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Agriculture-driven deforestation in Ecuador's Mache-Chindul Ecological Reserve: The farmers' perspective

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ABSTRACT

Tropical rainforests serve as invaluable global carbon stocks with long-term climate mitigation potential and important ecosystem functions and biodiversity. Recent scholarship has identified agriculture as the main driver of tropical rainforest deforestation worldwide, yet effective policy action needs to understand why farmers continue to clear land, beyond broad-brush attributions of blame. This study highlights the constellation of social forces that drive deforestation in a subsection of the Mache Chindul Ecological Reserve (REMACH) in northwest Ecuador. Rather than simply assuming that farmers are either indifferent to or ignorant of the effects of deforestation, we highlight the perspective of farmers themselves as they reflect on, both, their relationship with other key actors and the broader contextual factors informing their own land-use decisions. We surveyed 70 rural households using a 45-question data collection tool, conducted semi-structured interviews with key stakeholders such as local conservation practitioners and community elders, employed participant observation and reviewed government documents.

We find that colonist farmers who live in and around the REMACH clear land because they view doing so as their most reliable means of securing a livelihood for themselves and their children in a context of political and economic hardship and uncertainty. A history of government incentives to clear land, a deeply ambiguous land tenure system, and a sudden influx of externally-funded conservation NGOs to the region have all contributed to exclude farmers from the decision-making process, while simultaneously exacerbating the conditions that make deforestation farmers' most practical option—despite their awareness of its environmental impact. The data underscore that locals are, in fact, highly invested in the idea of conserving a healthy environment for future generations, but are nonetheless driven to act against this interest by their own precarity. By helping governmental and non-governmental conservation practitioners better understand farmers' land-use decisions, the study reframes the latter group not as the problem, but as vital future partners.

1. Introduction

According to the Intergovernmental Panel on Climate Change (2023:44), 22% of net global greenhouse gas emissions that lead to global warming and climate change come from land-use changes, predominantly deforestation related to agriculture and forestry. The loss of primary forests also threatens biodiversity and species richness (Wolf et al., 2021), and access to ecosystem services like clean water and fertile soils (Biggs et al., 2012; Knoke et al., 2020). Tropical forests, in particular, serve as global carbon stocks with long-term climate mitigation potential and important ecosystem functions and biodiversity (Lippe et al. 2022). A vast and growing scholarship using satellite images and spatial analysis to measure deforestation has identified "agriculture" as the main deforestation driver across tropical rainforests worldwide (see Fagua et al. 2019; Hoang and Kanemoto 2021; Hoek 2017; Kleemann et al., 2022; Noh et al., 2020). What we lack, however, are explanations—beyond broad-brush attributions of blame—for why farmers continue to clear land. To mitigate deforestation and enhance conservation's effectiveness, it is fundamental to understand the sociopolitical contexts in which locals living in tropical forest ecosystems make land-use decisions (Brechin et al. 2003; Osborne et al., 2021; Rudel and Horowitz 1993).

This paper highlights the farmers' perspective on such decisions to explain agriculture-driven deforestation in and around the Mache

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Chindul Ecological Reserve in northwest Ecuador. Ecuador serves as a case study for tropical deforestation because it is a global center of biodiversity and forest ecosystems, yet rates of anthropogenic deforestation remain high, including within protected areas (Hoek 2017; Kleemann et al., 2022). The *Reserva Ecológica Mache Chindul* (REMACH) was established in 1996 to protect the last standing patches of Chocó humid tropical forest, a top global biodiversity hotspot spanning western Colombia to northwestern Ecuador. Deforestation continues in and around the REMACH, however, with spatial and regression analysis showing agriculture as the main anthropogenic driver (Kleemann et al., 2022).

We apply sociological theory and methodology to explain the political and economic context and the individual values and behaviors that drive *colono* (colonist) farmers to clear land within and around the REMACH, particularly in the Esmeraldas province.[1] We build on environmental sociologist Thomas Rudel's pioneering work on tropical deforestation, which calls for a political-economic analysis of the constellation of social forces that drive deforestation, with particular attention to historical and geographical contexts (Rudel 2005; Rudel et al., 2005; Rudel and Horowitz 1993). Political-economic analysis also highlights the unequal power dynamics in decision-making over the control of material resources that sustain life and the uneven socio-environmental impacts resulting from those decisions (Rudel et al. 2011). Accordingly, our argument has two strands. First, we show that in order to understand the farmers' decisions, we need to understand the role of other relevant actors, especially those with substantially more power than colono farmers. We highlight, in particular, two new actors that entered the decision-making context with the creation of the REMACH—the Ministry of the Environment and transnational conservation non-governmental organizations (NGOs). Second, we incorporate to our political economic analysis the study of individual values and behaviors. Rather than assuming colono farmers' attitudes towards conservation efforts and rationale for continued land clearing, we draw on the perspectives of farmers themselves to identify the contextual factors shaping their values and decisions.

We find that, contrary to their stated mission to conserve and protect, the government and conservation NGOs in Ecuador have created a context conducive to deforestation. We identify top-down land management approaches that exclude farmers from decision-making, insecure land ownership, and an absence of reliable and meaningful economic alternatives to farming as the main reasons why farmers continue to clear land—despite their own understanding of the negative environmental impact of doing so. Ultimately, we argue this case presents a simple but important lesson for governmental and non-governmental conservation practitioners: locals are only likely to transition away from agriculture-driven deforestation if they can secure a reliable and meaningful livelihood for themselves and their children. This is farmers' most important goal, which they pursue in a context of political, economic, and environmental hardship and uncertainty. Unless that context changes, colonos will continue to deforest.

Following Schipper et al. (2021), our study underscores the need to apply interpretative social science methodologies to develop context-dependent solutions. As these authors argue, the exclusion of social sciences from climate change discourse risks oversimplified and reductive explanations, ultimately limiting the effectiveness of conservation strategies. The insights gleaned from this study thus hold significant relevance for governmental and non-governmental organizations working towards environmental solutions, both in the Mache Chindul Ecological Reserve and in other protected areas around the world.

In what follows, Section 2 presents the theoretical and historical framework for our study, and reviews sociological insights on the study of tropical deforestation with a focus on Ecuador. Section 3 describes our study site—an area comprising land within and around the boundaries of the REMACH in Quinindé, Esmeraldas—and our methods of data collection and analysis. Section 4 introduces the inhabitants of our study site, colonist farmers in La Zona, using demographic data based on household survey results. Section 5 explains the political and economic context driving the origins of deforestation over the Chocó tropical forest, while Section 6 explains how that context has changed since the establishment of the REMACH in 1996. Section 7 details how locals understand their broader context and other, more powerful, actors within it, and the various factors shaping their values and decisions. The Conclusion summarizes our findings and presents their broader lessons for conservation in the REMACH and beyond.

2. Theoretical & historical framework: sociological insights on tropical deforestation, with a focus on Ecuador

Through a number of influential works, environmental sociologist Thomas K. Rudel, working with various co-authors, has called for a political-economic analysis of the constellation of social forces that drive land-cover change, with particular attention to historical and geographical context (Rudel 2005, 2008; Rudel et al., 2005, 2009; Rudel and Horowitz 1993). Rudel argues that political and economic interests explain how and why poor people decide to clear land, and he has developed and empirically tested frameworks that consider geographical and historical dimensions to counter variable-oriented approaches that often focus solely on economic need, commodity prices, or population growth.

Rudel's work also highlights the importance of examining all the relevant actors making decisions regarding land-use and their varying resources, degrees of power, and susceptibility to socio-environmental impacts. Drawing from a comparative meta-analysis of hundreds of case studies, Rudel (2005) outlined the regional trajectories of tropical deforestation across three continents from the 1960s to the 2000s. He found that while national governments were the leading institution driving deforestation in Latin America, Africa, and Asia from the 1960s to the 1980s, this role has been taken up since the 1990s by corporate enterprises operating in response to the expansion of global market—a pattern that holds true for Ecuador. Between 1964 and 1994, the Ecuadorian Institute for Agrarian Reform and Colonization (*Instituto Ecuatoriano de Reforma Agraria y Colonización*, known as IERAC) led a program for colonization and agrarian reform to integrate and "modernize" what were perceived as "vacant" and "unproductive" rural lands and peoples (Gondard and Mazurek 2001). In Ecuador, as in other Latin American countries, government-sponsored programs for colonization and agrarian reform during this period served clear political interests—namely, to expand agrarian frontiers to develop capitalist farming and to prevent peasant uprisings (Kay 1998).

With the rise of neoliberal globalization, the 1990s saw a shift in historical deforestation patterns as corporate enterprises (logging, cattle ranching, agribusinesses) became the main agent of forest-cover changes in tropical regions with large forests (Rudel et al., 2005, 2009). Latin American governments were burdened by debt and under pressure from the World Bank and the International Monetary Fund to implement a neoliberal structural adjustment program based on the extraction and exportation of commodities for economic growth. This led to corporate expansion over large-scale extractive activities, such as mining, logging, cattle ranching, and soybean agriculture (Leguizamón 2023). Land clearing in the Ecuadorian Amazon, east of the Andes, is largely due to oil companies expanding road networks into forested areas (Rudel 2005), while in the northwest, in the Ecuadorian Chocó, deforestation is driven by the expansion of logging, infrastructure development, and agriculture (López et al. 2010). With the establishment of the REMACH in 1996, logging activities decreased only slightly and continue despite being illegal. This, in turn, fuels more deforestation, for, as Rudel has shown and we will elaborate in later sections,

[1] Throughout, we refer to our interlocutors as *colonos*, settler farmers or colonists, a commonly used term to refer to local inhabitants in the area, including by locals themselves.

when companies or governments build roads, poor small farmers follow (Rudel and Horowitz 1993).

Neoliberal restructuring in Ecuador also introduced a new set of actors that fundamentally reorganized decision-making over the environment: public and private transnational conservation organizations, such as the US Agency for International Development (USAID), the Nature Conservancy, and the Wildlife Conservation Society (Lewis 2016). In the late 1980s, conservation biologists designated Ecuador a "biodiversity hot spot," based on the region's exceptionally high species concentration and endemism. This designation resulted in an influx of foreign funding that reshaped the environmentalist movement in Ecuador and the role of the state in environmental governance. We show how these new actors with decision-making power in the REMACH have reshaped the context of agriculture-driven deforestation in the region.

3. Study site & methods

The Ecological Reserve Mache Chindul is in northwest Ecuador (see Fig. 1). It covers 121,376 ha, extending over five districts (*cantones*) in two provinces: Quinindé, Atacames, Esmeraldas, and Muisne districts in Esmeraldas province and Pedernales district in Manabí province. The REMACH retains fragmented and remnant primary tropical humid forests around the mountainous range created by the Mache and Chindul peaks. It sits within the Chocó-Darien Ecoregion, which spans coastal southern Panama to northwestern Ecuador. According to the 2010 Census (latest available), 6466 people live within the boundaries of REMACH (Marcillo et al. 2016:161). Inhabitants of the REMACH are primarily from three distinct ethnic groups: Indigenous Chachi (17% of the reserve population), Afroecuadorians (10–15% of the reserve population), and *colonos* or mestizo settlers (65% of the reserve population) (Ministerio del Ambiente del Ecuador 2005:44–45).

Our study took place within Cube Parish (*Parroquia de Cube*) in the Quinindé district in Esmeraldas province, an area locals refer to as *La Zona,* "The Area" (see Fig. 2). Cube parish is home to Laguna de Cube, an internationally recognized rainforest lake. The Cube Lake is the only inland wetland in the coastal mountains of the country and an essential resting place for migratory birds. It has been declared a RAMSAR site, meaning that it is protected under an international convention for the conservation of wetlands.[2] The ecological significance of the Laguna de Cube and surrounding Chocó habitats attracts private and public sector conservation initiatives and funding seeking to protect the wetland and surrounding ecosystems.

This research originates from an invitation to collaborate with the Foundation for the Conservation of the Tropical Andes (FCAT), a conservation and research NGO. FCAT established an approximately 1500-acre private reserve in 2018 spanning the REMACH border near Cube Lake (see Fig. 2).[3] Jordan Karubian, a professor of ecology at Tulane University and a founding member of FCAT, approached the authors (a then-graduate student in Latin American Studies and an associate professor in Sociology and Latin American Studies also at Tulane University) to pursue a research project to guide the NGO's design of future participatory reforestation initiatives that extend to the land of local residents.

The research design integrated quantitative and qualitative methods of data collection (Johnson and Onwuegbuzie 2004). The first author developed and administered a household survey to 70 households within the study area during June, July, and August 2021. The methodology backing the design of the 45-question household survey derives from Schons et al. (2019). The survey served to collect data from a large number of respondents in a relatively short period (Nardi 2018). Standardized questions and numerical data helped to identify patterns in family characteristics, land-use decisions, and environmental awareness. Qualitative methods included participant observations and semi-structured interviews with REMACH stakeholders: residents, government officials, conservation scientists, and conservation NGO staff and leaders that operate in Ecuador and the REMACH. We also relied on government documents and reports. Qualitative data served to understand the history of the region, how participants make sense of their context, and how their perspectives inform their actions (Maxwell 2013).

For participant selection and fieldwork support, we partnered with FCAT. FCAT's reserve includes a scientific field station that accommodates national and foreign students and researchers, including both the authors while conducting fieldwork. The first author conducted fieldwork in REMACH from June to August 2021, January 2022, and May to July 2022. The second author joined the first author in the study area for two weeks in early May 2022, and then conducted semi-structured interviews with conservation NGO leaders and government officials in Quito, Ecuador, later that month. The second author also conducted participant observations and interviews with conservation scientists and NGO staff and leaders in the United States (in person and over Zoom) from October 2021 to October 2022. In total, we conducted 18 semi-structured interviews: 9 with REMACH residents, 4 with government officials, and 4 with conservation NGO leaders and scientists, in addition to countless hours of informal chats during participant observations. All data collection was conducted in Spanish with Spanish-speaking participants and in English with English-speaking participants. Survey participants were selected based on convenience and snowball sampling (Nardi 2018). FCAT leaders convened a meeting with FCAT employees and their invited friends, family members, and neighbors who fit the research criteria (over 18 years old and reside in any of the eight rural communities in La Zona marked in Fig. 2) to explain the study based on an IRB-approved recruitment script. FCAT tasked Don V, a charismatic 60-year-old colono well known in La Zona and whom FCAT occasionally hires for odd jobs, to approach households he is acquainted with and ask for referrals of whom may also be interested in the study based on that same script. Volunteers who accepted the invitation to participate were included in the study. Interview participants were selected based on snowball sampling, where FCAT-associated conservation scientists, leaders, and staff referred REMACH residents, government officials, and other conservation scientists and NGO staff and leaders who operate in Ecuador and REMACH to participate in the study. While non-probability sampling techniques do not allow generalization to the entire REMACH population, the combination of quantitative and qualitative methodological approaches enables a rich interpretation and comprehensive analysis of deforestation within and around the boundaries of the REMACH.

4. Colonos in La Zona

The demographic data presented in this section introduce the inhabitants of La Zona who participated in the study, providing a descriptive account of household composition, trends in family origins, and an overview of agricultural activities.

In an average household in La Zona, there are four individuals: a heterosexual, married couple and their two children living in a single-family home on the same parcel of land where agricultural activities occur. The median age of the male head of household in our study was 54 (see Table 1). The median age of the female head of household was 48.

Employing the median age of women (48 years old) as a generational cut-off point highlights contrasting trends in access to education and medical care, two deeply held values to colono families, as we discuss in Section 7. We thus distinguish between an older generation of women, many of whom settled in La Zona before the establishment of REMACH, and a younger generation who settled or were born in La Zona post-REMACH. Women under 48 have fewer children than women in the generation older than 48 years of age (2 compared to 6, see Table 1). We

[2] https://rsis.ramsar.org/ris/1143 (Accessed October 30, 2023).
[3] https://fcat-ecuador.org/reserve/(Accessed October 3, 2023).

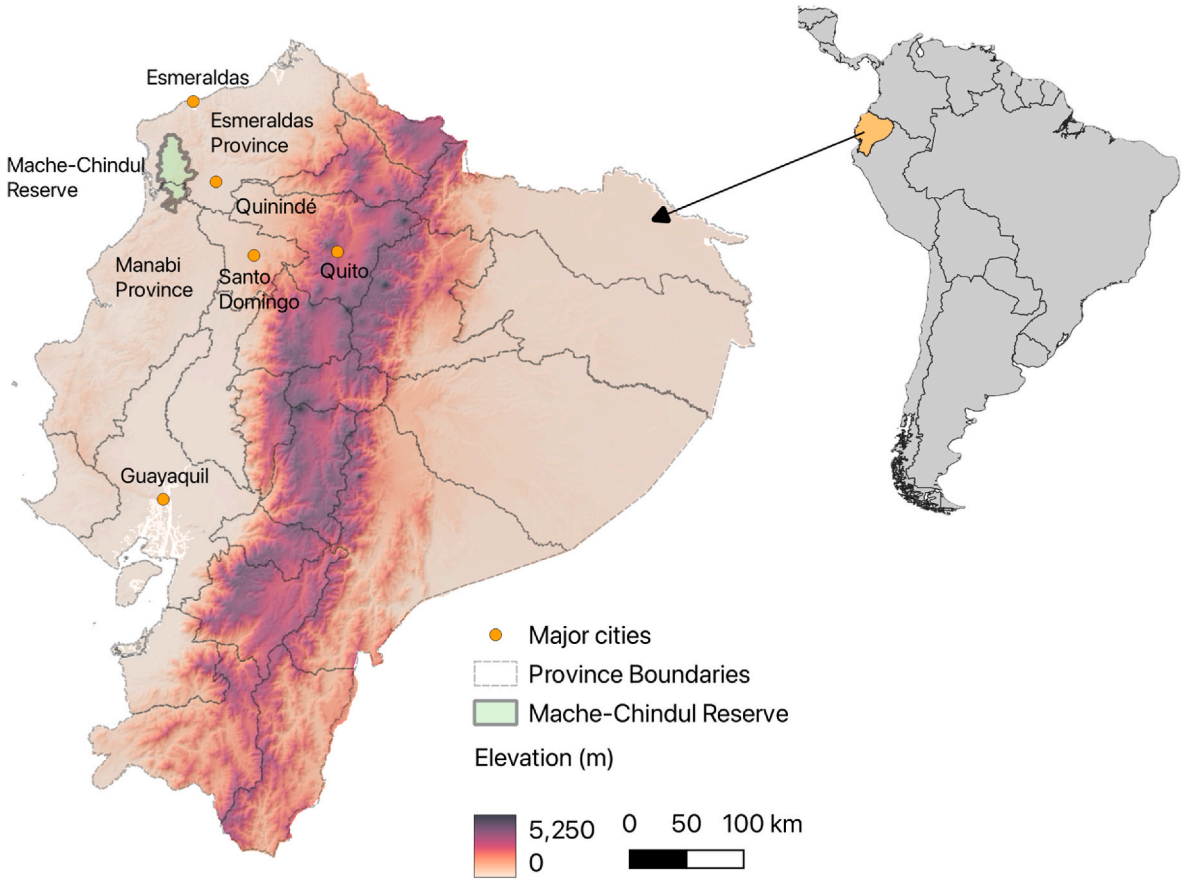


Fig. 1. Map of Ecuador with major cities and coastal provinces, and the Mache Chindul Reserve. On the right, map of South America showing Ecuador. Map created by Luke Browne. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

observe a similar generational trend in levels of educational attainment. Among the younger generation of women in the study, 28.6% completed *colegio*, or secondary school, compared to only 3.5% of women over the age of 48 (Table 2).

Colono families began arriving in La Zona before the founding of the reserve, although many of the individuals we spoke to (62%) traveled to the area after 1996 (Table 3). Most heads of households (87.5%) were not born in La Zona, with family origins outside of *cantón* Quinindé. Families primarily came from Manabí province (83%), with only 11% of the study population reporting family origins in Esmeraldas province and 6% reporting family origins elsewhere (Table 3).

Among the survey population, the median number of hectares of farmland owned by a nuclear family is 10, with 71.65% farming on less than a total of 20 ha and most (82.1%) living in a home on the land where agricultural activities occur (Table 4). As we will show in Section 5, this hectarage is half that of the average plot size allotted to colonos by IERAC upon settling in La Zona in the 1960s and 70s. Traditionally among *Manabitas* (colonos in La Zona from Manabí), both in their province of origin and in La Zona, land is divided equally into sub-parcels, one for each child, regardless of gender, when parents become physically unable to work their land. This cultural land inheritance practice may explain the small household composition, single-generation households, and decreasing land holding hectarage in La Zona today.

The primary agricultural activities on these small colono farms are either or both cacao cultivation (92% of study population) and pasture (50% of study population) for cattle ranching (Table 5). Families grow cacao for export, selling semi-dry fruit to a local aggregator in La Y. Cacao growers dedicate 43.9% of their total family hectarage to cacao cultivation. Cattle grazers maintain an average herd size of 13, with pastureland comprising about 56.2% of their total farmland. Since acquiring their farmland, families cleared an average of 92.5% of their total hectarage to make room for agriculture. Family land outside of the REMACH boundaries has a deforestation proportion rate of 99%, while family land within the boundaries of the reserve has an average deforestation proportion rate of 87.7%.

In the following sections, we explain the origins of agriculture-driven deforestation in La Zona and the legacy of agrarian reform and colonization today.

5. Origins of large-scale deforestation: IERAC's colonization program

> The single worst thing that contributed to deforestation in La Zona was IERAC. Colonos migrated here, took up land, and then went to register it with IERAC. They would only officially allocate you the land if you had cleared at least 50% for agriculture.
>
> – Male colono, age 57, January 2022

Families began arriving in what would become La Zona in 1976. Most families trace their origins to the neighboring province, Manabí (see Table 3). During interviews, older colonos recalled leaving Manabí because land was scarce and increasingly unproductive. Many spoke of an ongoing drought that imperiled farming and livelihoods. "It was a poor and sad life," agreed one elderly couple. "No one had any harvest to sell," the wife continued, "Everyone in our town left, not one stayed in Manabí." Older colonos recalled hearing from friends, family, and community members who had pioneered migration into the area. Word of mouth said that land in La Zona was plentiful, beautiful, and cheap, and that there was water and a long rainy season. Not surprisingly, many chose to migrate, seeking farmland that would enable them, as one

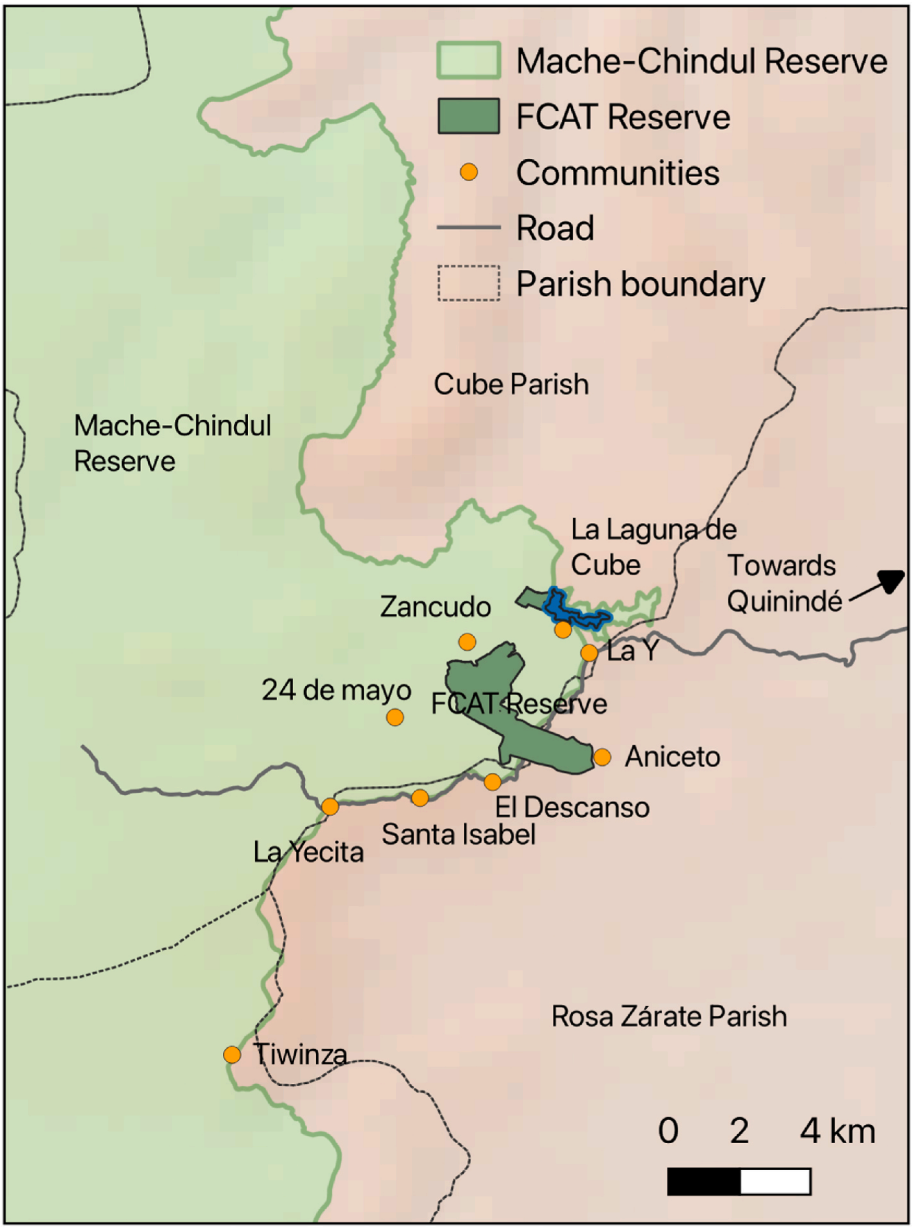


Fig. 2. Field site indicating parish and reserve boundaries, local communities of *La Zona*, the RAMSAR-protected Cube Lake FCAT's private reserve, and La Zona's main roads. Map created by Luke Browne. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Table 1
Household characteristics.

	MIN	MAX	Median	N
Household Size	1	8	4	67
Age Male Head of Household	26	76	54	63
Age Female Head of Household	20	75	48	66
# Children	1	12	2 (Women under 48) 6 (Women over 48)	65

Table 2
Educational attainment.

	Male Head of Household		Female Head of Household	
	#	Proportion (%)	#	Proportion (%)
No formal education	9	16.4	5	8.9
Primary school	31	56.4	30	53.6
Secondary school	8	14.6	10	17.9
Professional school	6	10.9	9	16.1
College/University	1	1.8	2	3.6
Total	**55**	**100%**	**56**	**100%**

Table 3
Migration and origins.

		Proportion of Survey Respondents
Birth location	Born in cantón Quinindé	12.5%
	Born elsewhere	87.5%
Family Origins	Manabí province	83%
	Esmeraldas province	11%
	Other	6%
Year of Arrival	Before 1996 (Pre-REMACH)	38%
	After 1996 (Post-REMACH)	62%

Table 4
Farm characteristics.

		# households (N = 67)	% of total
Farm Size (in ha)	Less than 5 ha	15	22.4
	5–10 ha	19	28.4
	11–20 ha	14	21
	21–40 ha	6	9
	41–60 ha (Average IERAC plot size allotment = 43 ha)	7	10.5
	61–100 ha	4	6
	More than 100 ha	2	3
Median farm size	10 ha		

Table 5
Summary of land uses and possession.

Percent of surveyed population who cultivate cacao	92.6%
Proportion of land dedicated to cacao (for those who report growing cacao)	43.9%
Percent of surveyed population who graze cattle	50%
Proportion of land dedicated to pasture (for those who report grazing cattle)	56.2%
Proportion of land cleared on properties completely covered in primary forest upon acquisition (inside REMACH)	87.7%
Proportion of land cleared on properties completely covered in primary forest upon acquisition (outside REMACH)	99%
Proportion of land cleared among all survey participants (regardless of REMACH)	92.5%
Percent of survey respondents with *escritura* (land title)	36.8%

middle-aged couple put it, to provide "a future for our children."

Land in Esmeraldas was cheap and available thanks to two laws passed in 1964 (the Law of Agrarian Reform and Colonization and the Law of Vacant Lands and Colonization), and the creation of the Ecuadorian Institute for Agrarian Reform and Colonization (IERAC), in charge of enacting these laws (Gondard and Mazurek 2001). As Gondard and Mazurek (2001:15) argue, agrarian reform and colonization were "two sides of the same policy" aimed at national integration. Between 1964 and 1994, the Ecuadorian government, through IERAC, aimed to incorporate marginalized peasant and indigenous peoples and vast expanses of land referred to as *tierra baldías* (vacant lands) into the national territory.[4] Effectively, the role of IERAC was to regulate and redistribute land to stimulate and expand markets (Goodwin 2017). Ideologically, the goal was to "modernize" and make productive what were seen as "backwards" and unproductive lands and peoples.

In Esmeraldas, IERAC's colonization program entailed expanding the agrarian frontier through the resettlement of colonos[5] (Barsky 1984; Gondard and Mazurek 2001). Colonos settled on their own initiative, with help from more affluent family members and cooperatives. Earlier migrants mentioned receiving anywhere between twelve and one hundred hectares from IERAC, in some cases at no expense. One man who arrived in 1984 explained that his family received 50 ha thanks to a cooperative of colonos from Manabí that helped cover the costs of land acquisition for recently arrived migrants. Another explained that his parents did not have to pay a cent for the 67 ha they received for IERAC. The program was quite ambitious: between 1964 and 1988, IERAC distributed 200,000 ha just in the Quinindé district (Ministerio del Ambiente del Ecuador 2005:53). In its three decades of existence (1964–1994), IERAC's colonization program regulated and redistributed 23% of the Ecuadorian territory; colonos in Esmeraldas province received 43 ha on average, substantially over the 30-ha national average (Gondard and Mazurek 2001:24).

Developing a national road system was central to IERAC's colonization process (Barsky 1984). The national road connecting Quito, Santo Domingo (in the foothill of the Andes), and Guayaquil, Ecuador's second-largest city, was completed in 1963 (see Fig. 1). Soon after, the government paved the road extending the Quito–Santo Domingo connection to Quinindé and the port city of Esmeraldas, and opened another road connecting Quinindé directly to Quito. As Barsky (1984) argues, this road was key to the expansion of the colonization frontier in Esmeraldas province, as it opened the way for colonos looking for land to resettle. By building the roads that connect farms to markets, the government became the leading institution to open large tracts of primary Chocó forest for agricultural activities (Rudel and Horowitz 1993).

Colonos in La Zona were initially given possessory rights over their lands. Under IERAC's law, colonos had to demonstrate occupation to be adjudicated a plot of land, and they did this by turning it into agricultural land (Barsky 1984). As the colono quoted at the start of this section explained, "IERAC would only officially allocate you the land if you had cleared at least 50% for agriculture." Deforestation was thus necessary—though, as we elaborate later, not necessarily sufficient—to establishing a claim over the land and acquiring land titles. Of those who settled in La Zona between 1976 and 1996, 81% (n = 22) acquired land completely covered by primary forest. Since acquisition, they personally cleared 73% (n = 20) of their land on average (Table 5). One elderly woman spoke with pride of her husband clearing 15 ha of his 20-ha plot on his own with only an axe, then the remaining 5 ha with a borrowed chainsaw. Another woman who arrived in 1980 with her now-deceased husband similarly described clearing land only with hand axes until chainsaws became more accessible.

As Rudel and Horowitz argue (1993), studies that blame farmers for deforestation underestimate the physical and psychological challenges of making life in a rainforest. Our data reveal that colono farmers were encouraged by the state to clear land and motivated by the desire to secure a future for their children, particularly when their economic livelihood was imperiled by drought in Manabí. The deforestation required by IERAC for colonos to claim land demanded intense physical effort that they now recount with pride. In the next section, we discuss the new challenges farmers faced when their lands were declared a protected area and their agricultural practices were suddenly banned.

6. The political-economic context of deforestation since the establishment of the REMACH

On August 9, 1996, the Ecuadorian Institute of Forestry and Natural Areas and Wildlife (*Instituto Ecuatoriano Forestal y de Areas Naturales y Vida Silvestre,* known as INEFAN) declared by executive order the establishment of the Mache Chindul Ecological Reserve as a Protected National Area (INEFAN 1996). From the signing of this document forward, "the activities to be carried out within the Ecological Reserve may only be for conservation, research, education, culture, recovery, and controlled recreation" (INEFAN 1996:Art. 3, our translation). As for the communities residing within the boundaries of the newly established

[4] Eurocentric ideology informed this mis-characterization of the land as "vacant; " which was in fact covered by thick forest that colonists had to clear before they could farm (Speiser 1993).

[5] The other important (and novel) aspect of IERAC's colonization program was the provision of collective land titles to Indigenous peoples (Barsky 1984; Gondard and Mazurek 2001).

protected area, their activities would be limited to the "traditional sustainable extraction of natural resources in a controlled manner" (INEFAN 1996:Art. 3). Any other activities that are "not compatible" with those stated purposes or that in any way "deteriorate natural resources" and "contaminate the environment," were thereby, "prohibited" (INEFAN 1996:Arts 4 and 5).

As we explained in Section 2, the neoliberal restructuring in Ecuador in the 1990s invited, on the one hand, the expansion of corporate extractivism and, on the other, a boom in transnational funding for environmental conservation. Debt-for-nature swap funds flowed into Ecuador through large environmental projects supported by USAID and other bilateral public donors, as well as private conservation organizations such as The Nature Conservancy (Lewis 2016). In keeping with the neoliberal emphasis on privatization and decentralization, transnational funding was mostly directed toward private actors, such as NGOs, rather than state agencies. Consequently, the number of environmental NGOs in Ecuador rose dramatically, particularly those that focused on biodiversity and land conservation in rural areas - "pure" environmental issues prioritized by the US conservation movement and preferred by transnational funders (Lewis 2016; Ordóñez Charpentier 2019). Two environmental NGOs, Fundación Natura and the Jatun Sacha Foundation, benefited greatly from transnational funding during this period (Lewis 2016) and were centrally involved in establishing the REMACH.[6] Foreign funds also supported the study that led to the creation of the REMACH and subsequent proposed management plans for the protected area (Ministerio del Ambiente del Ecuador 2005; Ordóñez Charpentier, 2019).

In this section, we focus on the actors and institutions with decision-making power over REMACH management: the Ministry of the Environment (formerly, INEFAN) and foreign-funded conservation NGOs. The stated mission of conservation agencies is to protect and restore natural ecosystems, yet our findings show that on land managed privately by colonos, their impact has been the opposite. By excluding farmers from decision-making over their territory, suddenly changing land ownership rules, and not providing sufficiently reliable and meaningful economic alternatives to transition away from cattle ranching and cacao farming, these powerful actors have increased colonos' political and economic hardship and uncertainty—ultimately encouraging further deforestation.[7]

For two decades, colonos were encouraged by IERAC to move to and colonize La Zona through farming. Then, in August 1996, from an office in the capital, INEFAN officials, alongside conservation NGO leaders from Fundación Natura and Jatun Sacha, abruptly declared export agriculture and cattle ranching activities in La Zona prohibited. During interviews, colonos expressed anger, distress, and confusion at not being consulted regarding such a major decision that would have drastic implications for their land and livelihood. Several recounted a similar story about how the boundaries of the Reserve were drawn:

> In the 90s the government declared the land here a reserve. They flew over in helicopters to measure out lots and determine what land was to be allocated for the reserve and what land was people's private property. I lost about 60ha of my land when that happened, and *no one ever came to talk to me*. There was a big protest that we organized when the government officials came to put the limits of the reserve. We blocked the few existing paths so that they couldn't get through. (Male cacao farmer, age 62, June 2021, emphasis added)

Even the Ministry of the Environment acknowledges that "the limited information and the total lack of participation that characterized the process of designing and establishing the protected area, determined the complete rejection by the population to the new territorial regime" (Ministerio del Ambiente del Ecuador 2005:8; our translation). Instead of viewing colonos as potential partners in conservation and restoration, government officials cast them as environmental destroyers. In an interview at the Quinindé office of the Ministry of the Environment, one REMACH park ranger said:

> To be honest, the conservationists that we currently have [in the REMACH] are the three [Indigenous] Chachi centers, the Afro Ecuadorian communities, and then a very low percentage of colonos, mestizo people. Many of them have deforested, similar to the case of Manabí where there are no trees in sight […] We must also take into account that the generation who claimed land in the 60s and 70s preserved more than those who buy land now. Today, they cut down everything without respect for the forest [*montaña*]. They even know that it is a reserve now and they still destroy the land.
>
> (Female park ranger, Ministry of the Environment, Quinindé, July 2021)

By excluding local populations from the REMACH decision-making process, the government and its conservation allies created a context of distrust and confusion that further impedes the Ministry's ability to protect the area and actually encourages more deforestation.

Colonos, for their part, feel cheated and abandoned by the government, particularly on the crucial issue of land titles. As one colono farmer explained:

> We cannot register for an *escritura* [official land title] for our land now because it is inside the Mache Chindul Reserve. When we came from Manabí, we received land through IERAC. It was part *montaña* [primary forest] and part *rastrojo* [regrowth]. We cleared the regrowth area to plant cacao but left the montaña as montaña. Now we are upset because, at the time, we did not know that our land would be inside a Reserve. I would prefer not to have land in the Reserve. The Ministry of the Environment messed with us and did not tell the truth. (Male colono, age 61, July 2021)

The REMACH is a protected area established entirely over private property. However, it is estimated that 85% of the households do not possess land titles (Ministerio del Ambiente del Ecuador 2005:53). Our survey results show that only 35.7% of surveyed households within the boundaries of REMACH (n = 28) hold an *escritura* (see Table 5). The rest claim possession rights. These are families who have lived and worked on a plot of land for years but were not able to complete the measurement and delimitation paperwork required to complete the adjudication process before the reserve's establishment (Ministerio del Ambiente del Ecuador 2005:53). By law, families who settled within the boundaries of the protected area *after* the establishment of the REMACH do not have rights to a land title, even if they have occupied the land for years (Interview with the Director of Protected Areas, Ministry of the Environment, Quito, June 2022). Therefore, they neither have the right to sell or bequeath land (even though we observed an active land market). This context of insecure landownership has only served to fuel a deforestation frenzy among colonos seeking to establish claims to the land.

The Ecuadorian government has also failed to provide "medium and long-term strategies to promote the sustainable development of the communities within the reserve" (Ministerio del Ambiente del Ecuador 2005:62–63; our translation). Repeatedly during our interactions, colonos spoke of the lack of viable economic alternatives to farming and cattle ranching, saying things like, "there are no other options" and "there is no other way to survive than working in the *finca* [farm]." They emphasized the lack of government help with immediate alternatives, but many also noted broader issues, such as the government's failure to provide adequate road and water infrastructure, education, and health

[6] Jatun Sacha, like FCAT, runs a private biological station within REMACH called Bilsa.

[7] For further research on how the establishment of protected areas can undermine conservation and lead to social injustice, particularly dispossession and displacement, see, Agrawal and Redford (2009); Brechin et al. (2003); Brockington and Igoe (2006); West et al. (2006).

services in the area—issues also highlighted in the 2005–2010 Management Plan for REMACH and the 2015–2019 Development Plans for the Cube Parish (Gobierno Autónomo Descentralizado Parroquial Cube, 2015; Ministerio del Ambiente del Ecuador 2005).

Ironically, it is the very NGOs involved in the establishment and conservation of the REMACH that have been an important source of jobs and resources for the community. During interviews, many colonos shared their experiences with conservation NGOs and their foreign researchers and students, identifying them as past, present, and potential future resources.[8] For example, some women recalled (and were extremely thankful for) two American researchers who raised funds to build a much-needed health center in the community. Several others fondly recalled receiving training and attending workshops and events on environmental education and conservation organized by Fundación Natura, Bilsa, and FCAT. The colonos we interacted with most were employed as FCAT guides, fieldhands, researchers, cooks, and cleaners, one of their many tasks being tending to students and researchers who, like us, stay in FCAT's private station to conduct fieldwork. Including Don V, who was hired to recruit survey participants (as mentioned in the Methods section) and subsequently rehired to accompany and taxi the first author on his motorcycle to conduct the survey. FCAT has also been instrumental in developing and maintaining a road that leads to the NGO's field station and benefits the families in the area.

Crucially, however, even as colonos realize that the non-governmental sector is now a main provider of jobs and resources in the area, they are also well aware that employment with the conservation NGOs is never guaranteed. A 75-year-old colono told us that, back in 1997, he was hired and trained by Fundación Natura to work in a nursery that gave plants and trees to locals in Cube, La Y, and La Laguna for reforesting. He also participated in another project where the conservation NGO provided education, money, and food to raise pigs. He was proud because Fundación Natura "kept raising [his] pay," he said, because he "worked hard" and "did such a good job." However, his job was suddenly terminated because, according to him, he "didn't have enough education." During our fieldwork, we did not encounter any locals currently hired or benefiting from any program established by Fundación Natura, which indicates that those projects for reforesting and pig raising have been terminated.

Bilsa, Jatun Sacha's biological station, was recognized by many as a recent source of jobs and income. We met several colono men who had been hired as guides and fieldhands for foreign researchers studying at Bilsa. One of them shared how much he loved the job because, besides the pay, he got to "see waterfalls and animals." We also heard from local women who were visiting FCAT's reserve in May 2022 about an income diversification project in Bilsa, where colonos wove hats to sell to foreign visitors at the field station. Bilsa biological station, however, reduced operations a few years ago, so jobs and initiatives have dried up. A 50-year-old woman we surveyed recounted with desperation, "Bilsa still owes my husband money!" The hats, we heard from the women at FCAT, were paid for by Jatun Sacha but left to rot as visitation to the field station declined. The group of women who shared this story with us were participating in another income diversification project; this one organized by FCAT and funded by the U.S. Fish and Wildlife Service. They were invited to learn printmaking and create handcrafts (earrings, in this case) for sale to foreign visitors. To date, the revenue from this project flowing to locals is a few hundred dollars.

Working for the NGOs, therefore, is (quite accurately) not seen as a viable alternative to farming. This view was true even among colonos who spoke with us of the need for environmental protection, including FCAT colono employees, many of whom continue to farm cacao on their family farms. In the following section, we focus on other features of colonos' everyday lives that continue to make cacao farming and cattle ranching the most reliable and meaningful way to secure a livelihood and a future for themselves and their children.

7. Colonos' everyday worlds and options for the future

Despite the many aspects of their lives shaped by political and economic forces beyond their control, colonos in La Zona exercise what agency and autonomy they can to shape their landscape and future. International, national, and regional politics, conservation initiatives, and a neoliberal economy contribute to La Zona's context of uncertainty. The government and NGOs forbid export agriculture through land clearing, yet colonos know that it remains the most reliable mode of attaining economic security for one's family and community. They continue to clear land not because they are unaware of, or necessarily indifferent to, the debates surrounding it, but because they want to secure stable and meaningful livelihoods for themselves and their children. In this section, we zoom in on individual- and family-level values and goals that inform colonos' decision-making—including their own understanding that some of their farming practices undermine the very stability and reliability they seek for their children's future.

Cacao cultivation is the basis of a steady income among most households in La Zona. The cacao fruit is harvested, left to ferment in hemp sacks, and then semi-dried before it is sold to an aggregator in La Y, La Zona's central town (see Fig. 2). Families sell in small quantities (at an average of 175 kg/month) every 2–3 weeks throughout most months of the year. Cacao farmers make about US$2544 annually after accounting for costs associated with agro-inputs and bank loan repayments. When asked about other sources of income, farmers mentioned occasional work as a *machete* (day laborer on a farm) or selling the occasional excess of meat, cheese, or tropical fruit (e.g., oranges, lychee, bananas), but none of these were considered as consistent as cacao production. As such, optimizing cacao production and avoiding damaging plagues is crucial. A hybrid variety of cacao, colloquially called *injerto* (graft), was recently introduced to the area, and has now replaced the *nacional* (native) variety among the vast majority of the survey population (95% of cacao growers in our survey). One farmer who recently switched explained, "I grow cacao injerto because it produces more yield than the nacional, even though the nacional is more aromatic and of higher quality." Opting for higher yields over quality is a logical choice given that, as of August 2021, only one cacao aggregator operated in La Y, the central town that serves as a funnel for all agricultural products leaving La Zona. When interviewed, that aggregator noted that he offers the same price for both nacional and injerto—$60 per *quintal* (45 kg) of semi-dried product—because his buyer, another link in the value chain that eventually leads to the port in Guayaquil (see Fig. 1), does not separate the two varieties.

To facilitate their switch to the hybrid variety, many farmers spoke of withdrawing bank loans to fund the purchase of starter trees and to accrue the necessary agrochemicals to support and protect their investment, which, unlike the nacional variety, demands full-sun and monocultural production. When asked whether agrochemical use was necessary, one farmer took the first author to his field where he showed her a purple cacao fruit stained with a large black oval. He said, "The monilia [a common genus of fungus that causes disease in cacao across Latin America] is damaging my trees." Another said, "*Es como la palma* (It's just like the oil palm)," when commenting on why he preemptively uses agrochemicals to ward off the fungus. Without viable, reliant economic alternatives to commodity cropping, farmers in La Zona seek the most lucrative, reliable, and secure production methods. This creates a

[8] Indeed, because we partnered with FCAT to conduct this research, many of the colonos saw us, too, as potential resources who could either facilitate their relations with the NGOs or assist them in other ways. While conducting the survey, many colonos identified the first author (a White female American researcher associated with FCAT) as a potential resource. For example, they wondered about paid opportunities to invite FCAT's foreign visitors as tourists to observe wildlife on their property or they asked for employment in FCAT's field station. Knowing that FCAT has lately expanded its private reserve, some also asked the first author to mediate with FCAT for the NGO to buy their land.

cycle of debt in which they are incentivized to adopt and purchase agricultural technologies that protect yields and promise short-term increases in income, but degrade the fertility of their land and introduce the risk of pests and plagues in the long term. It is a familiar pattern that colonos recollect experiencing with other commodity crops they have grown for export in the past, most recently, oil palm, as this one farmer recalled.

Aware of commodity crop price volatility, colono families aspire for longer-term stability (i.e., to pay back bank loans, save for unforeseen circumstances, and ensure children inherit some sense of security) by two primary means: livestock and trying to establish a secure claim to their land. In an interview, an FCAT leader from Quito recollected a moment when his understanding of conservation became more complex after confronting a colono mother who was defending her husband's decision to shoot and kill a jaguar:

> She told me she maintains a large and healthy group of hogs so that when one of her children falls ill and requires medical care, she can sell a hog for extra money and the family still has pork to eat. She said, "you have a bank account where you keep your money. You have a daughter that you care for with the money that you keep in your bank account. You have a job that provides for you and your daughter, that fills your home with the things that you need. How would you feel if a robber entered your home and stole all of your belongings? If all that you had built was stolen and you couldn't care for your child? Well, that jaguar visited while I was out selling a pig in town and killed the entire herd. We went out to look for that jaguar and had to kill it. That jaguar destroyed all of my equity and I wasn't going to let that happen again. I hate jaguars." (FCAT Reserve Director, July 2021)

Conservation of rare and endemic species, like jaguars, takes a necessary backseat to the care and protection of one's family. For this mother and others in La Zona, agriculture and livestock production are essential to caring for one's family, now and in the future. They provide not only immediate food but also investment for a child's future education or financial security in the case of unexpected illness. Moreover, after the initial cost of buying animals, livestock can walk and feed themselves within a fenced area and do not require much financial input or dedicated labor. This makes them an excellent use of agricultural lands in remote areas where roads are unreliable or non-existent.

Cattle ranching also provides supplemental proof of productivity on cleared land. On lands where possessory rights or land tenure is uncertain, cattle ranching can function as a claim to use and productivity. One couple runs an ecotourism business to which FCAT brings visiting students and researchers, yet they still retain their pasture, renting it to a neighbor who cattle ranches. They recounted:

> Some years back, officials from the Ministry of the Environment came to try to help us get an *escritura* (land title) but we needed official proof of sale and could not find the person that we had bought the land from. There was already about 7 ha of pasture on the property and so we decided to expand the pasture. (Colono ecotourism business owners in La Zona, July 2021)

Given the dependency of colonos in La Zona on agriculture for economic security, rights to land tenure are perhaps the most essential component of stability and ensuring security for future generations. Notably, parents repeatedly expressed their wish to leave not just productive land, but also a healthy environment for their children. Many made it clear they were fully aware of the long-term consequences of deforestation. One mother, for example, stated:

> I want to leave a healthy and clean environment for my children. I want the air to be clean and our water source to always flow. For this reason, we leave the trees around our water source. My son likes to tell me about the birds he sees in those trees when he collects water for the home. (Mother from Santa Isabel, age 33, July 2021)

Another couple mentioned that NGOs' conservation work maintains the tree cover necessary to ensure "clean and pure air" for the rural communities. Farmers in La Zona are not indifferent or opposed to environmental conservation, but colonos are faced with trying to strike a balance between having sufficient agricultural land for future generations to inherit and ensuring that land comes with abundant water and clean air.[9] With a sense of pride, one woman described her family's hard work to achieve this balance: "It was all jungle when my family arrived. My father used a hand ax to clear land until a chainsaw could be used for the bigger trees. He left forest around the river that runs through the property and monkeys still come there to drink water." Many younger or middle-aged parents expressed gratitude to their families for leaving them land that had already undergone the extremely burdensome process of being cleared by handheld tools. Now, these parents look to the future climate changes, such as an increasingly shorter rainy season, which only spur their anxiety to provide for their children's future:

> We left Manabí because we were losing our harvest due to the drought. Here our harvests are better because the climate is better for cultivation. About eight years ago though, we started to experience *verano* (dry, sunny weather) in La Zona. When we first arrived, there was one month of the dry season, now it is about half of the year. (Female colono from Manabí, age 55, June 2021).

That the very farming they are pursuing for the sake of their children may be contributing to the climate changes that threaten their farms' productivity and thus their children's future is not lost on many colonos, but they lack viable alternatives and are caught in an impossible situation.

In addition to wanting to pass on fertile agricultural land for future generations, colono parents spoke repeatedly about wanting increased access to quality education and medical resources as well. But the road developments imperative to such access have long been lacking. As one interviewee related:

> We settled in Mono [a remote community passed the Bilsa reserve] in 1984 because a cooperative was giving away 50ha of land near a river. But in 2005, I moved our family closer to La Y because my wife was sick, and it was time for the children to receive schooling. Before we moved, it would take us three days by horseback to get to the health center. (Husband and father from La Y, age 66, August 2021)

In Zancudo, a community that lies in a river valley and is accessible only by walking about 45 minutes down a steep footpath, families are organizing to raise money to bring a road out to their community so that their children can access the secondary school via motorcycle, rather than on foot. A mother from 24 de Mayo (see Fig. 2) recounted how teachers trekked through the muddy paths to bring assignments to the homes of families with children before the construction of the road. "*Puro lodo, feo era el camino* (nothing but mud, the way was terrible)," said another mother from Santa Isabel. Similarly, increased access to medical care serviced by trained practitioners is achieved only through the development of roads. "*Era duro* (it was hard) when we moved here and there were no roads. I was pregnant and was nervous about having to walk out to the main highway to get to the hospital in time," said one woman. And it was primarily logging entities, not the state, that interviewees recognized as the main hope for road building in the area. As one man recounted, "We made a deal with [a logging] company where we selectively felled some trees to give in exchange for a road to our community." He went on to explain that the new road allowed his family to start planting and eventually export commodity crops.

Colonos in La Zona themselves recognize the value of the environment and the benefit of conservation activities, but their ability to secure

[9] The COVID-19 pandemic was in full swing when our fieldwork took place and interviewees understandably emphasized clean air as especially important to protect against coronavirus.

a livelihood and live out their core values is restricted by available infrastructure. These conditions set up a dynamic wherein they have no option but to engage in unsustainable production methods that involve the use of agrochemicals and repeat the unsuccessful but familiar patterns of other commodity crops. They take out bank loans and ranch cattle on remote agricultural lands where tenure rights are insecure and ill-defined. Despite awareness that it affects the rainy season and groundwater, they continue to clear forest land because they have few nearby resources and no reliable alternative sources of income. Their access to education and medical resources likewise hinges to a large extent on continued logging and agricultural activities in the area. Exercising the limited agency they can within the confines of this political and economic context, colonos recognize and select commodity farming and cattle ranching as their best options to provide immediately for their families and hopefully establish a stable livelihood for future generations.

8. Conclusion

With growing scholarly consensus that agricultural land clearing is the leading cause of deforestation, much blame has been placed on farmers, yet there is insufficient attention to the contexts and other actors shaping farmers' decisions. Building on Rudel's pioneering analyses of the political economy of tropical deforestation, we have highlighted the constellation of social forces that drive deforestation in and around Ecuador's REMACH, with particular focus on how new actors shape the decision-making for protected areas, and the broader social, cultural, economic, and environmental contexts that shape farmers' practices. Far from a simple conflict that pits good environmental actors (government and NGOs) against bad environmental actors (farmers), we have shown a much more complicated story, in which locals began to deforest in response to government encouragement and incentives, and continue to deforest despite governmental and NGO efforts to the contrary.

This case presents several lessons for governmental and non-governmental conservation practitioners. First, locals are only likely to transition away from agriculture-driven deforestation if alternatives exist to secure a reliable and meaningful livelihood for themselves and their children. The problem is not indifference to or ignorance of environmental concerns. Understanding farmers' choices requires an analysis attentive to the historical and contemporary contextual factors shaping individual behaviors and values. In this case, the origins of deforestation stem from the macro-level political and economic context in the 1970s when the Ecuadorian government promoted the resettlement of colonist farmers to expand the agrarian frontier via agrarian reform and colonization. The government built the first roads cutting across large tracts of primary tropical forest connecting farms to markets. Since the founding of the protected area in 1996, governmental and non-governmental actors working on conservation projects have contributed to instability for colono communities by excluding farmers from decision-making, generating land tenure insecurity, and not providing both reliable and meaningful economic alternatives to farming. Jobs with conservation NGOs are not seen as sufficiently reliable alternatives to convince farmers to give up agriculture in order to provide for their families.

To ensure positive ecological and social outcomes when implementing conservation projects, solutions must consider individual and familial values, beliefs, and desires. Thus far, however, this has taken the form of incorrectly painting farmers as either not understanding or not caring about the environmental impact of deforestation. But colono farmers are aware that some of their livelihood choices feed a cycle that erodes long-term sustainability. They desire to lead a life in which they can provide for their families and ensure future generations inherit economic stability, secure land tenure, a healthy environment, and reliable and safe access to educational and medical resources. Conservation solutions must consider all of these elements.

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Declaration of competing interest

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

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