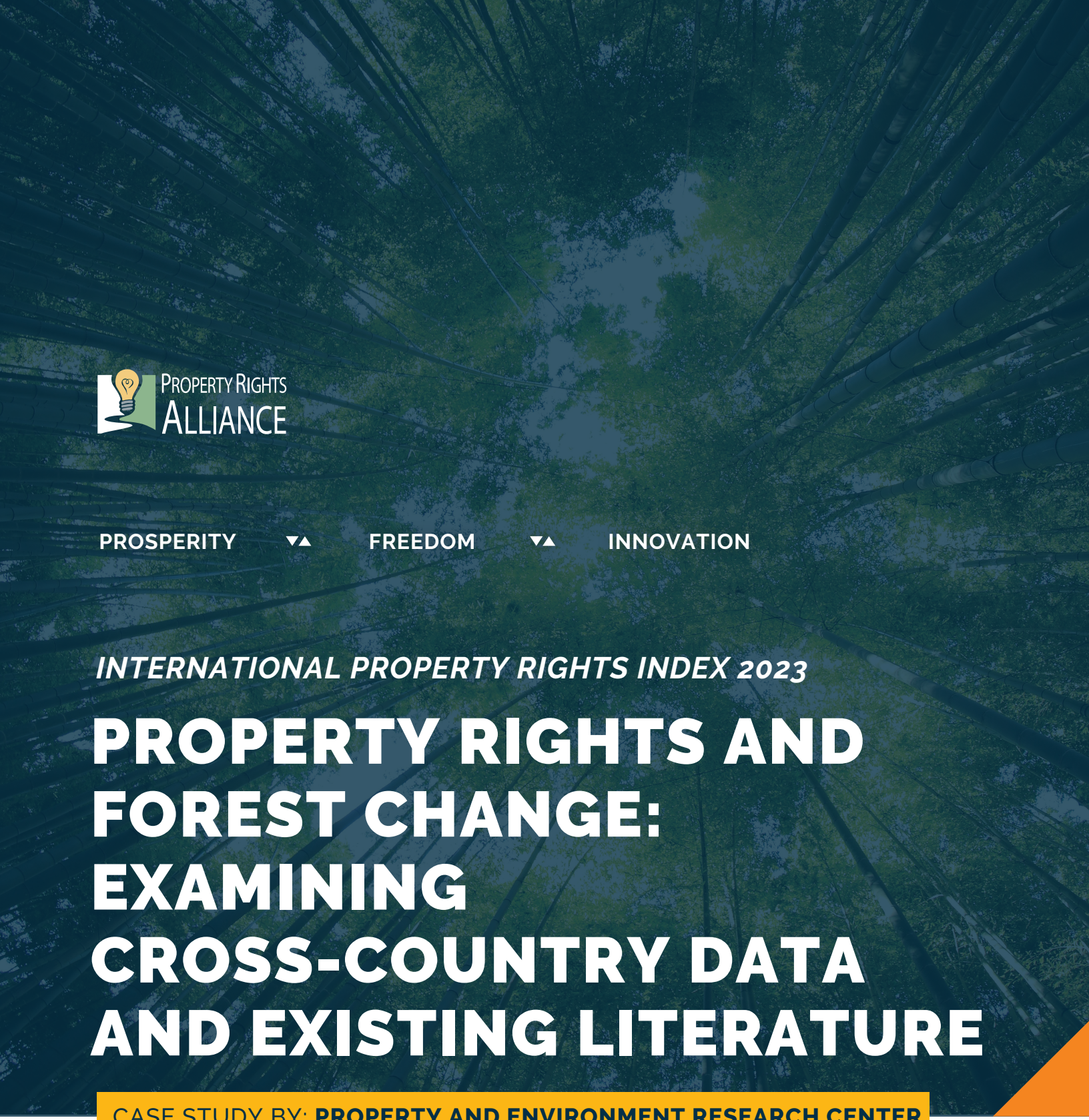

PROPERTY RIGHTS ALLIANCE

PROSPERITY ▼▲ FREEDOM ▼▲ INNOVATION

INTERNATIONAL PROPERTY RIGHTS INDEX 2023

PROPERTY RIGHTS AND FOREST CHANGE: EXAMINING CROSS-COUNTRY DATA AND EXISTING LITERATURE

CASE STUDY BY: **PROPERTY AND ENVIRONMENT RESEARCH CENTER**

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INTRODUCTION

Forests cover roughly one-quarter of the Earth and provide a multitude of important economic and ecological benefits.[1] Beyond serving as vital habitat for a diverse array of species, forests also function as carbon sinks that help mitigate climate change, contribute to water cycle regulation, and support the livelihoods of millions of people worldwide. The significance of forests has ignited a growing interest in their protection and restoration over recent decades.

The amount of global forested land, however, is not fixed; rather, it continually changes in response to a variety of factors. Since 1990, an estimated 420 million hectares of forest have been converted to other land uses, including agricultural production, infrastructure development, urban expansion, and illegal logging.[2] Between 2015 and 2020, approximately 10 million hectares of forest—an area roughly equivalent to the size of Portugal—was lost to deforestation annually.[3] While this figure is less than the average annual loss of 16 million hectares experienced in the 1990s, it still represents a significant loss of forest cover and its associated economic and ecological benefits.

Nor are all areas losing forest equally. In the span of two decades, from 2001 to 2020, nearly 1.5 million square kilometers of tropical forests was deforested—an area exceeding the size of France, Spance, and Germany combined.[4] Tropical forest deforestation accounted for more than half of all global forest loss during this period, and the region has experienced an even sharper uptick in recent years.[5] More than 4 million hectares of primary rainforest were lost in 2022—the equivalent of losing 11 soccer fields of forest per minute—an increase of 10 percent from the year before.[6]

Forests are changing in other ways, too. In some areas, forest cover is on the rise due to active reforestation efforts or natural forest expansion. Several countries that have historically lost large amounts of forestland have reached a turning point where forest growth outpaces forest loss.[7] When accounting for both forest loss and forest gain, the world experiences a net loss of an estimated 5 million hectares of forest annually, with the majority of this loss occurring in the tropics.[8]

Changes in forest cover are influenced by a number of factors, with agricultural expan-

[1]Hannah Ritchie & Max Roser (2021) "Forests and Deforestation." Our World in Data. Available at: https://ourworldindata.org/forests-and-deforestation.

[2]Food and Agricultural Organization (2020). "The State of the World's Forests." Available at https://www.fao.org/state-of-forests/en/.

[3]Ibid.

[4]Balboni et al. (2023) "The Economics of Tropical Deforestation," NBER Working Paper 31410.

[5]Ibid.

[6]World Resources Institute. "Forest Pulse: The Latest on the World's Forests." Available at: https://research.wri.org/gfr/latest-analysis-deforestation-trends?utm_campaign=treecoverloss2022.

[7]Hosonuma et al. (2012). "An assessment of deforestation and forest degradation drivers in developing countries." *Environmental Research Letters*, 7(4), 044009.

sion being the primary driver in many regions. Today, half of the world's habitable land is used for farming and livestock production.[9] In recent decades, the cultivation of crops such as palm oil and soybeans has led to substantial deforestation in Asia while livestock grazing is driving forest loss in many areas of South America. In particular, the clearing of the Brazilian Amazon for pasture and croplands is a growing international concern.

Although the proximate causes of deforestation may be agricultural expansion, infrastructure development, extractive industries, or illegal logging, the underlying causes are likely more complex. Weak property rights and governance failures can create perverse incentives for unsustainable land use, including deforestation and other forms of forest degradation. A large body of empirical research has found that when land tenure is insecure and property rights are unenforced or ambiguous, long-term planning horizons shorten and forests become vulnerable to opportunistic exploitation. By contrast, secure land tenure and well-defined property rights can provide landowners with the confidence and incentives to make sustainable investments in forest assets and agricultural intensification.

This case study explores the relationship between property rights security and forest cover change in countries across the world. It uses multiple property-rights indices and various measures of country-level forest cover to assess the relationship between property rights security and forest change, drawing general observations from the data. It then surveys the existing academic literature on the association between property rights and deforestation, reforestation, and afforestation, providing a detailed overview of the current state of knowledge. The paper concludes with policy recommendations aimed at leveraging property rights and land tenure security to reduce deforestation and promote forest conservation. This exploration of the role of property rights in forest conservation contributes to a more nuanced understanding of how legal and societal structures can influence deforestation and forest conservation efforts. By strengthening property rights and enhancing land tenure security, it may be possible to foster incentives for sustainable land use and forest conservation.

[8]Hannah Ritchie & Max Roser (2021), "Deforestation and Forest Loss." Our World in Data. Available at https://ourworldindata.org/deforestation.

[9]Hannah Ritchie & Max Roser (2019), "Land Use," Our World in Data. Available at https://ourworldindata.org/land-use.

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BACKGROUND

Understanding the relationship between property rights, land tenure security, and deforestation first requires a grasp of several key concepts. This section provides a brief overview of these concepts and their relevance to the case study.

PROPERTY RIGHTS AND LAND TENURE SECURITY

In the context of this case study, property rights refer to the legal rights individuals or groups hold over resources, such as land. These rights include the ability to use the resource, earn income from it, transfer it to others, and exclude others from it. Property rights can be held by individuals, groups, or communities, and they can be transferred through sale, lease, or inheritance.

Land tenure, meanwhile, is a broader concept that describes the ways in which people access, use, and control land. It encompasses a wide range of arrangements, from individual freehold ownership to community or Indigenous land rights. Land tenure security refers to the degree of certainty that an individual's or group's rights to land will be recognized by others and protected in cases of specific challenges. In the context of forest conservation and management, formal land rights may be granted to private individuals, communities, Indigenous groups, or others, with varying degrees of tenure security. Multiple indices exist that measure the strength and security of property rights in countries across the world, enabling cross-country comparisons.

TYPES OF FOREST CHANGE

Several categories of forest cover change are relevant to this case study. Deforestation refers to the permanent removal of trees from a forested area, typically to make way for agriculture, logging, or urban development. Deforestation can lead to loss of biodiversity, disruption of ecosystems, and release of stored carbon, contributing to climate change. Afforestation refers to the process of establishing a forest, or stand of trees, in an area where there was no forest. This is often done to create a new forest for timber or other uses, or to help mitigate the impacts of deforestation. Reforestation refers to the replanting of forests that have been cut down or otherwise lost. This can be

done through natural processes (e.g., allowing a cleared area to regrow naturally) or through human intervention (e.g., planting trees). The net change in forest cover can be measured by any gains in forest cover (whether from reforestation or afforestation) minus deforestation.

THE ROLE OF PROPERTY RIGHTS

In recent decades, there has been growing recognition of the importance of secure property rights and land tenure for sustainable development. International organizations like the World Bank and the Food and Agriculture Organization have advocated for land tenure reforms to improve land management, reduce poverty, and promote economic growth. Many countries around the world have responded by initiating land titling programs that grant formal rights to individuals or community groups, often for the purpose of forest conservation or other land-use goals.

Implementing these reforms has often been challenging, however, due to factors such as political resistance, institutional weaknesses, and conflicts over land. Moreover, the impact of these reforms on environmental outcomes, including deforestation, is complex and depends on a range of factors, including the specific design of the reforms, the local context, and the enforcement of property rights.

Property rights and land tenure security affect forest cover change because they influence the incentives for land use. Secure property rights can provide incentives for sustainable land use and forest conservation, as they give landholders a stake in the long-term productivity of the land. Conversely, insecure property rights can lead to overexploitation of forest resources and higher rates of deforestation. According to one meta-analysis of the relationship between land tenure security and forest cover change, tenure security is associated with less deforestation, regardless of the exact form of land tenure.[10] Unclear or insecure land tenure has been a major driver of deforestation, as people clear forest land to establish de facto ownership or exploit resources without regard for long-term sustainability. Likewise, secure property rights can provide incentives for reforestation or other forms of forest growth.

Several recent examples help demonstrate the basic relationship. More than half of the 11 million square kilometers deforested in the Amazon between 2019 and 2021 occurred in public forests with no legal title, according to the Amazon Environmental Research Institute.[11] Much of this is caused by illegal clearing of forests to graze cattle in an attempt to claim rights in the future. By contrast, a recent study of Indigenous communities in Brazil's Atlantic Forest found that deforestation declined and forest cover increased after communities attained full, formal legal recognition of their land rights. Using high-quality satellite imagery and data on land tenure, the researchers found less deforestation and more reforestation on lands where communities had been granted formal tenure rights compared to similar areas that had no legal rights. (More evidence for how property rights can affect forest cover is discussed in detail in the literature review section of this case study.)

[10]Robinson, Holland, and Naughton-Treves (2014).

[11]Eduardo Porter, "Want to Save the Amazon? Solve Property Rights," Bloomberg (July 20, 2023)

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PROPERTY RIGHTS AND FOREST CHANGE AROUND THE WORLD

What is the general relationship between the security of property rights and deforestation or other forms of forest cover change around the world? Before turning to the academic literature on the association between property rights and land tenure on forest-cover change, it is useful to understand the relationship between property rights and deforestation. This section provides a basic analysis of the correlation between property rights and various measures of forest cover change to provide general insights into the trends and relationships among countries around the world.

Given the discussion in the previous section, it is reasonable to hypothesize that countries with stronger property rights are associated with lower rates of deforestation. Relatedly, it is also reasonable to expect that countries with more secure property rights should have higher rates of afforestation and reforestation as well. Data was gathered to assess both of these hypotheses.

To assess the relationship between property rights and forest change, I gathered country-level data on property rights security and forest-cover change, using several different sources. To measure the strength of property rights, I use the following property rights indices: the 2023 IPRI and several of its relevant components (Legal and Political Environment [LP] and Physical Property Rights [PPR]), the World Bank's 2022 Worldwide Governance Indicators (WGI) (Rule of Law component, https://info.worldbank.org/governance/wgi/), and the Fraser Institute's Economic Freedom of the World Index (EFW) (Legal System and Property Rights metrics, https://www.fraserinstitute.org/resource-file?nid=14828&fid=18375). These metrics were chosen because they provide detailed, country-level measures related to the security of physical property rights, such as land, as well as the quality of the legal and governance systems necessary to ensure property rights protection.

To measure deforestation and other forms of forest change, I gathered data from several well-known sources that assess forest-cover change across the world. First, I use data from the Food and Agricultural Organization (FAO) that measures forest area as a percent of a country's total land area over time (https://data.worldbank.org/indicator/AG.LND.FRST.ZS). I use this data to calculate the percent change in countries' forest cover (measured as a percent of its total land area) from 1990 to 2020, omitting countries with less than 5 percent forest cover. I provide a longer-term measure of the data from 1990 to 2020 as well as a shorter-term measure from 2000 to 2020. This measure of forest area includes lands with natural or planted stands of trees at least 5 meters tall and excludes trees planted for agricultural purposes and trees in urban parks and gardens.

I also gathered data from the University of Maryland's Global Forest Change database (https://storage.googleapis.com/earthenginepartners-hansen/GFC-2022-v1.10/download.html) on tree cover gain and loss from 2001 to 2019, measured as a percent of a country's forest extent measured in 2000 to allow straightforward cross-country comparisons.[12] This database is frequently used in the literature of forest cover change. In this database, tree cover is defined as all vegetation greater than 5 meters in height and includes natural forests as well as plantations. Tree cover loss indicates the removal or mortality of tree cover, which can be due to a variety of factors including mechanical harvesting, fire, disease, or storm damage. As a result, tree cover loss in this context does not necessarily equate to deforestation.

To measure deforestation, I use data from the FAO's 2020 Global Forest Resources Assessment (https://fra-data.fao.org/assessments/fra/2020), which provides data specifically on deforestation. This database measures forested land spanning more than 0.5 hectares with trees higher than 5 meters and canopy cover of more than 10 percent. It does not include land that is predominantly in agricultural or urban use.

The results of this analysis are presented in Table 1, assessing the correlation between each of these various property rights and forest cover metrics. The results directionally align with the hypothesis that countries with stronger property rights experience less deforestation and more forest gain, while countries with weaker property rights are associated with more forest loss. For example, there is a weak but positive correlation between the IPRI (as well as its relevant LP and PR components) and various measures of forest cover gain. Meanwhile, there is a negative correlation between property rights and deforestation or other measures of tree cover loss, meaning countries that score higher on property rights indices such as the IPRI are associated with lower levels of deforestation. The correla-

	(1) FOREST COVER CHANGE FROM 1990 TO 2020 (AS A PERCENT OF TOTAL LAND AREA)	(2) FOREST COVER CHANGE FROM 2000 TO 2020 (AS A PERCENT OF TOTAL LAND AREA)	(3) TREE COVER GAIN (PERCENT OF 2000 FOREST EXTENT) (GLOBAL FOREST CHANGE)	(4) TREE COVER LOSS (PERCENT OF 2000 FOREST EXTENT) (GLOBAL FOREST CHANGE)	(5) DEFORESTATION (AS A PERCENT OF FOREST EXTENT IN 2015) (FAO)
IPRI	0.387	0.326	0.390	-0.105	-0.221
IPRI - LP	0.357	0.302	0.336	-0.084	-0.225
IPRI - PPR	0.347	0.312	0.384	-0.161	-0.204
WGI	0.381	0.302	0.379	-0.076	-0.207
EFW	0.380	0.300	0.377	-0.127	0.172

Table 1: Correlation Between Measures of Property Rights and Forest Change (Pearson's Correlation Coefficients).

[12]Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. High-Resolution Global Maps of 21st-Century Forest Cover Change. Science 342 (15 November): 850-53. Data available on-line from: https://glad.earthengine.app/view/global-forest-change.

tion appears to be robust, as the results are strikingly similar regardless of which property rights index or forest cover measure is used.

Assessing the relationship between property rights and forest change across all countries is useful; however, forests are not distributed equally around the globe. Two-thirds of the world's forests are found in just ten countries. As such, international efforts to curb deforestation often focus disproportionate attention on the subset of countries with large forest areas. To obtain a better sense of the relationship between property rights and forest cover change in these countries, Figure 1 plots the relationship between forest change and the International Property Rights Index (using the Physical Property Rights component) in the ten countries with the most tree cover. In the figure, bubbles are sized based on tree cover extent in 2010.[13] Forest change is measured as the percent change in the share of land covered by forests from 1990 to 2020 using FAO data (https://fra-data.fao.org/). Figure 1 again shows a positive relationship between property rights security and forest growth from 1990 to 2020 in countries with the most forest cover.

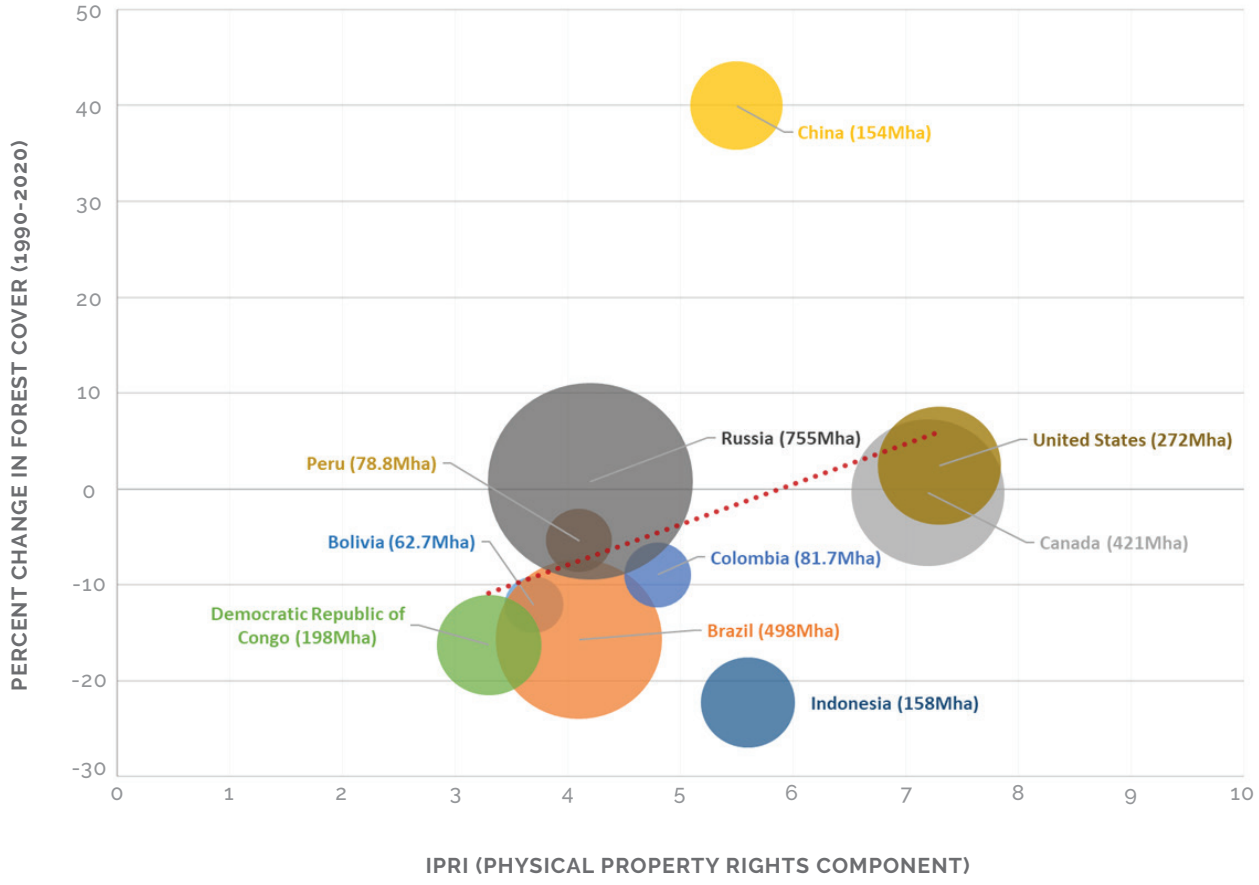

Figure 1: Relationship between IPRI (Physical Property Rights component) and Percent Change in Share of Land Covered by Forests (1990-2020) in 10 Countries with Most Tree Cover

[13]See Global Forest Watch: https://gfw.global/3rf9g9X.

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LITERATURE REVIEW

Analyzing cross-country data reveals correlations between stronger property rights regimes and lower deforestation rates, providing early indicative evidence of a relationship between the two. However, simple correlation does not prove causation, and many social, economic, and environmental factors simultaneously influence land use and forest cover change across countries. A rich body of academic research uses more robust empirical strategies to isolate the effect of tenure security while accounting for potential confounding factors. This research employs a variety of methodological approaches—from matched comparisons and natural experiments to spatial modeling and randomized evaluations—to more rigorously examine how property rights affect forest changes at multiple levels, from communities to indigenous territories to cross-country comparisons.

This growing literature, summarized in Table 2 at the end of this section, provides stronger causal evidence regarding the pathways through which secure land tenure and formalized ownership can shape incentives in ways that either encourage or discourage deforestation. This section provides an overview of the empirical research on the effect of property rights security on forest-cover change and discusses some of the main pathways through which property rights influence forest clearing and forest growth. Overall, the literature provides strong evidence that stronger property rights and land tenure security can reduce incentives for deforestation and encourage reforestation, with several exceptions and nuances discussed below and in Table 2. This result generally holds regardless of the exact form of land tenure (Robinson, Holland, and Naughton-Treves 2014, Pacheco and Meyer 2022).

INCENTIVES TO OVERHARVEST

A core principle of property rights theory is that secure land tenure reduces incentives for overexploitation of common resources that can lead to environmental degradation. This dynamic, known as the "tragedy of the commons," occurs when individuals or communities lack secure property rights and face pressures to maximize short-term private returns rather than collective long-term sustainability.[14] Forests managed as common property without restrictions on harvest quantities are consequently prone to overexploitation through uncontrolled commercial logging, fuelwood collection, or slash-and-burn agriculture.

Research has documented how insecure tenure motivates unsustainable overharvesting (Deacon 1999; Damnyg et al. 2012; Baragwanath & Bayi 2020; Wren-Lewis et al. 2020; Pacheco & Meyer 2022). Conversely, formalizing land rights has the potential to reduce overharvesting. In Nepal, forest cover dramatically expanded following the introduction of community forest

[14]Garrett Hardin. "The Tragedy of the Commons." Science 162.3859 (1968): 1243-1248.

management, the largest tenure reform initiative in the country (Fox et al. 2019). And Indigenous reserves in Brazil experienced reduced deforestation after receiving formal land tenure (Benzeev et al. 2023). Overall, insecure tenure creates an open-access dynamic prone to the tragedy of the commons, while secure property rights generally reduce incentives for overharvesting.[15]

REDUCED VALUE OF FORESTS WITH INSECURE RIGHTS

Another way that insecure land tenure drives deforestation is by reducing the value of forests as a long-term asset. Deacon (1994, 1999) and Bohne and Deacon (2000) find that when ownership is uncertain, landowners and communities have weaker incentives to conserve and invest in forests due to the risk of losing rights or benefits from the forest in the future. This finding is supported by Araujo et al. (2009), who find that insecure property rights in Brazil's Amazon led landowners to clear forest preemptively in order to establish *de facto* ownership through productive land use. This is particularly pronounced for farmers situated at forest fringes, who, in the absence of secure land titles, might be encouraged to expand their agricultural footprint. Without confidence in their long-term tenure, smallholders and communities have stronger incentives to convert forests to agriculture or other short-term uses before others can claim the land (Damnyag et al. 2012).

Securing ownership provides assurance that investments made today—such as selective logging, forest protection, or cultivation of high-value tree species—will generate returns years or decades later (Legesse, Jefferson-Moore, and Thomas 2018). With well-defined rights, landholders can capture the long-term economic benefits that forests provide as a valuable standing asset. This finding is echoed by Baragwanath and Bayi (2020), who find that granting property rights significantly reduced deforestation in the Brazilian Amazon inside Indigenous territories. Sustainable intensification is also encouraged where forests provide direct benefits to communities through payments for ecosystem services or tourism concessions, which depend on long-term forest stewardship only made feasible with land security.

CONSEQUENCES OF WEAK ENFORCEMENT

Even when formal ownership is granted, weak enforcement of property rights can still incentivize unsustainable forest use. If property rights are not well-enforced, then people may still clear forests illegally, because they believe that they are unlikely to be caught or punished. Araujo et al. (2009) shed light on this dynamic, noting that "deforestation is the consequence of strategic interactions between landowners and squatters" in the Brazilian Amazon. Landowners might preemptively clear forests to assert productive use of land and reduce expropriation risks. Concurrently, squatters, capitalizing on lax enforcement, might encroach upon these lands, leading to further forest clearance. Due to the threat of conflict or lost land, communities feel compelled to exploit resources unsustainably before others can seize them illegally. Therefore, effective enforcement is as important as tenure security itself in ensuring forests maintain their value as a long-term asset.

[15]For contrasting views and evidence, see Liscow (2012), Buntaine, Hamilton, and Millones (2015), and BenYishay et al. (2017) in Table 2.

ENHANCED AGRICULTURAL PRODUCTIVITY

Secure tenure also reduces deforestation pressures by encouraging farmers to invest in the productivity of their existing farmland rather than clearing new forests. Kubitza et al. (2018) find that secure land rights lead to agricultural intensification and reduce deforestation in Indonesia. The authors note that secure property rights "enable farmers to increase input intensity and productivity on the already cultivated land, thus reducing incentives to expand their farms by deforesting additional land." Several other studies find similar effects, including Deacon (1999), Abman and Carey (2020), and Wren-Lewis et al. (2020). Secure property rights can also provide farmers with access to credit, which can be used to invest in more sustainable farming practices (Kubitza et al. 2018). By encouraging investment and sustainable intensification of agricultural resources, secure tenure makes forest conversion less profitable relative to intensification on existing agricultural lands.

EFFECTIVENESS OF PROTECTED AREAS

Research suggests that secure property rights can affect forest cover in other more indirect ways. For example, the effectiveness of protected areas may be enhanced in countries with strong property rights. Abman (2018) examines 71 countries from 2000 to 2012 and finds that protected areas were more effective at avoiding deforestation in countries with higher levels of corruption control and property rights protection. The study suggests that when property rights are strong, people have more incentive to follow the rules and regulations of protected areas, which can prevent illegal logging.

INCENTIVES FOR REFORESTATION

Beyond deforestation, secure land tenure can motivate efforts to restore and regenerate degraded forests through reforestation. When ownership is in doubt, landholders or communities have little reason to invest considerable labor and money into long-term replanting projects. However, when property rights are secure, such long-term investments can become worthwhile. In this way, secure land rights serve not just to slow deforestation but to actively encourage efforts to rebuild forest landscapes.

Research has documented this relationship. In Ethiopia, tenure security ranked among top determinants of smallholder decisions to participate in reforestation programs (Legesse, Jefferson-Moore, & Thomas 2018). Similarly, a nationwide land titling campaign in Panama encouraged investment in reforestation (Walker 2021). Granting collective property rights to Indigenous territories in the Brazilian Amazon reduced deforestation while also leading to higher secondary forest growth in previously deforested areas. And after community land rights were formalized in Nepal, forest cover nearly doubled from 1992 to 2016 (Fox et al. 2019).

CONFLICTING EVIDENCE

While most of the evidence supports the theory that more secure property rights discourage deforestation, some studies have found little impact or even increased forest clearing associated with tenure reforms. For example, in Nicaragua, Liscow (2012) finds that property rights can increase deforestation by increasing investments in agricultural productivity, thereby increasing the economic returns to deforesta-

tion. In other words, while landowners with secure rights might not engage in haphazard or opportunistic logging, they might still opt for logging or other forms of land conversion if doing so is economically beneficial. The study underscores the importance of understanding the economic context in which property rights are established and the potential trade-offs involved.

Buntaine, Hamilton, and Millones (2015) also find that land titling and community management programs in Ecuador did not reduce deforestation in the five-year period following legal recognition. Similarly, BenYishay et al. (2017) find little evidence that formalizing land rights in Brazil reduced deforestation among affected Indigenous communities. And Kraus et al. (2021) do not find reductions in deforestation after community land titles were granted in Indonesia, although their study examines outcomes just one year after title was granted.

These studies highlight that the relationship between property rights and forest conservation is not linear and is influenced by many factors, including economic incentives, governance structures, and local contexts. While property rights can play a crucial role in forest conservation, their effectiveness is often contingent on the broader socio-economic and institutional landscape.

Overall, however, an extensive body of research finds that insecure property rights contribute to deforestation and other forms of net forest loss. While impacts depend on the context, recent studies continue to find formalizing community and smallholder tenure through titling programs can motivate forest conservation, especially when paired with local institutions that support the rule of law and good governance (Benzeev et al. 2023; Camino et al. 2023; and Rakotonarivo et al. 2023).

TITLE AND AUTHOR(S)	JOURNAL	CONTEXT	DATA AND METHODS	SUMMARY OF FINDINGS
DEACON (1994)	Land Economics	Cross-country data	Country-level data across 120 nations	Insecure property rights (resulting from government instability or the inability to enforce ownership) are associated with higher rates of deforestation.
DEACON (1999)	Land Economics	Cross-country data	Econometric estimation using cross-country data	Estimates based on cross-country data support the proposition that agricultural yields tend to be low and deforestation rates rapid where ownership is insecure.
BOHNE & DEACON (2000)	American Economic Review	Cross-country data	Cross-sectional analysis	Land tenure insecurity discourages investment in natural resources.
FERREIRA (2004)	Land Economics	Cross-country data	Cross-country regression analysis	Lowering trade barriers can increase deforestation, but the effect is mediated when accounting for a country's property rights regime.
ARAUJO ET AL. (2009)	Ecological Economics	Brazil	Panel data regression analysis	Insecure property rights in land drive deforestation in the Brazilian Amazon. The authors argue that secure property rights lead to less deforestation because they reduce the incentive for landowners to deforest their land to establish de facto property rights.
DAMNYAG ET AL. (2012)	Forest Policy and Economics	Ghana	Interviews with 756 randomly selected households	Land tenure insecurity can lead to increased deforestation in Ghana. The authors argue that insecure land tenure leads to short-term land use strategies, including deforestation.
LISCOW (2012)	Journal of Environmental Economics & Management	Nicaragua	Regression analysis	Insecure property rights resulting from Nicaragua's 1981 agrarian reform law resulted in 14 percent higher forest cover levels as measured in 2001.
ROBINSON, HOLLAND, AND NAUGHTON-TREVES (2014)	Global Environmental Change	Meta-analysis	Meta-analysis of 36 studies linking land-cover change and tenure conditions	Land tenure security is associated with less deforestation, regardless of the form of tenure.
BUNTAINE, HAMILTON, & MILLONES (2015)	Global Environmental Change	Ecuador	Regression analysis	Land titling and community management programs implemented in Ecuador's Morona-Santiago province did not reduce deforestation in the five years following legal recognition.

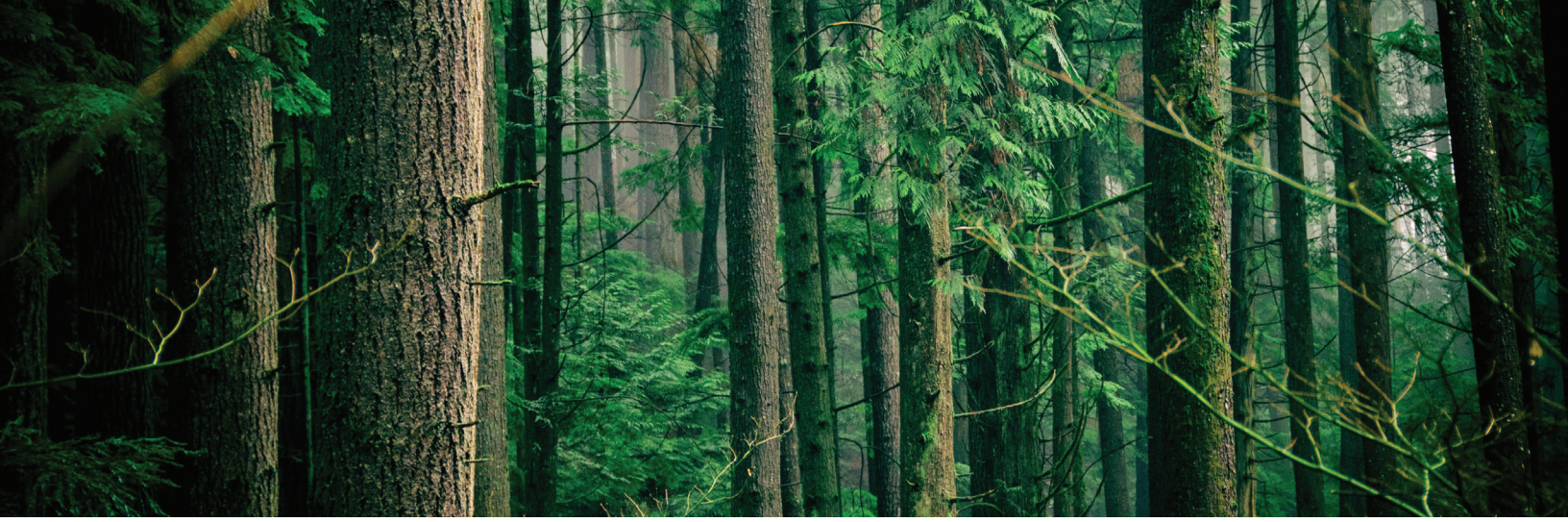
Table 2: Summary of Literature Review on Role of Property Rights and Forest Cover Change.

Full citations are listed in the References section

TITLE AND AUTHOR(S)	JOURNAL	CONTEXT	DATA AND METHODS	SUMMARY OF FINDINGS
BENYISHAY ET AL. (2017)	Journal of Environmental Economics and Management	Brazil	Panel data regression analysis	In the context of a program to grant formal title to land in the Brazilian Amazon, this study found little evidence that formalizing land rights reduced deforestation among affected Indigenous communities.
BLACKMAN ET AL. (2017)	PNAS	Peru	Community-level longitudinal data and satellite imagery	Land titling significantly reduces forest clearing and forest disturbances, at least in the short term, suggesting that formal land titling can advance forest conservation.
ABMAN (2018)	Ecological Economics	Cross-country data	Regression analysis and satellite data	Examining 71 countries from 2000 to 2012, this study finds that protected areas were more effective in countries with higher property rights protections.
KUBITZA ET AL. (2018)	Ecological Economics	Indonesia	Econometric model using panel survey data of farm households and satellite imagery	Secure land property rights can lead to agricultural intensification and reduce deforestation in Indonesia. They argue that secure property rights provide incentives for farmers to invest in land productivity, reducing the need for agricultural expansion and thus deforestation.
LEGESSE, JEFFERSON-MOORE, & THOMAS (2018)	Land Use Policy	Ethiopia	Case study assessing determinants of farmers' decisions to invest in reforestation	Land security is one of the most significant factors that affect Ethiopian farmers' decision to practice reforestation intervention.
WEHKAMP ET AL. (2018)	Ecological Economics	Meta-analysis	Meta-analysis of 32 empirical cross -countries studies in economics	Studies that use ownership rights as a measure of governance are more likely to find that better governance reduces deforestation.
FOX ET AL. (2019)	Journal of Forest and Livelihood	Nepal	Satellite imagery analysis and multilevel regression analysis	Forest cover in Nepal almost doubled between 1992 and 2016 following the introduction of community forest management, the largest tenure reform initiative in the country.
ABMAN & CARNEY (2020)	Food Policy	Vietnam	Econometric estimation combining satellite data on deforestation with household panel data	Land ownership can have both direct and indirect effects on deforestation in Vietnam: When more households in a community have any land title, deforestation tends to increase. But when a larger share of a household's land is officially titled, deforestation can decrease because households invest more in their land, reducing the need to clear forest.

TITLE AND AUTHOR(S)	JOURNAL	CONTEXT	DATA AND METHODS	SUMMARY OF FINDINGS
BARAGWANATH & BAYI (2020)	PNAS	Brazil	Regression discontinuity design	Granting property rights significantly reduces the levels of deforestation inside indigenous territories, and the results are of significant orders of magnitude.
PROBST ET AL. (2020)	Nature Sustainability	Brazil	Panel data regression analysis	Land titling programs in the Brazilian Amazon led to increases in deforestation among small and medium landholders, while deforestation remained unchanged among large landholders.
WREN-LEWIS ET AL. (2020)	Science Advances	Benin	Randomized control trial	Using a randomized control trial, this study finds that formalizing land rights reduced forest loss in treated villages, with no evidence of deforestation or negative spillovers to other areas.
KRAUS ET AL. (2021)	PNAS	Indonesia	Regression analysis, difference-in-differences	Examining the early effects of a program to grant community titles to forest land in Indonesia, this study does not find aggregate reductions in deforestation within a year of granting title.
ROMERO & SAAVEDRA (2021)	Journal of Development Studies	Colombia	Differences-in-differences	Deforestation decreased in communal areas after titling, especially in small communities.
WALKER (2021)	Land Use Policy	Panama	Propensity-score matching	Examining the effects of a nationwide land-titling campaign in Panama, this study finds that private land titling accelerates speculative deforestation, but it also encourages investment in reforestation.
PACHECO & MEYER (2022)	Nature Communications	Brazil	Quasi-experimental methods	Areas with poorly defined tenure rights increase deforestation relative to other land-tenure regimes (e.g., private, strictly protected and sustainable-use protected areas, Indigenous).
BARAGWANATH ET AL. (2023)	PNAS	Brazil	Regression discontinuity design and difference-in-difference	Examining collective property rights in the Brazilian Amazon, this study finds strong evidence that Indigenous territories with secure tenure not only reduce deforestation inside their lands but also lead to higher secondary forest growth on previously deforested areas.
BENZEEV ET AL. (2023)	PNAS Nexus	Brazil	Event study and difference-in-differences	Formalizing tenure of Indigenous lands improved forest outcomes in the Atlantic Forest of Brazil.

TITLE AND AUTHOR(S)	JOURNAL	CONTEXT	DATA AND METHODS	SUMMARY OF FINDINGS
CAMINO ET AL. (2023)	Global Environmental Change	South American Dry Chaco region	Matching estimators method	Examining a deforestation hotspot in South America (the Dry Chaco region), this study finds that land-tenure security is a barrier to deforestation and key to reducing forest loss on Indigenous Peoples lands.
RAKOTONARIVO ET AL. (2023)	Communications Earth & Environment	Madagascar	Mixed-method analysis	Using a mixed-method analysis, this study finds that land tenure insecurity is a major barrier to forest restoration in Madagascar. Secure land tenure is essential for attracting investment in restoration and ensuring that restoration efforts are sustainable.



4

POLICY IMPLICATIONS

The relationship between property rights and forest cover changes, as explored in this case study's data analysis and literature review, offers several insights for policymakers. While the establishment and enforcement of property rights can play a pivotal role in forest conservation, the effectiveness of such interventions is often contingent on the broader socio-economic and institutional landscape. This section delves into some of the policy implications of these findings and offers recommendations for leveraging property rights and land tenure security to promote forest conservation.

CLARIFY AND STRENGTHEN LEGAL LAND TENURE SYSTEMS

Many countries have taken at least initial steps to clarify and strengthen property rights to land and natural resources, but important work remains. Registering land titles and clarifying boundaries helps give landowners secure rights over their property. This provides incentives to invest in sustainable management and deters uncontrolled clearing for agriculture or grazing. Moreover, in addition to motivating sustainable use of natural resources, tenure security is also a precondition for payments for ecosystem services and other programs to financially reward landholders or communities for conserving or restoring forests.

RECOGNIZE AND PROTECT CUSTOMARY LAND TENURE SYSTEMS

Land titling programs must account for existing customary land users and other local institutions to avoid conflict or displacement. This is especially important for Indigenous groups and other local communities. Traditional or informal land governance structures can support sustainable use when communities manage lands according to customary practices passed down for generations. Formal recognition of these rights discourages encroachment and allows communities to continue sustainable forestry activities.

Policymakers should seek to formalize existing customary or collective use claims to give landholders clear, enforceable land rights. This could take a number of forms, including private, community, or Indigenous land tenure.

RECOGNIZE THE COMPLEXITY OF PROPERTY RIGHTS AND FOREST CONSERVATION

The relationship between property rights and forest conservation is multifaceted, and the drivers of global forest loss differ throughout the world. As some studies have shown, property rights in isolation might not always lead to reduced deforestation. The broader economic context, governance structures, and local incentives play a crucial role. Policies should be tailored to local contexts, taking into account the specific challenges and opportunities of each region.

The effectiveness of these policies will depend greatly on local socioeconomic, cultural and environmental contexts. Local communities are often the best stewards of their own land. Policies should be designed in consultation with local communities and consider traditional land use practices. Involving forest-dependent communities as partners recognizes their crucial role as stewards of forest resources and helps ensure the relevance and sustainability of policy efforts.

5

CONCLUSION

This case study provides evidence that stronger and more secure property rights are generally associated with lower rates of deforestation and higher levels of forest growth. The data analysis shows correlations between property rights indices and various measures of forest cover change across countries. More importantly, the literature review demonstrates causal pathways through which tenure security incentivizes sustainable forest management by reducing overexploitation, increasing long-term investments in forest lands, encouraging agricultural intensification, and motivating reforestation efforts. However, the effectiveness of property rights-based interventions depends greatly on local socioeconomic conditions and governance quality. Future policies aiming to leverage land tenure and property rights for forest conservation should recognize customary rights, consider economic contexts, consult local communities, and take a tailored, participatory approach to design. With flexible, long-term approaches that account for local complexities, strengthening property rights holds promise as a strategy to slow deforestation and encourage reforestation worldwide.

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PROPERTY RIGHTS
ALLIANCE