	295170	2922.475
Floor grass	Bhari	35kg	39356	100	3935600	38966.34
Pole	Number	Number	823	200	164600	1629.703
Total					8,434,173	83,506.66

Source: DFO [18]

3.1.2. Supply And Demand Condition of the Forest Product

The annual supply of wood and biomass (Syaula, sotar) were greater than the demand [18]. Similarly, the demands for fuelwood, fodder, grass and leaf litter were less than the annual supply. In the users' groups, supply was greater than the demand except for the fuelwood and leaf litter. From the secondary data of annual demand and supply, the total provisioning services of the forest were calculated as $84,799 per year with an average of $292 per household (Table 4).

Table-4. Supply and demand condition of the forest product

S. N	Forest products	Unit	Annual Demand	Annual Supply	Total value (NPR)	Total value ($)
1	Wood	Cu.ft	2,165	2,435	974,148	9,645
2	Fuel wood	Bhari	17,952	13,657	2,389,975	23,663
3	Biomass for composting (Syaula, Sotar)	Bhari	33,000	33,734	674,680	6,680
4	Fodder, grass	Bhari	21,648	19,678	3,935,600	38,966
5	Leaf litter	Bhari	51,480	39,356	59,0340	5,845
Total					**85,64,743**	**84,799**

Source: DFO [18]

3.1.3. Water Provisioning Services

Although the water was used for different purpose, this study was limited only to the freshwater use for the domestic purpose. Almost all depend on piped water from the springs inside the community forest. Some of them have a private water supply system managed by themselves. More than half of the respondents reported that the average consumption of freshwater was about 50-75 L per day and only seven percent of respondent consume less than 25 litters in a day. If their usual source of water is run out, almost the entire respondent goes to their nearest well. It was difficult to evaluate the water consumed by the household and the study only figure out the average consumption of the water. Almost all the household pay water revenue about $2.97 in a year. With considering this indicator as water in provisioning service it was assumed that all households pay for water as $2.97 and the resulting provisioning services of the water was estimated as $861 per year.

3.2. Supporting Services

The major crop species recorded from irrigated land was paddy, wheat, maize, potato, and mustard. Similarly, Soybean, sesame, beans, peanuts, maize was mostly cultivated in the rain-fed agricultural field. In addition, different kinds of green vegetable (cauliflower, radish, cabbage, ginger, garlic, onion, and pumpkin) were also cultivated.

3.2.1. Descriptive Statistics of Independent and Dependent Variables

The mean of species variety was 4.88 with a narrow confidence interval (Table 5). The average age of the respondent was 44.90; 92 % were male and the mean number of family size was found 6.22; about half of the respondents had access to a road. Average non-agricultural and non-forest income was about $237.62. Farming was the main occupation; the average cultivated land was about 0.45 ha, of which 57.68% were irrigated. The average crop income was close to $247.52 per household per year. Crop income was the welfare variable affected by the ecosystem service component including the agro biodiversity.

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Table-5. Descriptive statistics of dependent and independent variable

Variable #	Unit	Mean	Standard Error	95 % confidence interval range	
gen	dummy	0.92	0.037	0.82	0.98
age	year	44.90	1.550	42.06	47.75
fsize	number	6.22	0.254	5.58	6.86
livestock	number	9.58	0.44	8.55	10.4
road	dummy	0.53	0.066	0.38	0.69
Opag	ha	0.45	0.024	0.41	0.50
Irriag	% of opag	57.68	1.95	55.16	61.40
Innonagfo	NPR 1000	23.73	2.01	19.54	27.88
Spp_variety	number	4.88	0.176	4.64	5.27
Incrop	NPR	24475.14	1199.24	22292.48	27128.24
Ecoextent	ha	134.94	2.93	129.0	140.47

Field survey: 2017

3.2.2. Effects of Crop Varieties and Operated Agricultural Land in the Crop Income

A regression model was tested to determine the effects of a different independent variable on the crop income. From the results, it was found the operated agricultural land of the household was significant to the crop income. Similarly, species richness and gender were also significant to the crop income. In contrast, the other variable (family size, road access, ethnicity, age, number of livestock) did not significantly affect the crop income. From the observation, each unit increase in species variety of the agro ecosystem increased crop income by NPR 2350 per household and each unit (ha) increased in the operated cultivated land of the household increase crop income by NPR 32000 per household per year. Similarly, each unit (ha) increase in ecosystem extent increased the crop income by NPR 18.8 per household (Table 6).

Table-6. Effects of crop varieties and operated agricultural land in the crop income

Model Summary				
R	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	
0.952[a]	0.907	0.883	3150.962	

a. Predictors= (Constant), gen, year, eth, edu, fsize, livestock, road, opagirriag, innonagfo, sppvariety, ecoextent

coefficients[a]

Explanatory variables #	coefficients (b)	Std. Error	t- stat	P-value	95.0% Confidence Interval	
(Constant)	-2482.306	4302.114	-0.577	0.567	-11142.012	6177.399
Gen	-4016.858	1693.292	-2.372	0.022	-7425.279	-608.438
Age	26.814	42.216	0.635	0.528	-58.163	111.790
Eth	757.883	375.219	2.020	0.049	2.605	1513.160
Edu	1417.559	831.928	1.704	0.095	-257.024	3092.143
Fsize	32.832	301.024	0.109	0.914	-573.098	638.762
Livestock	-21.150	149.251	-0.142	0.888	-321.576	279.277
Road	-1370.717	965.860	-1.419	0.163	-3314.891	573.458
Opag	32468.425	4851.011	6.693	0.000	22703.845	42233.005
Irriag	-1.149	33.265	-0.035	0.973	-68.109	65.810
Innonagfo	-28.485	34.864	-0.817	0.418	-98.663	41.694
Spp_variety	2350.160	618.425	3.800	0.000	1105.335	3594.985
Ecoextent	18.840	22.315	0.844	0.403	-26.077	63.758

Dependent Variable (a) = incrop; Predictors (b) = (Constant), gen, year, eth, edu, fsize, livestock, road, opagirriag, innonagfo, Spp_variety, ecoextent), Sample size = 59, population size= 290 # Description of the variable were mentioned in (Table 1)

3.2.3. Value of Crop and Forest Ecosystem Services Estimated From the Effect on Crop Income

The average crop income of the sample household was extrapolated to determine the total crop income. The estimated crop income from the study site was NPR 7.097 million. Species variety coefficients per households were

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multiplied by the average species varieties to estimate the intangible (aggregate) value of the crop diversity and the resulting intangible value of the crop diversity was about NPR 3.32 million. Similarly, the ecosystem extent coefficients were multiplied by the average ecosystem extent and the total number of a household to determine the intangible value of forest biodiversity; the total intangible value of forest biodiversity within the users' groups was estimated as NPR 0.738 million (Table 8).

Table-7. Value of crop and forest ecosystem services estimated from the effect on crop income

Variable	Unit	Quantity	Equivalent Price ($)
Average Species diversity of major crops	Number	4.88	
Average ecosystem extent	Ha	135	
Average value of crop diversity	NPR/HH	24,475	242.33
Average value forest biodiversity	NPR/HH	(18.84*195 = 3674)	36.38
Intangible value of crop diversity	NPR	33,25,946	32930.16
Intangible value of forest biodiversity	NPR	737,586	7,302.83

Field survey: 2017

3.3. Economic Value of Cultural Services

There was one well-known temple at the center of the community forest. The amount of money collected through the Hindu devotees was evaluated on the study. The average amount of the money collected per month was NPR 10000 excluding the special occasion. Besides these, the extra donation was collected in other special festivals (Ekadashi Mela, Dashain, Magheskaranti etc.); that was about 30000 NPR. So, the total economic value of the cultural services of the forest was about NPR 42000 per year.

3.4. Economic Value of Carbon Stock

The average carbon stock of the forest was calculated as 340.03 tCha^{-1} and the total stock of the forest was calculated by multiplying this value, which was 66305.85 tCha^{-1}. This carbon was converted into the CO_2 equivalent by multiplying 3.67 (1 ton of carbon equals $44/12 = 3.67$ tons of carbon dioxide). The carbon rate prevailing at the international market was not stable. If the total forest was cleared all CO_2 goes into the atmosphere which may invite the environmental problem so the total carbon conservation value of the forest was estimated as a total of $10,463,726 and $53,660 per hectare (Table 9). The average carbon stock of the forest was calculated as 340.03 tCha^{-1} and the total stock of the forest was calculated by multiplying this value with total area, which was 66305.85 tCha^{-1}.

Table-8. Economic value of carbon stock

Variable	Unit	Average/hectare	Total in the forest (tons)
Carbon stock	tCha^{-1}	340.03	66,305.85
CO_2 equivalent	tCO$_2$	1247.9101	243,342.47

Field survey: 2017

3.5. Total Economic Value of the Forest

The total ecosystem value of the forest was estimated after summing the regulating, cultural, supporting and provisioning service of the forest. The total economic value of the forest was estimated 441,739 $ per year (Table 9).

Table-9. Total economic value of the forest

Total value of forest ecosystem services		
Value of provisioning services	**Value NPR/Year**	**Value ($)/Year**
Wood	1,160,000	11,485
Fuelwood and poles	1,551,500	15,361
Fodder	1,566,000	15,505
Others (leaf litters, grass etc.)	1,222,350	12,103
Wood sale	65,150	645
Fuelwood sale	3,000	30
Value of annually extractable forest resources	8,434,173	83,507
Water Provisioning services	87,000	861.39
Value of cultural Services	**Value NPR/Year**	**Value ($)/Year**
Donation collection from the Devotee	**42,000**	**416**
Value of supporting services	**Value NPR/Year**	**Value ($)/Year**
Intangible value of crop diversity	3,325,946	32,930
Intangible value of forest biodiversity	737,586	7303
Value of regulating services	**Value NPR/Year**	**Value ($)**
Carbon stock	26,420,908	261,593
Total	**44,615,613**	**441,739**

Field survey: 2017

4. DISCUSSIONS

4.1. Provisioning Services

People used to harvest different kinds of goods from the forest. People reported that they didn't go regularly to the forest for the fuelwood collection because most of their demand was fulfilled from their own land. Since last two years most of the households were accessed through the road and accessible through the tractor, jeep, and other lightweight vehicles so many of the respondents replace the fuelwood through the gas stove and some households have installed the biogas plant too. So the average harvesting rate of fuelwood, was very low as compared to the value reported by Dhyani and Dhyani [24] and Panta, et al. [25] because harvested resources are only the insufficient quantity to fulfill their daily demand. Almost all of the respondents were a farmer and their livelihood directly depends upon the agricultural products. The harvested goods are directly or indirectly related to the agricultural inputs. All the households have at least one livestock and subsistence agricultural practice. They used to harvest the forest biomass (leaf litter, twigs, and shrubs) to increase the quantity of compost manure for the farming. They often use live biomass to cover the agricultural field of the ginger, sweet potato, Pindalu (Colocasia antiquorum) during the time of germination. The most useful equipment for farming (Halo' Juwa and Harish) is also allowed to harvest from the forest with the permission from the CFUG. So, the forest product plays the vital role to the livelihood of the local people. Normally wood harvest from the community forest is not allowed to the community. From the allowance of district forest office, CFUG decided to tag the tree and distribute randomly, tree equivalent to 10 cu ft. and cost of NPR 4000 to each household as a relief to reconstruct the damaged household from the earthquake so the forest plays important role in mitigating during the calamities. Ohta [26] also mentioned that the importance of forest after the earthquake; victims prefer to live in a wooden house until they are capable to make reliable safety house. The secondary data of demand and supply condition of forest product also analyzed, the resulting value of about NPR 2.4 million less than the secondary information. Results are different because in recent days locals have an alternative cooking stove; more than half of the respondents have shifted to the LPG gas stove and some of them have biogas too. Similarly, information collected through questionnaire survey might be different in different time. In this study, only the major provisioning service was estimated, varieties of provisioning goods were used to harvest by the local people were not quantified. Many other NTFPs are either harvested very small amount or difficult to evaluate an economic term. Different kinds of medicinal plants are being used for the treatment of diseases locally but didn't sell to the market. Since these indigenous knowledge have been practicing from their ancestors and they still continue these Ayurveda treatment systems, this could be an

important topic for medical research. More than 80% of the population of Nepal lives in a rural area [27] and many of them are depends on the traditional medicine derived from the plants [28]. Although the harvested quantity and monetary value of fresh leaves of *Shorea robusta* are very small their value is culturally immeasurable since leaves are used in every type of religious and ritual activities which are not replaceable by any other product. People used these leaves to make 'Duna' and 'Tapari' (special kind of bowl and plate) in every religious sacrament. Similarly, wood and live pole size species of the same tree are also important in the marriage ceremony. CFUG member does not need to ask users committee for collecting leaves, live trees, and woods used during marriage and funeral ceremony of Hindu culture. Since *Shorea robusta* being major dominant species and its important cultural and religious value, the management and conservation planning of this species is very important.

Water supply system of the community is piped water whose spring is inside the community forest. Only the revenue collected from the user group was analyzed as an indicator of the water provisioning services. People who live near the tap and have more livestock has more water consumption in a day. The earthquake of 2015 has also affected their usual source of water and some springs have permanently dried out. People started to collect water from the well after their usual source of water was dried out due to the earthquake. Therefore, the forest was very supportive during the time of disaster by providing water as well as wood for construction. The economic benefits generated by the provisioning goods is about $ 279 per year per hectare is almost half of the benefit only by wood from the study of Southern Quebec Canada [29] and similar to the forest of Himachal Pradesh [30]. The harvested resources were less, however, the monetary value is one and half times the provisioning value of the central Terai [25]. Since the monetary value of the resource is dynamic over time and space, on the other hand, the evaluating procedure also affects.

4.2. Supporting Services

Supporting services has also a contribution of all the results discussed in this study however this service is estimated through the farm production resulting in the human wellbeing thus productivity method was considered to be best effective on evaluating of the supporting services. Different household characteristics determine the household crop income. The agro ecosystem can affect the farm production so the species richness was taken as the index of biodiversity. The nearest forest block was considered as the indicator of forest biodiversity as the ecosystem extent. Since supporting service is necessary for the production of all other ecosystem services including soil formation, nutrient cycling, photosynthesis, primary production, water cycling etc. Many studies include this agricultural income as the provisioning service of the ecosystem. But it is realized to analyze the supporting service separately from the crop income through productivity method.

4.3. Cultural Services

This rural area is not renowned for any tourism or recreational site, there are not any records of the tourist visit in the site. Although this forest has precious cultural value only spiritual and religious value is estimated through the donation collected by the devotee. There is the famous Kalika temple inside the community forest. People from nearest VDC and also from Nuwakot district goes there for worship. Different cultural and religious festivals including marriage ceremony, Thuloekadashi Mela, Mahnabamietc are celebrated there. Although a small amount of money is collected from the temple, it has a precious religious value to the Hindu devotee. From the observation, the surrounding area of the temple has very big old growth trees of DBH ranging from 50 to 100 cm as compared to the remaining area of the CF. All the forest in this CF is secondary growth forest beside the peripheral area of the temple area. The cultural and religious value has a greater role in forest conservation; the conservation policy would succeed if it can be linked with a social-religious value. Old people still believe that the area near the forest is the habitat of python and if they destroy the jungle the python could enter the village and there will be foreboding. In the past, when the forest was fired anonymously many times, the forest outside the

boundary of the temple area was always protected due to having a religious belief of local people. They used to clear leaf litter regularly which limits the spreading of fire in the area. It is easy to convert the monetary value of a recreational and aesthetic value of an ecosystem in terms of cultural value. Many studies have focused the recreational value of the ecosystem in cultural value. Zhang, et al. [31] have quantified the cultural value as a willingness to pay for the ES and estimated as 463$ha-1year-1. Similarly, Groot, et al. [32] have estimated cultural value of tropical forest biome as 867$ha-1year-1. It is unfair to relate the result of this study to this value because this study just focused on temple based income and tries to indicate only that the ecosystem has significant cultural services too.

4.4. Regulating Services

The total quantity of carbon stock in this community forest is about 66305.85tons with average of 340.03 tons per hectare which is higher than the ICIMOD knowledge park i.e. 263.44 t Cha⁻¹ [3] and also high in compared to the planted community forest of Kabhrepalanchok [4]. Although this study was designed to evaluate the carbon sequestration value through carbon stock measurement, previous data of carbon stock value is not available so only the total carbon stock value of the forest was estimated. It is assumed that the average age of the tree is 40 years and the carbon sequestration rate is equal in succeeding years. So, the average carbon sequestration rate of this forest is estimated as 8.5tC ha⁻¹ and 31.2 tCO$_2$ equivalents. Nordhaus [33] estimated the SCC is 31.2$/ton in 2015 and grows by 3% per year over the period of 2050, similarly, California Carbon Dashboard has estimated carbon value of $13/t in 2016. The different rate of social cost of carbon are available ranging from $10 − $+350 and the SCC is highly uncertain with an average of $43/tCO$_2$ with a standard deviation of $83/tCO$_2$ [22] so this value of carbon is used for estimation. The resulting SCC sequestration is about 1341.5 per hectare per year and the total carbon stock of the forest is equivalent to 10.5 million dollars till this time.

4.5. Total Economic Value

Actually, the tree growth may not be equal to the succeeding year and the main purpose of this study is to visualize the carbon stock value of the forest so it was taken the consideration. The provisioning, supporting and cultural value of the forest was estimated as 9,24$ha⁻¹ year⁻¹ and the carbon stock value was 1,341.5$ha⁻¹year⁻¹ so the total economic value of the forest was 2,265$ha⁻¹ year⁻¹. Groot, et al. [32] estimate the minimum and maximum value of 1,581 and 2,0851$ha⁻¹ year⁻¹ with the median of 2355$ha⁻¹ year⁻¹ for tropical forest and the total median value for a temperate forest is 1127$ha⁻¹ year⁻¹. Similarly, Sing [34] also reported similar results that the value of the forest of Uttarakhand, India has 1,150$ ha⁻¹year⁻¹. Our study forest is the subtropical forest so the outcome of this research is similar to these studies. In Nepal [23] had studied a similar study in Kanchenjunga landscape and reported that the value of Kanchenjunga Landscape was 4,286$ ha⁻¹year⁻¹. This outcome is a little higher from these studies because the quantity and type of harvested provisioning goods are more in that area. Similarly, the variation in the $ also affects the price because this price is estimated when 1$ equivalent to 70NPR but at present $ has also increased and the outcome of the result is converted by the 1$ equivalent to 101NPR. The valuation of the ecosystem service is the complicated process it is not necessary to compare to the other study. Different attribute plays the role for determination of the ecosystem value for example difference in the methodology employed, the number of ecosystem function evaluated, the forest and site characteristics, and the local context partially explains the large difference in the estimates [35]. So, the ecosystem shows the wide variation. Costanza, et al. [36] estimated the forest value from $8 ha⁻¹year⁻¹ to $4,080 ha⁻¹year⁻¹. Very limited research papers are available which measure the economic value per year per unit. Some paper, Uddin, et al. [37] estimated the economic value of the forest but not mentioned per unit value. The value of the ecosystem services will be higher if it is taken into consideration of all intangible value of the forest such as water regulation, climate regulation, flood control, waste treatment, pollination, habitat/refugia etc.

5. CONCLUSION AND RECOMMENDATIONS

People are less dependent on agriculture and they also have an alternative source of income for their livelihood. Farming is mainly carried out on irrigated land and most of the non-irrigated land is barren. Some of their lands are a transition between forest and farmland, and the major portion of the demanded resources easily harvested from their own land. In other hands, almost half of households have an alternative cooking stove for replacement of fuelwood i.e. gas stove and biogas. The numbers of livestock have been decreasing as compared to the past. Several factors have played a role for the reduction of the harvested quantity of resources from the forest so the provisioning services of the forest were estimated very low as compared to other studies. However, the demands of the wood are still high. Because most of the houses have been destroyed by the earthquake of 2015 and they have to rebuild it and CF is providing wood for the construction. From the study, it can be concluded that the stock of natural resources would be very helpful at the time of a natural disaster. The cultural value in the study is estimated very low however it has a significant role in forest conservation. People have a strong belief to preserve the tree and other resources near the culturally important sites. From the observation, old growth trees were present near the temple. Therefore, it can be concluded that though the cultural value is very difficult to measure (in a dollar) but it has a relatively greater value for resource conservation. The carbon stock value was so high so the forest has huge potential in carbon trading through clean development and REDDs mechanism. Area of the forest is not so large, the total value is estimated $441,739 per year. This report would alleviate the forest managers and planner to conceptualize the economic and environmental importance of the community forestry while formulating the plan and strategy for sustainable forest management. Choice of the investigated service may underestimate the total value of the forest beside these; there would be many other social, spiritual, recreational, ecological value which could not be able to capture in this study. The study estimates, not only the total value but also the value of individual ecosystem service which differs widely. So, the policy measure should be made by addressing the local context and value. The valuation of the ecosystem services would raise the awareness level of stakeholder but in Nepal, no study has been done related to it. This study is just one small step in moving forward to figure out the real value of the forest in the mid hill of Nepal.

From the study, it was known that the resource harvest rate from the community forest is very low. Live grass, dead leaves were common on the surface of the forest and there is always the risk of forest fire. It is better to encourage the development of forest-sector businesses, for example, there is the possibility of biomass briquetting, animal husbandry. Similarly, construction of the road should be controlled which was haphazardly carried out from the middle part of the forest. Capacity building, campaigns, and strengthening program should be organized on environmental issues about importance forest.

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