



Forest Governance, Forest Dependency, and Deforestation in Boxa Reserve Forest Area, Alipurduhar, North Bengal

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Abstract: About 300 million people live within or adjacent to dense forests and roughly 1.6 billion people depend on forest and forest products like food, fodder, fuelwood, and non-timber forest products. At the same time, high forest dependency harms the environment. The paper attempts to estimate forest dependency and to identify the factors affecting forest dependency. The study is based on primary data collected from the Buxa Forest Reserve Alipurduhar, North Bengal, during 2020-21. In the study, 6 villages and 151 households are selected randomly. The paper has utilized the forest governance index based on the FAOs indicators like the Rule of Law, Transparency, Accountability, Participation, Inclusive and Equitable, and Efficient and Effective. In addition, the paper has employed a beta regression model to estimate the impact of forest governance on forest dependence while the other socio-economic variables are treated as control variables. The forest dependence index and forest governance index of the households were 0.539 and 0.483 respectively. In addition, the study has identified timber broker nexus with forest officials and illegal extraction of forests backed by political intervention are the major sources of deforestation. The study revealed that good forest governance had a positive impact on forest dependency while socioeconomic variables like education and landholdings were negatively associated with forest dependency.

Keywords: Forest governance, Forest dependency, Non-timber forest products, Accountability, Participation, Beta regression

About 300 million people live within or adjacent to the dense forest (WWF 2019) and roughly 1.6 billion people depend on forest and forest products including food or fuel (Chao 2012, FAO 2020) and about 27 percent of household incomes derive from the forest (Angelsen et al 2014). Forests also provide global public goods like climate change mitigation, biodiversity, and carbon sequestration. The forest governance element like the control of corruption plays a leading role to enforce forest rules and regulations effectively for sustainable forest management (Banana et al 2014). The livelihood strategies are influenced by forest governance (Mustalahti et al 2012). In addition, governance has a strong link to forest conditions because of the existence of institutions that restrict forest use. There are three approaches for measuring forest dependency. The first approach is forest income (Rustin 2008, Wunder et al 2014). The second approach deals with livelihood or non-forest income forest dependency (Newton et al 2016, Basu 2020, Lauren et al 2020). The livelihood approach covers the use of forest products like fuel wood, food, fodder, and non-timber forest products as the measure of forest dependency (Sapkota and Odén 2008, Pandey 2010). The third is the socio-economic characteristics are the measure of forest dependency (Ntiyakunze 2021). The contribution of forest income is 22% of total household income across 17 developing countries while income lies between 14 and 20%

in South America (Uberhuaga et al 2012). In the case of Asian and African countries, it varies from 10 to 20% and 30 to 45% of total household income respectively (Mukul et al 2016).

Some studies have focussed on the importance of Non-timber forest products (NTFPs) to the livelihood of people in Africa and Asian countries including India (Babulo et al 2008, Bwalya 2013). It is emphasized that forests act as safety nets for the rural poor in times of crisis due to drought. Besides, more literature has revealed that there is a nexus between forest dependence and forest-based poverty alleviation strategies (Nielsen et al 2012). The main objectives is to measure forest governance and forest dependency at the household level and identify the causes of deforestation including the impact of forest governance on forest dependency.

MATERIAL AND METHODS

Study area: The study was conducted in the Buxa Tiger Reserve, Alipurduar Forest division, situated in the district of Alipurduar, the Northern part of West Bengal. There are various ethnic tribes such as Rajbanshi, Santhals, Bodo and Toto, Oraons, etc. living in this district. The overall literacy rate is 64.7% of which the male literacy rate is 36.25% and the female rate is 28.47%. The major livelihood of the people is agriculture, tea garden labor, and forestry. This forest division is a combination of rivers, hills, tea gardens, and

forests. Forests cover of different districts of West Bengal is shown (Fig. 1). The study area has witnessed a declining trend in forest cover, reserved forest as well as protected forest (Table 1).

Sampling technique: The study utilizes primary data and data has been collected from the selected villages under Buxa Tiger Reserve in the Alipurduar Forest Divisions, during 2020-21. In the North Bengal forest division, we have taken one forest division like Alipurduhar purposively. In the Buxa Tiger Reserve forest area, we have selected 6 villages based on tribal population concentration. Once the villages are selected, 20% of households from each village are selected randomly. Total number of households consists of 151. Data have been collected by interview method based on the structured questionnaire.

Analytical Model

Forest dependency index: Forest dependency is measured by the forest dependence index (FDI) (Lauren et al 2020). There are four main indicators used for the formulation of forest governance index. They are Forest Collection Importance (FCI), Physical Asset (PA), Wealth (Wh), and Non-forest livelihood strategy (NFLS) (Basu 2021). The sub-indicators are selected in consultation with local elders, forest beat officers, and with literature review shown in Table 12. All sub-indicators have been normalized and such normalized score value takes 0 to 1. After normalization, we take the simple average of all sub-indicators to get forest dependency index.

$$\text{Forest dependency index} = \frac{\sum (FCI+PA+Wh+NFLS)}{4} \quad (1)$$

The forest dependency index also lies between 0 and 1. Higher the index values represent higher forest dependency and vice-versa.

Forest governance index: Forest governance is measured by the forest governance index (FGI). FAO's governance has taken six main indicators like rule of law (RL), transparency (T), accountability (A), participation (P), inclusive and equitable (IE), and efficient and effective (EE). A description of main indicators along with the sub-indicators is presented in Table 11. All sub-indicators have been normalized and lies between 0 and 1. Then, simple averages of all sub-indicators are made. Once indices values of all sub-indicators are made can have separate indices of main indicators like indices of Rule of Law (RL), Transparency (T), Accountability (A), Participation (P), Inclusive and Equitable index (IE) and Efficient and Effective index (EE).

The overall forest governance index is measured by the averages of the Rule of Law index (RL), Transparency index (T), Accountability index (A), Participation index (P), Inclusive and Equitable index (IE), and Efficient and Effective index (EE). That is,

$$\text{Forest Governance Index} = \frac{\sum (RL+T+A+P+IE+EE)}{6} \quad (2)$$

The forest governance index lies between 0 and 1. Higher the index value of forest governance shows the indication of good forest governance and vice-versa.

Calculation of forest governance and forest dependency index of the sub-indicators and main indicators are presented in the Tables 11 and 12 respectively.

Model specification and estimation technique : To identify the factors affecting forest governance we apply the beta regression model. This model has been used because of the

Table 1. Trends of forest area, reserve forest and protected forests in Alipurduar forest division

Year	Forest area (ha)	Reserve forest (ha)	Protected forest (ha)
2009-10	179000	144300	16600
2013-14	179000	144300	16600
2018-19	106715	97503	9210

Source: District Survey Report, Govt. of West Bengal, 2021



Source: FSI 2020

Fig. 1. Forest cover in West Bengal

dependent variable say forest dependence index lies in the interval of (0, 1) (Das and Basu 2022).

Beta regression: Let $y_1, y_2, y_3, \dots, y_n$ be the values of dependent variable and each y_i follows beta distribution with two parameters p and q . That is, $B(p, q)$.

The beta regression model is given by

$$G(\mu) = \beta_0 + \beta_1 x_{11} + \beta_2 x_{12} + \beta_3 x_{13} + \beta_4 x_{14} + \beta_5 x_{15} + \beta_6 x_{16} = \eta_i, \quad i = 1, n \quad (3)$$

Table 2. Distribution of sample households in Alipurduhar forest Divisions of West Bengal

Alipurduar Forest Division, North Bengal	
Alipurduar	
Village name	No. of households
Garobasti	26
Pampubasti	29
Rabhabasti	15
Santrabari	25
28 Basti	25
Jayanti	31
Total = 6	151

Source: Field survey

Table 3. Socio-economic conditions of the sample households in the Alipurduar Forest Division

Socio-economic variables	Garobasti N=26	Pampubasti N=29	Rabhabasti N=15	Santrabari N=25	28 Basti N=25	Jayanti N=31	All N=151
Social status							
SC	3 (11.54)	3 (10.34)	2 (13.33)	2 (8)	1 (4)	7 (22.58)	18 (11.92)
ST	14 (53.85)	16 (55.17)	7 (46.67)	16 (64)	18 (72)	9 (29.03)	80 (52.98)
General	9 (34.62)	10 (34.48)	6 (40)	7 (28)	6 (24)	15 (48.39)	53 (35.10)
Gender							
Female	2 (7.69)	5 (17.24)	3 (20)	8 (32)	3 (12)	5 (16.13)	26 (17.22)
Male	24 (92.31)	24 (82.76)	12 (80)	17 (68)	22 (88)	26 (83.87)	125 (82.78)
Age of head of households							
21-40 years	11 (42.31)	18 (62.07)	6 (40)	10 (40)	14 (56)	7 (22.58)	66 (43.71)
41-60 years	10 (38.46)	8 (27.59)	8 (53.33)	13 (52)	10 (40)	19 (61.29)	68 (45.03)
above 60 years	5 (19.23)	3 (10.34)	1 (6.67)	2 (8)	1 (4)	5 (16.13)	17 (11.26)
Education							
Illiterate	10 (38.46)	6 (20.69)	7 (46.67)	8 (32)	10 (60)	9 (29.03)	50 (33.11)
Primary	5 (19.23)	9 (31.03)	2 (13.33)	8 (32)	4 (16)	5 (16.13)	33 (21.85)
Secondary	9 (34.62)	12 (41.38)	6 (40)	8 (32)	10 (40)	15 (48.39)	60 (39.74)
Above secondary	2 (7.69)	2 (6.90)	-	1 (4)	1 (4)	2 (48.39)	8 (5.30)
Average of family size	4.42	3.31	4.2	3.68	3.52	3.68	3.76
Economic status							
BPL	25 (96.15)	27 (93.10)	14 (93.33)	22 (88)	22 (88)	19 (61.29)	129 (85.43)
APL	1 (3.85)	2 (6.90)	1 (6.67)	3 (12)	3 (12)	12 (38.71)	22 (14.57)
Land holding (acre)							
Land less	1 (3.85)	-	-	-	-	15 (48.39)	16 (10.60)
<1 Acre	20 (76.92)	26 (89.66)	13 (86.67)	20 (80)	22 (88)	16 (51.61)	117 (77.48)
>= 1 Acre	5 (19.23)	3 (10.34)	2 (13.33)	5 (20)	3 (12)	-	18 (11.92)

Source: Field survey; Figures in parentheses show percentage of total households

Here, η_i is the linear predictor for the i th observations and $G(\cdot)$ is the link function. The logit link is used in our study [$G(\mu) = \log \mu / 1 - \mu$] for beta regression.

Where x_{11} = Forest governance index

x_{12} = Age of the head of household, x_{13} = Educational index

x_{14} = Caste of the head of the households

x_{15} = Landholdings (in acre)

x_{16} = % of forest income to total income (in INR),

y_i = Dependent variable = Forest dependency index

RESULTS AND DISCUSSION

The socio-economic condition of the sample households of the Alipurduar forest division are shown in Table 3. The sample households are dependent on the collection of NTFPs which include fuelwood, fodder, herbals, sal seeds and honey for their livelihood apart from agriculture and wage labour. About 78.81 percent of households collect fuelwood, followed by collection of mushroom, honey, fodder, herbals and others (Fig. 2).

The forest dependence index of the households is 0.539 (Table 4). The non-forest livelihood strategy index, wealth

index, forest collection importance index and physical asset index are 0.673, 0.538, 0.516, and 0.429 respectively. The households are classified into less forest dependence, moderate dependence and high dependence based on the values of forest dependence indices (Table 5). About 80 percent of households are highly forest dependent. The forest governance index in Alipurduar forest division is 0.483 (Table 6). The participation index value is highest followed by inclusive and equitable index and transparency index. The rule of law and efficient and effective indices are lowest compared to the other main indicators.

More than 95% of households expressed timber broker nexus with forest officials and 70 % of households expressed illegal forest extraction backed by political parties are responsible factors for deforestation in the Alipurduar forest division. About 72% of households pointed out that high forest dependency is not a responsible factor for deforestation (Table 7). The correlation matrix of the selected variables is calculated (Table 9). Since the dependent variable is forest dependency ranges in the interval of 0 to 1, beta regression is more appropriate to estimate the determinants of forest dependency. The estimates of beta regression model for Alipurduar forest division are presented in Table 10. The beta regression is run by adjusting heteroscedasticity.

Out of six independent variables included in the model, only four variables like forest governance index, educational index, landholdings, and percentage of forest income to total income are showing significant results. The model is overall significant as the LR Chi-square statistic is 103.77 (Table 10). The coefficient of the forest governance index is positive and significant. This means that forest dependency increases with the increase in forest governance. The increase in the forest dependency index shows there has been an increase in livelihood generation from forests. Thus, it also implies that good forest governance has a positive effect on the dependency vis-à-vis the livelihood generation of forest-

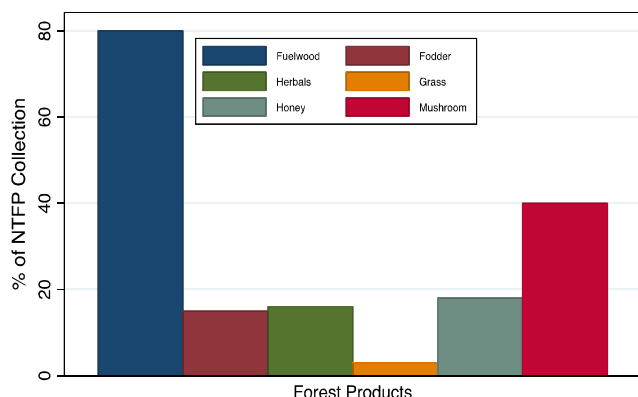


Fig. 2. Dependency on NTFPs in Alipurduar Forest Division

Table 4. Forest dependency index of households in the Alipurduar forest divisions in West Bengal

Forest dependence index	North Bengal
	Alipurduar
Forest collection importance index	0.516
Physical asset index	0.429
Wealth index	0.538
Non-forest livelihood strategies index	0.673
Forest dependency index	0.539

Table 5. Classification of forest dependent households in Alipurduar forest division

Forest dependency index	Assigned attribute	Households	
		Number	%
≤ 0.20	Less forest dependence	1	0.662
0.21-0.40	Moderate forest dependence	29	19.205
>0.40	High forest dependence	121	80.132

Table 6. Forest governance index across four forest divisions in South and North Bengal

Main indicator	Forest governance index
	Alipurduar
Rule of law index	0.172
Transparency index	0.545
Accountability index	0.385
Participation index	0.897
Inclusive and equitable index	0.775
Efficient and effective index	0.126
Governance index	0.483

Table 7. Causes of deforestation at the household level in Alipurduar forest division

Reasons for deforestation	Yes (=1)	No (=2)	Don't know (=3)
High forest dependency	37	109	5
Timber broker nexus with forest officials	144	3	4
Illegal extraction of forest due to political intervention	106	3	42

Table 8. Basic statistics for Alipurduar forest division

Variables	Mean	S D
Forest governance index	0.483	0.100
Forest dependency index	0.538	.0118
Age (in years)	44.596	12.148
Educational index	0.283	0.156
Caste	2.231	0.647
Landholdings (in acres)	0.429	0.498
% of forest income to total income	7.838	

Table 9. Pair wise correlation coefficient matrix of the selected variables

	Forest governance index	Forest dependency index	Age	Educational index	Caste	Landholdings	% of forest income to total income
Forest governance index	1.0000						
Forest dependency index	0.1860*	1					
Age	-0.0822	-0.1062	1				
Educational index	0.0063	-0.0989	-0.0853	1			
Caste	0.0093	-0.0820	0.1332	-0.0220	1		
Landholdings	0.1629*	-0.1953*	-0.0940	0.0208	0.0289	1	
% of forest income to total income	0.1328	0.6266*	-0.1513	0.0663	0.0076	0.0486	1

*significant at 5% level

Table 10. Estimates of beta regression model for Alipurduar Forest Divisions, West Bengal

Independent variables	Dependent variable = Forest Dependence Index			
	Coefficient	SE	Z- values	P-values
Forest governance index	0.6632	0.2847	2.33	0.020
Age of head of households	- 0.0009	0.0023	-0.39	0.699
Educational index	-0.4360	0.1785	-2.44	0.015
Caste	-0.0616	0.0432	-1.43	0.154
Landholdings	-0.0252	0.0585	-4.31	0.000
Percentage of forest income to total income	0.0440	0.0042	10.33	0.000
Constant	-0.1180	0.1826	-0.06	0.948

No. of observations = 151
 LR Chi square (6) = 103.77
 Prob > Chi square = 0.000
 Log likelihood = 162.45

dependent households. That is good governance helps to improve the livelihoods of the poor people who are forest dependent. This result is supported by the results in Nepal (WWF Nepal 2016). Education harms forest dependency. This means that the person with more education is less forest dependent. Higher education offers a lot of better employment opportunities compared to the forest sector. This result is consistent with the other studies (Fonta and Ayuk 2013, Baiyegunhi et al 2016). Similarly, the coefficient of land holdings is negatively associated with forest dependency. It seems to be the fact that high-holding farms have more opportunities for getting income from agriculture instead of depending on forests. Wen et al (2017) and Babulo et al (2009) also observed same trend. The coefficient of forest income to total income is positive and significant. This means that forest dependency increases with the increase in forest income and vice-versa. This further means that forest income has a positive impact on forest dependency. This result supports the result of Ntiyakunze (2021) in Tanzania.

CONCLUSION

The study concludes that there is poor socio-economic

conditions of the households in the study area. More than 80% of households are small and marginal farmers, and 64% belong to ST and SC populations. More than 80% of households are living below the poverty line. More than 80% of households are highly forest-dependent and they depend on fuelwood, mushroom, honey, fodder, and herbals for livelihood generation. The forest dependence index (FDI) of the households in the forest division of Alipurduar is 0.539 and the forest governance index is 0.483. The participation index value is highest followed by the inclusive and equitable index and transparency index. The rule of law and efficient and effective indices are found to be the lowest compared to the other main indicators. The study has identified timber broker nexus with forest officials and illegal extraction of forests backed by political intervention are the major sources of deforestation and forest dependency is caused by forest governance, education, landholdings, and the percentage of forest income to total income. The paper calls for controlling illegal forest logging and strengthening the proper functioning of the institutions particularly the forest sector such that sustainable development of forests is ensured.

Table 11. Forest governance index for Alipurduar Forest divisions in West Bengal

Main indicators	Sub indicators	Alipurduar	
Rule of law	Govt. rules regulating forest use	0.073	
	Existence of any rule for use of forest product	0.349	
	Encouragement for timber brokers for deforestation due to leakage in forest laws	0.149	
	Weak forest administration leads deforestation	0.036	
	Encouraging encroachers and illegal extraction due to political intervention	0.288	
	Strong administration saves RF	0.139	
		0.172	
Transparency	Need of permission to collect/ harvest forest product	0.344	
	If Y, do the users have to pay	0.629	
	Issuance of permit by the correct authority	0.232	
	Clearance of the agenda of the meeting	0.974	
		0.545	
Accountability	Regular presence in the meeting of the FPC	0.020	
	Experience of conflict in last 5 years	0.974	
	Obeying Govt rules by community members	0.162	
		0.385	
Participation	Planning index	Forest boundary demarcation	0.871
		Identifying forest users	0.868
		Participatory forest resource assessment	0.891
		Forest management committee election	0.921
		Encouraging others to participate	0.950
		Preparing forest management plan	0.914
		Developing forest management by laws	0.924
		Approval of forest management agreement	0.921
			0.907
	Implementation index	Reforestation of degraded forest areas	0.858
		Planting of fruit bearing trees such as mahua & mango	0.788
		Planting trees & management	0.669
		Nursery establishment	0.821
		Beekeeping	0.639
		Forest fire fighting	0.947
		Attending meetings	0.970
		Participations in knowledge & skill developing training	0.970
			0.833
	Monitoring index	Follow ups forest managements by law	0.964
		Forest patrols	0.921
Reporting of illegal activities		0.967	
Supervise forest management plan implementation		0.937	
Forest boundary maintenance		0.970	
		0.952	
		0.897	
Inclusive and equitable	SHG formation for female members	0.775	
Efficient and effective	Changes in the availability of Wood & NTFP in last 5 years	0.185	
	Poverty eradication programme reduce dependency on FPs	0.066	
		0.126	
Governance index		0.483	

Source: Field survey data

Table 12. Forest Dependence Index (FDI) in Alipurduar forest division

Main index	Sub index	Value
Forest collection importance	Collected forest products	0.243
	Household dependent on forest	0.788
		0.516
Physical asset	Distance from home to forest	0.278
	Avg. time spend by HHs for collecting NTFP	0.334
	Household engage in collection NTFP	0.430
	Gender engage in collection NTFP	0.673
Wealth	Total land holding including forest land	0.429
	Livestock	0.715
	Type of house	0.038
Non forest livelihood strategies	Agricultural income	0.538
	Business income	0.861
	Service income	0.895
	Monthly wage	0.963
FDI		0.648
		0.673
		0.539

Source: Field survey data

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