Ecology, Economy and Society–the INSEE Journal 6(2): 7-31, July 2023

RESEARCH PAPER

Does Assignment of Individual Property Rights Improve Forest Conservation Outcomes? Empirical Evidence from West Bengal, India

Sandip Chand* and Bhagirath Behera**

Abstract: The past few decades have seen significant changes in the governance of forests in India. The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Rights on Forest) Act (FRA), 2006, was a landmark act passed in the Indian Parliament to assign individual property rights over forest resources that have been de facto used by local communities. This paper examines whether the assignment of individual property rights results in positive outcomes for forest conservation using village-level forest *patta* (forest land title) and census data from Bankura district in West Bengal. Vegetation Continuous Fields data has been used to measure the change in forest cover from 2006 to 2012. The results show that the percentage of forest patta land in the village, distance to markets, the existence of pucca roads, and the presence of forest protection committees (FPCs) are negatively and significantly related to forest degradation, implying improvement in forest conservation outcomes. The presence of tribal people, a larger population, and higher literacy rate are positively associated with forest degradation, meaning that they have an undesirable impact on forest conservation outcomes. The findings of this study strongly suggest that the assignment of individual property rights to both the Scheduled Tribes (STs) living in the forest and Other Traditional Forest Dwellers (OTFDs) under the FRA, 2006, tends to improve forest conservation outcomes. Hence, it is suggested that the distribution of individual forest rights (IFRs) under the FRA may further improve forest conservation outcomes.

Keywords: Forest Rights Act, Individual Forest Rights, Forest Governance, Forest Conservation, West Bengal.

* Research Scholar, Department of Humanities and Social Sciences, Indian Institute of Technology, Kharagpur, India. chandsandip12@gmail.com

** Professor, Department of Humanities and Social Sciences, Indian Institute of Technology, Kharagpur, India. bhagirath9@gmail.com

Published by Indian Society for Ecological Economics (INSEE), c/o Institute of Economic Growth, University Enclave, North Campus, Delhi 110007.

ISSN: 2581–6152 (print); 2581–6101 (web).

DOI: https://doi.org/10.37773/ees.v6i2.709

1. INTRODUCTION

According to property rights theory, a person who holds exclusive rights to a property has an incentive to protect it because he or she will keep getting services from it. It further suggests that there are different classes of property rights holders, who have varying rights with respect to incentives, the types of activities undertaken, and the outcomes achieved (Schlager and Ostrom 1992; table 1). The bundles of property rights may be de jure or de facto. De jure rights are those that can be enforced legally with formal institutions, whereas de facto rights originate among and are enforced by resource users themselves (Schlager and Ostrom 1992). The right of exclusion provides proprietors considerable incentives to undertake required investments in natural resources because they can be reasonably confident of earning a return on their investment (Posner 2014). Therefore, exclusion rights incentivize resource owners to make long-term investments in the resource that he or she owns and make it more productive (Schlager and Ostrom 1992).

In light of the above arguments in favour of individual property rights, it can be seen why nearly every developing country in the world is currently experimenting with some kind of change in natural resource management by devolving some rights to the community and individual users to use and manage natural resources (Edmonds 2002; Persha *et al.* 2010). For several decades, India has also devolved a significant degree of property rights concerning the management of forest resources to local communities. The first step in this regard was taken in the 1988 National Forest Policy, which accepted the role of local people in forest resources management, followed by the adoption of the Joint Forest Management Programme in 1990. However, in 2006, a landmark forest act, called the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Rights on Forest) Act, was passed in the Indian Parliament, which assigned individual property rights to forest dwellers over forest resources that have been de facto used by them. However, it is important to note that individual property rights granted to forest dwellers under the FRA are not well defined in contrast to private property rights. For instance, under the FRA, forest dwellers do not have the right to transfer/trade forest land for which the *patta* (documented legal right/title over forest land) has been provided, and hence, they lack exclusive ownership rights over the land (Table 1), which violates the fundamental conditions needed to ensure an efficient structure of property rights with respect to a private property regime (Behera and Engel 2006). Table 2 summarizes the evolution of major forest policies, acts, and programmes in India since Independence, which clearly shows that over the

years, India has devolved several critical rights over forest resources to local forest dwellers.

Table 1: Bundles of Property Rights in FRA

Bundles of Rights	**Position**	**Patta Land**	**Community Forest Resources**
Access and withdrawal	Authorized user	✓	✓
Management	Claimant	✓	✓
Exclusion	Proprietor	✓	✓
Alienation	Owner	×	×

Source: Authors

Section 3(1) of the FRA provides de jure access, withdrawal, management, and exclusion rights in the case of IFRs, locally known as forest *patta* (see Table 1). As per Section 4(4) of the FRA, the rights recognized and vested will be heritable but not transferable or alienable, and in the absence of a direct offspring, the rights will be passed on to the patta holder's closest relatives. Since forest dwellers cannot sell or lease their rights of management and exclusion over patta land under the FRA, the patta holders are the de jure proprietors of that land. The official statistics of the Ministry of Tribal Affairs (Government of India 2021) indicate that 1,973,349 pieces of IFR land have been distributed, which cover 1.72 million hectares of forest land.

Given the above-mentioned strong arguments in favour of devolving individual property rights to achieve effective natural resources management and conservation outcomes, it is imperative to examine whether assignment of IFRs to forest dwellers under the FRA in India have improved forest conservation outcomes. Limited studies have examined the effectiveness of the FRA in improving these outcomes. This paper attempts to bridge this knowledge gap. We identify factors that are likely to influence forest conservation outcomes through an extensive review of the related literature and using our own understanding from field visits and analyse these factors using appropriate regression techniques. These factors include the assignment of individual property rights over forests along with physical, socio-economic, and demographic factors that may influence effective forest resource management and conservation outcomes after the implementation of the FRA.

Table 2: Evolution of Forest Policies in India since Independence

Major Forest Policies, Acts, and Programmes	Main Features
Indian Forest Policy, 1952	Introduced a functional classification of forest land. It aimed to bring 33% of the total geographical area of the country under forest cover
National Commission on Agriculture, 1976	Emphasis on meeting the requirements of forest-based industries through commercial forestry following a scientific approach to growing trees
Forest Conservation Act, 1980	Minimize deforestation and conserve biodiversity and wildlife
Indian Forest Policy, 1988	Recognition of the participation of local forest inhabitants in the protection of forest resources
Joint Forest Management Programme, 1990	Adoption of forest department and community-based joint forest management
Forest Rights Act, 2006	Devolution of forest rights to ST forest peoples and other traditional forest dwellers

Source: Authors

There is a large body of literature on the variables that might explicate the differential outcomes seen in forest conservation. It is observed that forest degradation is multifaceted, context-dependent, and caused by several socio-economic and demographic processes. A significant number of deforestation drivers have been reported globally, although the causes of deforestation are complex and region-specific (Ullah *et al.* 2022). Geist and Lambin (2001) arrived at a multi-causal structure of the determinants of deforestation, which describes the various interlinked proximate and underlying factors that contribute to deforestation. The proximate factors are human interventions that directly affect forest conservation or degradation outcomes—for example, wood extraction, expansion of agriculture, and extension of infrastructure. The underlying factors are vital factors that reinforce the proximate factors, which include demographic, socio-economic, technological, and policy and institutional factors (Geist and Lambin 2001).

Demographic factors significantly influence forest conservation outcomes. Human population pressure has been shown to be an important factor contributing to forest degradation (Wibowo and Byron 1999). Population size can have an impact on deforestation through the number of rural households requiring lands for farming, firewood, and timber (Kaimowitz and Angelsen 1998; López 2022).

Socio-economic factors play an important role in forest conservation and degradation. Households associated with forest degradation have low incomes, are less educated, and own less land (Mena, Bilsborrow, and McClain 2006; Yanai *et al.* 2020). Moreover, marginal farmers and labourers are more likely to be involved in deforestation due to insufficient physical and financial capital (Angelsen *et al.* 2014; Nerfa, Rhemtulla, and Zerriffi 2020). Consequently, families with relatively lower socio-economic status are more likely to contribute to deforestation (Specht *et al.* 2019). In addition, forest degradation is also found to be linked to closer proximity to markets and towns, shorter distance from the main roads and waterways, and greater road density, all of which assist in resource extraction activities and fuel an increase in demand for forest produce (López 2022; Haq *et al.* 2022; Li *et al.* 2015).

Cultural factors (e.g., beliefs and individual or household behaviours) are also important drivers of forest conservation outcomes. The indigenous and traditional cultures of India hold the religious view that plants and groves in the natural world are sacred (Sukumaran *et al.* 2008; Ray and Ramachandra 2010; Singh *et al.* 2010). Since ancient times, such socio-cultural and religious beliefs among indigenous groups have helped in conserving forest areas (Kandari *et al.* 2014).

Policy and institutional factors are crucial in forest conservation. As mentioned above, property rights regimes, titling, legalization, and consolidation (of individual titles) may influence conservation outcomes. In developing countries, co-management or joint forest management policies have been implemented, which have had mixed outcomes with regard to forest management and protection (Datta and Sarkar 2012; Behera 2009).

Very few empirical studies exist that examine the impact of the FRA on forest conservation outcomes even 14 years after the implementation of the Act. Khosla and Bhattacharya (2020) emphasize the recognition of IFRs, which have a substantial effect on forest conservation outcomes. Guntuka and Kukrety (2019) studied changes in forests using geospatial tools and recorded the net impact of the implementation of the FRA on forest conservation. Their results show that the forest areas awarded to tribal households under the FRA seem to have been adversely affected in terms of forest conservation outcomes, and the continued use of forest areas for agriculture under the FRA as well as encroachment may further adversely influence the ecosystem (Guntuka and Kukrety 2019). Some wildlife activists have opposed the FRA as being anti-conservation. However, others indicate that under the Act, local communities can be roped in to promote biodiversity conservation by blocking the use of forest land for

large-scale construction projects and by applying local knowledge and values to promote conservation (Broome, Rai, and Tatpati 2017; Sarangi 2017).

The remainder of this paper is organized as follows. Different provisions under the FRA and a description of its organizational structure are presented in Section 2. Section 3 provides a description of the study area, the sources of data used in the study, and the methods applied to analyse the data. The results and discussion are presented in Section 4. Section 5 concludes with significant policy implications.

2. PROVISIONS UNDER THE FRA AND ITS ORGANIZATIONAL STRUCTURE

As indicated in Section 1, the FRA empowers local communities by giving them some property rights over forests, which is a radical departure from previous forest policies, including provisions under the Joint Forest Management Programme. The primary goal of the FRA is to "recognize and vest the forest rights over forest land in forest-dwelling STs (FDSTs) and OTFDs who have been residing in forests for generations but whose rights could not be recorded." The Act grants forest dwellers rights over the sustainable use of forest resources, biodiversity conservation, and maintenance of ecological balance (Ministry of Tribal Affairs 2006). Therefore, it decentralizes forest management and devolves responsibility for it to forest dwellers and local village-level institutions in place of the state (Lee and Wolf 2018). The Act applies to tribal people and OTFDs who have been residing for three generations—which means for over 75 years before 2005—and who rely on nearby forest resources for their livelihood requirements (Ministry of Tribal Affairs 2006).

There are three categories of forest rights that the eligible parties can claim: (1) individual rights to forest land for self-cultivation and habitation; (2) community rights of ownership, collection, and use of traditionally collected non-timber forest produce as well as other customary community rights; and (3) community forest resource (CFR) rights, which establish legitimate community-based forest governance (Ministry of Tribal Affairs 2006; Lee and Wolf 2018). The Act recognizes 13 specific rights of forest dwellers which previously existed in all types of forest lands, even in protected areas (CFR–LA 2016; Ministry of Tribal Affairs 2006). Section 5 of the FRA empowers forest patta holders and the gram sabha to act to conserve and protect forests, wildlife, and biodiversity as well as their adjacent catchment areas (Ministry of Tribal Affairs 2006). Table 3 reports the main rights and responsibilities enshrined in the FRA, and Figure 1 presents the

organizational structure of the FRA, indicating various activities and the corresponding institutional levels.

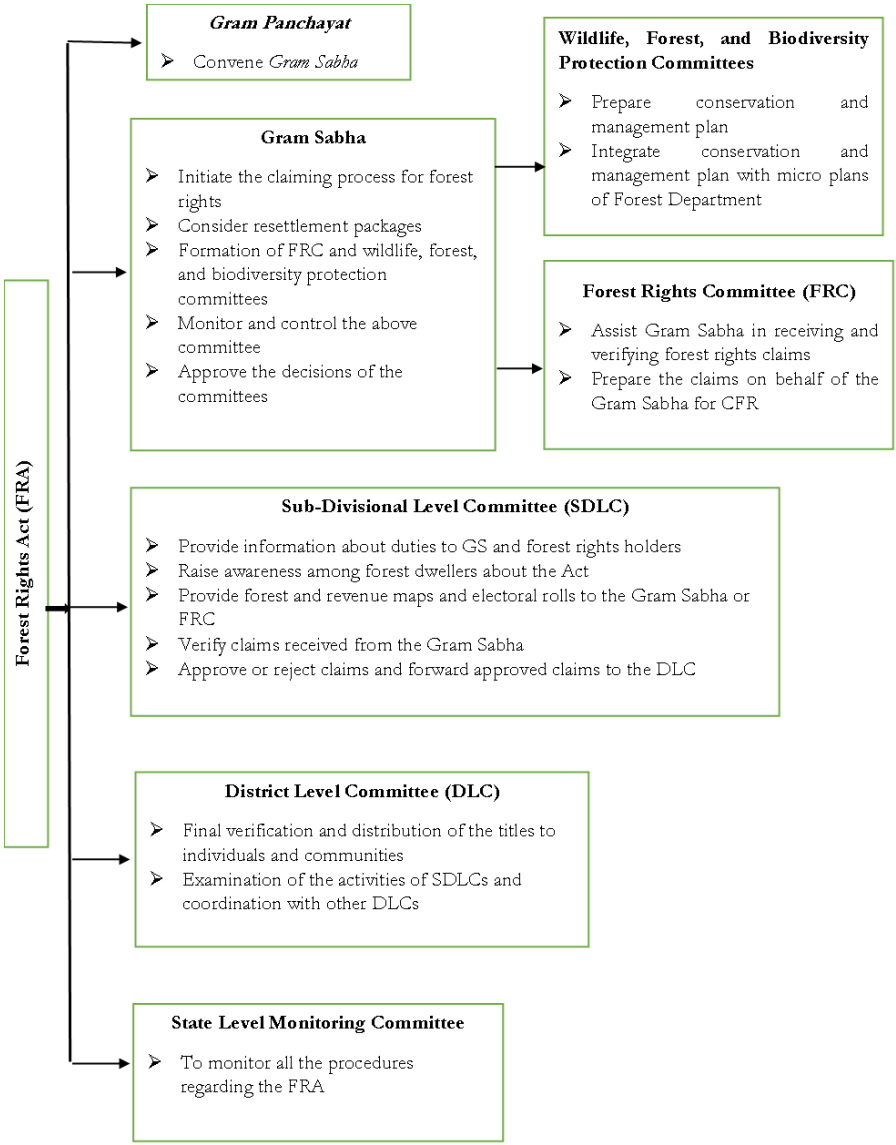
Table 3: Rights and Responsibilities of Forest-Dwelling Scheduled Tribes (FDSTs) and Other Traditional Forest Dwellers (OTFDs) under the FRA

Types	**Rights and Responsibilities**
Individual forest rights	(1) Rights to inhabit and cultivate forest land for livelihood needs (2) Rights over disputed lands and rights for the conversion of pattas or leases or grants issued by any local authority or any state government on forest land to titles (3) Rights to in-situ rehabilitation and getting alternative land in case of illegal eviction
Community rights	(1) Rights to own, collect, and use minor forest products (2) Community rights of forest-dependent people, for instance, *nistar*[1] (3) Other community rights such as fishing, grazing, etc. (4) Rights to have access to biodiversity and intellectual property rights over biodiversity (5) Habitation rights for primitive tribal groups (6) Any other customarily enjoyed traditional rights excluding hunting
Rights to community forest resources	Protection and management rights over those community forest resources that they have been taking care of so far for sustainable use
Duties of the forest rights holder and gram sabha	(1) Protect wildlife, forests, and biodiversity (2) Protect adjoining catchment areas and other ecologically sensitive areas (3) Confirm that the regulation decision of community forest resources is in accordance with the aim of protecting wild animals, the forest, and the biodiversity

Source: Authors

[1] *Nistar* refers to the permission given to forest dwellers to extract small trees from forest areas at predetermined rates, along with certain forest products meant for personal and legitimate domestic consumption.

Figure 1: Organizational Structure of the FRA (Activities at Various Institutional Levels)



Source: Authors

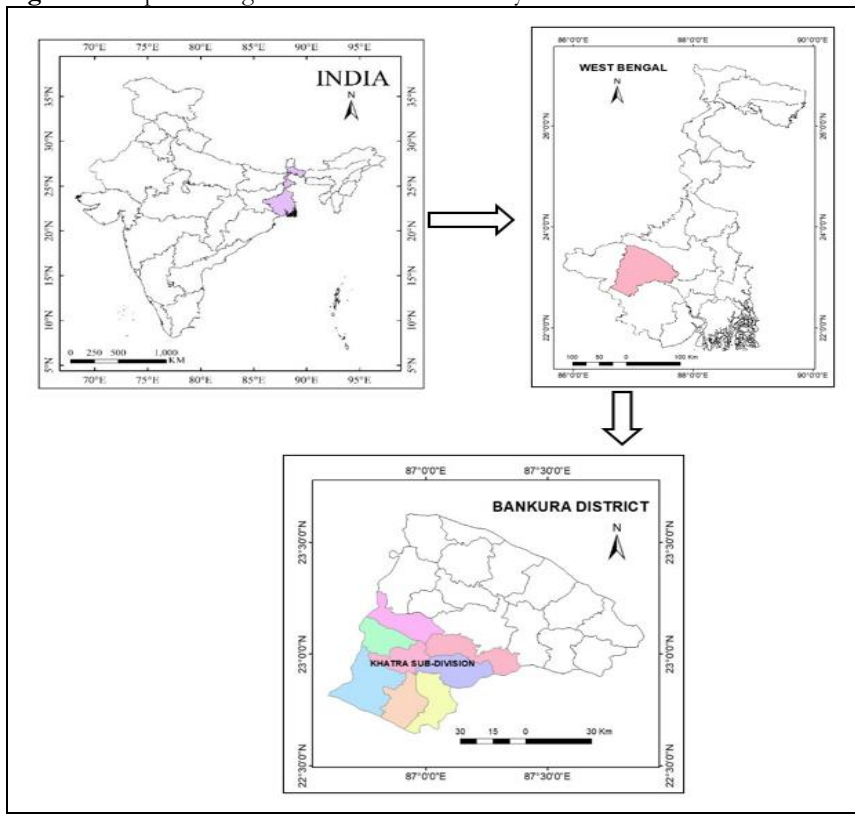
3. STUDY AREA, SOURCES OF DATA, AND METHODS

This section presents a detailed description of the study area, including geographical features and forest characteristics. In addition, a detailed discussion of the data sources and methods used in this study is reported.

3.1. Description of the Study Area

Forests in the state of West Bengal in India are found in three major regions: in the south-west, in the north, and in the Sundarbans region. This study was carried out using remotely sensed forest cover data in Bankura district in West Bengal. Bankura district is situated in the south-western part of the state between 22° 38′ and 23° 38′ north latitude and 86° 36′ and 87° 46′ east longitude.

Figure 2: Map Showing the Location of the Study Area



Source: Authors

This district has three subdivisions—Bankura, Bishnupur, and Khatra. Khatra subdivision, shown in Figure 2, is our study area. Most of the tribal population who are directly dependent on the forest for their livelihoods have been residing in Khatra subdivision for centuries. Geologically, it is a plateau fringe area. Sal (*Shorea robusta*) is the most common species in this forest; other significant species include *shimul* (*Bombax ceiba*), *palash* (*Butea monosperma*), *mahua* (*Madhuca longifolia*), *gamar* (*Gmelina arborea*), teak (*Tectona grandis*), *shirish* (*Albizia lebbeck*), *arjun* (*Terminalia arjuna*), and bamboo. Table 4 shows the biannual status of forest cover in Bankura district from 1991 to 2021. The data shows an increasing trend in total forest cover from 1991 to 2019. However, a negative change can be seen in 2021.

Table 4: Year-Wise Forest Cover in Bankura District

Year	Geographical Area (GA)	Very Dense Forest	Moderately Dense Forest	Open Forest	Total Forest Cover	Percentage of GA	Change with Respect to Previous Assessment
1991	6,882	153		600	753	10.94	—
1993		160		660	820	11.92	11.92
1995		197		653	850	12.35	30
1997		226		641	867	12.60	17
1999		233		636	869	12.63	2
2001		453		482	935	13.59	26
2003		101	295	584	980	14.24	45
2005		100	315	612	1,027	14.92	2
2009		214	510	332	1,056	15.34	2
2011		213	510	333	1,056	15.34	0
2013		222	365	657	1,244	18.08	188
2015		212	379	673	1,264	18.37	20
2017		220	388	662	1,270	18.45	8
2019		222.33	395.27	667.98	1,285.58	18.68	15.58
2021		226.34	411.67	641.36	1,279.37	18.59	−6.21

Source: *The India State of Forest Reports* from 1991 to 2021 (Forest Survey of India 2021).

Note: Area is given in sq km.

Table 5: Block-Wise Distribution of IFR Titles in Bankura District

Serial No.	Subdivision	Block	Total No. of Beneficiaries under the FRA 2006 (as Provided by the PO cum DWO of BCW[2])	Total No. of Beneficiaries under the FRA 2006 (According to BL & LROs[3])
1	Khatra	Taldangra	1,081	906
2		Hirbandh	718	602
3		Raipur	350	281
4		Khatra	182	255
5		Simlapal	792	727
6		Indpur	531	310
7		Ranibandh	630	511
8		Sarenga	374	268
9	Bankura	Bankura-I	0	0
10		Bankura-II	19	39
11		Barjora	184	159
12		Saltora	129	118
13		Onda	853	829
14		Chhatna	176	172
15		Mejia	6	6
16		Gangajalghati	273	273
17	Bishnupur	Bishnupur	505	505
18		Joypur	97	78
19		Kotulpur	0	0
20		Sonamukhi	233	233
21		Patrasayer	324	268
22		Indus	0	0
		Total	**7,457**	**6,540**

Source: District Land and Land Reforms Office (DL&LRO), Bankura (2020).

Table 5 reports the block-wise distribution of IFR titles in Bankura district. According to the project officer cum district welfare officer of the Backward Classes Welfare and Tribal Development Department,

[2] PO cum DWO of BCW refers to the project officer-cum-district welfare officer, Backward Classes Welfare Department.

[3] BL & LROs refers to the block land & land reforms officers.

Government of West Bengal, about 7,457 beneficiaries have received patta under the FRA here. Khatra subdivision has the largest number of beneficiaries as compared to the other two subdivisions—namely, Bankura and Bishnupur.

3.2. Sources of Data

There are about 1,400 villages in Khatra subdivision; among them, 89 are uninhabited and are therefore excluded from data collection. In addition, it is also observed that only 569 villages include forest areas, and these are considered in the model; 218 villages have obtained IFR titles (patta). Village-level forest patta data for these 218 villages have been collected from the Divisional Forest Office, Bankura. Socio-economic and demographic data have been sourced from the Village and Town Directory, Census 2011. The remotely sensed forest cover data obtained from the "Socioeconomic High-resolution Rural-Urban Geographic" (SHRUG) data set has been used for measuring the forest growth rate from 2006 to 2012 (SHRUG n.d.). Since the dependent variable is continuous, the ordinary least-squares (OLS) regression model has been used to analyse the data. A similar regression model has been used by other researchers (Dash and Behera 2015).

3.3. Variable Descriptions and Hypothesized Effects

3.3.1. Dependent Variable

Forest conservation outcomes are measured using a number of parameters: change in area under forest cover, change in canopy density, land degradation and soil erosion, reduction in wildlife numbers, and so on (Basu and Nayak 2011; Dash and Behera 2013). The change in percentage of forest cover from 2006 to 2012 has been measured using SHRUG data, as indicated above. It is important to note that the forest cover data available in the SHRUG data set are obtained from Vegetation Continuous Fields, which is a product of the Moderate Resolution Imaging Spectroradiometer (for more information, see Asher and Novosad 2019; Townshend *et al.* 2011). The average forest cover (in percentage) for 2006 for the respective village is measured by dividing the *total_forests value* by *num cells* (Equation 1). A similar method is used to determine the average forest cover (in percentage) for 2012 (Equation 2). The difference in the average forest cover values from the year 2006 to 2012 is taken as a change in forest cover for the respective village, where higher difference values mean that compared to 2006, there are fewer forests in 2012. Therefore, higher values indicate more forest degradation and lower values indicate less forest degradation (Equation 3). The primary reason for using 2012 SHRUG forest cover data is so that all socio-economic and demographic variables

used in the estimation of the model are from the same period because all the independent variables used in the model are taken from Census 2011. The average forest cover change (%) has been calculated using the following formulas:

The average forest cover (%) in 2006 = Value of *total_forests* for 2006/Value of *num_cells* for 2006. (1)

The average forest cover (%) in 2012 = Value of *total_forests* for 2012/Value of *num_cells* for 2012. (2)

Change in forest cover (%) = The average forest cover (%) in 2006 − The average forest cover (%) in 2012. (3)

3.3.2. Independent Variables and Their Hypothesized Effects

It is expected that the assignment of IFRs to forest dwellers may positively influence forest conservation outcomes as people enjoy de jure rights over the forest, and this may act as an incentive for further investment in forest lands to enhance productivity. It may also remove the fear of eviction resulting from insecure forest land tenure, which is often found to have a substantial effect on forest degradation (Datta and Sarkar 2012). Therefore, the assignment of IFRs, in our case, having a patta, could be a powerful incentive for the majority of traditional forest landholders to adopt more sustainable forest land management methods and, thus, contribute to forest growth (Kothari, Pathak, and Bose 2011). As such, there is no record in the official data regarding the types of IFR land; we assume that the larger IFR lands are agricultural land and could be backyard plantations or orchard land, whereas the smaller lands are mostly residential land. So, it is expected that villages with a larger average per capita size of IFR land and a higher proportion of IFR land to the total forest area are more likely to undertake better forest conservation measures, resulting in less forest degradation. The existence of FPCs under joint forest management in the village is another important variable that significantly influences forest conservation outcomes. Some studies have empirically shown improved conservation outcomes in forests managed and protected by FPCs (Ballabh *et al.* 2002; Behera 2008). Therefore, it is expected that the existence of FPCs would be negatively related to forest degradation.

Many researchers have suggested that user group characteristics tend to influence forest conservation management outcomes (Behera 2009; Agrawal 2001). Since free-riding issues are easier to resolve in smaller groups, smaller communities are more likely to be effective in the management and protection of forests than larger ones (Behera 2009).

Hence, in accordance with inferences in the literature, the size of the user group is hypothesized to be negatively associated with forest cover change. Here, the population size of the selected village is considered as the user group, and increased population is expected to have a positive relationship with forest degradation (Wade 1987; Heltberg 2001).

The tribal population in the village is another important variable in forest conservation outcomes. It is commonly understood that indigenous tribal people and their lives and livelihoods are intricately connected with forests. For this reason, it is expected that they will take good care of forests, aiding conservation. Hence, it is hypothesized that the higher the proportion of tribal people in the village, the lower the forest degradation.

The level of education is another important variable, which can directly and/or indirectly influence forest conservation outcomes. According to several studies, higher education levels among forest dwellers could increase their opportunity costs of pursuing traditional forest-based livelihood activities; hence, they may seek better off-farm employment opportunities, which could in turn minimize the burden on forest resources and increase forest cover in the village (Gunatilake 1998; Adhikari, Di Falco, and Lovett 2004). In addition, it is also observed that respondents with higher education levels tend to have a more positive attitude towards forest and biodiversity conservation in their private land than respondents with a lower education level (Baranovskis *et al.* 2022). Hence, the literacy rate of villagers is hypothesized to have a negative effect on forest degradation.

Marginal agricultural labourers form a sizeable population and rely on the forest and other common-pool resources for their daily livelihood activities, which is another key variable that is likely to influence forest conservation outcomes. It is observed in typical Indian villages that household reliance on forest resources is substantially linked to land holding size, as landless or marginal farmers often largely rely on forest resources for their livelihoods (Fernandes and Menon 1987). Therefore, the presence of a large population of marginal agricultural labourers is hypothesized to be positively associated with forest degradation.

The distance of the village to the nearest market is used as a proxy for market access, which can significantly influence forest conservation outcomes. The effect of market access on forest conservation outcomes is a priori ambiguous (Behera 2009). Some authors argue that easy access to markets can have a negative impact on outcomes by raising the demand for forest resources, which may lead to increased harvesting and depletion of these resources (Sundar 2000; Behera 2009). However, others argue that

Table 6: Dependent and Independent Variables and Their Expected Effects on the Model

Category	Variable	Definition	Expected Effects
Forest conservation outcome	ln of change in forest cover area	ln of change in percentage of forest cover from 2006 to 2012	Dependent variable
Institutional variables (assignment of property rights)	ln of IFR land size	ln of per capita average size of IFR land distributed to the villagers	—
	ln of Percentage of IFR land to total forest area	ln of percentage of IFR land to total forest area of the village	–
	Existence of FPC	Dummy variable = 1, if the village has FPC; 0, otherwise	–
Demographic variables	ln of population	ln of population in the village	+
Socio-economic variable	ln of Schedule Tribe population	ln of percentage of the scheduled tribe population to the total population of the village	–
	ln of literacy rate	ln of percentage of literate population to total population of the village	–
Economic variables	ln of marginal agricultural labour	ln of percentage of marginal agricultural labourer to total working population of the village	+
	Distance to market	Distance to the nearest market: categorical variable = 1 if the market is available within the village; if not available within the village, the distance range code depending on where it is available—namely, 2 for <5 km, 3 for >5 km	–
External environment	Existence of pucca roads	Dummy variable = 1, if the village has a pucca road; 0, otherwise	?

Source: Authors

access to markets facilitates more agricultural activity and diversifications of livelihood to non-farm activity (Agrawal and Chhatre 2006). This can minimize land-use pressure on forest resources, which may decrease forest degradation. However, the literature on the direction of effect is conflicting.

The existence of pucca roads is used as a proxy for forest monitoring, which can influence forest conservation outcomes. Pucca roads can contribute towards better outcomes because travelling becomes easier for monitoring authorities (Gautam, Shivakoti, and Webb 2004; Agrawal and Chhatre 2006; Behera 2009). On the other hand, it is also hypothesized that extension of pucca roads can have a negative impact on forest cover because of various development-related changes linked to land-use pressure and easy access to the forest, which can aid in the transportation of wood (Haq *et al.* 2022; Li *et al.* 2015). Hence, the effect of the existence of pucca roads on forest degradation is ambiguous.

Table 7: Summary of Variables Used in the Model

Variable	*N*	Minimum	Maximum	Mean	Standard Deviation
ln of Change in percentage of forest cover	563	–0.94	1.29	0.68	0.27
ln of Size of IFR land	563	–3.07	0.67	–0.39	0.66
ln of percentage of IFR land to total forest area	563	–1.47	1.79	0.22	0.49
FPC	563	0	1	0.89	0.31
ln of ST population	563	–1.11	2.00	1.31	0.71
ln of Population	563	0.78	3.87	2.66	0.45
ln of Literacy rate	563	1.02	1.93	1.76	0.09
ln of Marginal agricultural labourer	563	–0.49	2.00	1.41	0.56
Pucca road	563	0	1	0.28	0.45
Distance to market	563	1.00	3.00	2.80	0.54

Source: Authors

Table 6 summarizes the measurements and definitions of the hypothesized variables as well as their expected influence on forest conservation

outcomes. Since the dependent variable is measured in terms of percentage change, the relationships between the dependent variable and the aforementioned independent variables are measured using OLS regression. This regression equation takes the following form:

ln of Change in forest cover = α + β1 (ln of IFR land size) + β2 (ln of Percentage of IFR land to total forest) + β3 (ln of ST population) + β4 (ln of Population) + β5 (ln of Literacy rate) + β6 (ln of Marginal agricultural labourer) + β7 (Existence of pucca road) + β8 (Distance to market) + β8 (FPC) + ε1. (4)

Where, α is the intercept, β represents the vector of parameters to be estimated, and ε is the error term.

Table 7 reports the descriptive statistics of all the variables used in the OLS model. It is observed that there is considerable variation in the change in forest cover across villages. To explain this heterogeneity in forest cover change, the above-mentioned socio-economic, demographic, and institutional variables at the village level have been included in the model estimation.

4. RESULTS AND DISCUSSION

Table 8 reports the results of the OLS regression model, which estimates the determinants of forest conservation outcomes across the villages. The model is seen to be significant at the 1% level. Two important violations of the assumptions of the OLS regression model were tested—namely, multicollinearity and heteroscedasticity. Multicollinearity is tested for the explanatory variables by checking the variance of the inflation factor (VIF). The value of the mean VIF is 1.08, and all the VIF values of individual variables are less than 1.50, which indicates that there are no multicollinearity problems among the variables. The result of the Breusch-Pagan/Cook-Weisberg test for heteroscedasticity indicates that the variances are constant. With regard to the individual variables used in the model, most of them showed the expected sign except three variables. The percentage of IFR land to total forest is negatively and significantly (at the 1% level) associated with forest degradation, which indicates that villages with a larger percentage share of IFR land are less likely to contribute to forest degradation. This may be because the larger percentage of IFR land indicates larger assignments of individual property rights over forest lands, which may have incentivized the local villagers to protect the assigned land.

The variable existence of FPCs in the village is found to be positively and significantly (at the 1% level) associated with forest degradation, which implies that villages having FPCs are less likely to contribute to forest

degradation. This could be due to better management and protection of forest resources by the FPCs.

Table 8: Ordinary Least-Squares Regression Result of Determinants of Forest Degradation (Percentage Change in Forest Cover)

Average Percentage of Forest Cover Change	Coefficients	Robust Standard Error	*t* Value	Significance	VIF
ln of Size of IFR land	–0.025	0.016	–1.620	0.107	1.14
ln of percentage of IFR land to total forest	–0.107	0.023	–4.680	0.000	1.06
FPC	–0.105	0.032	–3.290	0.001	1.04
ln of Tribal (ST) population	0.084	0.014	5.850	0.000	1.10
ln of Population	0.127	0.022	5.690	0.000	1.10
ln of Literacy rate	0.281	0.106	2.650	0.008	1.06
ln of Marginal agricultural labourer	–0.022	0.019	–1.130	0.257	1.06
Pucca road	–0.039	0.023	–1.690	0.092	1.07
Distance to market	–0.061	0.016	–3.800	0.000	1.07
(Constant)	0.059	0.195	0.300	0.762	
Number of observations	563				
$F(9, 554)$	18.75				
R^2	0.1753				
Root MSE	0.24487				
Mean VIF	1.08				

Source: Authors

The variable tribal (ST) population is found to be positively and significantly (at the 1% level) associated with forest degradation, which implies that villages with a higher percentage of this population are more likely to be associated with forest degradation. This is contrary to the hypothesis above. This may be related to the absence of any significant diversification of livelihood systems away from forest-related activities and/or a breakdown of local traditional institutions and collective action in tribal society. This needs further investigation using primary data.

The variable population is found to be positively and significantly (at the 1% level) associated with forest degradation, which implies that villages with a larger population are more likely to experience more forest degradation. This could be because of the higher pressure on forest resources from the large population. The variable literacy rate is also positively and significantly (at the 1% level) related to forest degradation, which means that villages with a higher literacy rate are likely to register more forest degradation. This is contrary to our expectations as hypothesized above. This could be because educated people engage in intensive agricultural practices in the forest lands allotted to them in order to boost their income quickly.

The variable existence of pucca roads is found to be negatively and significantly (at the 10% level) associated with forest degradation, meaning that villages connected by pucca roads are less likely to experience forest degradation. This could be because roads enable monitoring authorities to travel easily inside the forest, thus enhancing forest protection. The distance to the nearest market is also negatively and significantly (at the 1% level) associated with forest degradation, meaning that villages that are located far away from markets are less likely to experience forest degradation. This is because better access to markets could incentivize forest dwellers to extract more forest produce and sell them in the market, which may result in the degradation of forest cover. Similar results are reported by Sundar (2000).

5. CONCLUSION AND POLICY IMPLICATIONS

This study attempted to identify and analyse the factors that could explain the differential forest cover change across the villages where the FRA has been implemented—where individual property rights have been assigned to improve forest conservation outcomes. The study was carried out within a well-defined framework of property rights, resource user characteristics, and the external environment and their relation to the percentage change in forest cover in Bankura district in West Bengal. The study clearly identifies the differences between a private property regime and individual property rights in the context of the FRA. It is observed that the pattas distributed among forest dwellers under the FRA do not conform with all the requirements for an efficient private property rights regime, such as exclusivity and transferability and/or tradability. However, even with ill-defined individual property rights over forest lands, the empirical results provide strong evidence that the key hypothesized factors explain different aspects of forest management outcomes under the IFRs.

It appears that villages having a higher percentage of IFR land are likely to experience less forest degradation, which essentially suggests that the distribution of IFRs (patta) for forest lands under the FRA has contributed to increased forest cover. As discussed above, the assignment of individual property rights over forest land may have helped in reducing fear of eviction among forest dwellers, encouraging them to follow pro-conservation measures. In addition to permanent tenurial right, the forest dwellers also receive other support services from the forest department; more importantly, fostering mutual trust between the forest dwellers and the forest department may have contributed to the increased forest cover. The findings of this paper are confirmed by an extensive body of literature on the importance of tenurial security for better resource management (Datta and Sarkar 2012). Hence, it may be suggested that more forest dwellers be given IFRs for better management of resources. An important institutional finding is the existence of FPCs in villages. The variable FPC is negatively and significantly associated with forest degradation, indicating that the FPCs may have better management and protection practices that help reduce forest degradation.

Another interesting finding, which has important policy implications, is the association between the distance to the nearest market and forest conservation outcomes. In villages that are located closer to markets, more incentives are needed to arrest forest degradation. Villages with a higher literacy rate are also likely to experience more forest degradation. This could be because more educated people may have greater aspirations to improve their living conditions and, hence, may engage in intensive agricultural practices on the forest lands allotted to them; they may also indulge in selling forest produce, especially high-value wood. Hence, there is a need to create awareness among educated people in the community to protect forest resources. There is also a need for adequate non-farm employment opportunities in forest communities, which could go a long way in improving forest conservation outcomes.

The study also found that villages with a higher percentage of ST people are likely to experience more forest degradation. It may be noted that in the absence of diversification of livelihood systems other than forest-related activities, population growth can put pressure on existing forest resources. The other probable reason for this result could be a breakdown of innate local traditional institutions and collective action in tribal society. However, it should be noted that the above findings are based on secondary data, which may have some limitations, and in-depth studies using primary data are needed to verify these findings.

Ethics Statement: I hereby confirm that this study complies with

requirements of ethical approvals from the institutional ethics committee for the conduct of this research.

Data Availability Statement: The data used in this paper is not provided in a repository as the study is secondary in nature and the data can be downloaded from the original sources mentioned in the paper.

Conflict of Interest Statement: No potential conflict of interest was reported by the author.

REFERENCES

Adhikari, Bhim, Salvatore Di Falco, and Jon C. Lovett. 2004. "Household Characteristics and 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

Agrawal, Arun. 2001. "Common Property Institutions and Sustainable Governance of Resources." *World Development* 29 (10): 1649–1672. https://doi.org/10.1016/S0305-750X(01)00063-8

Agrawal, Arun, and Ashwini Chhatre. 2006. "Explaining Success on the Commons: Community Forest Governance in the Indian Himalaya." *World Development* 34 (1): 149–166. https://doi.org/10.1016/j.worlddev.2005.07.013

Angelsen, Arild, Pamela Jagger, Ronnie Babigumira, Brian Belcher, Nicholas J. Hogarth, Simone Bauch, Jan Börner, Carsten Smith-Hall, and Sven Wunder. 2014. "Environmental Income and Rural Livelihoods: A Global-Comparative Analysis." *World Development* 64: S12–S28. https://doi.org/10.1016/j.worlddev.2014.03.006

Asher, Sam, and Paul Novosad. 2019. "The Socioeconomic High-Resolution Rural-Urban Geographic Dataset on India (SHRUG)." *Harvard Dataverse* 3. https://doi.org/10.7910/DVN/DPESAK

Ballabh, Vishwa, Kulbhushan Balooni, and Shibani Dave. 2002 "Why Local Resources Management Institutions Decline: A Comparative Analysis of Van (Forest) Panchayats and Forest Protection Committees in India." *World Development* 30 (12): 2153–2167. https://doi.org/10.1016/S0305-750X(02)00126-2.

Baranovskis, Ģirts, Olģerts Nikodemus, Guntis Brūmelis, and Didzis Elferts. 2022. "Biodiversity Conservation in Private Forests: Factors Driving Landowner's Attitude." *Biological Conservation* 266: 109441. https://doi.org/10.1016/j.biocon.2021.109441

Basu, Amrita, and Narayan Chandra Nayak. 2011. "Underlying Causes of Forest Cover Change in Odisha, India." *Forest Policy and Economics* 13 (7): 563–569. https://doi.org/10.1016/j.forpol.2011.07.004

Behera, Bhagirath. 2008 "Institutional Dynamics and Natural Resource Management: A Study of JFM in Andhra Pradesh." *Journal of Rural Development* 27 (4): 575–606.

Behera, Bhagirath. 2009. "Explaining the Performance of State–Community Joint Forest Management in India." *Ecological Economics* 69 (1): 177–185. https://doi.org/10.1016/j.ecolecon.2009.08.015

Behera, Bhagirath, and Stefanie Engel. 2006. "Institutional Analysis of Evolution of Joint Forest Management in India: A New Institutional Economics Approach." *Forest Policy and Economics* 8 (4): 350–362. https://doi.org/10.1016/j.forpol.2005.08.006

Broome, Neema Pathak, Nitin D. Rai, and Meenal Tatpati. 2017. "Biodiversity Conservation and Forest Rights Act." *Economic and Political Weekly* 52 (25–26): 51–54 https://www.epw.in/journal/2017/25-26/special-issues/biodiversity-conservation-and-forest-rights-act.html

CFR–LA. 2016. "Promise and Performance: Ten Years of Forest Rights Act in India." *Community Forest Rights–Learning and Advocacy Process*, India. https://www.oxfamindia.org/workingpaper/6078

Dash, Madhusmita, and Bhagirath Behera. 2013. "Biodiversity Conservation and Local Livelihoods: A Study on Similipal Biosphere Reserve in India." *Journal of Rural Development* 32 (4): 409–426. https://doi.org/10.25175/jrd.v32i4.114469

Dash, Madhusmita, and Bhagirath Behera. 2015. "Local Institutions, Collective Action and Forest Conservation: The Case of Similipal Tiger Reserve in India." *Journal of Forest Economics* 21: 167–184. https://doi.org/10.1016/j.jfe.2015.09.001

Datta, Soumyendra Kishore, and Krishanu Sarkar. 2012. "Threatened Access, Risk of Eviction and Forest Degradation: Case Study of Sustainability Problem in a Remote Rural Region in India." *Environment, Development and Sustainability* 14 (2): 153–165. https://link.springer.com/article/10.1007/s10668-011-9313-9

Edmonds, Eric V. 2002. "Government-Initiated Community Resource Management and Local Resource Extraction from Nepal's Forests." *Journal of Development Economics* 68 (1): 89–115. https://doi.org/10.1016/S0304-3878(02)00007-X

Fernandes, Walter, and Geeta S. Menon. 1987. *Tribal Women and Forest Economy. Deforestation, Exploitation and Status Change.* New Delhi, India: Indian Social Institute. https://www.cabdirect.org/cabdirect/abstract/19881856237

Forest Survey of India. 2021. *State of Forest Report 2021.* Dehradun, India: Forest Survey of India. https://fsi.nic.in/forest-report-2021

Gautam, Ambika P., Ganesh P. Shivakoti, and Edward L. Webb. 2004. "Forest Cover Change, Physiography, Local Economy, and Institutions in a Mountain Watershed in Nepal." *Environmental Management* 33 (1): 48–61. http://dx.doi.org/10.1007/s00267-003-0031-4

Geist, Helmut J., and Eric F. Lambin. 2001. "What Drives Tropical Deforestation?: A Meta-Analysis of Proximate and Underlying Causes of Deforestation Based on Subnational Case Study Evidence." *LUCC Report Series* 4: 116. https://agris.fao.org/agris-search/search.do?recordID=GB2013200077

Government of India. 2021. *Monthly Progress Report, September 2021*. New Delhi, India: Ministry of Tribal Affairs, Government of India. https://tribal.nic.in/FRA.aspx

Gunatilake, Herath M. 1998. "The Role of Rural Development in Protecting Tropical Rainforests: Evidence from Sri Lanka." *Journal of Environmental Management* 53 (3): 273–292. https://doi.org/10.1006/jema.1998.0201

Guntuka, Deepthi, and Sidhanand Kukrety. 2019. "Ecological Status of Areas Awarded to Tribals under Forest Rights Act 2006—A Geospatial Study of Adilabad Forest Division, Telangana, India." *Current Science* 117 (3): 434–439. https://doi.org/10.18520/cs/v117/i3/434-439

Haq, Noor ul, Fazlul Haq, Fazlur Rahman, Iffat Tabssum, Zahir Ahmad, and Inam Ullah Tariqi. 2022. "Extension of Roads towards Forest in Palas Valley Indus Kohistan, Hindu Kush-Himalayan Mountains, Pakistan." *GeoJournal* 87 (4): 3307–3321. https://doi.org/10.1007/s10708-021-10437-y

Heltberg, Rasmus. 2001. "Determinants and Impact of Local Institutions for Common Resource Management." *Environment and Development Economics* 6 (2): 183–208. https://doi.org/10.1017/S1355770X01000110

Kaimowitz, David, and Arild Angelsen. 1998. *Economic Models of Tropical Deforestation: A Review*. Bogor, Indonesia: Center for International Forestry Research. https://www.cifor.org/publications/pdf_files/Books/Model.pdf

Kandari, Laxman Singh, Vinod Kumar Bisht, Meenakshi Bhardwaj, and Ashok Kumar Thakur. 2014. "Conservation and Management of Sacred Groves, Myths and Beliefs of Tribal Communities: A Case Study from North-India." *Environmental Systems Research* 3 (1): 1–10. https://link.springer.com/article/10.1186/s40068-014-0016-8

Khosla, Ayesha, and Prodyut Bhattacharya. 2020. "Use of Composite Index to Critically Assess the Post Rights Recognition Impact of Forest Rights Act, 2006: A Case Study from the Tribal State of Tripura, India." *Trees, Forests and People* 2:100023. https://doi.org/10.1016/j.tfp.2020.100023

Kothari, Ashish, Neema Pathak, and Arshiya Bose. 2011. "Forests, Rights and Conservation: FRA Act 2006, India." In *Critical Review of Selected Forest-Related Regulatory Initiatives: Applying a Rights Perspective*, edited by Henry Scheyvens, 19–50. Kanagawa, Japan: Institute for Global Environmental Strategies. https://www.fra.org.in/document/IGES%20full%20report%20incl.%20FRA%20paper,%20as%20pub,%20June%202011.pdf

Lee, Jocelyn I., and Steven A. Wolf. 2018. "Critical Assessment of Implementation of the Forest Rights Act of India." *Land Use Policy* 79: 834–844. https://doi.org/10.1016/j.landusepol.2018.08.024

Li, Man, Alessandro De Pinto, John M. Ulimwengu, Liangzhi You, and Richard D. Robertson. (2015). "Impacts of Road Expansion on Deforestation and Biological Carbon Loss in the Democratic Republic of Congo." *Environmental and Resource Economics* 60 (3): 433–469. http://dx.doi.org/10.1007/s10640-014-9775-y

López, Santiago. 2022. "Deforestation, Forest Degradation, and Land Use Dynamics in the Northeastern Ecuadorian Amazon." *Applied Geography* 145: 102749. https://doi.org/10.1016/j.apgeog.2022.102749

Mena, Carlos F., Richard E. Bilsborrow, and Michael E. McClain. 2006. "Socioeconomic Drivers of Deforestation in the Northern Ecuadorian Amazon." *Environmental Management* 37 (6): 802–815. https://link.springer.com/article/10.1007/s00267-003-0230-z

Ministry of Tribal Affairs, Government of India. 2006. *Forest Rights Act, 2006: Acts, Rules and Guidelines*. New Delhi, India: Ministry of Tribal Affairs, Government of India and United Nations Development Programme, India. https://tribal.nic.in/FRA/data/FRARulesBook.pdf

Nerfa, Lauren, Jeanine M. Rhemtulla, and Hisham Zerriffi. 2020. "Forest Dependence Is More than Forest Income: Development of a New Index of Forest Product Collection and Livelihood Resources." *World Development* 125: 104689. https://doi.org/10.1016/j.worlddev.2019.104689

Persha, Lauren, Harry Fischer, Ashwini Chhatre, and Arun Agarwal. 2010. "Biodiversity Conservation and Livelihoods in Human-Dominated Landscapes: Forest Commons in South Asia." *Biological Conservation* 143 (12): 2918–2925. https://doi.org/10.1016/j.biocon.2010.03.003

Posner, Richard A. 2014. *Economic Analysis of Law*. Aspen Publishing, 9th ed. https://www.google.co.in/books/edition/Economic_Analysis_of_Law/o77fDgAAQBAJ?hl=en&gbpv=0

Ray, Rajasri, and T. V. Ramachandra. 2010. "Small Sacred Groves in Local Landscape: Are They Really Worthy for Conservation?" *Current Science* 98 (9): 1178–1180. https://www.jstor.org/stable/pdf/24110143.pdf

Sarangi, Tapas Kumar. 2017. "The Forest Rights Act 2006 in Protected Areas of Odisha, India: Contextualizing the Conflict between Conservation and Livelihood." *Asia Pacific Journal of Environmental Law* 20 (1): 180–205. https://doi.org/10.4337/apjel.2017.01.08

Schlager, Edella, and Elinor Ostrom. 1992. "Property-Rights Regimes and Natural Resources: A Conceptual Analysis." *Land Economics* 68 (3): 249–262. https://doi.org/10.2307/3146375

Singh, Harsh, Tariq Husain, and Priyanka Agnihotri. 2010. "Haat Kali Sacred Grove, Central Himalaya, Uttarakhand." *Current Science* 98 (3): 290. http://indiaenvironmentportal.org.in/files/Haat%20Kali%20sacred%20grove.pdf

Specht, Maria Joana, Braulio Almeida Santos, Nadine Marshall, Felipe Pimentel Lopes Melo, Inara R. Leal, Marcelo Tabarelli, and Cristina Baldauf. 2019 "Socioeconomic Differences among Resident, Users and Neighbour Populations of a Protected Area in the Brazilian Dry Forest." *Journal of Environmental Management* 232: 607–614. https://doi.org/10.1016/j.jenvman.2018.11.101

Sukumaran, Selvamony, Solomon Jeeva, Appavoo Deva Sobhana Raj, and Doraipandian Kannan. 2008. "Floristic Diversity, Conservation Status and Economic Value of Miniature Sacred Groves in Kanyakumari District, Tamil

Nadu, Southern Peninsular India." *Turkish Journal of Botany* 32 (3): 185–199. https://journals.tubitak.gov.tr/cgi/viewcontent.cgi?article=2003&context=botany

Sundar, Nandini. 2000. "Unpacking the 'Joint' in Joint Forest Management." *Development and Change* 31 (1): 255–279. https://doi.org/10.1111/1467-7660.00154

The SHRUG. n.d. "The Socioeconomic High-Resolution Urban-Rural Geographic Platform." https://www.devdatalab.org/shrug

Townshend, John, Matthew Hansen, Mark Carroll, Charlene DiMiceli, Robert Sohlberg, and Chengquan Huang. 2011. *User Guide for the MODIS Vegetation Continuous Fields Product Collection 5 Version 1*. College Park, MD: University of Maryland. https://modis-land.gsfc.nasa.gov/pdf/VCF_C5_UserGuide_Feb2013.doc

Ullah, S. M. Asik, Jun Tsuchiya, Kazuo Asahiro, and Masakazu Tani. 2022. "Exploring the Socioeconomic Drivers of Deforestation in Bangladesh: The Case of Teknaf Wildlife Sanctuary and Its Surrounding Community." *Trees, Forests and People* 7: 100167. https://doi.org/10.1016/j.tfp.2021.100167

Wade, Robert. 1987. "The Management of Common Property Resources: Finding a Cooperative Solution." *The World Bank Research Observer* 2 (2): 219–234. https://doi.org/10.1093/wbro/2.2.219

Wibowo, Dradjad H., and R. Neil Byron. 1999. "Deforestation Mechanisms: A Survey." *International Journal of Social Economics* 26 (1–3): 455–474. https://www.emerald.com/insight/content/doi/10.1108/03068299910230099/full/html

Yanai, Aurora Miho, Paulo Maurício Lima de Alencastro Graça, Maria Isabel Sobral Escada, Leonardo Guimarães Ziccardi, and Philip Martin Fearnside. 2020. "Deforestation Dynamics in Brazil's Amazonian Settlements: Effects of Land-Tenure Concentration." *Journal of Environmental Management* 268: 110555. https://doi.org/10.1016/j.jenvman.2020.110555