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Sustainability Livelihood Security in Community Forests, Surkhet District, Nepal

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ABSTRACT

Community forests play a significant role in supporting and improving livelihoods and thus sustainable livelihood security (SLS) is worthwhile for sustainable development, but the research regarding this is very limited in Nepal. Thus this research was objectively conducted to assess ecological value of tree species, socio economic efficiency and sustainable livelihood security index in three community forests (CFs) of Surkhet. Both primary and secondary data were collected from field using participatory rural approach and technique, related reports and publication. Total 75 sample plots were established; specifically 25 samples were collected from each CF applying stratified random sampling. Nested plots having size 20×25, 10×10,5×5 and 1x1m^2 were laid down for the tree, pole, sapling and seedling respectively. The Diameter at breast height and height of plants were measured, species were noted and their number was recorded. Total 3 focus group discussions were conducted with the users group. The collected data were analyzed using importance value index (IVI), biodiversity indices and finally scoring the SLS. The highest IVI of key species i.e. Shore arobusta was 249.96±10.88 in Janata CF and followed by Shiva CF (184.75±10.83) and Ambika CF (184.75±10.83). The Shannon-Weiner index was the highest 0.742±0.058 in Ambika CF while it was the lowest 0.292±0.071 in Janata CF. Similarly the Simpson's index was the highest about 0.798±0.045 in Janata CF and lowest was about 0.532±0.036 in Ambika CF. The regeneration was the highest in Janata community forest with 5280 seedling/ha but sapling was the highest in Ambika community forest with 5648 plants/ha. The volume was the highest in Ambika community forest with 244.66 m^3/ha. The Ecological Security Index was the highest in Ambika community forests with value 87.2 and the lowest value was 49.99 of Janata community forest. The average social equality value was similar in Shiva and Ambika community forest with 92% each. The average vale of economic efficiency was the highest 92% in Ambika community forest but it was the lowest 50 in Shiva CF. The sustainable livelihood security index was the highest around 90.4 in Ambika community forest while it was the lowest only 63.99 in Janata community forest . The study is useful to evaluate livelihood security in the forest.

Keywords: *sustainable livelihood security index, importance value index*

Introduction

Livelihood is the worldwide worth for people and environment (Roseland, 2000). The balance between these two components is very essential (Graham et al., 2017). So, the sustainable livelihood security is worthwhile. Sustainable livelihood security (SLS) is importantly useful in forest management because forest and the people are interlinked with each other (Cars & West, 2017).

It is big challenge for world to maintain the sustainability to assure the security of the people particularly in poor countries (Dang et al., 2020). The challenges importantly are fundamental need for instance food, water, cloth, shelter and infrastructure (Sengupta&Jha, 2020). Challenge of food, water and cloth are still increasing for poor people in rural areas. Millions of jobs are affected in different countries and different of scale of business so as (Kabir et al., 2020). The government and nongovernment institutions have been facing the enormous challenges. The challenges to reopen the office, business, transport, market and so on (Chancel, 2020). However, limited the economic activities are running (Kabagambe, 2020). The social security is significantly import to which can help to resume the life but the challenges has been increasing unanimously (Manta, 2020). In this context the livelihood security is meaning for sustainable livelihood as well as the community forest. Sustainability emphasize on the balance among the three major components

particularly social, environmental (ecological) and economical (Della & Diani, 2020). This is considered as warning to be cautious and be prepared for more calamities (Foster, 2020). Men are burying the dig for them. The ecology is affected, environment is affected, ecosystem is affected and whole life is affected and we are the part of influencing agent (Alagona et al., 2020).

There is long history of community forests and hence it questions regarding sustainability become in priority (Ostrom& Ahn,2003). A novel prize winner Elinor Ostrom designed theory based on the practice of community forest in Nepal (Saunders, 2014). Opportunity of employment and income generation through community forest management directly and indirectly link with the livelihood, so the sustainable livelihood security is meaningful concept in community forest management (Keige, 2019). Security for environment, it's for ecosystem, it's for living and non-living beings and thus, it's for community and community forest management, is essential (Bommarco et al., 2013). It is essential and how to measure the livelihood security is crucial to assess in Nepal because Nepal is recognized as the pioneer of community forests (Harrer, 2017). Many successful stories of community forest management are used to formulate the theory in Nepal. In this context, there is no any study conducted regarding this so far yet. Thus, this paper aims to assess the ecological value of the tree species in community forests, to find out the socio economic efficiency in community forests and to assess the sustainable livelihood security index.

Materials and Methods

Surkhet District is a part of Karnali province, is located about 600 kilometres (373 mi) west of the national capital Kathmandu. The latitude, longitude and altitude of Surkhet are 28° 35' 59.99" N and 81° 37' 59.99" E and 634m respectively. Winter temperatures drop to about 5 °C and in summer it goes up to 38 °C. Monsoon brings sufficient rainfall during the rainy season.

Study site: Three community forests i.e. Janata, Shiva and Ambika community forest were selected as the basis of similar altitude and similar vegetation composition. These community forests were situated in Birendranagar Municipility, ward no.21. The areas of Janata, Shiva and Ambika community forests are 56.15, 143.4 and 139.79 ha. These forests are natural dominated by Shorearobusta. Total 139, 157 and 555 households are the users of the Janata, Shiva and Ambika community forests respectively(Figure 1). Sampling design: Stratified random sampling was carried out in the study area. Total 75 sample plots were established for the field data collection. 25 sample for each CF were selected as sample plots to collect data from forest.

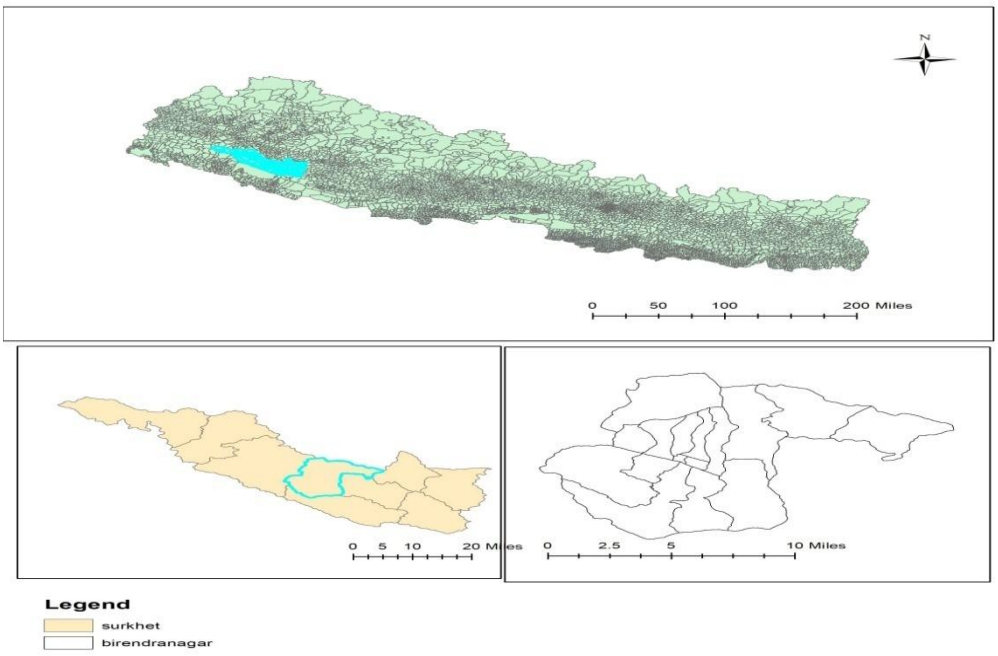

Figure1. *Study area*

Biophysical data collection: Indicators for the building of Sustainable Livelihood Security Index (SLSI) based on ecological value and availability of community based information.Ecological security indicators were forest condition, importance value index (Major spp: Shorearobusta), Biodiversity index and Species richness.

Reconnaissance survey was carried out in the field. The aim of this survey was to get a better idea about the distribution of tree species and community forest. The plot of size 20×25m2, 10x10m2 and 5×5 m2 plots were laid down for the tree, pole and sapling of each plot. The diameter, height, crown cover and crown width were measured and the number of trees present in plot was also be counted. The condition of the forest i.e. forest health condition, adverse factor and the distribution of species will be recorded. Total three focus group discussions, one from each community forest were organized to collect the social information. The four focus group discussion will be carried out to provide in-depth understanding of the livelihood assets and issues of particular group of people. Secondary data collection: Different information required for the study were collected from the existing secondary sources. Information regarding capacity builds up training, women participation, public hearing and auditing.

It will be calculated by following methodssince last five year period was collected to find the Social equality index. In addition, data related to total timber yield, fuel-wood yield, NTFP production, net income generation since last 5 years were collected to find the economic efficiency index.

Data Analysis

Ecological security index includes, the importance value index (IVI of Shorearobusta, as it is the most valuable tree species), biodiversity index, forest condition and species richness under ecological valuation was calculated and hence these values were calculated. Importance Value Index (IVI)=Percentage N/ha+ Percentage BA/ha +Percentage CA/ha (Curtis, 1959). The percentage value of IVI value of most valuable spp was calculated in order to find ecological security index.

Biodiversity index: Species diversity was assessed using Shannon wiener diversity index (H'), Simpson's diversity index (D) and Species richness.

Shannon wieners index (H') = $-\sum Pi \times \log pi$..... (I)

Simpson's diversity, (D) = $1-\sum Pi^2$..... (ii)

Where, Pi is the relative abundance of each species, i.e.; the proportion of individuals of a given species relative to the total no. of individual in the community. (Blamer, 2002)Economic efficiency index= (total timber yield+ fuel-wood yield+ NTFP productionnet income generation since last 5 years)/4Social indicator will be capacity build up training, women participation, public hearing and auditing. It will be calculated by following methods:

Women participation

A= total number of women participation in committee/ Total number of participation in committee

B=women presence in meeting/Total presence in meeting

Women participation= (A+B)/2

Auditing rate= number of auditing rate in five years/5

Public hearing= Total number of public hearing in five years/5

Capacity building= Total number of training organized by CF/ total training planned in Operational plan

Social equality index

$$SEI = \frac{\text{capacity build up training} + \text{women participation} + \text{public hearing} + \text{auditing}}{4}$$

Sustainable livelihood security index (SLSI) will be calculated by compiling of ecological valuation index, economic efficiency index and social equality index.

$$SLSI = \frac{\text{Ecological Value index} + \text{Economic efficiency index} + \text{Social equality index}}{3}$$

Result

Ecological Value of Plant Species in Community Forest

The table shows that Janata community forest has the highest IVI of Shorearobusta with a

mean value about 249.96±10.88 following the S.D. with the value of 54.42 comparing the IVI with Shiva community forest (Mean: 184.75±10.83, S.D:51.98) and Ambika Community forest (Mean: 184.75±10.83, S.D:43.98).Similarly, IVI of Syzygium cumini was lowest in Ambika community forest with 23.5±0 (Table 1).

Table1. *IVI of Community Forests*

Species	IVI in Janata C.F				IVI in Shiva C.F.				IVI in Ambika C.F.			
	Mean±S.E.	Max	Min	S.D	Mean±S.E.	Max	Min	S.D	Mean±S.E.	Max	Min	S.D
Shorearobusta	249.96±10.88	300	157.4	54.42	184.75±10.83	300	122.52	51.98	184.75±10.83	300	99.48	43.98
Semecarpusanacardium	55.48±5.74	61.23	49.74	8.12	24.51±0	24.51	24.51					
Termanaliaalata	55.48±8.43	122.8	70.21	22.32	105.36±5.89	139.77	65.72	21.18	56.6±16.23	89.07	40.26	28.11
Pinusroxburghii	55.48±13.43	89.83	46.11	23.26	88.77±13.45	102.23	75.32	19.02	122.13±8.25	188.4	53.65	36.91
Syzygiumcumini	55.48±7.89	63.06	47.24	11.16	41.17±1.48	42.65	39.69	2.09	23.5±0	23.5	23.5	
Dalbergiasissoo	55.48±0	37.18	37.18		184.39±66.35	300	70.15	114.93	43.83±9.02	61.44	31.66	15.62
Lagerstromeaparbhiflora	55.48±7.66	47.91	22.69	13.27	29.86±7.84	37.71	22.02	11.09				
Eucalyptus spp					89.15±4.11	96.13	81.89	7.12	87.47±5.58	93.21	76.31	9.67
Celtisaustralis					70.48±12.76	128.45	23.34	36.11	53.61±4.46	69.86	40.7	11.8
Ficusbengalensis									80.52±0	80.52	80.52	
Aeglemarmellos									31.58±0	37.58	37.58	
Colocasia					49.11±0	49.11	49.11					
Mitragynaparvifolia									53.52±0	53.52	53.52	

Biodiversity Index of Tree Species in Community Forests: The Shannon index was the highest about 0.742±0.058 in Ambika CF. while it was the lowest approximately 0.292±0.071 in Janata C.F. Similarly the Simpson's index was the highest about 0.798±0.045 in Janata C.F and lowest was about 0.532±0.036 in Ambika CF. The value of species richness was 10 in both Shiva and Ambika CF and it was only 7 in Janata C.F. The Lower the Simpson's index value the higher the diversity and vice versa is also true for value of Shannon's index (Table 2).

Table2. *Biodiversity Index of Tree Species in Community Forests*

Biodiversity index		Janata C.F.	Shiva C.F.	Ambika C.F.
Shannon weiner index	Mean±S.E	0.292±0.071	0.628±0.067	0.742±0.058
	Maximum	1.11	1.09	1.27
	Minimum	0	0	0
	S.D	0.357	0.336	0.293
Simpson index	Mean± S. E.	0.798±0.045	0.612±0.039	0.532±0.036
	Maximum	1	1	1
	Minimum	0.4	0.36	0.15
	S.D	0.227	0.199	0.18
Species richness		7	10	10

One-way ANOVA showed that, there was significant difference in value of Shannon weiner index among three community forests since $p<0.05$ ($P=0.0001$) at 95% confidence level. Moreover, Tukey's B showed that there was significant difference in the value of Shannon weiner index of Janata Community forest with this value of remaining two community forests since the mean value of Shannon weiner index lies in different subset at

95% confidence level. For Simpson index, One-way ANOVA showed that, there was significant difference in value of Simpson index among three community forests since $p<0.05$ ($P=0.0001$) at 95% confidence level.Moreover, Tukey's b test showed that there was significant difference in the value of Simpson index of Ambika community forest with this value of remaining two community forests since the mean value of Simpson index lays in different subset at 95% confidence level. Forest Condition of community forest:The regeneration was the highest in Janata community forest with 5280 seedling/ha but sapling was the highest in Ambikacommunity forest with 5648 plants/ha. The volume was the highest in Ambika community forest with 244.66 m3/ha(Table 3).

Table3. *Forest Condition of Community froests*

Forest condition	Janata CF		Shiva CF		Ambika CF	
	Details	Condition	Details	Condition	Details	Condition
Regeneration (N/ha)	5280	very good	4368	good	4288	good
Sapling (N/ha)	4880	very good	4608	very good	5648	very good
Tree (volume: m^3/ha)	209.41	very good	200	very good	244.66	very good

Value of Ecological Security Index

The table showed that Ecological Security Index was highest in Ambika community forests with value 87.2and the lowest value was 49.99 of Janata community forest (around 57.3% low). This indicates ecological Janata community forest is very weak (Table 4).

Table1. *Value of ecological security index*

CFs	Forest Condition	% IVI of most valuable spp (Sal)	Score for Biodiversity Index	Score for Species Richness	Total	Average Score
Janata	100.00	83.32	33.33	33.33	149.98	49.99
Shiva	88.88	61.60	66.67	100.00	228.27	76.09
Ambika	88.88	61.60	100.00	100.00	261.6	87.2

Socio-Economic Efficiency in Community Forest

Status and Scoring For Social Variables

The table 5 showed that the women participation in the committee was the highest in Shiva Community forest 2ith 45%. The auditing rate and public hearing were approximately similar in all community forests. However, the score of capacity building was the highest in Ambika community forest.

Table2. *Status and scoring for Social Variables*

	Janata CF		Shiva CF		Ambika CF	
Indicators	**Status**	**Score**	**Status**	**Score**	**Status**	**Score**
Women Participation	36%	1	45%	3	40%	2
Auditing	1	3	1	3	1	3
Public hearing	1	3	1	3	1	3
Capacity Building	2	2	2	2	3	3

Social Efficiency (%) In Community Forests

The indicators were calculated in percentage according to the scoring value. Shiva and Ambika community forests secured high value approximately same (higher) but this was low of Janata community forest (Table 6). The average percentage secured was similar in Shiva and Ambika community forest with 92% each.

Table6. *Social Efficiency(%) in community Forests*

Indicators	Janata CF	Shiva CF	Ambika CF
Women participation (%)	33	100	66
Auditing (%)	100	100	100
Public hearing (%)	100	100	100
Capacity building (%)	66	66	100
Average percentage	75	92	92

Economic Efficiency in Community Forests

Status and scoring for Economic Variables: The table showed that timber production was higher about 0.05m3/ha in Janata and Ambika community forests comparing to Shiva community forest. Similarly, fuel-wood production was higher about 2m3 /ha in Janata CF and lower in Shiva CF about 0.59. The NTFPs production was only recorded in Ambica CF and annual net income was the highest in Ambica CF about US$2325.52. The highest score was recorded in Ambika CF with 11 (Table 7).

Table7. *Status and scoring for Economic Variables*

	Janata CF		Shiva CF		Ambika CF	
Indicators	**Status**	**Score**	**Status**	**Score**	**Status**	**Score**
Timber production(year/ha)	0.05	3	0.049	2	0.05	3
Feulwood production(year/ha)	2	3	0.59	1	1.41	2
NTFPs production	0	1	0	1	1	3
Net income per year (US$)	608.69	1	2156.52	2	2325.52	3

Economic Efficiency in Community Forests

Average vale of economic efficiency was the highest 92 in Ambika community forest but It was the lowest 50 in Shiva CF (Table 8).

Table8. *Economic Efficiency (%) in Community Forests*

Economic variables: Percent value	Janata CF	Shiva CF	Ambika CF
Timber production	100	66	100
Feulwood production	100	33	66
NTFPs production	33	33	100
Net income per year	33	66	100
Average value	67	50	92

Sustainable Livelihood Security Index Calculation

The sustainable livelihood security index was the highest around 90.4 in Ambika community forest and it was the lowest only 63.99 in Janata community forest (Table 9).

Table9. *Sustainable livelihood security index calculation*

CF	Ecological Security index	Economic Efficiency Index	Social Equality Index	SLSI
Janata	49.99	67	75	63.99
Shiva	76.09	50	92	72.69
Ambika	87.2	92	92	90.4

Discussion

The ecological value indicators for sustainable livelihood security index were Forest condition, important value index (IVI), biodiversity index and species richness. The highest IVI of Shorearobusta was found in Janata community forest with a mean value about 249.96±10.88 following the S.D. with the value of 54.42.The Shannon index was the highest about 0.742±0.058 in Ambika CF. while it was the lowest approximately 0.292±0.071 in Janata CF. Similarly the Simpson's index was the highest about 0.798±0.045 in Janata CF and lowest was about 0.532±0.036 in Ambika CF. The value of species richness was 10. The Lower the Simpson's index value the higher the diversity and vice versa is also true for value of Shannon's index (Mahapatra et al., 2013). The forest condition of Janata CF was very good comparing to other two community forests. Similar studies were done by Mandal et al. (2013) to find the biodiversity index in community forest.

The Shannon-Wiener Biodiversity Index was the highest 2.33 in Banke-Maraha CFM, and it was the lowest 2.21 in Gadhanta-Bardibas CFM. This indicates that the highest biodiversity was in Banke-Maraha CFM. Overall, the ecological security index is higher in Shiva and Ambika community forest comparing to Janata Community forest. It means that the overall ecological part is week for the fulfillment of

livelihood of community forest users in Janata community forest.

Socio-economic efficiency in community forests: The indices of social efficiency or equality are mainly women participation, auditing rate, public hearing and capacity building trainings. Overall, social equality index values were same in Shiva and Ambika community forests.

The reason behind this may be good governance (effective participation, transparency and awareness creation as well. Some community forests in hilly region show the good governance in Nepal (Gentle et al., 2007, Lamichhane &Parajuli, 2014,Piabuo, et al., 2018).

The timber production, fuel wood and NTFPs production were differed in the community so economic efficiency was also varied. The net income was the highest in Ambica CF i.e. about $2325.52. The community forest having more source of income and selling timber is economically sound (Sunderlin , 2006, Kim et al., 2008, Gauli& Hauser, 2011) so value of economic efficiency index was in Ambika community forest where timber production and its trade is source of income.

Sustainable livelihood security index included ecological security index, economic efficiency index and social efficiency index (Kumar & Irfan, 2019). It was found that Ecological Security Index was highest in Ambika community forests with value 87.2. The species are more diverse in this community forest. Value of economic efficiency index was observed the highest of Ambika community forest with 92.

Social Equality Index of Ambika and Shiva Community forests was the highest with 92 of each. The sale of timber was the main source of income in the community forest and activities related to good governance were effectively conducted.

These three values of indices contribute to determine the sustainable livelihood security index (Yousefi et al., 2010, Van de Kerk& Manuel, 2008, Singh &Hiremath, 2010). The sustainable livelihood security index was the highest in Ambika community forest with value 90.4, this is because of cumulative effect of other indices.

Similar study was done by Singh, (2010) who released a paper that provided an overview of current growth indices and places them within the environmental, economic and social aspects of sustainable development, providing empirical evidence of the Sustainable Living Security Index (SLSI) at the Gujarat district level. It was a composite index with three component indices, namely the Ecological Security Index (ESI), the Economic Efficiency Index (EEI), and the Social Equity Index (SEI) (You, & Zhang, 2017).

It finds that the SLSI is one of the most extensive yet easy indicators for evaluating long-term living safety in rural regions, based on its simplicity and flexibility (Nordlund& Westin, 2011, Krishna et al., 2020).Thus, the SLSI not only identifies the general priorities for development but also the nature and types of policies to be pursued in each study unit to enhance livelihood security.

Conclusion and Recommendation

The ecological security index was the highest in Shiva and Ambika community forests comparing to Janata community forest. Similarly, Social Efficiency Index of Ambika Community forest was the highest whereas it was the lowest in Shiva community forest. Economic efficiency index was observed the highest in Shiva and Ambika community forest with same value in each. Sustainable livelihood security index was the highest in Ambika community forest but it was the least in Janata community forest. The study should be extended in other types of community based forests as well. Different practices of Sustainable livelihood security index should be needed to conduct. This paper will be useful to formulate the policy for academician working in community forest management.

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