Public spending on health care, education, and sanitation is linked to lower deforestation in the Peruvian Amazon: new empirical support for the climate debt framework

Abstract

This paper offers the first empirical assessment of the relationship between deforestation and spending on social services, centered in the Peruvian Amazon. We use a spatially explicit regression model to analyze the relationship between social spending and deforestation at the district level across the Peruvian Amazon. We find that districts with higher levels of spending on health care, education, and sanitation exhibit less deforestation on average, implying that unconditional funding for social services can serve as the basis for sound ecological policy. We then use further ethnographic, interview, and focus group data from the Amazonian districts of Echerate, Puerto Bermúdez, and Callería to shed light on how funding social services work to reduce deforestation. While Echerate and Puerto Bermúdez are similar in terms of ecology and population density, Echerate has a much higher budget due to natural gas levies. Respondents in Echerate indicated that a more robust social service net made deforestation and cash crop expansion less attractive. By contrast, in Puerto Bermúdez, many people aspired to an agrarian capitalist future with expanded cash crop plantations and hired labor as a means to build a better future for their families. Meanwhile, the case of Callería shows how conventional approaches to conservation have been fundamentally orthogonal to people's basic needs. We conclude by encouraging political ecologists and scholars of convivial conservation approaches like Conservation Basic Income to critically support unconditional funding for basic services as part of a global just transition, aligned with the climate debt framework.

1. Introduction

As tropical forests have attracted growing international recognition as key sites for climate politics, governments, multilateral institutions, and private firms have advocated for payments for ecosystem services and prioritized the establishment of protected areas (with and without collaborative management by Indigenous communities) as key strategies for conservation. These schemes have yielded mixed results, fueling evidence-based calls from Indigenous movement organizations to strengthen land rights as a conservation strategy (Garnett et al., 2018; Le Billon and Lujala, 2020; O'Bryan et al., 2021). Meanwhile, movements anchored in the global South have urged the global North to adopt a climate debt framework, which calls for unconditional funding to cover the costs climate mitigation and adaptation in the South based on the North's historic responsibility (Ajl, 2021; Turner, 2010). With its superlative biodiversity and high carbon stocks, the Peruvian Amazon offers a rich case study for analyzing how these alternative approaches might look in the context of several well-established conservation strategies.

Since 2000, Peru has pursued a development strategy based on the export of primary commodities while also pursuing conservation through a national Payment for Ecosystem Services schemes and expanding protected areas, including through co-management regimes with Indigenous communities (Biffi Isla, 2021; Börner et al., 2017; Giudice Granados, 2023; Ravikumar et al., 2023; Wali et al., 2017). Despite Peru's efforts to adopt international best practices for tropical forest conservation (Lock, 2023), deforestation has continued to rise, primarily due to expanding cash crop cultivation driven by rising global demand (MINAM, 2018). Meanwhile, Indigenous organizations have continued to mobilize for land rights and conservation funding (Osborne et al., 2014). Many have adopted "life plans" as tools to identify key priorities and seek funding and technical support in implementing them (Wali et al., 2017).

Life plans are widespread organizing tools aimed at advancing Indigenous empowerment, conservation efforts, and rural development objectives. Rooted in the transformative planning traditions originating in the 1970s, Indigenous organizations and conservation non-profits have championed life plans as alternatives to conventional development strategies that can promote ecosystem health and human well-being rather than narrowly emphasizing incomes and economic growth. They are anchored in the Andean Indigenous notion of *buen vivir,* and are typically constructed with the support of environmental non-profits and state agencies using methods including participatory resource mapping, collective visioning, household economic surveys, and other activities in focus groups and community assemblies (Campbell et al., 2023; Wali et al., 2017). Early scholarship suggests that life plans aim to center Indigenous values, assets, and perspectives more so than traditional development plans, articulating bioculturally specific needs (Albarracín, 2010; Caviedes, 2008; Monje Carvajal, 2015) (Albarracín, 2010; Caviedes, 2008; Monje Carvajal, 2015). In concrete terms, life plans often prioritize territorial integrity, biocultural approaches to providing education and healthcare, and cultural activities (Wali et al 2017; Ravikumar et al 2025). Life plans may in this way offer a roadmap for providing bioculturally appropriate services in Indigenous communities.

Overall, international environmental non-profits and bilateral aid agencies have maintained their historic focus on conservation activities in Indigenous communities that involve foot patrols, hi-tech monitoring systems, and support for 'sustainable' commodity production (Osborne et al., 2024). Yet many Indigenous Amazonians, including those living in communities targeted by conservation schemes, lack basic services such as health care, education, and sanitation. Meanwhile, deforestation rates remain stubbornly high across landscapes where Indigenous people live despite evidence that Indigenous communities are associated with lower deforestation rates than other areas (Sze et al., 2022). At the same time, emerging research on life plans suggests that many Indigenous communities may deforest primarily to earn cash incomes to cover elevated health expenses at distant clinics, or to cover the costs of sending their children to school in faraway towns (Ravikumar et al 2025).

This raises the question: would improving the availability of basic public services in rural Indigenous-controlled territories improve deforestation outcomes by reducing people's motivation to meet their basic needs by selling cash crops grown atop cleared forests? Forest-dwelling communities often feel pressure to degrade their homelands in order to acquire cash to pay for health care services and their children's education, threatening biological and cultural diversity (Jones et al., 2020; Eleanor J Sterling et

al., 2017). In light of this, it is worth asking whether funding basic services in rural tropical forest areas might address local needs while also offering a policy pathway to conservation and climate justice. While this is a simple premise, it has not been empirically tested in the Peruvian Amazon, even as a growing body of scholarship reveals that the prevailing conservation schemes, including payments for ecosystems services, are not reliably effective at meeting such needs (Fletcher and Büscher, 2017; He and Sikor, 2017; Osborne and Shapiro-Garza, 2018).

We begin by situating our study in the recent political and ecological context of Peru. We then present our quantitative analysis, revealing that more state investment in health care, education, and sanitation is correlated with lower deforestation at the district level. To explain these results, we present further findings from qualitative research using ethnographic methods, focus groups, and semi-structured interviews in two districts: Echerate, in the Cusco region, and Puerto Bermúdez, in the Pasco region. We conclude by situating these results in the political ecology literature while drawing from further field work in the Callería watershed to argue that our findings provide empirical support for the climate debt framework as an effective means to achieve tropical forest conservation goals, building on growing and vibrant debates about Conservation Basic Income.

2. Peru's political economy and mainstream conservation

While the Peruvian Amazon has been a site of extraction and settlement since the 19th century (Young and León, 1999), the current economic regime dominated by export crop production arrived in the the 1960s with the construction of the *Carretera Marginal de la Selva* (Paredes and Manrique, 2021). The state began to seriously encourage settlement through new roads and infrastructure, often deploying the refrain familiar to many settler colonies around the world, "a land without people for people without land" (ibid). The agrarian reforms of Juan Velasco Alvarado's left-wing military regime offered free land to Andean settlers who planted cash crops and grazed cattle in the region, with deforestation rising as migration and settlement continued to open up the Amazon throughout the 1980s (Schjellerup, 2000).

After Alberto Fujimori's right-wing dictatorship took power in 1993, the Peruvian state deliberately crafted a development strategy focused on exporting primary commodities to drive economic growth. After Fujimori's fall in 2000, successive governments passed reforms that aimed to spur private foreign investment in key sectors including mining, fossil fuels, and industrial agriculture. Jan Lust (2014) described the regime that has prevailed since Ollanta Humala took power in 2011 as "post-neoliberal," in the sense that the state has openly sought to make deals with transnational capital, ostensibly to fuel a more "inclusive" model of development with more social programs, despite evidence that public-private partnerships largely increase private profits rather than local welfare (Lust, 2014).

Peru saw an average economic growth rate of 4.5% between 2005 and 2016 (with a high of 9.1% in 2008) due largely to high mineral prices driven by Chinese demand (Riofrancos, 2020). John Crabtree and Francisco Durand (2017), in their seminal book *Peru: Elite Power and Political Capture*, document in

detail how Peruvian regimes since Fujimori built the state's capacity to administer poverty alleviation programs including food aid (the "Glass of Milk" and "Qali Warma" programs) alongside the conditional cash transfer program *Juntos.* They argue that Fujimori leveraged these programs, along with the new FONCODES (National Fund for Compensation and Social Development) to offset the social costs of structural adjustment and build a social base through clientelistic social policy (Crabtree and Durand 2017, 133). These programs primarily targeted the poorest regions of the Andes, but also impacted parts of the Amazon, and particularly the high jungle (ibid).

While poverty rates fell dramatically from 58.7% in 2004 to 23.9% in 2013 (INEI 2018), Crabtree and Durand show that these reductions were primarily driven by overall economic growth rather than expanded social programs. They show that social programs were important for addressing some of the most extreme poverty in the country, but ultimately did not durably improve health and education outcomes because they were not coupled with investments in health and education programs (Crabtree and Durand, 2017, 136; Webb, 2013). Further, Richard Webb shows that declines in extreme rural poverty during this period of high growth were driven by new road construction in the Andes, allowing peasant communities to access markets more easily (Webb 2013). Meanwhile, the *Juntos* conditional cash transfer program was reaching over 800,000 families annually by the end of 2016, though its effectiveness was severely curtailed in rural areas by limited healthcare facilities and schools, which families were required to access to qualify for *Juntos* payments (Crabtree and Durand 2017, 137).

While these programs have delivered some benefits to poor families, their impacts have been limited by low public investment in healthcare, education, and infrastructure (ibid). At the same time, organized labor has remained relatively weak and inequality has remained high with the GINI index trending between the low- to mid-40s over the past fifteen years (INEI, 2017). Fabian-Arias et al. (2021) show that in more recent years, these social programs failed to produce significant positive impacts for health and education at all, because cash payments are not helpful in procuring better healthcare and education when there are no good clinics or schools around. Perhaps most strikingly, some of the most dramatic improvements in healthcare and education facilities were found in communities near mining centers in the Andes, with private mining companies providing these facilities instead of the government (Crabtree and Durand 2017, 140). At the same time, organized labor has remained relatively weak and inequality has remained high with the GINI index trending between the low- to mid-40s over the past fifteen years (INEI, 2017).

Moreover, the Peruvian Amazon in particular was not a priority area for these prevailing welfare programs. The Peruvian Amazon constitutes an internal periphery region of Peru, with a sparse population compared to the coast and the Andes. The region has just over 4 million total inhabitants, about 9% of the country's total population (INEI, 2017). The Peruvian Amazon is tremendously significant ecologically and bioculturally (see Eleanor J. Sterling et al., 2017) its tropical forests store approximately seven billion metric tons of carbon (Csillik et al., 2019) and host some of the most biodiverse terrestrial landscapes on Earth (WWF, 2018), while dozens of distinct Indigenous groups practice a variety of agroecological techniques that maintain biodiversity (Brookfield and Padoch, 1994; Denevan et al., 1988; Garnett et al., 2018). Politically, the Amazon region has been an important site for

Indigenous politics. Since 1974, Indigenous Amazonians have organized to secure over 1,200 collective land titles totaling over 12 million hectares, or 20% of the country's total forest area (Monterroso et al., 2017). Some 400,000 people live in these collectively titled communities, which vary widely in size. In these communities, overwhelming majorities of people lack access to basic services (INEI, 2017). At the same time, hundreds of Indigenous communities across the Peruvian Amazon still lack formal land titles (Blackman et al., 2024).

Beyond collectively titled Indigenous communities, across districts of the Amazon[1] 36% of households cannot access a public water supply and 50% of households do not have basic sewerage services (INEI 2018). Outside of the cities and titled Indigenous communities, perhaps one million smallholder farmers also operate outside of collective tenure arrangements, instead holding private usufruct rights or land titles. These smallholders have been the primary focus of Peru's aggressive private titling schemes, and may constitute the majority of smallholders in the Amazon region, but they have been largely neglected by international environmental organizations (Menton and Cronkleton, 2019; Monterroso and Larson, 2018) who tend to focus on communities formally recognized as being Indigenous (Moulton, 2024; Winchell and Howe, 2024)

In this context, state and international conservation agencies have targeted titled Indigenous communities with a range of initiatives that aim to 'help' them conserve forests while also pursuing economic development through sustainable commodity production. The main pillars of Peru's approach to reducing deforestation are (1) protected area regimes including areas co-managed with local communities (Móstiga et al., 2024); (2) the National Forest Conservation Program, Peru's flagship PES scheme targeting titled Indigenous communities with conditional cash transfers S/ 10 PEN (about $3 USD) per hectare of avoided deforestation to be spent according to a mutually agreed 'incentive management plan,' (Giudice Granados, 2023); and (3) a range of public-private partnerships to 'green' key tropical commodities (Lock, 2023).

While protected areas have been associated with decreases in deforestation, they have also been sites of social conflict (Kowler et al., 2016). The legacy of fortress conservation still haunts the Peruvian Amazon alongside progressive efforts to build more 'inclusive' protected area management regimes. Studies of the National Forest Conservation Program to date have not produced convincing evidence that the Program conserves forests or improves livelihoods (Biffi Isla, 2021; Börner et al., 2017; Giudice Granados, 2023). Critiques of the on the NFCP (Giudice Granados, 2023; Ravikumar et al., 2023) have built on critiques of REDD+ that emphasize how many market-based conservation schemes tend to blame deforestation on smallholders (Ravikumar et al., 2017; Skutsch and Turnhout, 2020) while ignoring the global regimes of accumulation that drive extraction in the periphery (Carmenta et al., 2023). These studies have found that the NFCP has been ineffective at conserving forests (Giudice Granados 2023) while imposing onerous and unpopular conditions through excessive auditing practices (Biffi Isla 2021), pushing communities towards greater reliance on precarious markets (Ravikumar et al.

[1] We define the Peruvian Amazon as districts falling entirely within or intersecting with the technical boundary of the Amazon delineated by Peru's Ministry of Agriculture (MINAM, 2016)

2023). Likewise, voluntary "green" commodity certifications and partnerships between agribusinesses and communities have not significantly reduced deforestation (Lock, 2023). In this context, Indigenous organizations have pursued their own initiatives to lobby the state and conservation non-profits to support them in implementing their own priorities. In particular, widespread 'life plans,' based on the Andean Indigenous idea of *buen vivir,* have emerged as a common tool for communities to articulate priorities and seek support in conserving forests and meeting their needs on their terms (see Wali et al., 2017).

Scholars of political ecology, development studies, and degrowth have argued that the ideology of capital and commodity-oriented development promotes environmental policy that accommodates the imperative of private accumulation (Crabtree and Durand, 2017; Petras and Veltmeyer, 2014; Riofrancos, 2020). In Peru, this has meant that the state has been persistent in its commitments to conservation policies that have empirically failed to significantly reduce deforestation even as inequality remains high. Multilateral institutions, aid agencies from the global North, and large environmental non-profits with increasingly corporate boards have also remained broadly committed to such approaches. Major environmental non-profits and international organizations have not seriously considered providing unconditional funding for social programs that improve quality of life for communities that live in globally significant tropical forests on their own terms. Against this backdrop, the climate debt framework offers a radically different vision of global climate policy that forms the basis for our present inquiry.

3. Beyond conditionality: climate debt and new conservation frameworks e

In April 2010, a group of 30,000 people representing 100 countries convened in Cochabamba for the World People's Conference on Climate Change. In response to the collapse of the United Nations Framework Convention on Climate Change summit in Copenhagen the previous year, the People's Climate Agreement was announced in Cochabamba. The short document introduced the Climate Debt framework, arguing that countries of the global North were primarily responsible for climate change and, given the history of colonial and neo-colonial resource extraction from the global South, had an obligation to fund climate mitigation and adaptation in the global South. The document offered a specific estimate of what rich countries owed: 6% of GDP annually, in addition to existing overseas development aid, without any conditions or stipulations ("World People's Conference on Climate Change and the Rights of Mother Earth," 2010).

Since 2010, several tendencies have emerged with a range of proposals to advance climate justice. These include decolonial approaches anchored in that center the return of land and resources to Indigenous communities (Cusicanqui, 2012; Estes, 2019) and a burgeoning degrowth-ecosocialist movement mainly centered in the global North that urges a reduction in the total material size of the global economy with massive redistributions of wealth from the North to the South (Schmelzer et al., 2022). Meanwhile, Indigenous movements have organized to reject or at least secure better deals with

extractive industries operating on their lands, deploying more accommodating and more adversarial approaches in different contexts (Brown and Fernández, 2023; Riofrancos, 2020; Sawyer, 2004).

Despite robust scholarship and movement organizing around these ideas, the Climate Debt framework has never been formally adopted as an organizing principle by the UNFCCC, nor have major environmental nonprofits adopted it Instead, PES schemes have remained a dominant paradigm for conservation. Grounded in environmental economics, PES schemes rest on the premise that reducing deforestation requires paying the opportunity costs of deforestation to those who might otherwise deforest.

Around the world, PES schemes rarely target the owners of large cash crop plantations and grazelands because conservation programs have not been able to attract the large investments that would be necessary to offset the high per-hectare revenues generated by export commodities (Angelsen et al., 2018; Corbera and Izquierdo-Tort, 2023). The NFCP ins Peru follows this trend, exclusively targeting titled Indigenous communities that often rely on a mix of subsistence-oriented and small-scale production (Giudice Granados, 2023). However, there is substantial scholarship arguing that these forest-dwelling communities do not deforest to pursue endless accumulation, but rather to meet their basic needs (Martinez-Alier, 2003; Shapiro-Garza et al., 2020; Wali et al., 2017). This helps to clarify our central question: if communities had secure land rights that excluded outside extractive capital alongside guaranteed access to services like healthcare, education, and sanitation, would deforestation levels fall without requiring complex conditional PES schemes and contested protected area regimes? In other words, might international support for a robust commons of social care (Wichterich, 2015) constitute a more effective ecological policy?

Responding to critiques of PES, a growing group of scholars and conservation organizations have advocated for Conservation Basic Income (CBI) as a framework for addressing poverty and conserving tropical forest ecosystems. Fletcher and Büscher (2020) articulate a case for CBI that draws from scholarship on Conditional Cash Transfer programs (CCTs) for addressing poverty and also specific critiques of PES. They cite Saad-Filho who suggested that “CCTs also introduce commercial mediations and arbitrary limitations to the rights of citizens, manage poverty only within narrow limits, and provide subsidies to capital that, ultimately, reproduce poverty rather than supporting its elimination” (Saad-Filho 2016). They go on to argue that in light of more recent empirical scholarship showing that unconditional programs are as effective as conditional ones (Baird et al., 2014, 2013; Bastagli et al., 2019; Standing, 2021), it makes sense to explore unconditional cash transfers as part of conservation policy.

Unconditional cash transfers, including ‘basic income’ schemes have gained traction among a range of scholars, with promising pilot results in Canada and Finland (Standing, 2021; Van Parijs and Vanderborght, 2017). Despite these promising results critics have cautioned that without parallel programs to provide health and education facilities, basic income schemes may actually “provide political cover for the elimination of social programs and the privatization of social services” (Kleiner, 2016). This concern has long been raised with respect to cash transfer schemes in general. For example,

Freedland (2007) observed that “the areas typically inhabited by the most vulnerable groups are often those where health and education services are weakest, making them wholly unsuitable to this kind of approach.”

Despite these concerns, Fletcher and Büscher argue for Conservation Basic Income schemes that target communities that steward vulnerable and valuable ecosystems. The proposal has found purchase among conservation organizations in recent years. In the Peruvian Amazon itself, the non-profit Cool Earth has piloted such a scheme, claiming that early results point to lower rates of logging – though no independent studies have been conducted as of this writing (Hyolmo, 2025). Despite Cool Earth’s optimism, in an interview with Sheehan and Martin-Ortega (2023), project staff echoed the above concerns, noting that “in places where people's biggest need, to stay on their land, is like an education for their kids or healthcare for their kids, giving them cash, if there's no healthcare system in place, isn't going to help them.”

With established critiques of PES and growing interest in unconditional programs such as Conservation Basic Income, it makes sense to ask how public investments in health care and education in particular might improve conservation outcomes. Political ecologists and scholars in related fields have studied the relationship between basic services, poverty, and ecological processes in many contexts. Vogel et al. (2021) make an empirical case that provisioning basic services on a global scale would reduce pressures on natural resources. Degrowth scholars and political ecologists have broadly emphasized this idea, suggesting that a social commons of care reduces people’s need to engage in environmentally destructive practices (Hickel, 2020; Kallis, 2021; Millward-Hopkins et al., 2020; Schmelzer et al., 2022). With respect to deforestation in particular, Sathler et al. (2018) argue that ‘sustainable development’ policies in the Brazilian Amazon aimed at increasing human development indicators are effective in reducing deforestation. And in a significant study examining the efforts of the nonprofit Planet Indonesia to explicitly address deforestation by building and staffing health clinics in villages abutting Gunung Palung National Park in West Kalimantan, Jones et al. (2020) found strong evidence that improving health services led to lower logging impacts in addition to improved health outcomes.

Our research builds on this work by examining whether *public* investment in healthcare and education is associated with lower deforestation at the district level in the Peruvian Amazon. In this way, we extend the work of Jones et al. to a different geography, and analyze the issue at a larger scale. Likewise, we build on the analysis of Sathler et al by explicitly highlighting the role of unconditional funding for social services, rather than grouping such funding with other rural development schemes that aim to increase commodity production.

4. Quantitative Methods

In the Peruvian Amazon, some of the most important services that people need but often lack are health care, education, and sanitation. Widespread ‘life plans’ from Indigenous communities demonstrate that

these services are common priorities for communities (Wali et al., 2017), while existing studies have also emphasized their centrality across Amazonian communities. (Badanta et al., 2020; Sanchez et al., 2015; Torres-Slimming et al., 2019). National statistics also show that these services are severely deficient in the Amazon region (INEI, 2018). For this reason, we center our analysis on the relationship between these key services and deforestation, analyzing remote sensing data and public finance data to test the hypothesis that greater public investment in basic services is associated with lower deforestation.

We conduct our analysis at the level of the district, the lowest jurisdictional unit in Peru's unitary state. Our main empirical strategy uses OLS to compare district-level public spending between 2016 to 2022 with district-level deforestation from 2017 to 2023, all while controlling for a rich set of covariates. Our study area encompasses all districts located in the Peruvian Amazon biome (MINAM, 2017). After excluding nine districts created after 2017, our final sample consists of 330 districts.

4.1 Data

Public Spending

We obtained data on annual district-level spending by scraping data published by Peru's Ministry of Economy and Finance (MEF) on the Geo Perú platform[2]. This dataset disaggregates public expenditures into 25 functions according to Peru's public budgeting law (MEF, 2023). Additionally, we obtained district-level budget data to calculate revenues earned through natural resource levies ("canon"). Both datasets were merged with population statistics from the 2017 National Census to compute per capita measures of spending and revenue (INEI, 2018). As a unitary decentralized state, district government expenditures reflect a mix of funds allocated directly from the district budget alongside transfers from the national and regional governments. Our analysis uses the sum of these expenditures to encapsulate all relevant spending at the district level (see Figure 1, below):

[2] https://visor.geoperu.gob.pe/

Figure 1: District expenditures by category and source (2016 – 2022)

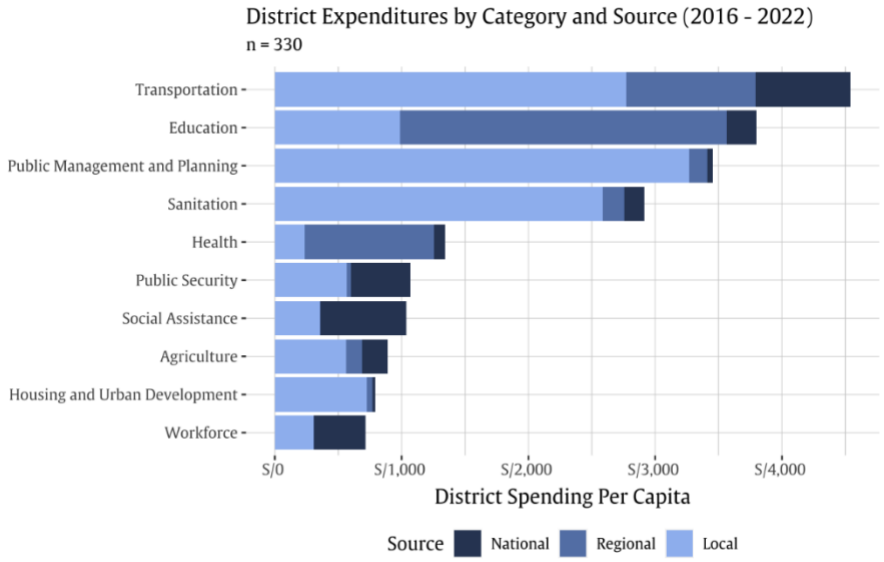


Table 1 displays the ten largest expenditure functions executed by districts in our sample, measured as a share of total spending. Our analysis focuses on the five largest functions, which cumulatively account for 74% of total spending: Transportation (19.2%), Education (17.2%), Public Planning and Management (17.2%), Sanitation (14.5%), and Health (5.8%). We note that while 'environmental' funding is especially small, this is because districts do not have significant purview over forests and land use. The majority of district environmental budgets go to trash pickup and solid waste removal (Wieland Fernandini and Farfan Soua, 2015).

Table 1. Largest public expenditure functions, measured as a percent of total spending from 2016-2022

	% of Total Expenditures	
	Mean	SD
Transportation	19.2	13.9
Education	17.2	15.9
Public Management and Planning	17.2	8
Sanitation	14.5	11.5
Health	5.8	8.9
Public Security	3.4	6.2
Social Assistance	4.4	5.5
Agriculture	3.5	5.7
Housing and Urban Development	4	6.4
Environment	2.6	3.3

Note: Original Spanish descriptions of function classifications are available from the Ministry of Economy and Finance[3]

Of these spending categories, we hypothesize that spending on health, sanitation, and education will be negatively associated with deforestation. National statistics highlight severe deficiencies in these services across the Amazon region, where 61% of districts lack access to basic sanitation and 31% lack access to public water infrastructure (INEI, 2018). In such contexts, inadequate access to essential services may force communities to engage in forest clearing activities to generate income and secure basic necessities. Similar dynamics have been observed in other tropical forest regions, including Indonesia's Borneo, where limited access to affordable healthcare has been linked to increased rates of illegal logging. In that case, deficiencies in water, sanitation, and hygiene infrastructure—along with high maternal and infant mortality and disease burdens—have created economic pressures that push households toward forest-dependent livelihoods (Jones et al., 2020).

A similar pattern may be occurring in the Peruvian Amazon, where weak health and sanitation infrastructure contributes to cycles of poor health and rising out-of-pocket costs, driving vulnerable households to forest clearing activities for financial stability. Likewise, poor education infrastructure may reinforce dependence on agricultural and land-intensive livelihoods, as limited access to schooling restricts alternative employment opportunities. In this context, increasing funding for education may lead to improved forest outcomes by expanding economic opportunities beyond agriculture and resource extraction, thereby alleviating pressures to clear forested land. However, the long-term effects of education on deforestation are more complex. Under certain conditions, higher levels of education may encourage permanent migration away from rural areas, potentially weakening communities' abilities to protect their ancestral lands (Parry et al., 2010). Indeed, research suggests that outmigration can have either positive or negative impacts on deforestation depending on local economic conditions and governance structures (Marini et al., 2024).

Conversely, we expect transportation expenditures to be positively associated with deforestation. Investments in transportation infrastructure, particularly road construction and maintenance, have been widely linked to forest loss by facilitating access to previously remote areas and accelerating agricultural expansion, logging, and land speculation (Bax et al., 2016; Southworth et al., 2011).

Deforestation

Forest loss from 2017 to 2023 was estimated using the Global Forest Change dataset version 1.11 (Hansen et al., 2013). This dataset characterizes global forest extent and change from 2000 through

[3] Peruvian Ministry of Economy and Finance Annex for National Investment Program URL: https://www.mef.gob.pe/contenidos/inv_publica/docs/anexos/new_direc/v12/Anexo_SNIP_01_Clasificador_Funcional_Programatico200115.pdf

2023 at a 30m spatial resolution using Landsat time-series imagery. Forest loss is provided as a binary measure that equals one when the disturbance or complete removal of tree cover is detected in a pixel.

We first construct a measure of baseline forest cover by estimating the amount of remaining forest cover in 2017, excluding regrowth occurring after the year 2012.

$$Forest\ Cover_i^{2017} = (\%\ Forest\ Cover_i^{2000} * Area_i) - Forest\ Loss_i^{2001-2016} + Forest\ Gain_i^{2001-2012}$$

We define our primary deforestation outcome as the log of the percentage of forest cover lost from 2017 to 2023. This is derived by dividing the amount of forest loss accumulated between 2017 and 2023 by the amount of forest cover in 2017.

$$ln\ (\%\ Forest\ Cover\ Lost_i^{2017-2023}) = ln\ (\frac{Forest\ Loss_i^{2017-2023}}{Forest\ Cover_i^{2017}})$$

Covariates

Additional explanatory variables were selected based on a literature review of deforestation drivers in Peru and other Amazonian countries. These variables are summarized in Table 2 and briefly described below.

Our primary socioeconomic indicator is the non-monetary poverty rate, as reported in the 2017 National Census. This index measures the proportion of households with at least one Unsatisfied Basic Need (UBN), including inadequate access to housing, inadequate access to sanitation facilities, low school attendance rates, and high economic dependency (INEI, 2018). We also include population density as a covariate, as urbanization and migration are commonly identified as key drivers of deforestation (Cruz et al., 2023).

Roads have been shown to increase forest access and reduce the costs of agricultural transport, thereby accelerating deforestation in many contexts (Bax et al., 2016; Southworth et al., 2011). We control for road access by calculating the average Euclidean distance from the centroid of each district to its nearest road. We apply the same methodology to calculate distance to the nearest departmental capital.

Public policies and institutional factors are also key determinants of land use change. Several studies have shown that deforestation varies across different forest governance regimes in the Peruvian Amazon, including protected areas (Giudice Granados, 2023; Schleicher et al., 2017), Indigenous territories (Schleicher et al., 2017), and logging concessions (Finer et al., 2014). To account for these impacts, we calculated the proportion of each district that falls within each of these areas.

Biophysical factors, such as terrain and climate, can affect deforestation through variation in local agricultural suitability and forest growth (Bax and Francesconi, 2018). We therefore control for the average altitude, slope, annual precipitation levels; and baseline temperature of each district. All variables were converted into spatially explicit layers and summarized at the district level. As detailed in Table 2, logarithmic and square root transformations were applied to several variables to ensure normality of the residuals.

Table 2. Description of variables and their sources

Variable	***Unit***	***Description***	***Transformation***	***Source***	***Spatial Resolution***
Outcome					
Percent of Forest Cover Lost	*%*	Percent of 2017 forest cover lost between 2017-2023	*log*	*Global Forest Change v1.11*	*30m*
Covariates					
Percent of Forest Cover in 2000	*%*	Percent of district covered in forest cover in 2000		*Global Forest Change v1.11*	*30m*
Elevation	*meters*	Mean elevation of district		*SRTM 90m Digital Elevation Database v4.1*	*1:500 000*
Slope	*degrees*	Mean slope of district		*SRTM 90m Digital Elevation Database v4.1*	*1:500 000*
Rainfall	*millimeters*	Average annual precipitation in district from 2017-2023		*CHIRPS*	*0.05°*
Temperature	*°C*	Average annual mean temperature of district recorded between 1981–2020		*Huerta et al. 2023*	*0.01°*
Distance to Nearest Road	*meters*	Distance from district centroid to the nearest major road, excluding roads classified as “residential”, “pedestrian”, or “path”	*sqrt*	*OpenStreetMap (OSM)*	
Distance to Nearest Capital	*meters*	Distance from district centroid to the nearest department capital	*log*		
Protected Areas	*%*	Proportion of district overlapping with national, regional, or private protected areas		*SERNANP*	

Indigenous Territories	%	Proportion of district overlapping with indigenous territories		*Instituto del Bien Común (IBC)*	
Logging Concessions	%	Percentage of district overlapping with logging concessions		*SERFOR*	
Population Density	*person/ km²*	Population from 2017 national census divided by district land area	*log*	*INEI, 2017*	
Non-Monetary Poverty Rate	*%*	Percentage of the population with at least one unsatisfied basic need (UBN) according to the 2017 national census		*INEI, 2017*	
Explanatory Variables					
Social Expenditures p.c.	*soles*	District-level per capita expenditures allocated to "Educación", "Salud", or "Saneamiento" between *2016-2022*		*MEF*	
Public Management and Planning Expenditures p.c.	*soles*	District-level per capita expenditures allocated to "Planeamiento, gestión y reserva de contingencia" between *2016-2022*		*MEF*	
Transportation Expenditures p.c.	*soles*	District-level per capita expenditures allocated to "Transporte" between *2016-2022*		*MEF*	
Total Expenditures p.c.	*soles*	Total district-level per capita expenditures from *2016-2022*		*MEF*	
Social Expenditures Share	*%*	Percent of total district-level expenditures allocated to "Educación", "Salud", or "Saneamiento" between *2016-2022*		*MEF*	

4.2 Empirical Strategy

We use a fixed-effect model to estimate the relationship between forest cover change and social expenditures. Our baseline specification is as follows:

$$ln\ (\%\ Forest\ Cover\ Lost)_{ip} = \beta(S_i) + \beta(X_i) + FE_p + \varepsilon_{ip}$$

Where i denotes the district and p denotes the province of the district. The outcome variable $ln\ (\%\ Forest\ Cover\ Lost)_{ip}$ represents the percent of forest cover lost between 2017 and 2023. S_i corresponds to district-level per capita expenditures between 2016 and 2022. We report separate estimates for social expenditures, transportation expenditures, public planning and management expenditures, and total expenditures. X_i is a vector of district-level control variables, as detailed in Table 2. We include province fixed effects (FE_p) to control for unobservable time-invariant factors that are common to each province, the administrative level above districts.

Deforestation often exhibits strong spatial dependence due to the interconnected nature of ecological and human activities. Prior work has demonstrated how deforestation patterns in one area can spill over to neighboring regions through ecological, economic, and political channels (Honey-Rosés et al., 2011). When spatial correlations are present in the data, traditional standard errors can lead to biased and inconsistent estimates. To address this potential source of bias, we implemented Anselin Moran's I and Lagrange Multiplier tests (Anselin, 1988). These tests failed to reject the null hypothesis of zero spatial autocorrelation. We therefore proceed under the assumption that our errors are randomly distributed across space.

5. Quantitative Results

5.1 Descriptive Statistics

Table 3 describes baseline characteristics of districts in our sample, distinguishing between districts with high levels of social expenditures per capita (top 50%) and low levels of social expenditures per capita (bottom 50%). Column 5 compares these groups using normalized differences, a scale-free measure of the difference between the two sample distributions (Imbens and Wooldridge, 2009). A normalized difference of zero indicates no difference, while positive values indicate higher values for districts with high social expenditures.

This test reveals no significant differences in population density, non-monetary poverty, or baseline forest cover share between these two groups. On average, districts with high social spending tend to spend more overall and receive more revenue from the resource canon. We also note important differences in how these two groups allocate their spending. In addition to spending more on social services, districts with high social spending tend to allocate larger portions of their budget to social services while allocating smaller portions to transportation and public management. We further examine the significance of these different expenditures in the following section, where we present separate estimates for each expenditure function. Figure 2 presents a visualization of per capita social expenditures from 2016-2023. Figure 2 presents a visualization of forest cover change from 2017-2023.

Table 3. Characteristics of districts with high and low levels of social spending

	High (Top 50%)		Low (Bottom 50%)		
	Mean	SD	Mean	SD	Normalized Diff.
Area (km²)	3,359.8	4,743.4	1,362.3	2,782.6	0.4988
Population (hab)	13,260	22,736.4	10,191.1	16,210.7	0.1551
Population Density (hab/km²)	28.7	109	26.2	57.2	0.0292
Forest Cover in 2000 (%)	75.2	25.2	74.4	21.5	0.0346
Forest Cover Loss 17-23 (%)	5.2	6.7	7.1	7	-0.2742
Protected Area (%)	13.5	21.5	11	17.9	0.1292
Indigenous Territory (%)	11.2	17.7	4.2	11.3	0.4551
Logging Concession (%)	6.8	13.7	9.8	17.1	-0.1928
Non-Monetary Poverty (%)	53.3	21.5	52.8	18.7	0.0256
Distance to Nearest Road (km)	20.5	29.6	13.5	26.5	0.248
Average Temperature (C)	27.4	4.6	26.8	4.4	0.1386
Annual Rainfall (mm)	1,881.8	818.8	1,674.9	727.8	0.265
Elevation (m)	1,273.8	1,071.8	1,452.9	962.5	-0.1752
Annual Canon Transfers p.c. (soles)	522	2,403.7	120.6	426.3	0.2307
Annual Total Expenditures p.c. (soles)	4,521.2	3,911.6	2,054.4	1871	0.7467
Annual Social Expenditures p.c. (soles)	1,833.6	1,062	467.7	224.7	1.3299
Social Expenditures Share (%)	46.7	15.5	29	14.8	1.0088
Transportation Expenditures Share (%)	16.1	14	22.1	14	-0.4142
Public Mng. Expenditures Share (%)	14.5	6.9	20.1	9.2	-0.6468

Note: Districts with high social spending have social expenditure p.c. levels in the top 50% of the distribution while low social spending indicates social expenditure p.c. levels in the bottom 50%.

Figure 2. Annual district-level social expenditures per capita from 2016 to 2022.

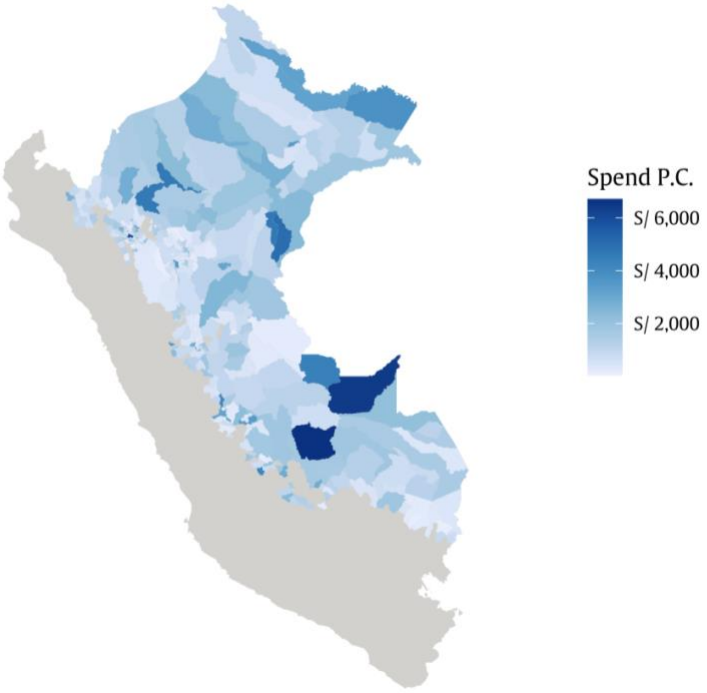
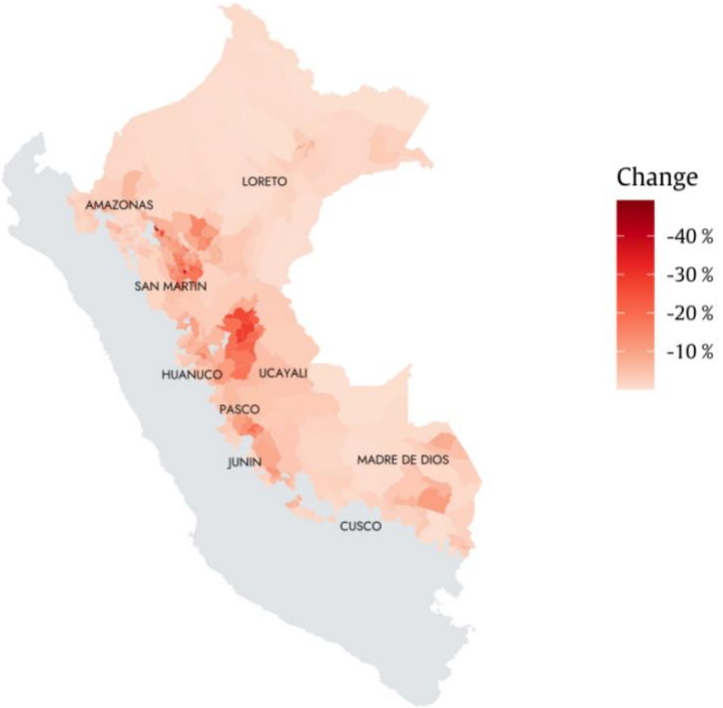


Figure 3. Percentage change in forest cover from 2017 to 2023, measured at the district-level.



5.2 Results

Baseline Results

Table 4 reports estimates from our baseline specification. To simplify the interpretation and comparison of coefficients, all explanatory variables are standardized. After controlling for observable confounding factors, we find a statistically significant negative relationship between social expenditures and deforestation rates ($P < 0.001$). This implies that on average, districts with higher levels of per capita social spending exhibited lower rates of deforestation throughout the study period. As reported in column (1), our estimates suggest that a one standard deviation increase in per capita social expenditures is associated with an 18.5% decrease in the percent of forest cover lost between 2017 and 2023.[4]

Table 4. Estimated effect of social expenditures on deforestation

	$ln\,(\%\,Forest\ Cover\ Lost)$		
	(1)	(2)	(3)
Social expenditures p.c. (std.)	-0.185^{***}	-0.237^{***}	
	(-0.045)	(-0.049)	
Total expenditures p.c. (std.)		0.095^{*}	
		(-0.043)	
Social expenditures share (std.)			-0.138^{**}
			(-0.050)
Controls	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes
Observations	330	330	330
R^2	0.867	0.870	0.861

*As all explanatory variables are standardized, coefficient estimates should be interpreted as a percentage change in the outcome variable associated with a one standard deviation change in the explanatory variable. Further details on control variables are provided in the methods section. Standard errors, clustered by province, are given in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.*

[4] A one standard deviation increase in social expenditures corresponds to an annual increase of 1,027 soles per capita, or an 89% increase from the mean.

Column (2) shows that the magnitude of the social expenditures coefficient increases after controlling for total district-level expenditures, suggesting that a district's overall level of spending does not explain the observed effect. This result is consistent with estimates reported in column (3), which show a significant negative relationship between deforestation rates and the share of expenditures allocated toward social services.

Importantly, this relationship appears unique to social expenditures. Table 5 shows that we do not find a statistically significant association between total expenditures and deforestation, nor do we detect a significant relationship between transportation expenditures and deforestation. Only the coefficient on public planning and management is significant (P < 0.1), though its magnitude and significance level are considerably lower than those of the social expenditures coefficient.

Table 5. Estimated effect of different expenditure functions on deforestation

	$ln\ (\%\ Forest\ Cover\ Lost)$			
	(1)	(2)	(3)	(4)
Social expenditures p.c. (std.)	-0.185^{***}			
	(-0.045)			
Total expenditures p.c. (std.)		-0.017		
		(-0.039)		
Public Mng. expenditures p.c. (std.)			-0.097^{*}	
			(-0.054)	
Transport. expenditures p.c. (std.)				-0.012
				(-0.031)
Controls	Yes	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes	Yes
Observations	330	330	330	330
R^2	0.867	0.855	0.858	0.855

*As all explanatory variables are standardized, coefficient estimates should be interpreted as a percentage change in the outcome variable associated with a one standard deviation change in the explanatory variable. Further details on control variables are provided in the methods section. Standard errors, clustered by province, are given in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.*

To further disentangle the relationship between social expenditures and deforestation, Table 6 presents separate estimates for each component of social expenditures. The coefficients for health, sanitation, and education expenditures are all negative and statistically significant, supporting the conclusion that increased spending in each of these sectors is associated with lower deforestation rates. However, the magnitude of these effects varies across categories. The coefficients on health and education expenditures are notably larger than the coefficient on sanitation expenditures, suggesting that

investments in health and education may play a particularly strong role in mitigating deforestation pressures.

Table 6. Estimated effect of health, sanitation, and education expenditures on deforestation

	$\ln(\%\ Forest\ Loss)$		
	(1)	(2)	(3)
Variables			
Health Expenditures std.	-0.137^{**}		
	(0.0485)		
Sanitation Expenditures std.		-0.084^{**}	
		(-0.342)	
Education Expenditures std.			-0.139^{**}
			(-0.049)
Controls	Yes	Yes	Yes
Province fixed effects	Yes	Yes	Yes
Observations	330	330	330
R^2	0.863	0.858	0.861
Within R^2	0.578	0.565	0.558

*All regressions are specified in log-linear form with standardized explanatory variables. Coefficient estimates can therefore be interpreted as a percentage change in the share of forest cover lost associated with a one standard deviation change in the explanatory variable. Standard errors, clustered by province, are given in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.*

Alternative Specifications

We conduct four additional exercises to check the robustness of our results. First, we test different forms of the social expenditures variable. In addition to our preferred specification, we include social expenditures expressed as a percentile and as a log transformed variable. In the second exercise, we conduct three tests that vary the length of the study period, successively shortening the scope of spend and deforestation data by one year in each test. In the third exercise, we expand our sample to include all districts in the Amazon (n = 398 districts). In the fourth exercise, we use total deforested area as the outcome variable. In the last case, we incorporate spatial error terms to account for spatial autocorrelation detected in standard OLS models. In the fifth exercise, we test how social expenditures correlate with social need. In the sixth exercise, we test the relationship between social expenditures and deforestation while adjusting social expenditures for social need. Further details on these tests are provided in the Supplementary Information, where we show that our results are robust to all alternative specifications detailed in this section.

Summary

Overall, these results highlight an inverse relationship between deforestation rates and district-level spending on education, health, and sanitation services in the Peruvian Amazon. This association holds for both the level and share of social expenditures. Moreover, we do not find a significant relationship between deforestation and other forms of public spending, suggesting that it is social expenditures in particular that matter. These findings have important implications for policy efforts aiming to reduce deforestation in tropical forest areas. While we cannot interpret these results as evidence of a causal relationship, they provide initial evidence for the hypothesis that increasing access to basic services can serve as an effective conservation policy. To explore why these relationships might hold, we now present qualitative research findings from three watersheds in the Peruvian Amazon.

6. Qualitative research methods and study sites

In 2021, the first author visited three watersheds reflecting socially and ecologically distinct conditions in the Peruvian Amazon: the Pichis Valley in central jungle region of Pasco, the upper Urubamba watershed in Cusco's high jungle, and the Callería basin in the low floodplain of the Ucayali region. This research was part of a collaborative project with Indigenous organizations to understand how 'life plans,' Indigenous planning tools rooted in the notion of *buen vivir,* were working to advance these communities' priorities alongside conservation initiatives. In particular, Indigenous organizations were interested in surfacing stories of whether and how the National Forest Conservation Program, Peru's flagship Payments for Environmental Services scheme, had in practice supported their vision for their communities. The research involved visits to four villages within the titled Indigenous community of Septimo Unidos Santa Fé de Aguachini in the Pichis Valley; three titled communities in the Upper Urubamba, and three titled communities in the Callería basin. Figure 4 shows a map of these study sites within Peru.

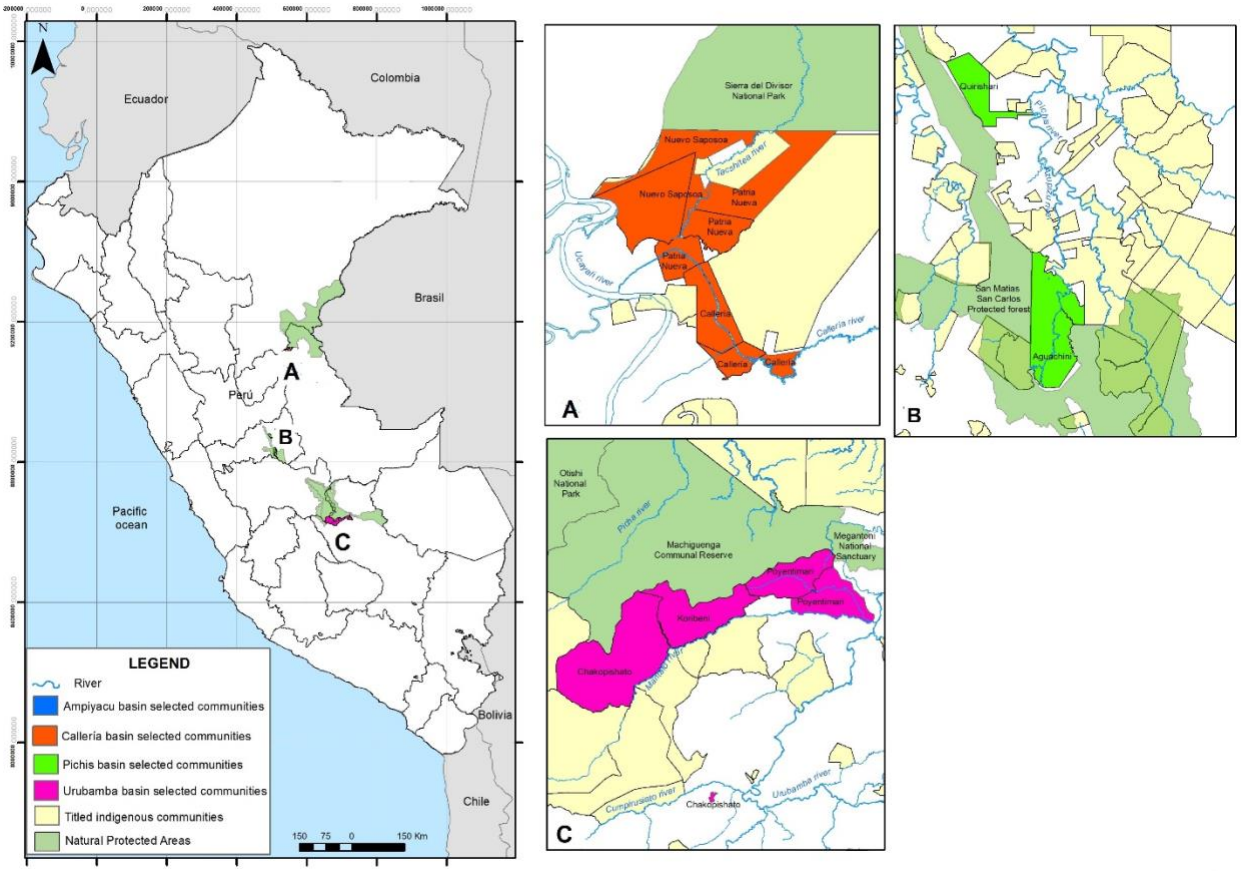


Figure 4: Site locations within Peru (A - Callería Basin B - Pichis Valley Basin C - Upper Urubamba Basin

We selected these sites because they were the most recent sites of collaborative life plan development, and some of the first sites where the National Forest Conservation Program had explicitly agreed to incorporate the priorities found in life plans into their program strategy. Within each watershed, we selected communities and villages within communities that reflected variation in population density and remoteness from the urban center. The first author had previously worked on the life plan process in these watersheds as an employee of an environmental non-profit, and had returned as an independent researcher to critically evaluate how these plans had functioned. A key aim of this research was to explore community members' motivations for clearing forests and their future plans for managing their lands.

In collaboration with the elected leadership of watershed-level Indigenous organizations, we carried out 18 specialized focus groups, convened 10 community assemblies, and 80 semi-structured interviews in each of the seven settlements that we visited. Table 7 describes these villages and the number of participants in this research. We used participatory spatial mapping, actor mapping, and participatory timeline construction in community assemblies. We then asked basic questions about life plans, the performance of the NFCP, the main drivers of deforestation, and people's vision of the future. In these initial assemblies, we identified community members who represented groups involved in major economic activities to interview independently or in focus groups. These groups included women artisans, fishers, cocoa and coffee cultivators, environmental monitors, and community leaders.

In presenting our findings from this work below, all information about events that transpired in communities derive from multiple cross-checked interviews, unless we indicate a secondary citation. We present our results in a narrative form, synthesizing evidence from the range of interviews and focus group activities that we conducted. We verified claims about non-profit and government activities by examining project documents from the relevant organizations and by interviewing relevant staff. Unless otherwise indicated, none of the claims made by community members about state and non-profit activities in their territories were contradicted by any of these triangulation measures.

Table 7: Summary of study sites

Watershed	# Communities studied	# respondents (interviews + focus groups)	Accessible by road or river?	% of 2001 forested area in district deforested by 2021 (Ministry of Environment of Peru, 2024)	Main economic activities (and focus groups)
Pichis	2 (with 5 and 4 'sectors' studied respectively)	63 focus group participants, 40 interviews	Road	6.87	Achiote, cocoa, and coffee production, artisanal crafts, some subsistence activities
Urubamba	3	71 focus group participants, 20 interviews	Road	3.58	Coffee, cocoa, achiote, ecotourism, artisanal crafts, subsistence farming & fishing
Callería	3	31 focus group participants, 20 interviews	River	3.34	Subsistence farming, fishing, artisanal crafts, community-based forest management

7. Conservation and basic needs in three watersheds of the Peruvian Amazon: how funding services can support ecological outcomes

7.1 The Pichis basin: conservation as a punitive and antagonistic force

"We don't want to hear any more about conservation: the protected forest has sanctioned us and harmed us. We cannot sell products to meet our needs because of them!" - Focus group participant, Platanillo Shimaki Sector, Séptimo Unidos Santa Fé de Aguachini Community

The Asháninka communities of the Pichis basin are upriver from the district capital of Puerto Bermúdez, with cocoa giving way to coffee as the most important cash crop at higher elevations. The region has been a major deforestation hotspot in the Peruvian Amazon for the past decade (Finer and Mamani, 2020). We began our research in the highest and most remote sector of Séptimo Unidos Santa Fé de Aguachini, Platanillo de Shimaki. The settlement is in the buffer zone of the San Matías-San Carlos Protected Forest, which is managed by the National Protected Areas Service with the primary aim of protecting the headwaters of the watershed. From the moment we arrived, residents made clear that they were intensely hostile to conservation agencies. Early on in the opening assembly convened by the secretary of the watershed-level federation, ANAP, a community member remarked that "We do not want to hear any more about life plans, conservation, or the NFCP! They have only harmed us so far."

The conflict was primarily caused by Protected Forest staff penalizing community members with fines for attempting to improve a very small road between their village and the city of Pichananki where they can sell their coffee. Even though Protected Forest staff participated in building 'life plans' in the community as a means to improve relationships between the community and conservation agencies, the leadership of the Protected Area insisted that no modifications to existing roads could be made. People in Pichananki had come to see all conservation agencies as broadly implicated in this core antagonism, including the NFCP, which had recently suspended the entire community for failing to comply with its stringent accounting requirements and for exceeding deforestation quotas. To the latter point, a focus group respondent candidly asked, "Why would we avoid opening up more land for cultivation under these conditions?"

In the nearby sectors of Haway and Coybol, other conflicts with conservation agencies had emerged. Both communities were granted funds to improve their existing roads in a participatory budgeting process at the provincial level. Unlike in Platanillo Shimaki, these roads did not directly cut through the protected forest. In Haway, the national Forest Service nonetheless arrested and incarcerated the chief of the community for allegedly deviating from the required construction plan for the road. Meanwhile, in Coybol, the municipal government had simply dragged its feet in funding the road, leaving community members to simply build it themselves. Residents of Haway were outraged at the arrest of the chief, and as in Platanillo Shimaki, were broadly disillusioned with conservation. As another community member told us, "The NFCP has failed, and the state will not provide us with a serviceable road that we need to survive. If one of us gets sick or has an emergency, we cannot easily leave. It is an abuse."

When we asked about community members' visions of the future in all sectors that we visited, we heard wide agreement that conservation was important to them in principle, but they needed to sell cash crops in order to meet their families' needs. Most cocoa farmers in Haway and Coybol along with the coffee farmers in Platanillo Shimaki agreed that without more support for meeting their basic needs, a prosperous future would require larger and more productive plantations. In a focus group with eight cocoa-growers, they agreed that ideally families would manage plantations with 15-20 hectares of cocoa in production staffed by hired labor. The secretary of ANAP told us that she had encouraged people to expand their cash crop production while hiring seasonal labor from the nearby towns to help with the harvest. In essence, she was advocating for an agrarian capitalist future for these communities, and, in the absence of significant support from the state, through conservation or otherwise, this was largely seen as desirable.

7.2 The Upper Urubamba basin: collaborative conservation and fossil fuel funding for services

"The most beneficial thing that our community has ever done for itself was directly turning the valves of the natural gas pipeline off and forcing the company to negotiate. This has been more impactful than any conservation policy" - Chief of Poyentimari Community

The Machiguenga communities of Koribeni, Poyentimari, and Chakopishiato border the Machiguenga Communal Reserve in Cusco's high jungle. The protected area is co-managed by an Indigenous organization, ECA Maeni, and the National Protected Area Service. Like in the Pichis basin, these communities are connected to markets by roads, and most people grow cocoa at lower elevations and coffee at higher elevations. The district of Echerate, where these communities are located, is also home to the vast Camisea natural gas fields, which produce about 14 billion cubic feet of natural gas (OSINGERMIN, 2022). The deal that the Peruvian government signed with the Camisea Gas Consortium in 2000 allowed the consortium to tap the 11 trillion cubic feet of gas below these forests in exchange for a relatively cheap guaranteed domestic supply along with levies (known as "canon" funds in Spanish) on profits that would go to both the national and local governments (Corral et al., 2018).

In this context, the municipal government of Echerate has received over 3.4 billion soles since 2007, or about $845 million US dollars. This means that Echerate has a much larger budget than other districts of similar size, including Puerto Bermúdez. For example, in 2021 Echerate received a levy of S/ 131 million PEN (about $32 million USD), while Puerto Bermúdez had a total budget of just S/ 18 million PEN (about $4.5 million USD). In addition, communities have struck side deals with natural gas transportation companies to receive cash and employment contracts in exchange for allowing pipelines to be built on their lands.

The chief of the Poyentimari community told us that "the most beneficial thing that our community has ever done for itself was directly turning the valves of the natural gas pipeline off and forcing the company to negotiate. This has been more impactful than any conservation policy." By taking this direct action in 2007, the communities forced the companies to offer far better terms on subsequent deals. For example, Poyentimari received S/ 1.2 million PEN in such a deal in 2016, which they used to build a community fund that could support neighbors during emergencies, which ended up being vital during the COVID-19 pandemic. They also used these funds to improve their school buildings and build shared community spaces.

In Koribeni, the municipal government had funded the construction of a large community center, a center for women's handicraft production, and a community sanitation project. ECA Maeni, the Indigenous agency that co-manages the adjacent protected area, helped facilitate many of these programs, supporting communities in leveraging municipal budgetary resources to meet their needs. Likewise, in Chakopishiato, the municipal government had helped fund internet access, a sanitation project, and solar panels. This contrasts starkly with the Pichis valley, where communities encountered an austere local government alongside a punitive set of conservation agencies.

In a focus group with the community association of cocoa producers, we were told that support from municipal and regional governments had helped them to acquire cocoa processing equipment to sell a more refined product. They had also received some support (S/ 2200 PEN or $600 USD) from the National Forest Conservation Program to buy equipment related to cocoa production. According to one focus group respondent "the communal reserve has been helpful, as has the municipal government, but what is the point of the NFCP? They don't provide much support compared to what we make by selling cocoa, and on top of that they make us do a lot of paperwork." In addition, cocoa growers and coffee growers in all three communities were clear that they had no interest in expanding their cocoa cultivation beyond the two to five hectares that they typically cultivated. So long as they were able to

count on basic infrastructure and services along with reasonable incomes from selling more refined cocoa products, they did not find more extensive conversion of the forest to cash crop production attractive.

In both watersheds we found evidence that funding from conservation was neither adequate for nor intended to help meet people's basic needs. In the Pichis valley, conservation funds from the NFCP had been allocated to a few communal projects before being removed due to community non-compliance with program requirements; but in the larger context, people saw conservation agencies as antagonists, placing hope for their futures in collaborating with them. Instead, they broadly aspired to an agrarian capitalist future. In the Alto Urubamba, more funding from fossil fuels was available for basic services, and an Indigenous conservation organization built by local communities was helpful in navigating the bureaucracy associated with implementing projects with these funds. But conservation funding, *per se*, had not been particularly significant for supporting people's basic needs in any of these watersheds.

8. Climate debt, re-commoning social care, and insights from the Callería watershed

In major global climate policy forums, we rarely see serious conversations about unconditional funding for basic services in communities that live in forests as a policy for combating deforestation. The primary "achievements" coming out of each successive COP never include unconditional funding from the North according to the logic of climate debt as articulated by the Cochabamba People's Climate Agreement. Instead, the Glasgow conference in 2021 produced expanded public-private partnerships for tropical forest conservation through the Lowering Emissions through Accelerating Forest Finance (LEAF) coalition, which aims to turbocharge more REDD+-like market based approaches with funding from massive emitters like Shell, Uber, Blackrock, Delta, Walmart, Amazon, and many more (Blanton et al., 2024). Meanwhile, forest-dwelling communities who have managed, stewarded, and protected forests for many generations have continued to struggle in meeting their basic needs, even as they have pushed for more inclusive approaches to conservation through sustained Indigenous and peasant movement organizing (Müller, 2020; Osborne et al., 2014)

The results of our qualitative research underscore how the some of the most prevalent conservation efforts in the Peruvian Amazon have failed to support people in meeting their basic needs. Initiatives like the National Forest Conservation Program have remained committed to improving 'livelihoods' by raising incomes through better and more ecological cash crop production, while also imposing stringent requirements on communities (see also Ravikumar et al 2023). We found little evidence in the Pichis and Urubamba watersheds the Program was helping people to meet their basic needs in a substantial way. Environmental non-profits have also pushed projects rooted in the logic of 'green growth,' which commit communities to more commodity-oriented production systems alongside conservation.

The final watershed that we visited, the Callería basin, serves as an important case in point. In 2019, the United Nations Development Program awarded the prestigious Equator Prize for forest conservation to the Indigenous Amazonian Shipibo communities of Patria Nueva de Callería and Nuevo Saposoa (UNDP, 2019). Two community leaders were flown out to New York to receive the prize and participate in a

series of talks, dinners, and events attended by other environmental and Indigenous leaders from the global South along with high-ranking decision-makers from aid agencies, the United Nations, foundations, universities, and nonprofits.

These fancy ceremonies and galas marked a jarring contrast to the realities of life in these communities, where the state and international donors have failed to provide communities with clean water, sanitation, and adequate healthcare. In all three of the communities we visited, children played in the stagnant waters that inundated the fields between houses. With no functional latrines or running water, people explained to us that they had no choice but to defecate directly into these same waters. They would collect drinking water from areas with slightly more flow when possible, but even the nearby river was contaminated: diarrheal disease was common, especially among children. Meanwhile, the state has reduced the number of full-time healthcare professionals present in communities over the past decade. While each community used to be able to count on a nurse, a triage technician, and at times a obstetrician-gynecologist, now there is just a part time nurse who is often absent. The communities also lack medicine and equipment for emergencies.

While basic infrastructure and services have declined, funding for activities considered narrowly related to "conservation" has blossomed. These communities were awarded the Equatorial prize for their "innovative approach to community-led monitoring using satellite imagery and mobile phone apps that enable them to rapidly detect and respond to illegal deforestation" (UNDP 2019). A constellation of state and non-state actors made it possible for communities to acquire and deploy these technologies: USAID, the non-profits Rainforest US and Global Conservation, the Peruvian National Forest Conservation Program, and the National Protected Areas Service all played a role (Rainforest US, 2017; USAID Peru, 2021; Santos, 2023) . These organizations have celebrated the communities' use of the technologies they have provided including drones, cell-phones, and GPS in their reports and well-produced promotional video spots (UNDP, 2019). They emphasize how communities have been able to respond to reports of settlers from elsewhere causing deforestation through rigorous, high-tech patrols of their territory.

While discussing these issues, the chief of the Patria Nueva community summarized the situation to us: "International environmentalists say that we are model communities. But when it comes down to it, we are forgotten." In saying this, the chief correctly identified a glaring contradiction in climate policy that the international climate justice movement must take seriously: from the international climate talks in Glasgow to national conservation policy dialogues held by the Peruvian Ministry of Environment, Indigenous people are heralded as indispensable allies in the fight against climate change (Einhorn and Buckley, 2021). But investing climate funds in guaranteeing their basic needs, including healthcare education, infrastructure, sanitation, and internet access is generally dismissed in policy circles as outside the scope of conservation. At the highest levels of global climate policy, Indigenous Amazonians are presumed to be heroic forest protectors who need only a bit of technical support in order to keep forest standings; not people who are owed basic services and support to thrive on their own terms.

The climate debt framework offers a substantively different vision for conservation supported by our results. Our quantitative findings suggest that when other relevant factors are controlled, more public spending on healthcare, education, and sanitation is indeed associated with less deforestation. Furthermore, we found no significant relationship between deforestation and other types of public spending, underscoring the importance of how public funds are allocated. This aligns with our comparative findings between the Urubamba and Pichis basins; where natural gas money funded more public services in the Urubamba, cocoa farmers were explicit in saying that they had no interest in expanding their cash crop production, while in the Pichis people believed that an agrarian capitalist future would best provide for their families. Indeed, the central jungle region where the Pichis valley is located has been one of Peru's most troubling deforestation hotspots over the past 15 years, despite considerable efforts from conservation programs like the NFCP to intervene.

Our findings expand upon vibrant and growing discussions about Conservation Basic Income and Connected Conservation. Conservation Basic Income has generated novel research and pilot projects. Scholars and project proponents have both acknowledged that cash incomes cannot substitute for basic public services, particularly in more remote rural areas where cash economies co-exist with subsistence livelihoods. We hope that our findings will encourage political ecologists, scholars of Conservation Basic Income, and climate justice movement organizers to consider how their work might explore and provide further critical support for basic services as part of a larger conservation strategy. We also suggest that the Climate Debt Framework offers an existing advocacy model for an internationalist conservation politic. The reality is that most governments in the global North are not moving to expand unconditional climate finance for the global South at the time of this writing. Nevertheless, our findings provide an empirical foundation for advocacy and further research in that direction.

While our results show that funding basic services in the Peruvian Amazon is associated with lower deforestation, it is worth noting that in the long run, the overall impact of services will depend on how they are implemented. If the state builds schools that provide a primarily Western education that encourages people to pursue professionalized careers in the city, then more education may actually lead to more out-migration and perhaps even weaken local movements to conserve forests. Conversely, more bioculturally specific education services may reinforce local movements to retain agroecological practices and protect forests. Likewise, as we saw in Callería, more *funding* for sanitation does not necessarily imply long-term access to clean potable water; instead, the government has often built large concrete water towers that do not work well with local flood-drought cycles. Further research on the potential for leakage under regimes that connect conservation to basic services would also be helpful. Our research should therefore serve as a starting point for scholars and social movements interested in the role of unconditional funding for basic services as part of global conservation policy. We encourage further research and debate over how basic services should be delivered that centers the voices of impacted community members, alongside critical conversations about the role of climate debt in supporting such programs, including by funding the implementation of Indigenous life plans.

Funding basic services can be seen as an approach to re-commoning social care, in that it creates more space for communities to envision and create more ecological futures. Without strong services like

healthcare and education in the rural periphery, communities turn to commodity production as the only way to meet their basic needs. Our new evidence suggests that funding basic services in the Amazon is not only a moral imperative, but is also sound ecological policy. We call upon scholars to continue to investigate these relationships, which have been under-studied and under-emphasized in global environmental policy discussion. The climate debt framework is explicit in calling upon the global North to provide funding for the South to build the social and ecological futures that they want. In light of our findings, we suggest that researchers and movement organizers take this framework even more seriously with more empirically-grounded advocacy for funding basic services in the rural periphery as part of a global climate justice program.

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