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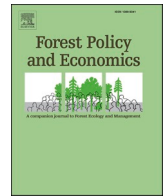
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Justice and injustice under authoritarian environmentalism: Investigating tensions between forestland property rights and environmental conservation in China

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ABSTRACT

This study investigates how forestland property rights, established under the Chinese Collective Forest Tenure Reform (CFTR) from 2003, were affected by the emergence of the “Ecological Civilization” discourse in the 2010s. It does so through the lens of environmental justice. Case studies were conducted in four counties in Fujian and Yunnan provinces. The results show outright injustice in the Fujian cases which originate from the government’s authoritarian approach to Ecological Civilization, including severe restrictions on timber harvest, lack of recognition of decentralized forestland property rights, and only limited compensation for people affected. Those who heavily invested in forestry activities encountered the most unjust treatment. Meanwhile, despite a similar authoritarian policy in Yunnan, injustice in these cases were less salient because restrictions on timber harvest (for the sake of conserving natural forests) already existed there before the introduction of CFTR, thus deterring private actors from investing in forestry. The results highlight the necessity of upholding justice of distribution, participation, and recognition for all engaged actors, particularly when environmental conservation is prioritized and needs to be sustained.

1. Introduction

In September 2019, the first author started field work in Fujian province of China to research local forestry development after the Collective Forest Tenure Reform (CFTR) was initiated in 2003. Through CFTR, the central government allowed three things: the allocation of forestland from government-controlled village committees to rural households and business actors, the formalization of their property rights by issuing forestland-use certificates (FUCs), and the reduction of restrictions on timber harvest. In so doing, CFTR encouraged recipients of forestland to utilize the new property rights and invest in forestry (Liu et al., 2017; Xu and Hyde, 2019; Yin et al., 2013b). However, a forestry businessman who accepted our interview request talked about “extreme injustice!” soon after the start of field work, uttering his complaints about unexpected forestry losses due to increased restrictions on timber harvest again in recent years.

To understand this strong utterance concerning injustice, it is necessary to look at the rise of China’s authoritarian environmentalism,

particularly embodied in the discourse of Ecological Civilization, which was subsequent to CFTR. The deterioration of environmental quality, caused by China’s rapid economic growth in the 2000s, became a serious concern among Chinese governors and citizens. Against this backdrop, Ecological Civilization appeared as a governmental discourse in 2007 and gained momentum as high-priority national policy in 2012, when the 18th National Congress of the Chinese Communist Party (CCP) was held (Hansen et al., 2018; Kostka and Nahm, 2017).

The Ecological Civilization discourse envisions a comprehensive transformation of Chinese economy, society and environment based on integrating technological innovation and institutional reform to improve environmental conservation. The practices under the rubric of Ecological Civilization, however, are described in recent studies as “authoritarian environmentalism” (Beeson, 2010; Gilley, 2012). Authoritarian environmentalism is characterized by top-down governmental interventions aimed at improving environmental conservation and by social obedience under these interventions. In forest governance, authoritarian environmentalism under the Ecological Civilization

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discourse was exemplified by heightened restrictions on timber harvest (Li et al., 2021; Lo, 2021). Such restrictions may, however, contradict property rights established through CFTR at an earlier state and explain the outcry of injustice by the businessman who was interviewed.

This study applies the concept of environmental justice to understand and analyze the potential (in)justice as a consequence of the tensions between forestland property rights under CFTR, on the one hand, and environmental conservation under Ecological Civilization, on the other. While environmental conservation has become a pressing global challenge, related questions and concerns about justice and injustice resulting from the *distribution* of benefits and burdens, *participation* in decision-making processes, and *recognition* of different actors' statuses have emerged (for example, Strzelecka et al., 2021). Environmental justice matters because it supports the voices of marginalized actors and the behaviors of those who are affected by conservation policies. Effective conservation also depends on their perceptions of justice (Martin et al., 2016; Martin et al., 2013; Sikor et al., 2014; Strzelecka et al., 2021). Therefore, environmental justice has found its expression in international agreements, research, and practices ever more in the past decade (Friedman et al., 2018; Martin, 2013; Sikor, 2013).

Two concerns from the general literature are also shared by this study. First, international studies have expressed concern about the undermining of forestland property rights due to intensified conservation initiatives in response to environmental challenges, such as climate change (Borras et al., 2020; Larson, 2011). This study extends this concern to the Chinese context, particularly regarding conflicts between upholding forestland property rights and increasing forest conservations. Second, scholarly attention has been paid to the role of government in causing both environmental justice and injustice. For example, in the United States, environmental justice activists often depend on governmental institutions to rectify injustice. However, these institutions operate within bureaucratic and hierarchical systems and have internal or external conflicting interests, which sometimes fails to correct or even sustain perpetuation of environmental injustice (Harri-son, 2023; Kojola and Pellow, 2021). This study extends this attention into examining how government interventions are likely to instigate both environmental justice and injustice under authoritarian environmentalism in the Chinese context. Therefore, the research question is framed as follows: “to what extent was justice of distribution, participation, and recognition realized when the Chinese government imposed heightened forest conservation policies onto the recipients of forestland property rights?” This question will be answered through illustrating the implementation of CFTR and authoritarian environmentalism, presenting the environmental justice framework and showing the Chinese cases and relevant discussion.

2. CFTR and the subsequent rise of authoritarian environmentalism

China's authoritarianism changed over time. After Mao Zedong's passing away in 1976, the new CCP leadership under Deng Xiaoping's reign ushered in the post-1978 reform era that gradually formed China's “decentralized authoritarianism” (Landry, 2008; Xu, 2011). Decentralized authoritarianism unfolded as economic decentralization through replacing the socialistic planning system with neoliberal economic policies, on the one hand, while maintaining political centralization under the unwavering leadership of CCP, on the other.

Being part of the decentralization agenda in the post-1978 reform era, CFTR was targeted at reforming the system of collectively owned forestland. Before CFTR, the so-called collectively owned forestland represented an example of ill-defined property rights (Ho, 2001; Xu and Hyde, 2019). According to Chinese statutes, village members had collective ownership of forestland and shared inputs and outputs of forestry, which resembled the theory of community-based forest management (CBFM) (Ostrom, 1990; Toole, 2010). In practice, however, it

violated the CBFM assumption of upholding inclusive decision-making processes. Top-down governmental forest policies were imposed in villages, mediated through village committees. The village committees did not completely ignore the interests of rural households or exclude them from village affairs (Sargeson, 2018; Tsai, 2007), but they were held upwardly accountable to the government and thus authorized to control forest resources (Liu and Lv, 2007; Zhang et al., 2005; Zhang et al., 2019). Consequently, a poor performance of forestry production resulted from overlapping and conflicting claims about using and managing forest resources among the multiple levels of governments, village committees, villagers, and other actors (He, 2008; Yin et al., 2013a; Zhang et al., 2019). More salient problems emerged in Fujian province, where the earliest implementation of CFTR was executed. Situated in the southeast coastal region, Fujian enjoyed geographical advantages for developing the economy during the post-1978 reform era, while experiencing prevalent corruption. Facilitated by the establishment of market transactions, intermediate actors – village leaders, for example – could collude with others and translate their control over forest resources into additional income through corruption, which was recalled by Huang Jianxing, the policy designer of CFTR (He, 2008; Huang, 2006).

Against this background, the central government authorized Fujian province to pilot the implementation of CFTR in 2003, after which it could be gradually extended nationwide. The key step for the government was to remove village committees from local forestry production and relocate this task to households, through implementing CFTR. Noteworthy, Forestry Classification, a policy initiated in the late 1990s by the central government, divided collectively owned forestland into two categories: (1) commercial collectively owned forestland that supplies commercial timber and other products and (2) ecological collectively owned forestland that provides ecosystem services (SFA, 1999). CFTR only focused on the first type, thus allocating the control over commercial collectively owned forestland away from village committees (hereafter referred to as “forestland”, if no other indication applies).

CFTR followed the principle of egalitarian allocation of forestland to rural households. This implied changes in forestland property rights. While keeping the collective forestland ownership unchanged due to the socialistic constitution of the country, CFTR allowed for the allocation of the forestland usufructuary right away from village committees up to 70 years, or longer upon expiry, and required permanent entitlement of the timber ownership and timber usufructuary right for recipients of forestland. Therefore, the government issued FUCs to all recipients of forestland to enhance tenure security and facilitate forestland transactions (Yin et al., 2013a; Zhang et al., 2020). Nonetheless, the implementations of CFTR varied across provinces. For example, while Fujian witnessed more business actors obtaining forestland through transactions and active timber harvest, cases in Yunnan province showed more restrictions on timber harvest due to its stricter conservation policy predating CFTR, and therefore less forestland allocation to business actors occurred (Xu and Hyde, 2014; Zinda and Zhang, 2018).

Next to CFTR was the rise of China's authoritarian environmentalism. Authoritarian environmentalism shows its nuances in combining environmentalism and top-down rulings together. Early academic interest in authoritarian environmentalism stemmed from assuming it as a swift response to solving environmental problems, especially in the face of escalating and globalized environmental crises (Beeson, 2010; Wainwright and Mann, 2013). The increasing attention to authoritarian environmentalism, however, is not solely due to its modified approaches to environmental conservation, but also its broader implications for societal changes. Top-down environmental interventions as such simultaneously change relations among multiple levels of a government and between governmental agencies and non-government actors (Li and Shapiro, 2020). With regard to the Chinese context, the rise of authoritarian environmentalism was consequential – and even frightening – due to reversing many agendas of previous decentralization efforts, though it gained momentum as the government responded to the rising

social concern over environmental deterioration (Kostka and Nahm, 2017; Li and Shapiro, 2020).

Noteworthy, the escalation of authoritarian environmentalism was a gradual trend in China (Kostka and Zhang, 2018). As observed by Mol and Carter (2006), space for non-government actors to participate in environmental governance expanded in the 2000s. The rise of the Ecological Civilization discourse since the early 2010s, however, signified an increase in authoritarian environmentalism (Li and Shapiro, 2020; Lo, 2020). Recent studies report intensified top-down interventions into various fields of environmental issues, such as air pollution, water cleansing, and forest conservation, although the effectiveness of these measures differs and may even be questionable (Ahlers and Shen, 2018; Jiang et al., 2021; Lo, 2021; Zhang, 2017). In addition, Xi Jinping's reign since 2012 has contributed to further centralization – and thus intensified authoritarian environmentalism – through disciplining personnel management and punishing non-compliance of policies at decentralized levels, while keeping local governments under surveillance (Kostka and Nahm, 2017; Li and Shapiro, 2020).

In particular, forest governance in the 2010s presented itself as a prominent field characterized by the emerging authoritarian environmentalism (Liang et al., 2023a, 2023b; Lo, 2021). A publicly visible example occurred in 2017 when the central government announced a nationwide ban on the commercial harvest of natural forests, even though regional bans had already been rolled out before 2017 (Zhang and Chen, 2021). Against this backdrop, Lo (2021) presents a case in northeast China where state-owned forestry enterprises had thrived in the past but struggled in recent years due to a combination of causes, both depletion of mature forest stock and new restrictions on timber harvest. At the same time, laid-off forestry workers and other people affected were under-compensated for income loss and also excluded from decision-making processes in this “transition” from timber harvest to forest conservation. This shift echoes with a question in recent literature on whether a transition can be “just” or not, despite the urgency of fundamental societal changes to solve climate and other environmental problems across the globe (McCauley and Heffron, 2018; Wang and Lo, 2021). This question also concerns us in the context of the Chinese Ecological Civilization process, given its possible negative consequences for local forest-dependent households, whose rights were previously strengthened by the CFTR reform. Therefore, in the next section 3, the framework of “environmental justice” will be detailed to establish our analytical base for this paper.

3. Framework of environmental justice: Distribution, participation, and recognition

The topic of environmental justice emerged in the United States in the 1980s. Distributions of environmental hazards were unequally and disproportionately borne by ethnic minority groups and working classes (Mascarenhas, 2007; Pellow, 2000). These unequal distributions triggered the emergence of the environmental justice movement, which in turn drew academic attention (Mohai et al., 2009). After summarizing the early environmental justice movement, Bullard framed the well-known definition of environmental justice as follows: “all people and communities are entitled to equal protection of environmental, health, employment, housing, transportation, and civil rights law” (Bullard, 2000). Since then, there has been a growing literature on environmental justice that extends the analytical scope from US to global concerns and from pollutants to natural resources and climate change (Friedman et al., 2018; Schlosberg, 2009, 2013). Nevertheless, Brulle and Pellow (2006) pointed out that research at this early stage lacked sufficient theories to support environmental justice analyses.

The theorization of environmental justice is nourished not only from environmental justice movements, but also from the development of justice research. The distributive paradigm of justice was influential in early research, focusing on finding just principles for distributing benefits and burdens in societies. In the classic work, *A Theory of Justice*,

Rawls defines justice as fairness that supports “the appropriate division of social advantages” (Rawls, 1999, p32). Nevertheless, critics argue that the distributive paradigm of justice tends to overlook the underlying conditions that shape unjust distributions. This steered expansive studies to go beyond the distributive paradigm. In particular, Fraser developed her tripartition approach to justice: (re)distribution, representation (participation), and recognition (Fraser, 1999, 2009). Compared to the distributive paradigm, the tripartition approach provides a more visible and critical analysis of justice and injustice through focusing “not only on the ‘what’ of justice, but also on the ‘who’ and the ‘how’” (Fraser, 2009, p29).

This tripartition approach was gradually integrated into research on environmental justice. An early attempt was accredited to Schlosberg (2004). In his view, distribution adjustment in itself is insufficient to solve diverse environmental problems. A focus solely on the equitable distribution of environmental benefits and burdens ignores the importance of recognizing the diversity of participants and their participation in decision-making processes. The latter two aspects are neither (fully) distributable in practice nor equivalent to distribution in theory. In addition, global movements for environmental justice show expansive notions of justice that are not confined to distribution. Therefore, he suggests to extend focus into distribution, participation, and recognition to unravel multifaceted environmental (in)justice embedded in different social-ecological contexts. This tripartition approach was further developed in subsequent studies of environmental justice, such as contributions from Sikor et al. (2014) and Walker (2012). Over the years, environmental justice analysis has also been associated with forest governance, a field that involves diverse actors, with varying resources and in different favorable conditions, e.g., various governmental agencies, local households, communities, NGOs, business actors, etc. Forests are critical not only to biodiversity and climate change mitigation, but also to the livelihoods of local people. Therefore, environmental justice concerns also apply to forest governance because certain actors, particularly various groups of local communities and indigenous people, are often extra disadvantaged by deforestation and forest degradation as well as by forest policy outcomes and impacts (for example, Forsyth and Sikor, 2013; Strzelecka et al., 2021; Wang et al., 2019).

Our study adopts the tripartition approach to environmental justice and applies it to forest governance.¹ Distribution justice is concerned with the fair distribution of benefits and costs regarding environmental matters among actors. Distribution is closely associated with the concept of property rights. Property rights define who can act on resources in relation to other actors and who cannot, which implies various arrangements of resources management (Coase, 1960; Feeny et al., 1990; Schlager and Ostrom, 1992). Well-defined property rights internalize benefits and costs and, if well implemented, avoid depletion of natural resources (Feeny et al., 1990; Ostrom, 2010; Schlager and Ostrom, 1992). Additionally, property rights should secure a fair distribution of benefits and costs among actors and avoid the marginalization of vulnerable groups (Forsyth and Sikor, 2013). Due to its importance, distribution is a key aspect of international agreements related to forests. For example, Reducing Emissions from Deforestation and Forest Degradation (REDD+) emphasizes the need for well-defined property

¹ Despite a general consensus on the tripartition approach to environmental justice, it is necessary to recognize the plural usages of terms in the literature. Specifically, “participation”, as used in this study, focuses on examining justice and injustice in decision-making processes. This usage aligns with “representation” or “procedural justice” used in other environmental justice studies (details see Schlosberg, 2009; Walker, 2012). It is crucial to note, however, that “participation” in this context is comparable to “representation” used by Fraser but different from her “parity of participation” (or “participatory parity”) whereby any member of society participates in social interactions on a par with others. In her analysis, “the most general meaning of justice is parity of participation” (Fraser, 2009, p16). “Parity of participation” therefore encompasses all the three dimensions of justice, not just the aspect of participation.

rights to secure a fair distribution of benefits and costs from forest conservation, the practice of which is also examined by scholars (Forstner and Sikor, 2013; Isyaku et al., 2017; Suiseeya, 2017).

The participation dimension of justice serves to investigate whether all actors in a policy domain have equal access to the decision-making process that determines policy outcomes and resources mobilization (Bodwitch et al., 2022; Sikor et al., 2014). The effectiveness of forest conservation will very likely be reduced if some actors are excluded from participation. As exemplified in the implementations of REDD+ and other forest carbon projects, participation is crucial today because the battle against climate change necessitates multi-level collaboration, large-scale support and sufficient knowledge and information (Pham et al., 2021; Suiseeya and Caplow, 2013).

Recognition justice requires mutual recognition among actors (He et al., 2021; Martin et al., 2016). Environmental justice is concerned with recognition because “the moral high ground of conservation” risks the marginalization of certain actors. Recognition unfolds through the appreciation of the statuses of diverse individuals and groups that are constituted by their rights, knowledge, and values (Bodwitch et al., 2022; Figueroa, 2015; Strzelecka et al., 2021). In contrast, diverse types of mal-recognition could trigger social mechanisms that weaken certain actors (Martin et al., 2016; Wang et al., 2019). Based on the analysis of Fraser (1999) and on relevant environmental studies, Schlosberg (2009) exemplifies several forms of mal-recognition, e.g. cultural domination that prioritizes certain actors' values but denies others, non-recognition that keeps ignorant of some actors' statuses, and disrespect that renders some actors inferior. For example, Myers and Muhajir (2015) report about local people's protests against a nature reserve established by the government in West Kalimantan, Indonesia. Although the government offers plans for benefit sharing, local people still protest because of the government's insufficient attention to recognizing customary practices of land use.

The three dimensions of justice are interwoven with each other in practice. For example, distribution injustice may originate from insufficient participation in decision-making and insufficient recognition of local people's rights (Wang et al., 2019). Injustice of participation may be caused by mal-recognition of certain actor's status (Myers and Muhajir, 2015). And mal-recognition may also be associated with unfair distribution and limited participation (Bodwitch et al., 2022). Therefore, a comprehensive understanding of (in)justice situations necessitates an investigation of distribution, participation, and recognition altogether in a specific context.

4. Methodology

A case study design was adopted because the tripartition framework of environmental justice urges researchers to do in-depth studies, whereas large-N and variable-based research will be difficult to unravel its complex characteristics. Within this research strategy, the key unit of analysis for the cases in this paper is the county level. Regarding the Chinese administrative hierarchy, five administrative levels exist: center, province, prefecture, county, and township. A county is considered as our basic analytical unit because it is the basic administrative unit in China to execute forest policies. A county government usually receives policy commands from higher-level governments, governs township agencies, and implements policies into its jurisdiction. In particular, the Forest Law articulates that a county forestry department is the basic unit of implementing forest policies (National People's Congress, 2019).

The nature of this case study is exploratory due to the extensive variations in forest policies across China's vast territory and scarce applications of the environmental justice framework to China's forest governance. Given this exploratory nature, multiple cases are preferred over single case so as to explore case variations (Gerring, 2006; Yin, 2013). Therefore, multiple cases were selected, step by step, starting from the province level and moving down to the county level. Two provinces, Fujian and Yunnan, were initially selected because they

showed sufficient variations in geographical conditions and forest policies. Fujian, located in the southeastern coastal region, has a more developed economy and was the first province to implement CFTR, while Yunnan, situated in the southwestern inland region, has a less developed economy and follows more conservation-oriented policies to protect abundant natural forests. Next, two prefectures were selected from each province: Sanming prefecture in Fujian and Chuxiong prefecture in Yunnan. The selection was based on two reasons. First, field work in these prefectures was feasible with the help of personal networks. Second, both prefectures are located in approximately the middle region of each province, being consistent with the overall provincial characteristics regarding forest policies. Sanming prefecture was a pilot region in Fujian for implementing CFTR. Chuxiong prefecture had approximately 74% of its total forestland covered with natural forests and implemented the Natural Forest Conservation Program (NFCP, details see the section 5.2). Finally, specific counties were visited with the help of personal networks. This resulted in four counties, including County A and County B in Sanming prefecture of Fujian province and County C and County D in Chuxiong prefecture of Yunnan province.² Basic county characteristics are summarized in Table 1 (overview of forestland categories in Appendix Table A2). Of note, it is necessary to recognize that the four cases are far from exhaustive variations across the two provinces, let alone the entire Chinese territory. Rather, the selected cases could reveal potential variations of different regions and inspire future scholars to conduct more extensive studies.

Regarding data collection, the first round of field work was conducted from September 2019 to January 2020. Due to the outbreak of COVID, the second round was resumed and conducted in September 2020. Additional data was collected in October 2021 and May 2022. The first phase of data collection was oriented towards policy documents. Around 700 policy documents, issued from central to county levels and from 2001 to 2019, were systematically collected from archival rooms of the four county forestry departments. These documents include topics about CFTR, Ecological Civilization, timber regulations, forestland demarcations, forest conservation regulations, forestry statistics, and local forestry chronicle records (multiple topics could coexist in a document). Additionally, 53 semi-structured interviews were conducted (interview questions in Appendix Table A1), including officials from forestry departments, village leaders, village members, forestry business actors, and experts (Table 2). When visiting a county, the interview process began with forestry officials. The snowballing strategy was used; interviewees were asked to recommend additional ones. The interview process in a county was completed when information was saturated. Moreover, the first author used direct observation during the field work

Table 1
Basis county characteristics.

Characteristics	Fujian		Yunnan	
	County A	County B	County C	County D
GDP per capita in 2019	8600	14,589	6343	5074
Collectively owned forestland	241,307	184,047	245,101	153,432
Commercial collectively owned forestland	178,000	136,267	150,161	107,444

Note:

1. The currency unit throughout this study is converted by annual average exchange rate in 2019. 1 USD = 6.8985 RMB.
2. The unit of land size is hectare.
3. Data source: collection during field work.

² The real county names are coded throughout this study to protect the anonymity of interviewees from local forestry departments.

Table 2

List of interviews.

Categories of respondents	Interview locations				Other
	County A	County B	County C	County D	
Forestry officials	3	3	5	4	1
Village leaders	3	2	2	2	
Village members	3	5	7	7	
Forestry business actors	2	2			
Experts					2
Total	11	12	14	13	3

Note: interview locations were categorized into “other” in case of interviews conducted in jurisdictions outside the four counties: (1) a forestry official interviewed in another Sanming district, Fujian province, in order to corroborate policy changes observed in County A and County B; (2) the two experts were interviewed in Nanjing, Jiangsu province, in order to gain expert views of policy changes.

as a complementary approach to understand forest policy processes, local daily life, and forestry practices. Relevant scientific publications were reviewed to collect complementary data.

NVivo 12, a software for managing and analyzing qualitative data, was used in data analysis. The approach to data analysis was qualitative content analysis (Boréus and Bergström, 2017). Initial codes were operationalized based on the themes of distribution, participation, and recognition. Then, initial codes were revised during repetitive processes of analyzing policy documents, interviews, and other data. The final coding scheme resulted from such repetitive processes (Appendix Table A3). The final coding scheme was applied to coding policy documents, interviews and scientific publications, the analysis of which was finally nested into the empirical results. These results were consistent and complementary to each other. For example, top-down decision-making processes in the cases were reflected in policy documents describing top-down policy deliveries and interviews showing forestry officials' confirmation of top-down policy processes and local people's experience of limited participation. The key policy documents that support the results in section 5 have been listed in Appendix Table A5. The key interviewee responses – quotes in section 5 and additional supplementary quotes – have been listed in Appendix Table A6.

5. Results

Fujian started the implementation of CFTR in 2003 and completed it in 2004, while Yunnan initiated CFTR in 2006 and finalized it in 2009. Subsequently, in the 2010s, forest conservation appeared to be a high-priority policy agenda in both the Fujian and Yunnan cases. The results of the Fujian and Yunnan cases are summarized in Table 4.

5.1. Results in Fujian

County A and B completed CFTR in 2004. The majority of the recipients of forestland were rural households. Meanwhile, some forestland ended up in the hands of “forestry entrepreneurs”, which is in accordance with the local daily expression of *linye dahu*, meaning “forestry big households” in the literal English translation. According to local views, a person is considered a forestry entrepreneur if he/she has 10 ha or more of forestland in possession, although no rigid criteria exist. In comparison, the average size of forestland was only 4.90 ha per household and 1.04 ha per capita in Fujian after CFTR, as reported by the Collective Forest Tenure Reform Monitoring Group (2012). A forestry entrepreneur is usually a resident in the county but not necessarily a member of a village community where the plot of forestland is located. Forestry entrepreneurs are usually wealthier than ordinary rural households, which is what gives them the means to invest in forestry. In some cases, however, forestry entrepreneurs were not

wealthy but borrowed from financial institutions to invest in forestry (serious problems ensued later on. See section 5.1.3).

The emergence of forestry entrepreneurs was a gradual process. Since the incipient establishment of market transactions in the late 1980s, village committees intermittently leased forestland to private persons to obtain revenues or pay village debts. These lease contracts to private actors were subsequently formalized into FUCs during CFTR. In addition, the Fujian government allowed village committees to auction some forestland to private persons during CFTR for the sake of securing village revenues. When CFTR was completed in 2004, 26% of forestland was possessed by forestry entrepreneurs, while 68% and 6% of forestland were possessed by rural households and village committees, respectively in County A. In County B, 20% of forestland was possessed by forestry entrepreneurs, while 70% and 10% of forestland were possessed by rural households and village committees, respectively (Appendix Table A4). After CFTR, the government further encouraged forestry entrepreneurs to invest in forestry because timber production requires heavy investments to achieve efficiency and economies of scale.

The Fujian provincial government promised to incrementally remove restrictions on commercial timber harvest after CFTR but reversed the promise in the 2010s under influence of the discourse of Ecological Civilization. Four major restrictions were introduced. First, the provincial forestry department introduced a ban on commercial harvest of natural forests in 2010. Second, clear-cutting harvest was restricted and selective logging was encouraged in 2012. Third, beginning in 2012, the provincial forestry department demarcated the Ecological Commercial Forestland that was banned from commercial timber harvest. Ecological Commercial Forestland accounted for 9% of commercial collectively owned forestland in County A and 10% of that in County B. Fourth, in 2014 the provincial forestry department lengthened the harvest rotation cycles of two important forestry tree species: *Chinese fir* from 16 to 26 years, and *horsetail pine* from 21 to 31 years (Table 3).

5.1.1. Distribution

The progressive restrictions on timber harvest over time caused economic losses due to both decreased forestry benefits and increased forestland management costs. The decreased forestry benefits ensued from reduced timber outputs caused by the restrictions on timber

Table 3

Progressive restrictions on timber harvest in Fujian.

Time	Restriction	Issuer of restriction	Document title
2010	Ban on commercial harvest of natural forests	Fujian Provincial Forestry Department	Urgent Announcement of Pausing Harvesting Natural Forests (<i>Guanyu zanting tianranlin caifa de jinji tongzhi</i> , in Chinese)
2012	Restriction on clear-cutting harvest	Fujian Provincial Forestry Department	Announcement on Further Changing Harvest Approaches (<i>Guanyu jinyibu tuijin zhuanbian caifafangshi gongzuo de tongzhi</i> , in Chinese)
2012	Restriction on timber harvest on newly demarcated Ecological Commercial Forestland	Fujian Provincial Forestry Department	Announcement of Demarcating Central-level Ecological Forestland, Provincial-level Ecological Forestland, and Ecological Commercial Forestland (<i>Guanyu gongbu guojiaji shengtaigongyilin he shengji shengtaigongyilin ji zhongdianshengtaiquwei shangpinlin quhuajiedingfanwei de tonggao</i> , in Chinese)
2014	Extended harvest rotation cycles	Fujian Provincial Forestry Department	Announcement on Some Issues of Timber Harvest (<i>Guanyu senlin caifaguanli youguan wenti de tongzhi</i> , in Chinese)

Note: the documents were collected during field work.

Table 4
Summary of Fujian and Yunnan cases.

Dimensions	County A and County B in Fujian	County C and County D in Yunnan
Distribution	Unjust distribution: the decreased benefits and increased costs caused by the restrictions on timber harvest were borne by rural households and forestry entrepreneurs. It disproportionately fell to entrepreneurs who invested in forestry.	Mediocre performance of distribution: benefits matched with costs among rural households, while the distribution of benefits and costs were unevenly shared between the government and rural households.
Participation	Non-participation: decisions on heightened restrictions on timber harvest were made exclusive of rural households and forestry entrepreneurs	Non-participation: decisions on restrictions on timber harvest under NFCP were made exclusive of rural households
Recognition	Non-recognition: local forestry officials understood, but failed to recognize, the new statuses of rural households and forestry entrepreneurs regarding forestland property.	Growing mutual recognition: forestry officials and rural households adapted to recognize each other's statuses under the combination of limited property rights and strict conservation under NFCP

harvest. The increased costs were due to higher labor costs and capital costs for forest management. Labor costs increased because additional labor inputs were necessary to meet the higher standards of timber harvest, such as selective logging. Capital costs increased because rural households and forestry entrepreneurs were subject to longer rotation cycles and thus a longer time to get returns from investments, which means higher “opportunity costs” according to economic theory. In other words, if the restrictions did not exist, an investor could get returns more quickly and invest those in other activities.

The overall scale of economic losses due to these progressive restrictions in the 2010s is unknown because the government does not collect such statistics, but governmental buy-out plans to compensate affected people do give some impression. In 2014, the Fujian provincial government authorized county governments to experiment with buying out forestland demarcated as Ecological Commercial Forestland. [Fu et al. \(2017\)](#) provide a case in Yong'an of Sanming prefecture in which the average buy-out price for natural forests was 2590 USD per ha in 2014 and 2825 USD per ha in 2015. For plantation forests it amounted to 4753 USD per ha in 2014 and 5945 USD per ha in 2015. These buy-out prices matched the contemporary market costs for timber assets. However, this buy-out experiment ceased to exist in 2019 due to a lack of sufficient fiscal revenues. An additional remedy rolled out in 2016 when the central government started to subsidize those whose forestland met the ban on commercial harvest of natural forests. The annual subsidy, however, was only 33 USD per ha, much lower than the market prices of timber assets, compared to the buy-out prices for natural forests provided by [Fu et al. \(2017\)](#). Consequently, despite some ecological gains from the restrictions on timber harvest, an unjust distribution manifested itself in the economic losses which were disproportionately distributed among recipients of forestland property rights.

Noteworthy, compared to forestry entrepreneurs, ordinary rural households experienced much less economic loss for two reasons. First, many off-farm jobs were created during China's rapid economic growth. In the 2010s, the average daily wage in the labor market increased to around 30 USD. Rural households were thus motivated to migrate to urban areas and earn their income via off-farm jobs, instead of forestry. Second, rural households were reluctant to invest in forestry, and thus encountered less losses thereafter. This tendency was caused not only by the minimal forestland allocated to rural households and its marginal income contribution to them, but also by forestland fragmentation as a consequence of the egalitarian principle of allocating forestland during CFTR. The entire forestland in a village was first divided into tiny plots,

then classified into several quality levels, based on fertility, and finally allocated to rural households.

Investments by forestry entrepreneurs were thus very distinct from that of rural households, as was their care for the forests through management practices. A forestry official, who was a middle-aged man, expressed these differences as follows:

In general, a rural household only has a small size of forestland. Could you become rich by managing such tiny forestland? Younger generations don't care about it anymore. Now, even hard-working senior villagers would not do so. So, if you travel across different places, you will find forestland with the worst vegetations, this is the kind of (rural household's) forestland [...] When forestland is in the hands of private persons (referring to forestry entrepreneurs), forest quality indeed becomes better. Fertilizers, tree plantations, are better (9th September 2019, interviewed in County A).

Given these differences, forestry entrepreneurs disproportionately bore the burden of the restrictions on timber harvest. Since these restrictions were based on criterion for forestland conservation, regardless of whether one had invested in forestland or not, entrepreneurs had a higher chance of encountering economic loss as compared to households. A forestry official, a middle-aged man, explained it as follows:

If you have more forestland, it is more likely for you to have forestland qualified for the restrictions on timber harvest (19th September 2019, interviewed in County A).

5.1.2. Participation

The unjust distribution of benefits and costs was associated with a non-participation of rural households and forestry entrepreneurs in forest policies. After all, authoritarian environmentalism is characterized by top-down policy processes. A forestry official, a middle-aged woman, described this feature as follows:

We implement what higher-level governments mandate us to do. Even in case of our policy experiments, there must be authorization from higher-level governments. We also need to submit our implementation reports all the way to the provincial government after implementation (8th November 2019, interviewed in County B).

In particular, the restrictions on timber harvest emerged from top-down decision-making processes and lacked consultation with rural households and forestry entrepreneurs. The central government dictated the policy discourses of Ecological Civilization and steered the assessment of lower-level governments' performance of realizing the objectives of this discourse. At the provincial level, the provincial forestry department specified those detailed restrictions on timber harvest ([Table 3](#)). The prefecture forestry department functioned as an intermediary and imposed those policies upon counties. In the end, county forestry departments had to implement the restrictions in their jurisdictions. For example, expressions from a forestry official, a middle-aged man, reflect how restrictions on timber harvest emerged and persisted throughout the top-down decision-making processes:

In fact, the State Forestry Administration (the central governmental agency) came to our county several times in recent years. We provided feedback (regarding restrictions on timber harvest), which was ultimately futile. The State Forestry Administration said that General Secretary Xi (Jinping) proposed “green water and verdant mountains” (the slogan of Ecological Civilization) and mandated forest protection [...] So, no one dared to do otherwise (regarding changing the restrictions) from higher to lower governmental levels (4th September 2019, interviewed in County A).

It was sufficient to deliver those policy documents stipulating the timber harvest restrictions to county forestry departments ([Table 3](#)). Subsequently, the implementation was relatively easy, mediated through the arrangement of Timber Logging Quotas (TLQs). Everyone

must go to the county forestry department and apply for quotas via the digital online system of TLQs before timber harvest. The online system has an algorithm to automatically decide whether a plot of forestland could pass the restrictions. Consequently, many people were even unaware of these updated restrictions until applying for quotas. For example, one rural household head who was a middle-aged man expressed:

When I applied for timber harvest quotas at the forestry station, forestry officials told me about the restrictions (on timber harvest) (14th September 2019, interviewed in County A).

5.1.3. Recognition

Ordinary rural households became better-off due to the economic development in the 2010s and encountered much less economic loss, related to the harvest restrictions, than entrepreneurs. So, they tended to be satisfied with the situation. For example, a senior man who was the head of his household expressed:

My main income comes from producing roasted bamboo shoots. My son earns his income via working outside of village [...] I planted some Chinese fir and horsetail pine but not too much because the costs are expensive [...] Fairly speaking, I feel current policies okay (2nd November 2019, interviewed in County B).

In contrast, forestry entrepreneurs were negatively affected by the restrictions. As they became aware of the timber harvest restrictions, they also realized that it was futile to consult officials of county forestry departments. For example, one forestry entrepreneur, who was a middle-aged man, said:

I don't know how much money has been wasted and trapped because of forestry. I worry about money every day. But there is no solution. Previously, the government promised a lot. I bought forestland. I spent countless money on tree plantations. Now, there are so many restrictions on harvest. I cannot even repay the interest of credits for investing in forestry. All that I did only contributes to society (19th September 2019, interviewed in County A).

The injustice in this context should be acknowledged, particularly for forestry entrepreneurs, whose property rights were infringed upon. The policymaking was rooted in non-participation and there was an unjust distribution of costs. More serious problems were perceived by local officials in that the basic freedoms of some forestry entrepreneurs were negatively affected too. Since some forestry entrepreneurs borrowed credit from banks, when they were unable to pay their debts, some of them were put on the "blacklist" of the social credibility system. Possible punishments could be restrictions on buying flight tickets, high-speed train tickets, kid's school enrollment, etc. For example, a local official, who was a middle-aged woman, recognized:

Nowadays, some forestry entrepreneurs cannot repay debts to banks. Logically speaking, they could not repay because of forest policies. But banks do not consider it. So, these people are on a blacklist. Currently we don't have a solution (10th September 2020, interviewed in County B).

In addition, local forestry officials worried that the restrictions disincentivized recipients of forestland property rights to invest in forestry and produced additional pressures on demand on imported timber and deforestation overseas. However, they could not move from sympathetic understanding to true recognition because the Ecological Civilization was imposed by the central government, while the restrictions on timber harvest were issued by the provincial government. As a result, one official, a middle-aged man, expressed the difficulties of lessening the restrictions:

Ecological forests have already been protected. Natural forests have been additionally protected. But now, even the commercial

plantations are restricted from timber harvest. In my view, it is unreasonable to impose such restrictions. People use their own money to plant trees. Don't they know how to manage and profit from it? The government should not interfere with private forestry management. The government is doing what should not be done (13th October 2021, interviewed in a Sanming district).

5.2. Results in Yunnan

Since the initiation of the first round of NFCP in 2001, local timber markets were shut down in Yunnan to eradicate commercial timber transactions. Given the strict forest conservation under NFCP, forestland allocation through commercial auction was rare during CFTR from 2007 to 2009. Most forestland was allocated to rural households through egalitarian allocation. When CFTR was completed in 2009, 93% and 6% of forestland were possessed by rural households and village committees, respectively, in County C. Only 1% of forestland was auctioned to private persons. Forestland allocation in County D was applied similarly. 93% of forestland went to rural households and 6% to village committees. 1% of forestland was auctioned to private persons (Appendix Table A4).

Although the provincial government promised to experiment on releasing restrictions on timber harvest after CFTR, no substantial reduction occurred because of the priority of conserving forests under NFCP. In the 2010s, the rise of Ecological Civilization served to strengthen the importance of NFCP. When the first round of NFCP ended in 2010, the central government announced NFCP as a permanent policy and decided to update the implementation of NFCP every 10 years. Therefore, commercial timber harvest still stagnated at low levels in the two counties.

5.2.1. Distribution

Different from the situation in Fujian, most recipients of property rights over forestland were ordinary rural households in County C and D in Yunnan. Since the initiation of NFCP in 2001, restrictions on timber harvest have been strict and remained so over time. Therefore, when CFTR was initiated in Yunnan, the forestland allocation did not leave much room for commercial timber management and harvest.

Overall, the distribution of benefits and costs were homogenous among rural households in the two counties. Due to the strict and long-lasting timber harvest restrictions, rural households benefited much less after CFTR completion, compared to the Fujian cases. Rural households only received limited rights, such as collecting firewood or timber for personal uses, and had to apply for (hardly available) quotas of TLQs at a county forestry department. In line with the limited benefits foreseen, rural households tended to avoid investment in forestry.

Meanwhile, the fiscal budget of NFCP benefited a county forestry department through executing the conservation tasks. The shutdown of commercial harvest under NFCP meant that fiscal revenues could no longer be generated through the taxation of timber harvest. Against this background, the fiscal budget of NFCP, provided by the central and provincial governments, now covered costs of forest plantations for ecosystem services, forest protection, prevention of wildfires and parasites, and management costs of forestry departments. In addition, the NFCP budget provided salaries for those people who were fired from state-owned forestry enterprises after the shutdown of local timber markets since 2001 and helped them to become NFCP forest guards. A forestry official, who was a middle-aged man, confirmed the importance of the NFCP budget:

NFCP is funded by the central and provincial governments. NFCP is funded very little by the prefecture government, let alone our county government. Our local governments are struggling for fiscal revenues. Honestly speaking, if fundings from the central and provincial governments ceases, nothing (related to forest conservations) can be done anymore (20th November 2019, interviewed in County C).

5.2.2. Participation

Similar to the Fujian cases, the decision-making process was also non-participatory in nature in the two Yunnan counties after initiation of the Ecological Civilization policy, showing characteristics of authoritarian environmentalism. However, different from the Fujian cases, no major revisions of restrictions on timber harvest occurred throughout the decision-making process because of the ongoing priority for forest conservation.

Immediately after the completion of the first round of NFCP in 2010, the State Council at the central level announced the start of the second round of NFCP. The provincial government then followed this decision and mandated county governments to update detailed plans for the second round of NFCP. NFCP shapes the upward accountability structure. First, a lower-level government is directly accountable to the government one-level higher regarding the implementation of NFCP. Such an arrangement is established all the way from province, prefecture, county, to township level. The performance of the program matters for officials' promotion, demotion, and punishment. Second, although NFCP forest guards are not government officials, they are directly accountable to county forestry departments. The departments will cease to pay their salary or fire them in the case of unqualified performance. County forestry departments can easily monitor such daily activities of guards because they are equipped with GPS devices and thus their real-time locations are tracked. Third, the NFCP budget is mainly supported by the central and provincial governments. When delivered to a county, the NFCP budget is managed by county fiscal departments. This means that the county forestry department cannot use the budget unless applying with and getting approval from the head of the county government. The operation of the NFCP budget thus strengthens the upwardly accountable structure. This is also expressed by a forestry official, who was a middle-aged man:

The implementation of NFCP necessitates careful implementation from higher to lower governmental levels. For instance, the prefecture government orders the county government to sign the contract (for taking the responsibilities of implementing NFCP). Then the county government orders township governments to do the same. Township government then signs contracts with NFCP forest guards (20th November 2019, interviewed in County C).

Rural households had little influence on and participation in the decision-making process. Instead, rural households could be better described as decision *takers*, in that they must follow policy outcomes of the decision-making processes. County forestry departments continued to be upwardly accountable to higher-level governments regarding forest conservation under NFCP, while directly mandating rural households to obey the restrictions on timber harvest. Consequently, forest conservation is still vested in the forestry department, thus excluding rural households. As manifested in everyday life in the villages, NFCP forest guards hired by county forestry departments patrol villages and forbid illegal logging activities, grazing in forests, and use of forest fires, and the like, whereas rural households play little role in forest use, management and conservation.

5.2.3. Recognition

As forestry officials and rural households adapted to the new situation, there was growing mutual recognition among them under the combination of limited property rights and strict conservation under NFCP. Forestland allocation during CFTR was welcome among rural households, irrespective of limited rights. Through CFTR, rural households obtained access to their allocated forestland and could now prohibit others from unauthorized use of forestland. Despite restrictions on timber harvest, rural households still benefitted from collecting firewood on forestland for personal use. In addition, rural households now recognized the forestry department's status of enforcing strict conservation regulations. NFCP forest guards must patrol villages on a daily basis and carry speakers that incessantly advertise NFCP to rural

households. For example, a man who was in his thirties and worked as a long-haul truck driver expressed his views:

NFCP prevents us from harvesting timber. So, no one dares to harvest. I want to harvest and have some plans of modifying the trees on forestland. But it is impossible because of restrictions on cutting natural forests (5th December 2019, interviewed in County C).

Rural households' acceptance of NFCP should also be attributed to the increasing off-farm jobs during the economic development. Many people earned their incomes outside of the villages, a phenomenon which emerged in the early 2000s and prevailed in the 2010s. Rural households had livelihoods not dependent on forestry so they did not oppose the strict conservation regulations. For example, a village leader who was a senior man expressed:

Social situation changed. In the past, if you did not commit to logging or even illegal logging, you could not have money to eat. Even buying an egg needs money. The social situation was different from nowadays. Now people are not that poor. Young people can do off-farm jobs (28th December 2019, interviewed in County D).

Rural households did not invest much in forestry after CFTR. During interviews, rural households rarely expressed their commitment to increasing tree seedlings, fertilizers, pesticides, etc. Their inputs into forestland were confined to pruning trees and irregular patrol over forestland.

County forestry officials started to recognize the status of rural households under NFCP / CFTR over time, in particular regarding their half-hearted commitment to forestry due to the limited property rights. Officials understood that it was unfair to expect rural households to bear the burden of the conflicting policies. Additionally, county forestry officials were satisfied with their own status of enforcing forest conservation since NFCP provided resources for county forestry departments to persist. Their recognition was exemplified in expressions of a forestry official who was a middle-aged man:

Although CFTR allocated forestland to rural households, most plots of forestland were natural forests that were banned from timber harvest. Rural households' actual rights to manage forestland were quite limited (18th November 2019, interviewed in County C).

Another forestry official who was a woman in her thirties said:

Currently NFCP is functioning well. NFCP has become a regular task and has no problems. (9th December 2019, interviewed in County C).

6. Discussion and conclusion

This study investigated tensions between forestland property rights and environmental conservation through the lens of environmental justice. Case studies were conducted in Fujian and Yunnan provinces. Conservation efforts under the discourse of Ecological Civilization in the 2010s were characterized by authoritarian environmentalism, given the top-down, non-participatory decision to highly increase the restrictions on timber harvest. This undermined the recently acquired forestland property rights of households and entrepreneurs, on the one hand, and left the burden of costs with them, on the other. Hence, Ecological Civilization not only violated participation justice but also distributive and recognition justice. In addition, injustice in the Fujian cases was more severe than in the Yunnan cases due to a shift in policy priority from CFTR in the 2000s to Ecological Civilization in the 2010s. Despite heightened restrictions on timber harvest, the government provided neither fair compensation for nor recognition of the marginalized status of recipients of forestland property rights. In comparison, injustice was less severe in the Yunnan cases. Recipients of forestland property rights did not increase investments in forestry after CFTR initiation, and thus avoided economic losses, due to restrictive and ongoing forest conservation policies throughout the past two decades.

Other literature also observes tensions between forestland property rights and environmental conservation (Fairhead et al., 2012; Larson et al., 2013; Scheidel and Work, 2018). But this study particularly corroborates the paradox that environmental conservation serves as a rational, logical and nuanced discourse that many will support, while at the same time it can undermine property rights and marginalize local people from access to forests. In addition, our study adds to the literature by specifying these tensions in the context of authoritarian environmentalism. Notably, the role of the state was crucial in instigating these tensions in our cases. Government policies in all cases were designed and implemented through the top-down governmental system in Fujian and Yunnan. The policy-making processes lacked participation from non-governmental actors, even excluding recipients of forestland property rights that were severely affected. Such top-down and non-participatory environmental conservation fits squarely into the definition of authoritarian environmentalism (Beeson, 2010; Gilley, 2012).

Recent studies have started to pay attention to examining environmental justice under authoritarian environmentalism in the Chinese context (Jiang et al., 2021; Lo, 2021; Mao et al., 2021). With regard to this discussion, our results imply that complete environmental justice is difficult to achieve under authoritarian environmentalism. Authoritarian environmentalism obviously violates participation justice due to the non-participatory nature of policymaking. Additionally, policy changes under such conditions can further worsen distribution and recognition justice. As shown in the Fujian cases, restrictive timber regulations applied to commercial collectively owned forestland have undermined property rights established through CFTR and compromised forestry investments by businessmen and rural households. Given the long cycle of timber production, such restrictions can result in reduced timber provisions in the domestic market, increased poverty in the countryside, and increased timber burdens overseas, the evidence of which has been reported by Zhang and Chen (2021). It leads to dubious sustainability of environmental conservation. Hence, our cases revealed a lack of public participation in deliberating the “how” of the restrictive timber regulations and the “what” of environmental problems that could be solved by these restrictions. Under such authoritarian environmentalism, improvement of environmental justice would be contingent upon the introduction of public participation and deliberation in policymaking.

Meanwhile, incomplete but improved environmental justice is still possible under authoritarian environmentalism, which was evidenced in the Yunnan cases. First, certain forms of distribution could be acceptable for local actors. The long-lasting governmental emphasis on conservation decreased rural households' benefits from forest resources and their motivation to invest, but it also shifted the burden of conservation to the government side and benefited county forestry departments with fiscal budgets. Second, mutual recognition is realizable through the adaptation of status and acceptance of the new situation. Rural households and governmental officials adapted to recognize each other's status. This happened in the context of an ongoing combination of limited forestland property rights and with strict environmental conservation under NFCP. Therefore, different performances of environmental justice between the Fujian and Yunnan cases imply the importance of policy stability. However, our caveat is that the extent of policy stability would be unforeseeable for actors who are excluded from decision-making processes, an observation which is shared in the literature (Eaton and Kostka, 2014; Mao and Zhang, 2018). A lesson from this paper, even to be shared beyond the Chinese context, is that inclusive participatory environmentalism, rather than its authoritarian variant, is necessary for credible and population-wide commitments to environmental challenges and environmental justice.

As compared to Myers and Muhajir (2015) observation of active and organized protests by local people in the face of environmental injustice, no such evidence was observed in our study. The lack of active protest, however, should not be misinterpreted as an implicit endorsement of the policies by local people. Instead, this absence of visible protest may

better attribute to difficulties in confronting government under authoritarian context, as shown in our analysis. It also implies that a remedy for injustice under authoritarian environmentalism would be more challenging than democratic contexts. Scholarship should explore how to enlarge the spaces for inclusive participation. Given the authoritarian context, researchers may explore soft approaches to bringing governments and non-government actors together. Examples and efforts of international collaboration for conservation may also offer examples and serve as leverage points for improving national and local participation modes.

Finally, our findings show that policy arrangements vary across regions in China and lead to different outcomes of justice and injustice. The four cases investigated in this study are just initial steps in exploring this variety. It therefore invites future research to conduct more extensive and in-depth environmental justice analyses in Chinese forest policy and maybe other sectors.

CRediT authorship contribution statement

Wenyuan Liang: Conceptualization, Data curation, Investigation, Methodology, Writing – original draft, Writing – review & editing, Funding acquisition. **Bas Arts:** Conceptualization, Methodology, Supervision, Writing – review & editing. **John Aloysius Zinda:** Conceptualization, Methodology, Writing – review & editing. **Jiayun Dong:** Conceptualization, Funding acquisition, Investigation, Writing – review & editing.

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.

Data availability

The data that has been used is confidential.

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Appendix A. Supplementary data

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