World Development 201 (2026) 107295

Contents lists available at ScienceDirect

World Development

journal homepage: www.elsevier.com/locate/worlddev

Regular Research Article

Can indigenous political representation improve forest conservation? India's experience

Bina Agarwal [a,b,*], Shamindra Nath Roy [c], Shiva Chakravarti Sharma [d]

[a] GDI, University of Manchester, Manchester M13 9PL, UK
[b] Institute of Economic Growth, Delhi, India
[c] Office of Interdisciplinary Studies, OP Jindal Global University, Sonipat, Haryana, India
[d] George Washington University, Washington DC, USA

ARTICLE INFO

Keywords:
Forest conservation
Political representation
Scheduled Tribes
Indigenous communities
Chhattisgarh
India

ABSTRACT

Can political representation by indigenous communities – often seen as stewards of forests – help enhance forest conservation? Or would indigenous political control over forests catalyse greater extraction for revenue gains? Does the level of representation matter? This paper addresses these under-researched questions, drawing on India's multi-layered enactments which granted Scheduled Tribes political representation, and hence influence over local resources including forests, in constituencies reserved for them in state assemblies and village councils.

Taking Chhattisgarh state as an example, geospatial technologies are used for accessing forest cover, village boundaries, and village characteristics, to compare the state's 20,000-odd villages across diverse reserved and unreserved categories, over almost two decades, 2001–2019. It differentiates between Assembly Constituency (AC) reservations and PESA (Panchayat Extension to Scheduled Areas) reservations – the former at the assembly level, the latter at the village council level – and between delimitation time periods.

Over 2001–2019, village area under forest cover is found to have increased by almost 240,000 ha for the 10,554 ever-reserved villages, constituting four times the increase in never-reserved villages. Also, over 2009–2019, regression analysis (using different specifications) shows that relative to never-reserved villages the likelihood of an increase in percentage village area under forest cover was significantly greater in solely AC reserved villages, but significantly *lower* in solely PESA villages. Rural non-village forests also improved under AC reservation. This suggests a policy win–win for assembly-level representation in promoting both social inclusion and conservation. Divergent interests could, however, stymie village-level outcomes, needing additional incentives to conserve. These results also hold lessons for other countries with large forest areas and substantial indigenous populations.

1. Introduction

The critical role of forest conservation in mitigating climate change and preserving biodiversity is well recognised. The relationship between forests and indigenous communities has also long been emphasised. Can these links provide new policy pathways for conserving nature?

Although indigenous communities comprise only about 5 % of the world's population, they use or manage areas that cover an estimated 25 % of the planet's land surface, intersecting with some 40 % of all protected areas and ecologically intact landscapes, especially forests (Garnett et al, 2018). Indigenous people are also seen to have deep economic and cultural ties with forests (World Bank, 2022). Many argue that these connections – and especially the dependence of indigenous people on forests for everyday needs – give them a high stake in forest protection. Hence, granting them greater political control over the ecological systems on which they depend will enhance conservation.

This is part of a larger argument dating to the 1980s, made by researchers, civil society groups and social movements in many countries, that forests would be better protected by local communities (indigenous or other) who live near them, rather than top-down by governments. The importance of involving communities in forest protection was also recognised by the Brundtland Report (1987). Indeed, by 1999, over 50 countries were pursuing partnerships between governments and local communities to better protect their forests (Agrawal & Gibson, 2001).

* Corresponding author at: GDI, University of Manchester, Manchester M13 9PL, UK.
E-mail address: bina.agarwal@manchester.ac.uk (B. Agarwal).

https://doi.org/10.1016/j.worlddev.2025.107295
Accepted 13 December 2025
Available online 22 January 2026

This focus on community forest governance, however, was not specific to *indigenous* communities, nor did it involve *political* representation by these communities. Hence, while a considerable literature emerged on the impact of forest co-management (such as on Joint Forest Management (JFM) in India and Nepal, launched in the early 1990s),[1] it still left open the question whether political representation by indigenous communities could improve forest condition.

If, indeed, indigenous political representation leads to enhanced conservation, this would point to a policy win–win, offering a mechanism for simultaneously promoting social inclusion and forest protection. And it would be of particular interest for rainforest rich regions with large indigenous populations, such as Indonesia in Asia, or the Amazon basin in Latin America. In the latter, Brazil holds 58 % of the rainforest basin but has no political representation by indigenous communities in Congress (as of 2015), while Bolivia, which does well with some 25 % of seats occupied by indigenous communities in Congress, holds only 7.7 % of the Amazon rainforest (see Appendix Table A1).

We cannot, however, automatically assume a win–win between political representation and conservation. The proposition needs testing. On the one hand, it is argued that indigenous people are potential stewards of forests, and indigenous political control over forest management can greatly improve conservation (see, e.g., Gulzar et al., 2023). On the other hand, it can also be argued that, given their dependence thereon, increasing indigenous community control over forests might encourage more extraction and hence degradation. Moreover, indigenous political representatives might have other motivations: for example, they might favour extraction for short-term revenue gains, cater to their elite, or prioritise infrastructure, and thus need additional incentives to conserve.

India offers a unique and globally relevant opportunity to test these opposing propositions. First, it has one of the largest forest-dependent populations in the world (World Bank, 2005; TEEB, 2009),[2] a vast majority of which is constituted of tribal (indigenous) communities, formally termed Scheduled Tribes (STs) in India's Constitution.[3] India has over 104 million STs who make up 8.6 % of its population, by the 2011 demographic census. Second, since 1951, India has enacted several laws, multi-layered and staggered over time, granting STs political power through representatives elected to reserved constituencies in state assemblies and village councils. These representatives can also exercise power over resources, including forests.

To elaborate, under the "People's Representation Act of 1951", Independent India launched an ambitious programme of political inclusion through reservations for the two most socially disadvantaged categories: STs and Scheduled Castes (SCs). Political constituencies with a high percentage of STs and/or SCs were reserved for these groups both in the central and state governments, with parliamentary constituencies (PCs) at the federal level, and assembly constituencies (ACs) at the state level. These are subject to periodic delimitation. Additionally, in the early 1990s, based on caste/tribe and gender, seats were reserved in local institutions of governance for elected representatives. These Panchayati Raj institutions (PRIs), as they were termed, operated at the district, block and village council (Gram Panchayat – GP) levels. PRI reservations were not linked to forests, although *panchayats* could have jurisdiction over common pool resources, including any forest land.

In 1996, the PRI reservations were extended to areas with a preponderance of tribal populations (termed 'Scheduled Areas'[4]) through the Panchayat Extension to Scheduled Areas (PESA) Act, although implementation came much later. The PESA *panchayats* were distinct from non-Scheduled Area *panchayats* in having a mandatory 50 % ST membership (half being women), an ST chairperson always (rather than rotationally), and recognised rights over minor forest produce (MFP).

We therefore see three important policy shifts, with substantial implications for local forest governance in India. One shift, dating from Independence, was of political reservation for STs at the Assembly level. This gave STs substantial political oversight over resources, including forests, through their elected representatives in reserved constituencies. The second shift was from state-driven forest protection to community-led protection in 1990, via the JFM programme, that enabled participating communities to co-manage forest resources with the forest department, to regenerate degraded forest land.[5] Although not specifically focused on tribal communities, the geographic overlap of tribal people and forests in many regions meant that the communities managing forests often had tribal concentrations. The third shift was from granting STs rather few legal rights in forests to granting them enhanced rights over MFP under PESA. These shifts underlie the central research question driving this paper: has there been an effect on forest conservation of granting tribal communities political control in regions which also have considerable forests, via two levels of reservation – in assemblies and in village councils?

Potentially, the effect could be either positive or negative. It could be positive if the ST representatives and their constituents promote forest conservation. It could be negative if the ST representatives allow their constituents to extract more forest products for income gain, with an eye to increased revenue, or prioritise infrastructure development over conservation, since areas with high tribal concentrations tend to be poorly developed (Banerjee and Somanathan, 2007).

Moreover, ST communities themselves can be economically heterogeneous (India has over 705 ethnic groups: Xaxa, 2014), with divergent interests. Elite STs may be more interested in timber extraction while poor STs may favour the sustainable collection of non-timber forest produce (see e.g. Kumar, 2002, for Jharkhand state). This again creates a counter-pull to the standard assumption that tribal/indigenous communities will necessarily be "stewards" of the environment.

Notably too, "tribal/indigenous" is not the same as "local" — the latter is a spatial concept, the former is linked to socio-cultural identity. Local communities living near forests in India can belong not only to scheduled tribes but also to Hindu caste groups or to non-Hindu religions, but it is STs which are the most disadvantaged, and hence were the focus of political reservation. Their cultural beliefs regarding sacred plants also have implications for conservation (as discussed later).

The *level* of political representation could also matter. Assembly-level representatives can command more financial resources, frame and implement policy at a more macro level, and be less subject to the divergent pressures faced by a village council head.

In our paper, we test the effects of this multi-layered and multi-temporal process of political reservation, using India as an example. Globally, only one prior study – that by Gulzar et al (2023) – which is also on India, has examined the link between political reservation and forest conservation. This study covers several states but only focuses on the impact of PESA. We focus on one state but cover both PESA and AC reservation. This dual coverage is essential since in many villages they

[1] Notably, in the decade 1991–2001 after JFM was launched, forest cover in India increased by 3.6 million hectares (Agarwal, 2010), whereas earlier it was declining rapidly.

[2] Forest dependence is different from forest proximity, since not everyone living near forests may depend on them. Newton et al (2020) map 'forest-proximate' people globally.

[3] In India's context, tribal communities can be seen as synonymous with those termed 'indigenous' internationally.

[4] These areas are described in the 'Fifth Schedule' of the Indian Constitution. In addition, a few states with large tribal populations fall under the 'Sixth Schedule'. These are treated differently, and PESA does not apply to them.

[5] In practice, power sharing between local communities and the forest department varied across states (World Bank, 2014; Baumann & Farrington, 2003).

overlap. In addition, unlike Gulzar et al, we spatially separate forest cover within the village geo-boundaries from forests lying outside those boundaries.[6] These non-village forests (reserved, protected, or unclassified) can affect village forest use and their conservation outcomes. We also take account of these forests in our analysis as well as government plantation policies.

Focusing on Chhattisgarh state, which has 41 % of its geo-area under forest cover and one-third of whose population is tribal, we conducted a full state analysis based on its 20,000-odd villages, to examine the effect of both AC and PESA reservations on forest cover change over time (2001–19), and across combinations of reservations and time periods.[7]

Our analysis also sheds light on the relationship between forest change and other explanatory variables at the village level, such as village population increase, dependence on cultivation, new roads built, distance from large towns, and proximity to forests in rural non-village areas (RNVs). RNVs include all state land that falls outside the census village boundaries but excludes urban settlements. In addition, we controlled for baseline forest cover as well as for the presence of a critical mass of ST population in each village, to separate out the effect of reservation over and above that of ST presence.

It needs mention, however, that the context of our study is not conducive to standard causal analysis, given the shifting boundaries of AC reserved villages with delimitation in 2008, and the overlap of AC and PESA in many villages. In a strict sense, what our regression analysis provides is a rich analytical exposition of change. However, as elaborated further in the methodology section of the paper, we have taken several measures to establish the robustness and reliability of our regression results, including some supplementary analysis using propensity score matching.

We used the Geographic Information System (GIS) to create and categorise our databases, which involved identifying the AC and PESA reservations. This was done based on village maps, block maps and electoral boundaries, as detailed in Section 5 of the paper. A list of acronyms is given in the Appendix.

The rest of the paper is organised as follows: Section 2 gives some background to India's forest governance and associated property rights as well as to its electoral system and political reservation for disadvantaged groups. Section 3 examines existing studies. Sections 4 and 5 focus on methodology and data used. Section 6 gives the cross-tabulation results and Section 7 the regression specifications and outcomes. Finally, Sections 8 and 9 probe aspects of the results in more detail. Section 9, in particular, seeks to provide a credible narrative about the channels by which political representatives (some of whom we interviewed) tend to intervene. This illuminates our findings beyond the statistics.

2. Background

2.1. Forest governance and tribal rights

India has a complex history of community rights over forests. Historically, village communities enjoyed customary and regionally diverse usufruct rights in local forests on which they depended for many items of daily needs. These rights were curtailed under British colonial rule in the second half of the 19th century through a series of legislations. The Indian Forest Act of 1878, for instance, divided forests into four categories: reserved, protected, private, and village. Most forest land fell under the first two categories. Local residents were given almost no use rights in reserved forests, and highly restricted rights in protected forests. State control over forests was further consolidated under the 1927 Indian Forest Act which enabled the colonial government to extract revenue through timber export, fell trees to build ships and railways, and clear land for agriculture and other uses (Sivaramakrishnan, 1999; Guha, 1989).

This centralised approach continued in post-Independence India until, in 1988, conceding the limits of top-down forest management and civil society pressure to recognise the rights of village communities, the government framed a more community friendly forest policy that emphasised both environmental conservation and "meeting the requirements of fuelwood, fodder, minor forest produce and small timber of the rural and tribal populations" subject to the forest's carrying capacity (Government of India, 1988). This paved the way for the Government of India's JFM programme in 1990, under which degraded government forest land would be co-managed with village communities (Agarwal, 2010). The programme was refined and implemented in diverse ways by state governments, since forests in India are on the concurrent list which gives both the central and state governments legislative oversight. Subsequent legislation, of particular relevance to Scheduled Tribes, was PESA in 1996 and the Forest Rights Act (FRA) in 2006.[8] Both Acts sought to recognise the traditional rights of tribal communities in forest land. The FRA gave Scheduled Tribes two types of community rights, one of collecting non-timber forest produce and the other of community management of local forests (Mokashi and Lele, 2021). In practice, the implementation of the two Acts has been poor (Kumar et al., 2017).

Independent of forest governance, a system of political representation for STs was also instituted. To help understand this, we provide a background to India's electoral system and its methods of political representation and reservation, as below.

2.2. Electoral system and political representation

India has a three-tier structure of representation:

(1) Central government. The Parliament at the Centre is based on parliamentary constituencies, distributed across the 29 states and eight Union Territories, each of which elects a Member of Parliament.

(2) State governments. Each of the 29 states has several assembly constituencies, and each constituency is represented by a Member of the Legislative Assembly (MLA). All assembly and parliamentary constituencies are "delimited" on the basis of the preceding decennial census figures. Each AC in a state has to be delimited such that the populations of all constituencies, to the extent practical, are the same throughout the state.

(3) Local bodies. Within each state, in rural areas, there are district councils at the top, block councils in the middle, and village councils or GPs at the bottom. Similarly, urban areas have different tiers of local bodies.

Central and state legislatures (PCs and ACs) have different geographies of operation from those of the local government. Administratively, states are divided into multiple districts, within which the village is the lowest unit. One or several villages can constitute a GP, and several GPs can make up an AC. A district can have one or more ACs. Fig. 1 represents this graphically. We used GIS to map the ACs with their constituent villages and GP boundaries.[9]

Every five years, each state elects MLAs who represent their ACs in

[6] Although our demarcation is not based on a legal notification of the village forest area, in recent years the Chhattisgarh government (like many other state governments) has been actively involved in notifying village forest boundaries, especially through the recognition of Community Forest Resource (CFR) rights under the Forest Rights Act (FRA) 2006 (Mokashi and Lele, 2021).

[7] Chhattisgarh is also appropriate since not all states with reservation have dual reservations. PESA, for example, was not implemented in all states, or was implemented in different years. The 2008 AC Delimitation was again done in some states but not all.

[8] Specifically, FRA is called "The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act."

[9] Digitised spatial boundaries of ACs and villages were overlaid using GIS. Other ways of mapping can include using Delimitation Commission information or electoral rolls (Alam, 2010).

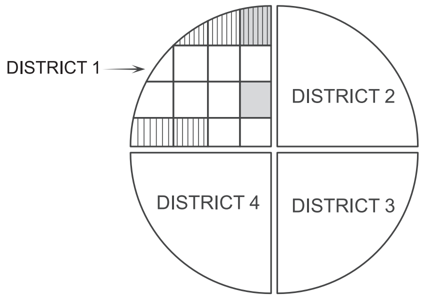

Fig. 1. Levels of political reservation in a state.
Note: In the figure, envision a state with four districts, each containing 15 Gram Panchayats (GPs). Within each district GPs can be under different regimes of reservations. For example:

- GPs with no AC or PESA reservation.
- GPs in one AC but no PESA reservation.
- GPs with only PESA reservation.
- GPs with both AC and PESA reservation.

the state legislature. MLAs legislate on items mentioned in the state list or in the concurrent list (shared by the central and state governments) in India's Constitution. The concurrent list includes forests. MLAs also promote development activities within their constituencies (using their area development funds); help their constituents access government schemes (Jensenius, 2015); and seek to attract business projects to their constituencies (Asher & Novosad, 2017).

Sarpanches (GP/village council heads) are elected every five years to represent their GP. The current GP system was initiated in 1992 through the 73rd amendment of the Constitution and was extended in 1996 to the Scheduled Areas through the PESA Act (Government of India, n.d.). The *sarpanch* leads the GP council to promote village development and oversee village resources such as forests.

Although ACs and GPs are not directly linked politically, they are indirectly connected because MLAs oversee all the villages in their constituencies.

2.3. Reservation system

Recognising the social and economic disadvantage faced historically by STs and SCs, India's Constitution reserved seats for them in educational institutions and public employment in all states. *In addition*, political representation was promoted in states which had a concentration of STs or SCs.

Today, India has political reservations for STs and SCs in both the PCs and ACs, and the PRIs. In the PCs and ACs, the current practice of delimiting reserved constituencies for STs began in 1961. A complex multi-step procedure is followed for identifying the states where constituencies are to be reserved and estimating the total number of AC seats to be reserved, taking account of the proportion of STs in the state's population (and further in the district's population within the state), using the preceding population census (Ambagudia, 2019). At present, 24 states have reserved constituencies.

The PRIs, again, have reserved seats for SCs and STs. In GPs, 33 % of the seats are so reserved but, as noted, these reservations did not cover the "Scheduled Areas". These are areas with a high proportion of tribal populations and are identified in 10 states. Within these states, some districts are fully or partially designated as Scheduled Areas (Xaxa, 2014). *It needs emphasis that this designation is based solely on a district's ST population and is not linked in any way to its forest area.*

PESA reservations, as noted, differ from non-Scheduled Area GP reservations in that in PESA GPs all *sarpanch* positions are permanently reserved for ST candidates and not rotated every five years as in non-PESA GPs. PESA reservations also strengthened the link between STs and forests since the Act devolved powers over minor forest produce to PESA *panchayats*.

Implementation was, however, slow. In Chhattisgarh, PESA was implemented only after 2005, when the new state's first *panchayat* elections were held. Various government reports suggest that actual implementation began around 2008–09 (Government of India, 2012; Enviro-Legal Defence Firm, 2011), while rules were notified only in 2022, following a 2021 petition from the state's tribal representatives to their Chief Minister. The amended rules strengthened the jurisdiction of PESA *panchayats* over MFP in the state (Verma, 2021), but between 2008–09 and 2022, although PESA was operational its effectiveness was limited.

3. Existing studies

In our paper we examine the triangulated relationship between community management of forests, political reservations/representation for indigenous communities, and conservation outcomes.

While many studies have examined the links between community forest management and conservation outcomes, and some have focused on political representation for minorities and socioeconomic outcomes (not specifically forest-related), only Gulzar et al (2023) consider all three aspects, and even they confine themselves, as noted, to PESA. Below, we provide a broad overview of these studies, to place our work in context.

3.1. Community forest management and forest cover

Globally, the impact of community forest management on conservation outcomes has been examined widely from diverse angles since the 1980s. The Bruntland Report (1987) and Elinor Ostrom (1990) argued that local resource management would be more effective in environmental governance than centralised government management. Several empirical studies affirmed this argument and found a positive relationship between community forest management and improved forest condition.[10] A review of World Bank interventions also showed that community participation in forest management was more effective than other interventions, such as payments for forest-related services, and had a positive effect on both environmental outcomes and their sustainability (World Bank, 2014).

Only a few studies found no significant links between local decision-making and improvement in forest management (Buntaine et al, 2015; BenYishay et al, 2017; Slough et al, 2021). This neutral effect is attributed by some to the limited empowerment of local decision-makers following democratic decentralisation (Gulzar et al., 2023), or too much interference by local political leaders or the forest department, even after handing forest-management responsibilities to communities (Sarin et al, 2003; World Bank, 2005).

3.2. Political reservations and economic benefits

A second body of studies relating specifically to India examines the effect of political reservation for minorities on development outcomes unrelated to forests.[11] The bulk of these studies focus on SC representation and only a few on STs, or both.

At the GP level, most scholars report positive effects from political reservation. Duflo and Fischer (2017), for example, find that SC hamlets

[10] See, e.g., Agarwal (2010), Agrawal et al (2014), Baland & Platteau (1996), Baragwanath & Bayi (2020), Blackman et al (2017), Bonilla-Mejia & Higuera-Mendieta (2019), Nepstad et al (2006), Nolte et al (2013) and Robinson et al (2014).

[11] See, e.g., Bardhan et al (2010), Besley et al (2005), Duflo and Fisher (2017), Dunning and Nilekani (2013), Jensenius (2015), Gulzar et al (2020), Krishnan (2007), and Pande (2003).

received 14 % more investment in public goods in SC-reserved GPs compared to non-SC GPs. Bardhan et al (2010) find that SC or ST reserved villages had better intra-village targeting of SC and ST households. Besley et al. (2005) note a correlation between a higher proportion of SC politicians and benefits for SC communities. Gulzar et al (2020) examine the borders of Scheduled Areas and find that PESA reservations are strongly related to better outcomes for STs in terms of government employment schemes and public infrastructure. Only Dunning and Nilekani (2013) find no relationship between GP reservations and the channelling of development funds to the leader's community groups.

At the AC level, however, the effects are weak or mixed. Jensenius (2015), for example, studied over 3100 ACs in 15 states, using a propensity score-matching technique and found "no detectable constituency-level effect on overall development or redistribution to SCs in an SC-reserved constituency" (Jensenius, 2015, p 198). Further, her qualitative data revealed that SC politicians were unable to work for their own groups, because, to win elections, they also had to cater to the general caste groups. Similarly, Chin and Prakash (2010) found no significant relationship between SC reservations and poverty among SCs. Pande (2003), however, found a positive relationship between AC reservation for SCs and quotas for SCs in government jobs.

Notably, when some of these studies analyse AC reservations for *STs* rather than SCs, they find positive effects on welfare spending (Pande, 2003) and poverty reduction among ST communities (Chin & Prakash, 2010). A possible reason (following Jensenius's logic) could be that, unlike SC constituencies, ST constituencies have a higher concentration of tribal populations. On average, for India as a whole, an SC constituency has 26 % SCs while an ST constituency has 55 % STs (Election Commission of India, 2008 delimitation), so ST politicians need to rely less on votes from the non-ST population.

Finally, some scholars have examined SC or ST access to public goods relative to non-SCs and STs, but without specifically linking this to political reservations (ACs or PESA). Their insights, however, have some tangential interest for us. Banerjee and Somanathan (2007), for example, find that although, overall, regions with a high SC and ST concentration have lower access to all public goods, this access increases over time in SC areas but rather little in ST areas. They attribute the SC results to "increased assertiveness and political representation" of SC communities, while STs have remained "largely invisible on the political stage" until the 1990s. Asher et al. (2022) similarly find that although STs show intergenerational upward mobility, they lag far behind the general population and even SCs. STs thus remain seriously disadvantaged in developmental terms. This could impinge on how political representatives approach forest resources, namely, whether they prioritise development or the environment.

3.3. Political reservations and forest outcomes

The link between political reservation for indigenous communities and forest conservation has, however, been little examined, either in India or elsewhere. To our knowledge, only Gulzar et al (2023) have done so. They compare Scheduled Areas with non-Scheduled Areas in nine Indian states. But they focus only on PESA 1996, using difference-in-difference and propensity score-matching methods to assess how PESA affects forest improvement. They report that formal representation for PESA gram panchayats led to an "average increase of forest canopy by 3 % per year as well as a reduction in the rate of deforestation" (Gulzar et al., 2023: 3). They offer two explanations for this: first that STs tend to work as stewards of forests and can pursue their economic interests better with political reservation; second that STs oppose mining.

Both factors, however, are conjectural. The authors' assumption that the economic interests of STs automatically lie in protecting forests needs testing, given that STs also depend on forests for their livelihood and could overdraw, while mines tend to be concentrated locationally and can even provide an alternative income source and so reduce forest extraction.

More importantly, their paper is confined to PESA and does not cover AC reservations, or the overlap of AC and PESA. Nor does it account for the late and poor implementation of PESA. Hence, the positive conservation outcomes that they attribute to PESA could be due to AC reservations, at least in part. In fact, as our results will show, AC reservations are linked to significantly greater improvements in forest cover relative to never-reserved areas, while PESA-only areas do worse than never-reserved areas. Moreover, Gulzar et al (2023) do not consider two other important factors: the effect of non-village forests on village forest change; and the effect of forest planting within and outside village boundaries by the government or private parties.

Our paper analyses the effect of both levels of political reservations (AC and PESA), separately and overlapping, as well as changes in forest cover over time. We also control for other socioeconomic factors which can impinge on conservation outcomes, take account of non-village forests, and discuss plantation policies.

4. Methodology

4.1. Choice of state

We selected Chhattisgarh state in central India because it has a high proportion of STs in its population and a high proportion of its geographic area is under forest cover. The state was formed in November 2000 after a split from a larger state, Madhya Pradesh. In 2021, 41.2 % of Chhattisgarh's geographic area was forested (Government of India, 2021, ch. 2). Also, 29 of the state's 90 ACs were reserved for ST candidates. This means that 32.2 % of all ACs were reserved for STs, relative to 9.4 % in India as a whole. Moreover, 19 districts in the state are fully or partially designated as Scheduled Areas, and thus subject to reservations under PESA. This enables us to assess the effects of both AC and PESA reservations.

4.2. Reservation categories

When created in 2000, Chhattisgarh inherited the prior reservation status assigned to Madhya Pradesh. This persisted until 2008 when a new delimitation exercise changed the electoral boundaries for ACs, based on the 2001 census.

To untangle the effects of AC and PESA reservations we created seven non-overlapping categories of reservation and time periods, as given in Fig. 2 and Table 1.[12]

The spaces A, B and C in Fig. 2 cover AC reservations for the periods 2001–08 (eight years), 2009–19 (11 years) and 2001–19 (19 years), respectively. D represents only PESA reservations (c. 2008/09–2019).[13] E and F have overlapping AC and PESA reservations, while the G villages have never been reserved under either AC or PESA.

Table 1 supplements Fig. 2 and shows the years of reservation and number of villages in each category. These categories form the basis of our graded reservation and inter-temporal analysis. Three of the six categories (B, D, E) have the same length of reservation (11 years), while category A is close (8 years). Only categories C and F (AC 2001–19 alone or in combination) have a much longer period of 19 years. Hence, we can compare, on the one hand, different types of reservation with

[12] The number of villages in these categories is uneven and exogenous, since they reflect the different points in time when reservations were carried out. The overall numbers for ever-reserved and never-reserved villages are, however, broadly equal.

[13] Although this does not affect our identification of PESA villages, we have taken c.2008/09 as the likely date for PESA implementation, based on various government documents cited earlier. This is also close to the AC delimitation date of 2008.

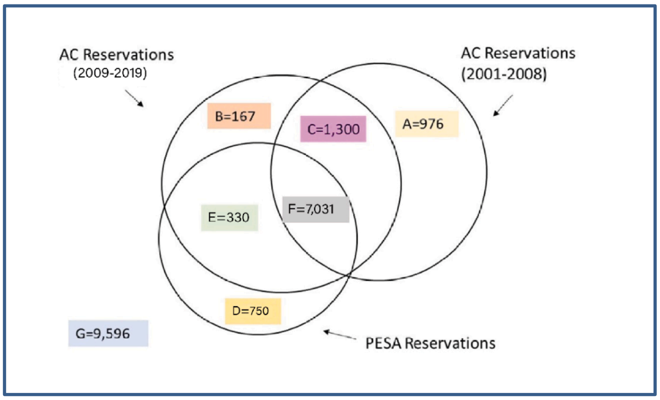

Fig. 2. Non-overlapping reservation categories.
Notes:

A = villages under only AC reservation 2001–08.
B = villages under only AC reservation 2009–19.
C = villages under only AC 2001–19 reservation.
D = villages under only PESA reservation.
E = villages under AC 2009–19 reservation and PESA reservation.
F = villages under both AC 2001–08 and AC 2009–19 reservation as well as PESA.
G = villages never reserved under either AC or PESA.

Table 1
Villages under AC and PESA reservation (non-overlapping categories).

Reservation category	Number of villages in the state	Years of reservation in given category
A: AC 2001–08 only	976	8
B: AC 2009–19 only	167	11
C: AC 2001–19 only	1,300	19
D: PESA only (c.2008/09 –19)[a]	750	11
E: AC 2009–19 and PESA (c.2008/09 –19)	330	11
F: AC 2001–19 and PESA (c.2008/09 –19)	7,031	19
G: Neither AC nor PESA reserved (never reserved)	9,596	0

Source: Authors' calculations.
Note: Villages in the AC 2001–08 group were reserved before the 2008 AC delimitation. Villages in the AC 2009–19 group were reserved after the 2008 delimitation. Some villages were reserved in both periods (C).
[a] The date c. 2008/09 is approximate. See footnote 13 in text. Whenever we refer to PESA in the text it implies this period.

equivalent length of reservation and, on the other hand, the same type of reservation (AC) with varying lengths of reservation, viz. 8, 11 and 19 years. We take all the villages in Chhattisgarh to analyse the effect of the different combinations of reservations identified above.

4.3. *Full state analysis*

Chhattisgarh has 20,150 villages by India's 2011 Census *Administrative Atlas*. We map these villages by their reservation status starting in 2001 after Chhattisgarh was formed (Fig. 2).[14] Complete socioeconomic data could, however, be obtained only for 17,606 villages and our regression analysis is limited to these villages.

We first examine changes in forest cover cross-sectionally by period and type of reservation. We then use different regression models to examine the effects of AC and PESA reservations for STs on change in forest cover at the village level, between 2001 and 2019. Then we introduce further explanatory variables (in addition to forms of reservation) at the village level, as controls.

Empirically, forest cover change can be represented and tested in several different ways, such as: (a) yearly via a panel regression with time fixed effects; (b) as a continuous variable via OLS regressions; and (c) as a dummy variable for a minimum specified percentage point increase in forest cover, using logistic regressions. We undertook all three types of regressions for robustness. As will be noted and further discussed in Section 7, the results for different levels of reservation are similar for all three regressions. However, we discuss our logistic regression analysis in more detail (method c) where forest cover change is represented by a dummy variable that takes the value 1 if forest cover increased between 2001 and 2019 by at least five percentage points, to ensure that we are capturing more than non-trivial effects.

We assess the effects of all reservations (AC and PESA) aggregated and then each separately, through three models (see Fig. 2 as a reference point for clarity). In Model 1, we compare villages that have had any form of reservation (AC or PESA) over any time period (A + B + C + D + E + F in Table 1), with villages that have never been reserved (under AC or PESA) since Chhattisgarh was formed (G in Table 1). In Model 2, we disaggregate the effects of AC and PESA reservations, and compare never-reserved villages (G) with six categories of villages that have had varying levels of reservation, as follows: AC (2001–08), AC (2009–19), AC (2001–19), PESA alone, AC (2009–19) with PESA, and AC (2001–2019) with PESA. These constitute, respectively, categories A, B, C, D, E, and F. In model 3 we add other variables described in Section 4.4 below. All variables are identified at the village level. The actual equations for all models are given in Section 7.

As mentioned earlier, the issues we want to study are not conducive to standard causal economic analysis, such as difference-in-difference or other methods, for the full set of villages, since the boundaries of AC reserved villages moved in 2008 with delimitation, and PESA reservations only came into force around 2008–09. Restricting our analysis to villages where there is only one change would leave too few villages for the analysis. Moreover, we are seeking to capture the effect of multilevel reservations – both AC and PESA. The changing reservation status is important, in itself, for capturing the intensity and continuity of representation, rather than just binary reserved/unreserved categories.

However, we have sought to undertake a robust analysis to establish the relationship between reservations and forest cover change for the full set of villages in two ways (a) undertaking three types of regressions – panel (with time fixed effects), OLS and logistic regressions, to check consistency of outcomes; (b) controlling for a range of village-level variables, including the percentage of STs in the village population. In addition, we undertook propensity score matching as a supplementary exercise, by pairing 149 villages with AC reservation over 2009–2019 with an equal number of never reserved villages, and also comparing 574 PESA reserved villages over that period with an equal number of villages never reserved under either PESA or AC. The pairing was done using the nearest neighbour method, as described in Section 7.4. The results of this are presented in the Appendix.

Hence, although the material does not lend itself to a standard causal analysis, we seek to provide a strong analytical exposition and rich exploration into less charted territory.

4.4. *Village control/explanatory variables: some hypotheses*

Apart from reservations, a range of additional factors could affect forest cover. The "control variables" we use are: percentage of village households below the poverty line in 2011, increase in village population (2001–11), percentage of households with cultivation as their main

[14] The 2011 Census Village Directory, however, enumerates only 20,126 villages. The 24 unenumerated villages likely lay in conflict zones or in otherwise geographically challenged areas.

income source in 2011, whether the village got connected by a new paved road during 2001–11, distance of the village from a town (Class II and above in 2011),[15] distance of the village from the nearest RNV forest in 2011, per cent village under forest area in the base year, 2001, and whether the village had ≥33 % ST population. Some of these variables could affect forest cover positively, some negatively, and some could go either way.

The incidence of poverty, for example, can have a positive effect in that the poor are more forest-dependent (Vira et al., 2015) and would thus have a stake in conserving their local forests by, say, keeping out intruders. But poverty can also have a negative effect in that high dependence can lead to high extraction.

An increase in population density again would put additional pressure on the forest reserve. We use a dummy variable for an increase in population greater than 1 % between 2001 and 2011. The percentage of households dependent on cultivation as their main income source can affect forests either way. On the one hand, since cultivators depend on forests for green manure and fodder, we expect them to have a stake in conservation. On the other hand, farmers may clear forests for cultivation, thereby reducing forest cover (FAO, 2016).

The effect of new roads can again go either way. Roads could reduce forest area because forests may be cleared for their construction or because roads can facilitate the commercial exploitation of forests (Freitas et al, 2010), but roads can also open up new employment options leading to neutral effects (Deng et al, 2011). Urbanisation can have a similar dual effect, so we use distance of the village from a Class II town as a control variable.[16]

In addition, the proximity of a village to non-village forests can matter. Villagers draw upon forests for their daily needs, such as firewood, fodder, and other products. Those who have non-village forests nearby are likely to draw upon these, either as a supplementary source, or in lieu of exploiting their own village forest. Typically, non-timber forest produce is collected by women who go on foot. Hence distances matter. We thus examine the effect of RNV forests located at 5 km and 10 km from the village boundary to test this hypothesis. In a household survey by Khanwilkar et al (2022) for three states, including Chhattisgarh, women reported walking 2.74 km for firewood on average, across the seasons. We took a somewhat higher figure of 5 km to cover diverse terrains, with 10 km as the upper bound.

Some authors (e.g. DeFries et al, 2021) use a "buffer" variable to measure the effect of proximity to a non-village forest, for example the percentage of RNV-forest cover that falls within, say, a 5 km buffer around a village polygon. However, a buffer would only measure the percentage of the forest that is within a certain distance from the village. It does not help us test our hypotheses of interest, namely the effect of RNV availability to village women in lieu of village forests. Nevertheless, we did calculate the effect of a buffer variable. This was positive and significant too. In other words, this did not change our overall results.

We also controlled for the percentage village area under forest cover in the base year, 2001. We expect villages that already have high proportions of their area under forest cover to be less able to expand it over time.

Finally, we controlled for the presence of a critical mass of ST population in the village in 2001. This was to see the effect of reservation over and above the presence of a substantial ST population (which, some argue, may itself explain better conservation). Existing literature indicates that one-third presence is typically needed for a disadvantaged group to be effective in terms of presence and voice in a public forum, be it village councils (Agarwal, 2010), industrial corporations (Kanter, 1977), or legislatures (Dahlerup, 1988). We therefore created a dummy variable with ≥ 33 % ST population as the cut-off point.[17]

5. Data

We needed four types of data for our analysis: (1) on political reservation; (2) on village area under forest cover; (3) on RNV forests; and (4) on village socioeconomic factors. For this purpose, we collated both spatial and statistical indicators from various sources (Appendix Table A2 gives details).

Political reservation data consist of AC boundaries and GIS shapefiles (village maps). The AC shapefiles were obtained from DataMeet, while the village shapefiles were obtained from the digitised *Administrative Atlas* of India's 2011 Census. These AC and village maps were spatially adjusted, and the AC boundaries were laid over village boundaries to ascertain whether a village fell under an ST or a non-ST constituency, pre- and post- the 2008 delimitation. The PESA reservations were identified through the lists of districts and blocks with Scheduled Areas, as specified in The Scheduled Areas (States of Chhattisgarh, Jharkhand and Madhya Pradesh) Order, 2003. We matched these to the list of districts and blocks given in the Primary Census Abstract of the 2011 Census of India.

For forest area, we use the digitized Vegetation Continuous Field (VCF) product (Version 6.1) derived from the NASA-MODIS TERA satellite imagery with a spatial resolution of 250 m, which provides the percentage area under forest cover for each pixel.[18] Since a pixel can fall across more than one village boundary/RNV area, to allocate pixel proportions (and hence forest cover) across boundaries we first derived the fraction of a pixel area that intersects with a village/RNV area. We then weighted the percentage forest cover with these fractions to get a weighted forest cover percentage for each pixel. We multiplied this share with the total area of the pixel (0.0625 sq km) to get the absolute value of forest cover per pixel in square kilometres. Finally, we aggregated the absolute values of all the pixels in the villages/RNVs and calculated the share of forest cover to total geographic area of the village/RNV.

For socioeconomic indicators we used several sources. The distance of the village from the nearest town was calculated using locational data from the 2011 Census *Administrative Atlas*. For the other variables, such as new roads, population change, and so on, we mainly used the SHRUG platform (Socio-economic High Resolution Rural Urban Geographic Data Set for India). This extracts information from India's decennial population censuses. Where the SHRUG database had missing

[15] Class II towns in the Indian census are those with at least 50,000 people. We took these, since larger towns are more likely to have an effect than small towns.

[16] We also tried distance of the village from coal mines. This too was negatively significant (as found by Mishra et al, 2022). However, coal mine distance and town distance were strongly correlated. We kept town distance for several reasons: towns are spatially dispersed across the state, while coal mines are concentrated in northern Chhattisgarh; the impact of towns on forests is dynamic, while land use change around mines can be sporadic; and we could only access data on coal mines, while the state also has many iron-ore and other mines.

[17] We also wanted to control for the presence of JFM committees but could not get data on this.

[18] The MODIS VCF 6.1 product we have used to calculate the percentage share of forest cover within a pixel is standard and comparable over time. In GIS mapping the adequacy of spatial resolution is important. The minimal mappable unit of a standard MODIS VCF pixel is 56 ha while an average Chhattisgarh village is 464 ha in size (2011 census village directory), namely about 8 times larger than a standard pixel. Our data is thus sufficiently fine-tuned to capture forest cover within the state's village boundary. Moreover, the data is publicly available and can capture forest cover change continuously over the 19 years. It is also the standard source used by several other studies seeking to measure forest cover changes (e.g. Gulzar et al, 2023; Aditya et al, 2019) making cross-study comparisons easier. See also DiMiceli et al. (2021).

Table 2
Comparisons of forest cover area by type and period of reservation.

Time-period (Total N = 20,150)	Forest cover area means (ha) by reservation categories		Difference in means of forest cover (ha) (2–1)	*t*-values for difference in means	% forest cover change over relevant period
	1	2	3	4	5
1 (a) AC 2001–08 (N = 976)	**2001** 83.35	**2008** 71.40	−11.95	−5.517***	−1.55
1 (b) AC 2009–19 (N = 167)	**2009** 55.26	**2019** 72.64	17.38	6.13***	3.10
1 (c) AC 2001–19 (N = 1,300)	**2001** 270.06	**2019** 297.87	27.81	9.72***	2.69
2 PESA 2009–19 (N = 750)	**2009** 25.89	**2019** 32.80	6.91	6.54***	1.70
3 AC 2009–19 and PESA (N = 330)	**2009** 59.40	**2019** 78.94	19.54	5.81***	3.50
4 AC 2001–19 and PESA (N = 7031)	**2001** 86.79	**2019** 112.86	26.07	37.25***	3.26
5 Any reservation 2001–19 (N = 10,554)	**2001** 103.50	**2019** 126.21	22.71	37.39***	2.88
6 (a) Never reserved 2001–19 (N = 9,596)	**2001** 31.71	**2019** 37.09	5.38	26.95***	1.32
6 (b) Never reserved 2001–08 (N = 9,596)	**2001** 31.71	**2008** 29.08	−2.63	−6.23***	−0.64
6 (c) Never reserved 2009–19 (N = 9,596)	**2009** 29.45	**2019** 37.09	7.64	33.88***	1.89

Source: Calculated by the authors.

information we filled this directly from the censuses, where possible. We also used SHRUG's estimates of the poverty rate, that is, the proportion of village households living below the poverty line.[19] Villages with missing data on any of these variables were excluded.

Where relevant and possible, we computed change over 2001–2011, such as for new roads and population change. However, the number of Class II towns had increased only by one since 2001, and the location of RNV forests had not changed: here we took 2011 data. We did the same for poverty and dependence on cultivation income, since India's socio-economic and caste census on which SHRUG draws was conducted only for 2011–12.

6. Results: Cross-tabulations

We first compare forest area by varying reservation categories and then discuss the regression results.

6.1. Forest cover change: cross-tabulations

Table 2 presents changes in forest cover over time for 20,150 villages by different reservation categories. We note that villages that remained solely AC reserved over the entire period, 2001–19, show the highest average increase in forest cover of 27.81 ha per village (row #1c). However, when we consider AC reserved villages before and after the 2008 delimitation, the result is more complex. Villages reserved in 2001–08 show an average *decline* in forest cover of 11.95 ha per village (row #1a), but those reserved over 2009–19 show an average *increase* of 17.38 ha/village (row #1b).

Solely PESA reserved villages do poorly, with an average increase of only 6.91 ha/village over 2009–19 (row #2) which is not very different from never-reserved villages, while villages that had both AC and PESA reservations over 2009–19 show a mean increase of 19.54 ha (row #3).

Notably, villages that have been ever reserved in any form between 2001 and 2019, do well overall, showing a mean increase of 22.71 ha/village (row #5). This amounts to a total rise in forest covered area of over 239,681 ha for the 10,554 villages aggregated. In contrast, in the 9,596 never-reserved villages, the mean increase in forest cover was only 5.38 ha/village over the same period (row #6a), amounting to an aggregate rise of 51,626 ha of forest area. In other words, although never-reserved villages also show an improvement in the long run, the average increase in forest cover in ever-reserved villages is over four times greater (row #5 *vs* row #6a). All the mean differences are statistically significant at 1 % by *t*-tests.[20]

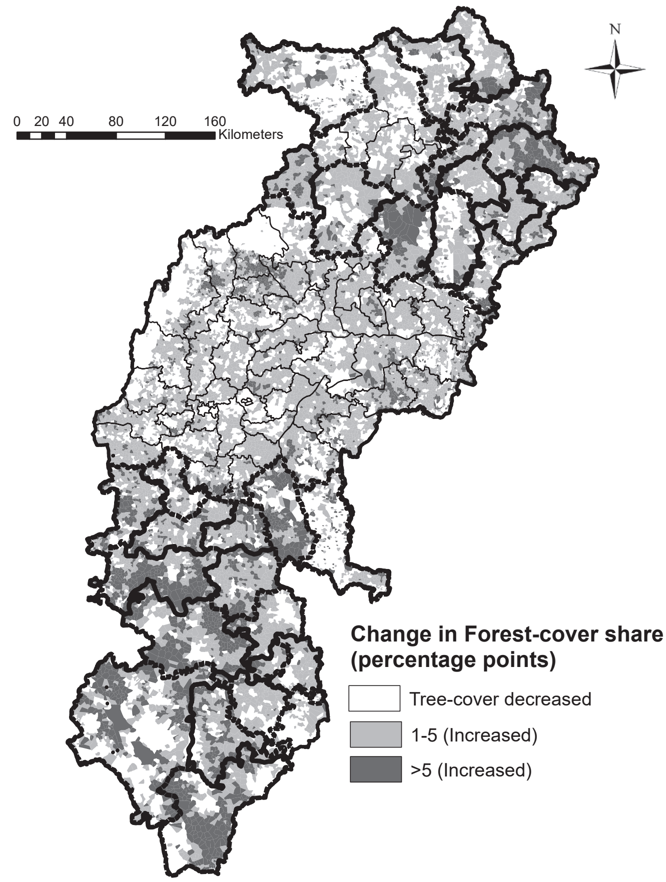

Fig. 3. Change in percentage village area under forest cover, 2001–19.
Note: Dark lines give AC reserved boundaries.

[19] To arrive at poverty estimates, the SHRUG team used the Government of India's 2011–12 Socio-economic and Caste Census and the India Human Development Survey (IHDS-II, 2012–13) for consumption data on which India's poverty estimates are normally based.

[20] It needs mention that the Forest Survey of India (FSI) figures show a net decrease in Chhattisgarh's state level forest cover overall between 2001 and 2019. This is likely because the FSI figures are an aggregation of village forests, rural non-village forests, *and urban area forests*. Hence villages which were rural in 2001 but have urbanised since, would have negatively affected FSI's aggregation of forest cover in 2019. We focus only on *rural* forests (village or non-village). Also, our data is differently sourced (see footnote 18).

Table 3
Descriptive Statistics for key variables.

Variables below (Mean values)	AC 2001–08	AC 2009–19	AC 2001–19	PESA Only	AC & (2009–19) & PESA	AC (2001–19) & PESA	*Ever-reserved*	*Never-reserved*	Difference in means Cols. 7 minus 8	*t-values of difference*	Total for state (rural areas)
Columns	1	2	3	6	4	5	*7*	*8*	9	10	11
Number of villages	778	149	1037	574	259	6362	***9159***	***8447***	–	–	17,606
% ST population 2001	55.9	51.6	82.0	47.3	62.2	72.1	***69.7***	***21.4***	48.3	121.9***	46.5
% ST population 2011	55.5	51.3	82.9	47.0	62.2	72.1	***69.7***	***21.2***	48.5	112.0***	46.4
% village area under forest cover (2001)	4.9	6.2	19.9	4.2	8.1	8.4	***9.1***	***6.2***	3.0	26.2***	7.7
% village area under forest cover (2008)	4.9	6.0	12.3	5.0	7.7	6.8	***7.2***	***6.7***	0.4	5.9***	7.0
% village area under forest cover (2019)	6.0	10.1	22.4	6.0	10.6	11.4	***11.8***	***8.0***	3.8	33.1**	10.0
Forest cover change % points (2001–19)	1.1	4.0	2.5	1.9	2.5	2.9	***2.7***	***1.8***	0.8	15.2***	2.4
% village households in poverty, 2011	52.8	47.8	64.6	50.7	56.2	58.1	***58.0***	***49.1***	8.6	35.3***	53.6
Rate of village population growth over 2001–11	20.4	18.0	12.6	18.3	21.9	17.6	***17.1***	***35.0***	–17.9	–32.0***	25.7
% village HHs with cultivation as main income source, 2011	43.3	45.3	80.3	38.23	38.7	59.8	***57.7***	***35.0***	23.5	59.52***	47.3
Distance of village from nearest town (km) 2011	26.0	29.2	113.6	27.6	30.5	63.6	***58.6***	***40.3***	22.0	47.1***	51.8
% villages with new paved road built between 2001 & 2011	35.0	54.4	6.8	49.30	47.1	32.3	***31.5***	***36.6***	—	—	33.9
Distance of village from RNV (km) 2011	17.6	15.2	26.9	16.8	13.4	23.5	***22.6***	***29.6***	–7.0	–31.0***	25.9
% villages with RNV ≤5 km, 2011	6.2	0.7	2.8	3.0	10.8	3.7	***3.9***	***1.8***	—	—	2.9
% villages with RNV >5 & ≤10 km, 2011	14.3	16.8	9.4	15.8	23.9	14.4	***14.3***	***6.8***	—	—	10.7
% RNV forest buffer (within 5 km), 2011	8.8	19.2	1.6	17.6	8.5	13.6	***14.6***	***5.8***	8.8	10.3***	10.4

Moreover, over the period 2001–08, although both never-reserved and AC reserved villages showed a decline in forest covered area (rows 1a and 6b), in the subsequent period the AC reserved villages picked up much more substantially than the never-reserved ones.

The change in village forest cover over the whole period 2001–2019 is mapped visually in Fig. 3. The areas within the dark outlines are those that fall under AC reservation for STs after the 2008 delimitation exercise. Most of the land with over 5 percentage point increase in village forest cover is seen to lie in AC reserved areas.

6.2. Descriptive statistics for other explanatory variables

Table 3 gives us mean values of a range of variables for villages under different levels and time periods of reservation (columns 1–6). Further it gives (in columns 7–10) the consolidated averages for ever-reserved and never-reserved villages, and their t-values of differences in means.

Notably in 2001, the starting point for our analysis, except for villages which were continuously under AC reservation from 2001 to 2019, all other villages, be they under AC or PESA reservation, did not differ much from never-reserved villages in terms of percentage village area under forest cover (see row 4 in Table 3).

On other counts, overall, the ever-reserved villages tended to have higher levels of poverty and percentages of ST populations; were more dependent on cultivation for their livelihoods; had much lower levels of population growth; and were farther from towns.

This provides the background for the regression results presented in Section 7.

7. Regression specifications and results

7.1. Regression specifications

We use three models for our regression analysis:

Model 1 compares change in forest covered area over 2001–2019 for the ever-reserved and never-reserved villages.

Model 2 examines change in forest covered area over 2001–2019 for all six categories of reservation relative to never-reserved villages.

Model 3 examines change in forest covered area as affected both by the six reservation categories and other explanatory ("control") variables, relative to never-reserved villages.

For *Models 1 and 2* we ran three different types of regressions, with different ways of measuring change in forest area as below:

(a) Panel regressions: Dependent variable: Change in % village area under forest cover, each year of 2001–02 to 2018–19.[21]

(b) OLS regressions: Dependent variable: Change in % village area under forest cover, with 2001 and 2019 as the end years.

(c) Logistic regressions: Dependent variable: dummy: rise in % village area under forest cover by ≥ 5 percentage points between 2001 and 2019.

For *Model 3* with village-level control variables, we ran OLS and logistic regressions.

We will provide comparative results to demonstrate the consistency of results across the models and then focus our discussion more on the logistic regression results.

We use the following equations for our main regression analysis.

Model 1 (never-reserved vs ever-reserved)

Basic equation: $Y_i = \beta_0 + \beta_1 D_{reserved} + \in$

(a) Panel: where Yi is change in percent village area under forest cover each year from 2001–02 to 2018–19.
(b) OLS: where Y_i is change in percent village area under forest cover between the end years, 2001 and 2019.
(c) Logistic: where Y_i is a Dummy: rise in percent village area under forest cover by ≥5 percentage points between 2001 and 2019 = 1; Otherwise = 0

Model 2 (never-reserved vs varying type and period of reservation)

$$\text{Basic equation}: Y_i = \beta_0 + \beta_1 D_{AC2001to2008} + \beta_2 D_{AC2009to2019} + \beta_3 D_{AC2001to2019} + \beta_4 D_{PESA} + \beta_5 D_{AC2009to2019andPESA} + \beta_6 D_{AC2001to19andPESA} + \in$$

Yi definitions for (a) (b) and (c) are the same as for Model 1. Other variables are defined further below.

Model 3 (never-reserved vs varying type and period of reservation, and other explanatory variables)

$$\text{Basic equation}: Y_i = \beta_0 + \beta_1 D_{AC2001to2008} + \beta_2 D_{AC2009to2019} + \beta_3 D_{AC2001to2019} + \beta_4 D_{PESA} + \beta_5 D_{AC2009to2019andPESA} + \beta_6 D_{AC2001to19andPESA} + \beta_7 poverty + \beta_8 D_{popchange} + \beta_9 pcult + \beta_{10} D_{newroad} + \beta_{11} town + +\beta_{12} D_{RNVforest5} + \beta_{13} D_{RNVforest10} + \beta_{14} p_{forest2001} + \beta_{15} D_{\geq 33\%ST2001} + \in$$

where Y_i definitions for (b) and (c) are the same as for Model 1.

$D_{reserved}$: Dummy: ever-reserved villages (2001–2019) = 1; never-reserved = 0.

$D_{AC2001to2008}$: Dummy: only AC reserved villages (2001–08) = 1; never-reserved = 0.

$D_{AC2009to2019}$: Dummy: only AC reserved villages (2009–19) = 1; never-reserved = 0.

$D_{AC2001to2019}$: Dummy: only AC reserved villages (2001–19) = 1; never-reserved = 0.

D_{PESA}: Dummy: only PESA reserved villages = 1; never-reserved = 0.

$D_{AC2009to2019andPESA}$: Dummy: AC reserved villages in 2009–19 and PESA = 1; never- reserved = 0.

$D_{AC2001to2019andPESA}$: Dummy: AC reserved villages in 2001–19 and PESA = 1; never- reserved = 0.

Poverty: Proportion of village households below the poverty line.

$D_{popchange}$: Dummy: villages over 1 % increase in population (2001–11) = 1; Rest = 0.

pcult: Proportion of village households dependent on cultivation as the main income source.

$D_{newroad}$: Dummy: villages with new paved road made between 2001 and 2011 = 1; Rest = 0.

town: Distance of a village from the nearest town (km) in 2011.

$D_{RNVforest9}$, $D_{RNVforest10}$,: Two dummies for distance of village from RNV forests, one for ≤ 5 km = 1, another for > 5 to ≤ 10 km = 1. The reference category is > 10 km = 0.

$p\,forest_{2001}$: Percentage of village area under forest cover in base year 2001.

$D_{\geq 33\%ST2001}$: Dummy: villages with ≥33 % ST population in 2001 = 1; Rest = 0.

7.2. Regression results: comparing models and specifications

Table 4 compares the results for the three models using different methods. (See Appendix Table A3 for the summary statistics of variables relating to the regressions). We note a consistency across the models and specifications as below:

(a) Forest cover change is significantly positive for ever-reserved *vs* never-reserved villages (equations 1a, 1b, 1c).
(b) Forest cover change is significantly negative for AC reserved villages 2001–08 relative to never-reserved villages (equations 2a, 2b, 2c).
(c) Forest cover change is significantly positive for all other AC reserved villages with or without PESA.
(d) Forest cover change is significantly negative or insignificant for PESA villages in all models and specifications.
(e) When we add further village level explanatory variables to the OLS and logistic regressions, the results from both regression methods are similar in terms of the direction of change for the reservation variables as well as other explanatory variables (equations 3b and 3c). The noted consistency across models bolsters our confidence in the robustness and reliability of our regression findings.

7.3. Regression results: detailed discussion

Now consider the results of the logistic regressions (for all 3 models: equations 1c, 2c, 3c together) in more detail.[22] Without control variables, when we aggregate villages which have had any type of reservation at any point in time over 2001–2019, we find a 9.8 percentage point greater likelihood of increase in percent village area under forest cover in reserved villages compared to never-reserved ones (Model 1, equation 1c).

Disaggregating by type of reservation and over time but without other control variables, we get interestingly mixed results (Model 2, equation 2c). First, with AC reservations, barring one exception (the period 2001–08), there is a significant and positive improvement in percent village area under forest cover. The highest improvement is with AC reservation over 2009–19, with a 19.8 percentage points greater likelihood of increase in percent forest cover in reserved villages relative to never-reserved ones, followed by a 17.4 percentage point greater likelihood of increase in percent forest cover among villages which have been AC reserved for the full period 2001–2019. The one exception relates to 2001–08, when AC reserved villages show a 9.9 percentage points less likelihood of

[21] As the state was formed in 2000, there is no comparative data for 2000–01. We thus begin with 2001–02.

[22] The results relate to a rise in forest cover by ≥5 percentage points over 2001–19. We get similar results for ≥1 percentage point improvement in forest cover.

Table 4
Factors affecting forest conservation outcomes: Comparative regression runs.

	FOREST COVER AREA CHANGE 2001–2019							
Regression type	**PANEL**		**OLS**			**LOGIT**		
Dependent variable	**Change in % village area under forest cover each year, 2002 to 2019**[a]		**Change in % village area under forest cover (2001, 2019 end years)**			**Dummy: rise in % village area under forest cover by ≥ 5 percentage points (2001–19)** [c]		
Model number	Model 1	Model 2	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Equation number	1a	2a	1b	2b	3b	1c	2c	3c
No. of observations[b]	316,908	316,908	17,606	17,606	17,606	17,606	17,606	17,606
R^2/Pseudo R^2	0.1769	0.1770	0.013	0.0265	0.105	0.0171	0.0346	0.0545
Explanatory variables	**coeff**	**coeff**	**coeff**	**coeff**	**coeff**	**ME**	**ME**	**ME**
D: ANY RESERVATION	0.0453*** (0.000)		0.816*** (0.000)			0.098*** (0.000)		
D: AC 2001–08		−0.042*** (0.000)		−0.765*** (0.000)	−1.182*** (0.000)		−0.099*** (0.000)	−0.111*** (0.000)
D: AC-2009–19		0.118*** (0.000)		2.135*** (0.000)	2.060*** (0.000)		0.198*** (0.000)	0.197*** (0.000)
D: AC 2001–19		0.037*** (0.000)		0.659*** (0.000)	1.264*** (0.000)		0.174*** (0.000)	0.027* (0.057)
D: PESA		0.002 (0.755)		0.026 (0.814)	−0.359*** (0.002)		−0.053** (0.011)	−0.055** (0.009)
D: AC (2009–2019) and PESA		0.036*** (0.000)		0.661*** (0.003)	0.651** (0.003)		0.079*** (0.001)	0.058** (0.011)
D: AC (2001–2019) and PESA		0.060*** (0.000)		1.081*** (0.000)	0.719*** (0.000)		0.107*** (0.000)	0.035*** (0.000)
Poverty (2011)					2.047*** (0.000)			0.171*** (0.000)
D: Population change (2001–11) >1 %					−0.701*** (0.000)			−0.045*** (0.000)
Percentage Cultivators (2011)					0.951*** (0.000)			0.062*** (0.000)
D: Villages with new Roads (2011)					−0.212*** (0.000)			−0.022*** (0.001)
Distance to the nearest town (2011)					0.004*** (0.001)			0.001*** (0.000)
D: Distance to RNVs (≤5 km)					0.570*** (0.002)			0.056*** (0.001)
D: Distance to RNVs (>5–10 km)					0.153* (0.057)			0.010 (0.303)
Percentage Forest Cover in 2001					−0.149*** (0.000)			−0.001** (0.046)
D: ≥33 % ST population in village					0.179** (0.007)			0.021** (0.009)

Source: Authors' calculations.
Notes: Figures in brackets are *p*-values. Significance levels: *** 1%, ** 5%, * 10%.
ME = marginal effects. 'D' = dummy variables. All estimates are derived using robust standard errors.
Reference category: Villages never reserved over 2001–2019.
RNV forest dummies: differences between ≤ 5 and 5–10 km dummies are significant at the 1 % level.
Differences between included reservation dummies (eqn. 3c): AC 2009–19 does significantly better than all other reservation categories. AC 2001–08 does significantly worse than all other reservation categories. The same holds for PESA. But, AC 2001–19, AC 2001–19 with PESA, and AC 2009–19 with PESA are not significantly different from each other.

[a] Panel regressions: we begin with 2001–02 for the reason given in text fn. 21. Adjusted for time fixed effects.
[b] Several villages had to be dropped due to incomplete socioeconomic information.
[c] Standard errors are clustered at the village level.

improvement in percent forest cover relative to never-reserved villages.

These results also indicate that a longer period of reservation need not, in itself, increase the likelihood of forest improvement. For example, AC 2009–19 (11 yrs) does better than AC 2001–19 (19 yrs). Rather than simply years of reservation, policy measures matter, especially those taken around and after 2008, as discussed in Section 8.

Second, PESA reserved villages do worse than never-reserved ones even in the 2009–19 period. They show a 5.3 percentage point less likelihood of improvement relative to never-reserved villages (equation 2c).

The inclusion of other explanatory variables makes no difference to the direction of the reservation results (Model 3, equation 3c). And when disaggregated by time periods, AC reserved villages again perform significantly better than never-reserved ones across time periods, except 2001–08, while PESA villages again show worse results than never-reserved ones.

The other explanatory variables are interesting in themselves. Villages with higher percentages of poor households, or of households dependent mainly on cultivation, or villages located far from a large town show a significantly positive relationship with improvement in forest cover, while villages with an increase in population or a new road built during 2001–11, show a negative relationship. The results for RNV forest distances are also interesting. Villages located within 5 km of an RNV forest are found likely to have better conserved village forests, after which the relationship becomes insignificant. As noted, beyond 5 km, walking to forests outside the village for collecting firewood etc. would become increasingly cumbersome for village women. However, there is a negative and significant effect of base line forest cover, namely of the proportion of area under forest in 2001.

Moreover, whilst the presence of ≥ 33 % ST population in the village is linked with a positive effect on forest cover, the effect of AC reservation (except for 2001–08) is greater and over and above this, with villages under AC reservation in 2009–2019 doing the best and PESA villages showing a negative effect.

7.4. Supplementary results

7.4.1. Propensity score matching

For a robustness check, we supplemented our main regressions presented above with a propensity score matching (PSM) exercise, to assess the effect of solely AC reservations with no reservation. This involved several steps. We first used a logistic model to forecast the probabilities of villages being AC reserved, considering a range of variables given in Appendix Table A4a. These predicted propensity scores were then used to match each AC-reserved village with its closest neighbour in the never-reserved category, giving us 149 villages in both categories. As Appendix Table A4a shows, there were very few statistically significant differences between the reserved and never-reserved villages in the matched sample. When we ran regressions for these matched villages, the coefficients were positive and significant for AC reservation in 2009–2019 (Appendix Table A4b), consistent with our panel, logistic and OLS models.

We undertook a similar exercise for PESA. We matched 574 PESA reserved villages with never-reserved ones in the period 2009–2019 (Appendix Table A5a) and ran regressions for them. We found that the PESA coefficients were significantly negative (Appendix Table A5b), again consistent with our logistic and OLS models.

The PSM exercises provide us supplementary robustness checks but given the small samples they cannot substitute for our main regression results which cover the entire state.

7.4.2. Conflict and conservation

We undertook one further exploration, namely the relationship between civil conflict and forest conservation. For an extended period of time, Chhattisgarh (along with its neighbouring states) has faced conflict between villagers and the government (officially termed the Maoist insurgency) in several of its districts or sub-districts (Government of India, 2008). It can be argued that such conflict would deter commercial exploitation and encroachment in forests which would thus be better conserved. To test this, we used data compiled by one of the authors on villages under conflict (constituting 53 % of the study villages),[23] to see if these differed from non-conflict villages in forest cover change, adding a dummy variable for this in our Model 3c. We did find that conflict villages had better conservation outcomes than non-conflict ones, but it did not change the direction or statistical significance of the other variables, except for AC 2001–19 which remained positive but less significant, likely due to the relatively high correlation between it and the conflict dummy.[24]

7.5. Rural non-village forest cover change

Finally, we examined the link between AC reservations and RNV forest cover. In Table 5, we note that as with village forests so with non-village forests, there is a substantial improvement over 2009–19 but a decline between 2001 and 2008, across all village categories, reserved or not. Notably, the biggest percentage point increase during this period (4.79) was under AC reservation over 2009–19.

8. What changed after 2008? Insights into shifts

Our results consistently show that in the period 2001–08 there was a decline in average forest cover in both AC reserved and non-reserved areas, but this changed for the better after 2008, and much more substantially in the reserved areas. The poor performance over 2001–2008 and the striking improvement over 2009–2019 is seen both for village forest cover and RNV forest cover. What explains the shift?

A number of factors appear to underlie the poor performance before 2008 (the AC delimitation year) and the subsequent improvement. To begin with, Chhattisgarh became a separate state in November 2000 and faced a period of administrative adjustment. Hence, although the state government framed a new pro-conservation forest policy soon after its formation (Government of Chhattisgarh, 2001; Marothia, 2009), the implementation of the policy, and hence its gains, came into effect only after a time lag. This was also true of other steps taken, such as the approval of higher pay scales for forest guards in 2003 but only implemented in 2008 (Putul, 2022). Forest guards play a critical role in protecting forests against illegal logging and forest fires.

Most importantly, between 2005 and 2008, Chhattisgarh launched several forest planting schemes, in particular the Hariyali Prasar Yojna (HPY) in 2005,[25] and established the Compensatory Afforestation Fund Management and Planning Authority (CAMPA) post-2008. The HPY encouraged villagers to fulfil their firewood and other household needs and raise incomes by planting forests on wasteland, fallow land and field boundaries, and by practising agro-forestry. CAMPA was ordered to be established in all states by the Supreme Court of India to promote afforestation in non-forest areas, as compensation for forests lost due to industrial or other commercial activities. Under the law, a company diverting forest land to other uses needs to pay for forest planting on alternative land provided to the state. The user must also pay compensation for the loss of environmental services provided by the forest land

[23] The data was coded from the official South Asia Terrorism Portal: https://www.satp.org/.

[24] The results are not reproduced in this paper but can be shared on request.

[25] See Government of Chhattisgarh, Forest and climate change department website (in Hindi) at https://www.forest.cg.gov.in/posts/research-extension?l=Hindi.

Table 5
Changes in rural non-village forest cover by AC reservation periods.

RNV reservation type	% RNV area under forest cover				Percentage point changes in RNV forest cover		
	2001	2008	2009	2019	2001–08	2009–19	2001–19
AC reserved 2001–08	18.11	14.33	17.59	21.83	−3.77	4.24	3.72
AC reserved 2009–19	20.22	17.55	19.66	24.45	−2.67	4.79	4.23
AC reserved 2001–19	21.45	14.98	19.69	24.17	−6.48	4.48	2.72
Never-reserved over 2001–19	19.91	12.76	16.40	20.33	−7.14	3.93	0.43

Source: Authors' calculations.

due to the diversion. The Compensatory Afforestation Fund Bill was passed by Parliament in 2008,[26] and CAMPA was formally launched in Chhattisgarh in July 2009.[27]

Did this affect ground reality? To assess this, we calculated the contribution of plantations to the change in forest cover between 2009 and 2019, both within villages and in RNV areas (Tables 6 and 7). To capture the percentage of forest covered area under plantations, we obtained spatial data on plantations from the e-greenwatch website. We then overlaid the plantation polygons on the village and RNV shapefiles to obtain forest cover under plantations, distributed within and outside the village boundaries.[28]

Several points are notable from Table 6. On the one hand, plantations do contribute to increase in aggregate village forest cover over 2009–19. On the other hand, the share of plantations to total village forest cover is relatively small (≤2% in all cases), and, within this, the figures are slightly lower in AC reserved villages relative to non-AC reserved villages, in both 2009 and 2019. In addition, the contribution of plantations to the increase in village forest cover over 2009–19 is greater in non-reserved villages than in reserved villages. This indicates that forest cover rise in AC reserved areas (relative to non-AC reserved areas) depends less on plantations and more on the protection and conservation efforts of tribal communities.

The above observations also hold for contributions of plantations to RNV forest cover (Table 7): the contribution is less in AC reserved areas relative to non-AC reserved areas over 2009–2019. Indirectly though, village forests can benefit from RNV plantations over time, in so far as villagers can draw more firewood, etc. from RNV forests than their own.

9. Summary results and underlying processes

9.1. Summary results

In this paper we have probed the effect of political representation for STs on forest conservation, using India's Chhattisgarh state as an example. Our results were consistent across models and methods.

Our most important finding is that political representation for STs at the AC level is linked with significantly improved forest cover, except for the early years of the state's formation. We had earlier noted the possibility of tribal MLAs being conflicted between the goals of development and the goals of conservation. If such conflict exists, it does not appear to be undermining conservation so far. Indeed, conservation goals have been given particular importance by the government, both in the shaping of forest policy after the state was formed in 2000, and in the implementation of afforestation policies from 2008 onwards.

On PESA, however, the results are discouraging. Solely PESA reserved villages (that is, without AC reservation) do less well than never-reserved ones. Our supplementary exercise using propensity score matching further supports this observation.

The effects of other factors on forest cover are also interesting and consistent. We find significantly positive conservation outcomes in villages with a higher proportion of households whose primary source of income is farming. Cultivators are more dependent on forests for complementary inputs such as green manure and fodder, while the typically landless non-cultivators depend on forests more for saleable MFP. Villagers with easier access to non-village forests in the vicinity also show better conservation outcomes, while the outcomes are worse for villages located near large towns, or which have had new roads that can facilitate the commercial exploitation of forests.

As can be noted, our results differ from the sole study by Gulzar et al (2023). Their study focused only on PESA reservations and reported significantly positive effects on conservation, while we found that PESA areas performed worse than never-reserved areas, whereas AC villages performed significantly better, both on their own and along with PESA. Hence, the positive PESA effects observed by Gulzar et al could be attributable, at least in part, to AC reservations rather than PESA reservations. In fact, in Chhattisgarh, PESA was belatedly and poorly implemented.

9.2. Underlying processes of change

Our results raise a key question: by what process might an MLA in reserved AC constituencies be able to influence forest conservation positively which PESA sarpanches alone are unable to do so? First consider the role of MLAs.

States in India hold considerable (though not exclusive) jurisdiction over forests, and MLAs have influence over rules, budgets, and programmes, including schemes that affect forest outcomes. MLAs can also bring forest-related issues into debates, committee proceedings, and line department decisions. Financially, MLAs control constituency development funds (MLA-LADs), which they can direct towards schemes such as social forestry and the promotion of Liquified Petroleum Gas (LPG) for cooking that reduces firewood withdrawals from forests (Khanwilkar et al., 2022).

Beyond these general features, to understand the ground situation specifically in Chhattisgarh, we telephonically talked with two ST MLAs (currently in office) and one close associate of a deceased MLA who had served in the 2018–2023 period, as well as some senior forest department officials. This provided interesting insights.

First, the MLAs said they regularly meet with their constituents as part of "jan sampark" (public contact), not only at their offices but by travelling almost daily to the villages, to understand local problems and needs. One MLA, who has been in office since 2018, told us:

> "I go continuously to the villages. It is a big area, and I organise visits through my party workers or send word to the panchayat that I will be coming… The meetings are attended by village members and the panchayat sarpanch. We sit under a tree, and hear the villagers' demands and needs. I also have an idea of their needs. I discuss with the sarpanch and senior villagers which demands should be

[26] The Compensatory Afforestation Bill 2008. See https://prsindia.org/billtrack/the-compensatory-afforestation-fund-bill-2008.

[27] CAMPA, Performance Report of Chhattisgarh. https://www.forest.cg.gov.in/cms/media/44fb7b85-c08f-4fb1-884c-8f249e88d91e_campa_performance31616.pdf.

[28] The spatial data gave us 3,446 plantation areas/shapes (=1,357.91 sq km). Of these, we considered 1,749 plantation areas (=1,221.79 sq km), distributed across villages and RNV areas. We included all compensatory afforestation and other plantations, except plantations in urban areas or along roads and canals.

Table 6
Contributions of plantations to change in village forest cover.

Reservation	Total forest area (sq km)	Plantation area (sq km)	% Plantation to forest area	Total forest area (sq km)	Plantation area (sq km)	% Plantation to forest area	Change in forest area (sq km)	Change in Plantation area (sq km)	Share of plantation in change in forest area (%)
	2009			2019			2009–19		
AC reserved[a]	9854.36	117.86	1.20	12189.6	136.17	1.11	2335.24	18.31	0.78
Non-AC reserved[b]	3791.66	62.98	1.66	4690.55	80.94	1.73	898.89	17.96	2.00
All villages[c]	13646.02	180.84	1.33	16880.15	217.11	1.29	3234.13	36.27	1.12

Source: Authors' calculations.
Notes: 1 sq km = 100 ha. [a] Relates to 8828 villages (B + C + D + E in Table 1). [b] Relates to 11,322 villages (A + F + G in Table 1). [c] 20,150 villages.

Table 7
Contributions of plantations to change in RNV forest cover.

Reservation	Total forest area (sq km)	Plantation area (sq km)	% Plantation to total forest area	Total forest area (sq km)	Plantation area (sq km)	% Plantation to forest area	Change in forest area (sq km)	Change in Plantation area (sq km)	Share of Plantation in forest area change (%)
	2009			2019			2009–19		
AC reserved	1364.04	23.67	1.74	1675.94	27.22	1.62	311.9	3.55	1.14
Non-AC reserved	573.24	10.99	1.92	719.05	14.1	1.96	145.81	3.11	2.13
All RNVs	1937.28	34.66	1.79	2394.99	41.32	1.73	457.71	6.66	1.46

Source: Authors' calculations.

prioritized. If necessary, I involve the collector and district magistrate and, if it is a big issue, I may even take the matter to the Vidhan Sabha [State Legislative Assembly]. On forests, I also appeal to the village pramukh [head] to stop tree cutting for agriculture."

A further perspective was provided by a senior forest department official when asked what an MLA could do for forest conservation: "He can work with the District Forest Officer on behalf of his constituents; provide funds for plantations; give speeches to create awareness about the importance of forest conservation; object to tree felling for mining; and even write to the Chief Minister, if needed".

Second, ST MLAs from both major political parties in Chhattisgarh (Congress and the Bharatiya Janta Party-BJP) have been prioritizing the restoration and promotion of sacred groves (called *devgudhis* or *matagudis*) across the state (Niyogi, 2024),[29] sometimes spending considerable funds for this purpose. Sacred groves are dedicated to a deity. Their area in Chhattisgarh ranges from a small plot of under 1 ha to several hectares (Dwade, 2015). Here tree-felling is strictly prohibited and entry restricted. Many of the flora and fauna in these groves are worshipped by tribal communities and trees deemed sacred may be planted on this land (Warrier et al., 2023). These cultural beliefs can, in turn, help forest conservation. Politically, sacred groves are promoted variously to demonstrate sensitivity to tribal culture, further forest conservation goals, and as a counter-insurgency measure (see, Mistra, 2020; Niyogi, 2024; *Times of India*, 2024a; and *Times of India*, 2024b). Whatever the motive, sacred groves help to protect tree cover.

India has an estimated 33,000 ha of sacred groves (Amirthalingam, 2016), although figures can vary. Exact estimates for Chhattisgarh are difficult to come by, but a government book lists 6738 *devgudi/matagudi* sites in greater Bastar district alone (Dhawde, 2025).

Third, Chhattisgarh MLAs are allocated Rs. 4 crore (approx. $ 0.45 million) for development projects, but, in 2015, District Mineral Foundations (DMFs) were established in the state to enhance the welfare of people in mining-affected areas. This gave MLAs additional funds via the District Mining Fund, and the close party associate of the deceased MLA told us that the latter had spent half of the fund from this source under his command for *devgudi/matagudi* restoration, including tree planting in these sites.

Fourth, both MLAs and forest department officials act on frequent complaints from villagers about encroachments into forest land. A common form of encroachment is of people from neighboring villages clearing a piece of the village forest for agriculture or building a hut. As a forest official said: "if it goes unchecked you could even end up with a full [illegal] hamlet!" Such encroachments are dealt with strictly and their removal can be seen as part of forest protection and conservation.[30] Similarly, the MLAs said they take up the issue of tree cutting for mining and promote LPG to substitute for firewood.

Fifth, one ST MLA mentioned fixing the sale prices of tendu leaves to reduce exploitation by middlemen. This forest produce is an important income source for STs. Support for MFP creates a community incentive for local forest protection.

Although some of the mentioned practices, such as "jan sampark", are likely also followed by non-ST MLAs, the focus on sacred groves and MFP is more specific to ST reserved constituencies, given their cultural importance to tribal communities. And on this there is congruity across political party lines.

What about ST panchayat sarpanches – how would they affect forest outcomes? In general, village panchayats can prioritize social forestry which falls in their mandate as one of the 29 subjects they can take up.[31] In addition, in Scheduled Areas, PESA gives gram sabhas (village general bodies) rights over local MFP. The Forest Rights Act too, as noted, has provisions by which villagers have community rights to extract MFP and to manage Community Forest Resources. And mining leases need the prior recommendation of the panchayat gram sabha (Nusrat, 2023). In principle, this framework empowers ST sarpanches to promote forest conservation in various ways.

[29] The Congress party was in power at the state level over 2000–2003 and 2018–2023, while the BJP was in power over 2003–2018, and has been again since 2023 (Yadav, 2023). MLAs in office, however, continue to be active on behalf of their constituents even when in the opposition.

[30] Niyogi (2004) reports that in one part of Chhatisgarh the Forest Department staff removed 190 ha of encroachment near a *devgudi* and so stopped 15 years of rampant illegal felling.

[31] The 73rd constitutional amendment in India specifies in the 11th schedule a list of 29 subjects that village councils can take up, the sixth subject being social forestry (see https://www.mea.gov.in/Images/pdf1/S11.pdf.).

In practice, however, we found that PESA-only villages have not done well on forest cover growth. This is likely due to several factors. To begin with, PESA has been poorly implemented in Chhattisgarh. The state government's steps to strengthen PESA jurisdiction are very recent: e.g., PESA rules were only notified in 2022 (Verma, 2021; Drolia, 2022). Before this, PESA jurisdiction over forest produce was quite limited, and any resultant advantage PESA could bring to conservation was not adequately realised during our study period. Where PESA and FRA provisions remain only partially implemented, as several studies have noted (e.g. Mokashi and Lele, 2021; Sankaran, 2017), sarpanches often lack the authority or resources to translate formal rights into effective forest management.

More particularly, at the village level, political representatives are susceptible to contradictory pulls and pressures of diverging demands from different segments of the community – non-STs, elite STs and poor STs. Many PESA villages lack a majority ST population: on average only 47 % of Chhattisgarh's PESA-village population is ST (Table 3). ST sarpanches in mixed-caste villages have to respond to heterogeneous constituents, many of whom may not prioritize forest conservation (although more probing is needed here). For example, attempts to strengthen PESA rules for tribals in 2022 are reported to have met with resistance from non-tribals in some districts (Drolia, 2022).

Most importantly, much can depend on whether the PESA village is also within an AC reserved constituency and hence under the jurisdiction of an ST MLA. MLAs and village sarpanches have different scales of authority. MLAs, as noted, act at the state and constituency level, with leverage over policy and local administration, while sarpanches operate at the village level, with weaker institutional capacity and influence.

This would also explain the divergence in our results between AC and PESA reservations, namely why villages under AC reservation (with or without PESA) show positive forest conservation outcomes, while villages under PESA alone show negative or poor outcomes. ST MLAs in AC reserved constituencies, whether or not covering PESA villages, can direct policy attention and resources towards forest protection, while PESA sarpanches who want to protect forests may not always be effective on their own, although they could be effective if working in tandem with ST MLAs.

9.3. Concluding reflections

Do our results offer lessons for other countries? While aspects of our paper, especially the overlapping granularity of political reservations, are quite India-specific, the larger question is whether enhancing political representation of indigenous communities in other countries with large indigenous populations (as in parts of Latin America) could contribute to forest conservation. On this count our paper can offer some generalizable lessons. This is akin to, say, political reservation for women in Parliament, or other ethnic and gender quotas implemented in many countries, which are often found to influence policy priorities in favour of their constituents.

Viewed in this way, our results open up notable possibilities for improving forest cover and biodiversity internationally, via a route which could prove to be a win–win, namely the political inclusion of socially disadvantaged communities at high levels of governance. At lower levels of governance, such as in village communities, political representatives may need support from higher level representatives to be effective, while on their own they may not have the same impact, and even face contrary pressures if villagers who favour forest exploitation supersede those who favour conservation. This does not imply, however, that village communities should not be accorded political control over local resources. Rather, in such cases, the way forward would be to provide indigenous communities with incentives (financial or non-financial, including carbon credits) for protecting their forests, recognising that they could face conflicting livelihood choices, and may not uniformly or necessarily serve as forest stewards. These results would be relevant for a number of countries which have both large forest areas and substantial indigenous populations.

CRediT authorship contribution statement

Bina Agarwal: Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Conceptualization, Visualization. **Shamindra Nath Roy:** Writing – review & editing, Visualization, Validation, Software, Methodology, Formal analysis, Data curation. **Shiva Chakravarti Sharma:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We are grateful to Abhiroop Mukhopadhyay, Neelanjan Sircar and the two anonymous referees for their helpful comments on an earlier draft. We thank Kanhu Charan Pradhan and Dhananjay Upadhyay for technical inputs; Manjeet Kaur Bal (consultant), officials in the Department of Forests and Climate Change, Government of Chhattisgarh, and the Chhattisgarh MLAs we interviewed for sharing valuable information; and Kavita Chakravarty for providing MLA contacts. An earlier version of this paper was presented at the University of Cambridge, Department of Land Economy in 2025, and the Institute of Economic Growth (IEG), Delhi, in 2023. We thank seminar participants at both institutions for their useful comments and the IEG for logistical support. We also acknowledge the International Balzan Foundation's prize research funds awarded to Bina Agarwal which helped cover part of Shiva Sharma's time.

Appendix

List of acronyms	
AC	Assembly constituency
FRA	Forest Rights Act
GP	Gram Panchayat (village council)
MLA	Member of the State Legislative Assembly
MFP	Minor Forest Produce (used interchangeably with non-timber forest produce)
PESA	Panchayat Extension to Scheduled Areas Act
PRIs	Panchayati Raj institutions
RNV	Rural non-village area
ST	Scheduled Tribe
SC	Scheduled Caste

Table A1
Amazon rainforest and political representation of indigenous people by country.

Country	Amazon forest basin (2011) (%)	Indigenous people as a percentage of the country's total population (2015) (%)	Percentage of total seats in the country's Congress held by indigenous people (2015)
Brazil	58.4	0.5	0
Peru	12.8	26.0	6.9
Bolivia	7.7	41.0	24.7
Colombia	7.1	3.3	1.1
Venezuela	6.1	2.8	1.82
Guyana	3.1	ni	ni
Suriname	2.5	ni	ni
French Guiana	1.4	ni	ni
Ecuador	1.0	7.0	5.11
Total	*100.0*		

Sources: For Amazon forest shares, see, Castro, et al (2013: 3). For indigenous populations and seats in Congress, see Global Americans (2017: Table 2).

Table A2
Data sources.

Indicators	Nature of data	Source	Description of data	Temporal profile
Reservation	AC boundaries	DataMeet (https://github.com/datameet/maps)	GIS shapefiles of ACs	Post-2008 delimitation
	Village boundaries	*Administrative Atlas of India*	GIS shapefiles of villages	As per Census, 2011
	PESA reservation status; block boundaries	Government of India, Ministry of Tribal Development[2]	Villages that have PESA reservations and other villages	–
Forest area changes	MODIS Vegetation Continuous Fields (VCF), Version 6.1	Raw data extracted from https://lpdaac.usgs.gov/products/mod44bv061/	Percentage forest cover derived at 250 m resolution[1]	2001–19
	Spatial data of plantation areas	e-greenwatch website[3]	Areas covered by plantation	2009–19
Developmental/other factors	Location of towns with ≥ 50,000 people	Census of India, 2011 *Administrative Atlas*		2011
	Village population	SHRUG[4]	Population of villages	2001 and 2011
	Proportion of village households dependent on cultivation as main source of income	Census of India, 2011	Cultivators (people who are engaged in agriculture and own land)	2011
	Paved road in the village	SHRUG[4]	Whether the village has access to a paved road	2011
	Proportion of village households below the poverty line (INR 28)	SHRUG[4]	Small area estimates of poverty ratios at village level	2012–13

Notes:
[1]Percentage forest cover from MODIS VCF is measured on the basis of "the portion of the skylight orthogonal to the surface which is intercepted by forests". 'Forests' are woody plants > 5 m in height.
Sources:
[2] See https://tribal.nic.in/downloads/CLM/CLM_Declare/3.pdf. This source in Hindi provides the list of districts and blocks under PESA in Chhattisgarh.
[3] See https://egreenwatch.nic.in/WorksAndEstimate/Public/KMLs/View_Download_Work_KML.aspx.
[4] See https://shrug-assets-ddl.s3.amazonaws.com/static/main/assets/other/shrug-codebook.pdf.

Table A3
Summary statistics for dependent and explanatory variables in the regression analysis.

Variable	Mean	CV	Min	Max
RELATING TO REGRESSIONS IN TABLE 4				
Dependent variables (N = 17,606)				
Change in percentage village area under forest cover for each year from 2001 to 02 to 2018–19 **(N = 316908)**	0.126	4.11	–33.3	34.47
Change in percentage village area under forest cover between the end years, 2001 and 2019 **(N = 17,606)**	2.275	1.57	–23.10	22.04
Dummy: villages with positive forest change ≥ 5 percentage points over 2001–2019 = 1 **(N = 17,606)**	0.184	2.11	0	1
Explanatory variables (N = 17,606)				
Dummy: Ever-reserved villages (AC or PESA in any time during 2001–19) = 1	0.520	0.96	0	1
Dummy: AC reserved villages, only 2001–08 = 1	0.044	4.65	0	1
Dummy: AC reserved villages, only 2009–19 = 1	0.008	10.82	0	1
Dummy: AC reserved villages, only 2001–19 = 1	0.059	3.99	0	1
Dummy: PESA reserved villages, only 2009–19 = 1	0.033	5.45	0	1
Dummy: AC (2009–19) and PESA = 1	0.015	8.18	0	1
Dummy: AC (2001–19) and PESA = 1	0.361	1.33	0	1
Proportion of village HHs below poverty line (2011)	0.536	0.31	0.01	1.00

(*continued on next page*)

Table A3 (*continued*)

Variable	Mean	CV	Min	Max
Dummy: villages with ≥ 1 % increase in population (2001–11) = 1	0.928	0.28	0	1
Proportion of households dependent on cultivation as the main source of income, 2011	0.473	0.61	0.002	1.00
Dummy: villages with a new road (2001–2011) = 1	0.339	1.40	0	1
Distance of village from nearest town 2011 (km) = 1	51.759	0.64	1.74	188.11
Distance of village from RNV (km), 2011 = 1	25.925	0.59	1.20	106.13
Dummy: nearest RNV forest ≤ 5 km of village, 2011 = 1	0.029	5.80	0	1
Dummy: nearest RNV forest > 5 km and ≤ 10 km of village, 2011 = 1	0.107	2.89	0	1
% village area under forest cover, 2001	7.699	0.99	0.22	53.43
Dummy: ≥33 % ST population, 2001 = 1	0.574	0.49	0	1

Table A4a
Propensity score matching analysis for AC 2009–2019 (*t*-tests).

Indicator	Non-Matched Sample			Matched village sample		
	No Reservation(N = 8,447)	AC reserve Villages (N = 149)	*t*-values of difference in means (2–1)	No Reservation(N = 149)	AC reserved Villages (N = 149)	*t*-values of difference in means (4–5)
	1	2	3	4	5	6
Percentage of STs 2011	21.20	51.31	14.11***	48.61	51.31	0.79
Mean Forest area in 2009 (hectares)	28.10	38.27	2.51***	21.73	38.27	3.12***
Population 2011	1168.63	849.08	−4.14***	897.00	849.08	−0.60
% Population below the poverty line (2011)	49.07	47.87	−0.95	46.43	47.87	0.81
% HHs with cultivation as main income source (2011)	35.03	45.27	5.87***	40.17	45.27	5.87***
% villages with roads in 2011	69.78	75.16	1.41*	81.87	75.16	−1.41*
Distance to the nearest RNV	29.58	15.21	−11.74***	14.62	15.21	0.74
Distance from Town (km)	40.30	29.25	−5.94***	27.27	29.25	1.23

Table A4b
Regressions for AC 2009–2019.

Dependent variable	Forest cover change, 2009–2019	Forest cover change, 2009–2019
Model	OLS	OLS
Equation number	1a	1b
Pseudo R^2	0.033	0.079
Explanatory variables		
D: AC 2009–19	1.579***	1.206***
	(0.001)	(0.011)
Mean Forest area in 2009 (hectares)		2.063***
		(0.000)
% HHs with cultivation as main income source (2011)		0.621
		(0.500)

Table A5a
Propensity score matching analysis for PESA (*t*-tests).

Indicator	Non-Matched Sample			Matched village sample		
	No Reservation(N = 8,447)	PESA Villages (N = 574)	*t*-values of difference in means col 2 minus col 1	No Reservation(N = 574)	PESA Villages (N = 574)	*t*-values: difference in means col 5 minus col 4
	1	2	3	4	5	6
Percentage of STs 2011	21.20	46.95	23.06***	45.85	46.95	0.66
Mean Forest area in 2009 (hectares)	28.10	18.69	−3.82***	18.36	18.69	0.27
Population 2011	1168.63	964.65	−5.08***	905.98	964.65	1.39*
% Population below the poverty line, 2011	49.07	50.70	2.45***	50.61	50.70	0.09
% HHs with cultivation as main income source, 2011	35.03	38.23	3.50***	38.38	38.23	−0.11
% villages with roads, 2011	69.78	85.88	8.24***	82.92	85.88	1.38*
Distance to the nearest RNV (km), 2011	29.58	16.84	−20.29***	16.65	16.84	0.37
Distance from town (km), 2011	40.30	27.61	−13.27***	27.47	27.61	0.17

Table A5b
Regressions for PESA.

Dependent variable Model	Forest cover change, 2009–2019 OLS		Dummy: rise in forest cover by ≥ 5 percentage points LOGIT	
Equation number	1a	1b	2a	2b
R^2 or pseudo R^2 as relevant	0.021	0.041	0.014	0.087
Explanatory variables				
D: PESA (c. 2008/09–19)	−0.821***	−0.780***	−0.060***	−0.054***
	(0.000)	(0.000)	(0.001)	(0.003)
Population 2011		−0.0003**		−0.000***
		(0.007)		(0.004)
% villages with roads in 2011		−0.813***		−0.096***
		(0.000)		(0.000)

Significance: ***1%, **5%, *10 %.

Data availability

Data will be made available on request.

References

Agarwal, B. (2010). *Gender and Green Governance: The Political Economy of Women's Presence within and beyond Community Forestry*. Oxford: Oxford University Press.

Agrawal, A., & Gibson, C. (2001). *Communities and the Environment*. New Brunswick NJ: Rutgers University Press.

Agrawal, A., Wollenberg, E., & Persha, L. (2014). Governing agriculture–forest landscapes to achieve climate change mitigation. *Global Environmental Change, 29*, 270–280.

Aditya, V., & Ganesh, T. (2019). Deciphering forest change: Linking satellite-based forest cover change and community perceptions in a threatened landscape in India. *Ambio, 48*, 790–800. https://doi.org/10.1007/s13280-018-1108-x

Alam, M. S. (2010). On matching census tracts and electoral boundaries: The bottom-up aggregation approach. *Economic and Political Weekly, 45*(34), 64–72.

Amirthalingam, M. (2016). Sacred groves of India – An overview. *International Journal of Current Research in Biosciences and Plant Biology, 3*(4), 64–74.

Ambagudia, J. (2019). Scheduled tribes, reserved constituencies and political reservation in India. *Journal of Social Inclusion Studies, 5*, 44–58.

Asher, S., & Novosad, P. (2017). Politics and local economic growth: Evidence from India. *American Economic Journal: Applied Economics, 9*, 229–273.

Asher, S., Novsad, P. and Rafkin, C. (2022). *Intergenerational Mobility in India: New Methods and Estimates across Time, Space and Communities*. Institute of Labor Economics (IZA) Working Paper 66.

Baland, J.-M., & Platteau, J.-P. (1996). *Halting degradation of natural resources: Is there a role for rural communities?* Oxford: Oxford University Press.

Banerjee, A., & Somanathan, R. (2007). The political economy of public goods: Some evidence from India. *Journal of Development Economics, 82*, 287–314.

Baragwanath, K., & Bayi, E. (2020). Collective property rights reduce deforestation in the Brazilian Amazon. *Proceedings of the National Academy of Sciences, 117*, 20495–20502.

Bardhan, P., Mookherjee, D., & Monica, P. T. (2010). Impact of political reservations in West Bengal local government on anti-poverty targeting. *Journal of Globalization and Development, 1*, 1–38.

Baumann, P. and Farrington, J. (2003). 'Decentralizing natural resource management: lessons from local government reform in India'. *Natural Resource Perspectives* June, 1–4.

BenYishay, A., Heuser, S., Runfola, D., & Trichler, R. (2017). Indigenous land rights and deforestation: Evidence from the Brazilian Amazon. *Journal of Environmental Economics and Management, 86*, 29–47.

Besley, T.J., Pande, R. and Rao, V. (2005). 'Political selection and the quality of government: evidence from south India'. Discussion Paper No. 921, Yale University Economic Growth Centre.

Blackman, A., Corral, L., Lima, E. S., & Asner, G. P. (2017). Titling indigenous communities protects forests in the Peruvian Amazon. *Proceedings of the National Academy of Sciences, 114*, 4123–4128.

Bonilla-Mejía, L., & Higuera-Mendieta, I. (2019). Protected areas under weak institutions: Evidence from Colombia. *World Development, 122*, 585–596.

Brundtland, G. (1987). *Our Common Future: The World Commission on Environment and Development*. Oxford: Oxford University Press.

Buntaine, M., Hamilton, S., & Millones, M. (2015). Titling community land to prevent deforestation: An evaluation of a best-case program in Morona-Santiago, Ecuador. *Global Environmental Change – Human and Policy Dimensions, 33*, 32–43.

Castro, A.C., Reymondin, L., Bellfield, H., and Hyman, G. (2013). 'Land use status and trends in Amazonia: A Report for the Amazonia Survey Agenda Project'. [Available at: https://www.researchgate.net/publication/264474268_Land_use_Status_and_Trends_in_Amazonia_A_report_for_the_Amazonia_Security_Agenda_Project] Accessed: 28 April 2023.

Chin, A. and Prakash, N. (2010). *The Redistributive Effects of Political Reservation for Minorities: Evidence from India*. National Bureau of Economic Research (NBER) Working Paper.

Dahlerup, D. (1988). From a small to a Large Majority: Women in scandinavian politics. *Scandinavian Political Studies, 11*(4), 275–298.

DeFries, R., Agarwala, M., Baquie, S., Choksi, P., Khanwilkar, S., Mondal, P., Nagendra, H., & Uperlainen, J. (2021). Improved household living standards can restore dry tropical forests. *Biotropica, 54*, 1480–1490.

Deng, X., Huang, J., Uchida, E., Rozelle, S., & Gibson, J. (2011). Pressure cookers or pressure valves: Do roads lead to deforestation in China? *Journal of Environmental Economics and Management, 61*(1), 79–94.

DiMiceli, C., Townshend, J., Carroll, M., & Sohlberg, R. (2021). Evolution of the representation of global vegetation by vegetation continuous fields. *Remote Sensing of Environment, 254*, Article 112271. https://doi.org/10.1016/j.rse.2020.112271

Drolia, R. (2022). 'Chhatrisgarh notifies PESA rules', *Times of India*, 9 August.

Duflo, E. and Fischer, G. (2017). 'Efficiency and rent seeking in local government in India' [available at: https://www.povertyactionlab.org/sites/default/files/research-paper/107_Duflo_Efficiency_and_Rent_Seeking.pdf]. Accessed: 28 April 2023.

Dunning, T., & Nilekani, J. (2013). Ethnic quotas and political mobilization: Caste, parties, and distribution in Indian village councils. *American Political Science Review, 107*, 35–56.

Enviro Legal Defence Firm (2011). *PESA Implementation – Some Essential Prerequisites and Suggestions for the State of Chhattisgarh*. Final Report. Noida, Uttar Pradesh.

Food and Agriculture Organization (FAO) (2016). *State of the World's Forests: Forests and Agriculture – Land-use Challenges and Opportunities*. Rome: FAO.

Freitas, S. R., Hawbaker, T. J., & Metzger, J. P. (2010). Effects of roads, topography, and land use on forest cover dynamics in the Brazilian Atlantic Forest. *Forest Ecology and Management, 259*, 410–417.

Garnett, S. T., Burgess, N. D., Fa, J. E., Fernández-Llamazares, A., Molnár, Z., Robinson, C. J., Watson, J. E. M., et al. (2018). A spatial overview of the global importance of Indigenous lands for conservation. *Nature Sustainability, 1*, 369–374.

Global Americans (2017). *Report on Indigenous Political Representation* [available at https://theglobalamericans.org/2017/10/report-indigenous-political-representation-introduction-summary/#]. Accessed: 28 April 2023.

Government of India (n.d.). 'PESA Act 1996'. Ministry of Panchayati Raj, Government of India. [available at: https://tribal.nic.in/actRules/PESA.pdf. Accessed: 28 April 2023.

Government of Chhattisgarh (2001). *Chhattisgarh State Forest Policy, 2001*. No. F 7 -42/ 2001/F.C. Mantralaya, Raipur: Government of Chhattisgarh Forest and Culture Department, 22 October.

Government of India (2008). *Report of the Expert Group Set Up by the Government of India to Examine Development Challenges in Extremist Affected Areas* (New Delhi: Planning Commission).

Government of India (2012). *Twenty-ninth report of the standing committee on rural development (2011-12)*, Demands for grants (2012-13), Ministry of Panchayati Raj, Report presented to the Fifteenth Lok Sabha, Ministry of Panchayati Raj.

Government of India (2021). *India State of the Forest Report 2021*. Dehradun: Forest Survey of India.

Guha, R. (1989). *The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalaya*. Delhi: Oxford University Press.

Gulzar, S., Haas, N., & Pasquale, B. (2020). Does political affirmative action work, and for whom? Theory and evidence on India's Scheduled areas. *American Political Science Review, 114*, 1230–1246.

Gulzar, S., Lal, A. and Pasquale, B. (2023). 'Representation and forest conservation: evidence from India's Scheduled Areas'. https://doi.org/10.31235/osf.io/3uvmc. Accessed: 28 April 2023.

Jensenius, F. R. (2015). Development from representation? A study of quotas for the Scheduled Castes in India. *American Economic Journal: Applied Economics, 7*, 196–220.

Kanter, R. M. (1977). Numbers: Minorities and Majorities. In R. M. Kanter (Ed.), *Men and Women of the Corporation* (pp. 206–244). New York: Basic Books.

Warrier, K. C. S., Warrier, R. R., & Thangavel, V. (2023). Status of sacred groves in India: A review. *International Journal of Environment and Climate Change, 13*(8), 170–181.

Khanwilkar, S., Gould, C. F., DeFries, R., Habib, B., & Urpelainen, J. (2022). Firewood, forests, and fringe populations: Exploring the inequitable socioeconomic dimensions of Liquified Petroleum Gas (LPG) adoption in India. *Energy Research and Social Science, 75*, Article 102012. https://doi.org/10.1016/j.erss.2021.102012

Krishnan, N. (2007). *Political Reservations and Rural Public Good Provision in India*. Discussion Paper DP-175. Boston MA: Institute for Economic Development, Boston University.

Kumar, S. (2002). Does "participation" in common pool resource management help the poor? a social cost–benefit analysis of joint forest management in Jharkhand, India. *World Development, 30*, 763–782.

Kumar, K., Singh, N., & Rao, Y. G. (2017). Promise and performance of the Forest Rights Act a ten-year review. *Economic and Political Weekly, 52*(25&26).

Marothia, D. (2009). Chhattisgarh forest policy at the crossroads: An institutional interpretation. *International Journal of Ecology and Environmental Sciences, 35*, 219–230.

Mishra, M., Santos, C.A.G., Nascimento, T.V.M. do, Dash, M. K., da Silva, R. M., Kar, D., Acharyya, T. (2022). 'Mining impacts on forest cover change in a tropical forest using remote sensing and spatial information from 2001–2019: a case study of Odisha (India)', *Journal of Environmental Management 302*, e114067.

Mistra, R. (2020). Chattisgarh government fixes tribal devegudis to counter Maoists in Bastar region. *Hindustan Times, Nov., 23*.

Mokashi, S. and Lele, S. (2021). Community Forest Rights recognition in Chhattisgarh State: Progress and Challenges. Report, Centre for Environment and Development, ATREE, Bengaluru.

Nepstad, D., Schwartzman, S., Bamberger, B., Santilli, M., Ray, D., Schlesinger, P., Lefebvre, P., et al. (2006). Inhibition of Amazon deforestation and fire by parks and indigenous lands. *Conservation Biology, 20*, 65–73.

Newton, P., Kinzer, A. T., Miller, D. C., Oldekop, J. A., & Agrawal, A. (2020). The number and spatial distribution of forest-proximate people globally. *One Earth, 3*, 363–370. https://doi.org/10.1016/j.oneear.2020.08.016

Niyogi, D. G. (2024). 'Preserving sacred groves can help community achieve its conservation and climate goals', *Down to Earth*, Dec. 7.

Nusrat, R. (2023). *Status of Implementation and Governance challenges of PESA Act in Extremist Affected Areas: A Study of Chhattisgarh Centre of Equity and Social Development*, Research Report 149, NIRDPR, Ministry of Rura Development, Government of India, Hyderabad India.

Nolte, C., Agrawal, A., Silvius, K. M., & Soares-Filho, B. S. (2013). Governance regime and location influence avoided deforestation success of protected areas in the Brazilian Amazon. *Proceedings of the National Academy of Sciences, 110*, 4956–4961.

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge: Cambridge University Press.

Pande, R. (2003). 'Can mandated political representation increase policy influence for disadvantaged minorities? Theory and evidence from India. *American Economic Review, 93*, 1132–1151.

Putul, A.P. (2022). 'Chhattisgarh forest fires continue while forest staff remain on strike'.

Robinson, B. E., Holland, M. B., & Naughton-Treves, L. (2014). 'Does secure land tenure save forests? A meta-analysis of the relationship between land tenure and tropical deforestation. *Global Environmental Change, 29*, 281–293.

Sankaran, S. R. (2017). Governance, Resources and Livelihoods of Adivasis in India: Implementation of PESA and FRA, policy Brief. NIRD, https://nirdpr.org.in/nird_docs/srsc/srsc-pub-030718.pdf.

Sarin, M., Singh, N.M., Sundar, N. and Boghal, R.K. (2003). *Devolution as a Threat to Democratic Decision Making in Forestry? Findings from Three States in India*. Center for International Forestry Research (CIFOR)/Overseas Development Institute (ODI), London. [available at https://www.cifor.org/knowledge/publication/1189/]. Accessed: 28 April 2023.

Sivaramakrishnan, K. (1999). Modern Forests: State Making and Environmental Change in Colonial Eastern India (Stanford, Calif.: Stanford University Press).

Slough, T., Rubenson, D., Levy, R., Rodriguez, F. A., del Carpioe, Buntaine, M. T., Christenseng, D., et al. (2021). 'Adoption of community monitoring improves common pool resource management across contexts'. *Proceedings of the National Academy of Sciences 118*, 98–126.

Times of India (2024a). 'Chhatrisgarh launches tree-plantation drive around tribal sacred sites in Bastar', June 23.

Times of India (2024b). 'Sacred groves revival? Renewed efforts to preserve tribal devgudi sites in Chhattisgarh', Nov 4.

The Economics of Ecosystems & Biodiversity (TEEB) (2009). *The Economics of Ecosystems and Biodiversity*. Report. Nairobi: UNEP.

Verma, G. (2021). 'Explained: what is PESA Act, and politics behind its implementation in Chhattisgarh'. *The Indian Express*, 24 November. [available at: https://indianexpress.com/article/explained/chhattisgarh-pesa-act-explained-7635076/] Assessed: 28 April 2023.

Vira, B. Wildburger, C. & Mansourian, S. (eds. 2015). *Forests and Food: Addressing Hunger and Nutrition Across Sustainable Landscapes*. Open Book publishers. [available at: https://www.openbookpublishers.com/books/10.11647/obp.0085] Assessed: 28 April 2023.

World Bank (2005). *India: Unlocking Opportunities for Forest-dependent People in India.* Volume 1*: Main Report*. Washington DC: World Bank [available at https://openknowledge.worldbank.org/handle/10986/8416]. Assessed: 28 April 2023.

World Bank (2014). 'Managing forest resources for sustainable development: an evaluation of the World Bank Group's experience'. Independent Evaluation Group, World Bank, Washington DC [available at: https://doi.org/10.1596/IEG156889]. Accessed: 28 April 2023.

World Bank (2022). *Indigenous Peoples*. Washington DC: World Bank [available at https://www.worldbank.org/en/topic/indigenouspeoples]. Accessed: 28 April 2023.

Xaxa, V. (2014). *Report of the High Level Committee on Socio-economic, Health and Educational Status of Tribal Communities of India*. Ministry of Tribal Affairs, Government of India.