

REVIEW

An interdisciplinary review of the interplay of conflict, socio-economic factors, and land cover and vegetation dynamics in Colombia

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Societal Impact Statement

Colombia's forests play a crucial role in preserving biodiversity and mitigating climate change, but they are currently facing severe degradation, particularly after the 2016 Peace Agreement. Our literature review highlights a growing research interest in this topic and demonstrates how interdisciplinary approaches combining diverse methods can enhance our understanding of the complex interplay of conflict, socioeconomic factors, and land cover changes. These insights are valuable not only for future interdisciplinary studies but also for policymakers seeking to develop more effective sustainable development initiatives. The lessons learned from Colombia's situation offer guidance for addressing similar challenges in conflict-prone regions around the world.

Summary

Colombia's forests, covering over half the country, face significant threats linked to its socio-political landscape and armed conflict history, particularly the recent peace agreement with the Revolutionary Armed Forces of Colombia–People's Army (FARC-EP, for its abbreviation in Spanish) guerrillas in 2016. In this study, we conducted a systematic literature review examining the complex interplay between land cover changes, socio-political dynamics, and economic development in Colombia before and after the Peace Agreement. This review focuses mainly on deforestation, incorporating perspectives from environmental and social study disciplines, and inspecting top-down and bottom-up scaling approaches to analyze the multifaceted scenarios that emerged during this period. Our review reveals increased research interest from environmental and social sciences in understanding the environmental impacts of Colombia's civil conflict and the 2016 Peace Agreement since its signing.

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Environmental sciences favor top-down analyses, while social sciences prefer bottom-up methods. Interestingly, the number of interdisciplinary studies combining both methods is increasing. Multiple methodologies confirm increased environmental degradation after the Peace Agreement, especially in the Andes and Amazon regions. The power vacuum left by the guerrilla, not filled by governmental institutions, is widely acknowledged as a key source of important drivers of uncontrolled forest loss, such as land grabbing and illegal cattle ranching. External factors such as international demand for gold and illegal drugs continue to fuel environmental degradation and armed conflict, with international aid programs to local farmers often proving ineffective. Although Colombia's situation is unique, the complex interplay of social, economic, political, and environmental factors offers valuable insights for understanding similar dynamics in other conflict-prone regions globally.

KEYWORDS

armed conflict, bottom-up analysis, deforestation, environmental degradation, FARC-EP Peace Agreement, interdisciplinarity, top-down analysis

1 | INTRODUCTION

Colombia's forests cover more than half of its territory (Monroy et al., 2022), serving as crucial hotspots for biodiversity and ecosystem services (Rodríguez et al., 2020; Salazar et al., 2022). They store over 6.5 Pg of carbon (Phillips et al., 2016; Rodríguez-Veiga et al., 2019) and include significant areas of indigenous reserves (Ramírez-Gomez et al., 2015), Afro-Colombian communal territories (Huezo, 2019), and Peasant Reserve Zones (Osejo Varona et al., 2018). Yet, these ecosystems have not been immune to the impacts of armed conflicts; on the contrary, their state has been shaped by conflict dynamics both before and after the Peace Agreement. Following its signing, deforestation surged by 44%, primarily in the Amazon region (Rodríguez de Francisco et al., 2021). This rise in deforestation presents complex challenges with widespread consequences for Colombia's economy, society, and environment, including biodiversity loss, disruption of the water cycle, soil erosion, pollution, and increased greenhouse gas emissions (Arias-Gaviria et al., 2021; Negret et al., 2019).

Deforestation in Colombia stems from both proximate and underlying causes. Proximate causes involve direct human activities that immediately impact forest cover, while underlying causes encompass broader socio-economic processes that reinforce the proximate causes (Geist & Lambin, 2002). Key proximate causes include infrastructure expansion—such as roads, mining, and settlements (Anaya et al., 2020; Bautista-Cespedes et al., 2021; Ramírez et al., 2018), agricultural expansion through cattle ranching, coca crops, permanent and shifting cultivation, and colonization (Anaya et al., 2020; Armenteras et al., 2013; Duarte et al., 2021; Ganzenmüller et al., 2022; Prem et al., 2020; Vásquez-Velásquez, 2016), as well as wood extraction (Botero-García et al., 2019; Castro-Nunez et al., 2016; Hoffmann et al., 2018). Underlying causes encompass demographic factors like migration, economic factors such as expanding markets for palm oil and illicit crops, and political-institutional factors including economic

development policies, governance weaknesses, inequalities, and mismanagement (Arias-Gaviria et al., 2021; Furumo & Lambin, 2020; Krause, 2020; Prem et al., 2020; Sánchez García & Wong, 2024). Additionally, cultural aspects like conservation of ethnicities and places of religious importance to the local communities also play a role (Arias-Gaviria et al., 2021).

While forest degradation in the neighboring Amazon countries shares similar contextual factors (Hänggli et al., 2023), Colombia's socio-environmental dynamics are unique, shaped by its history of armed conflicts and peace-building efforts. Notably, the 2016 Peace Agreement signed between the government and the Revolutionary Armed Forces of Colombia (FARC-EP, for its abbreviation in Spanish; now the political party Comunes) and the “Total Peace” (Paz Total) initiative launched in 2022 by President Gustavo Petro to negotiate with multiple armed groups.

The armed conflict in Colombia has produced both negative and positive environmental impacts: While some legal and illegal land uses caused forest loss and environmental damage, others facilitated forest regeneration and improved ecological connectivity (Camargo et al., 2020; Christiansen et al., 2022; Sánchez-Cuervo & Aide, 2013). Before 2016, FARC-EP guerrillas, despite clearing forest for coca cultivation (Bautista-Cespedes et al., 2021), unintentionally protected forests in their controlled areas by restricting logging and limiting forest, relying on dense canopy cover to evade detection (Krause, 2020; Murillo-Sandoval et al., 2020). Then, the 2016 Peace Agreement and subsequent FARC-EP demobilization and reform processes brought major land-use changes: a power vacuum emerged that the state failed to fill, allowing farmers, miners, loggers, and new armed groups to occupy previously restricted forests (Clerici et al., 2020; Fergusson et al., 2014; McClanahan et al., 2019; Prem et al., 2020; Rodríguez de Francisco et al., 2021; Sanchez-Cuervo & Aide, 2013). This shift has driven the expansion of legal activities like cattle ranching alongside illegal practices such as gold mining and illicit coca cultivation, while

also triggering a surge in land grabbing and speculation in these newly accessible areas (Marín-Ilanes et al., 2024; Murillo-Sandoval et al., 2020, 2023; van Uhm, 2020).

Other armed groups have contributed to environmental degradation before and after the Peace Agreement. In the late 1990s, paramilitary groups like the United Self-Defense Forces of Colombia (AUC, for its abbreviation in Spanish) cleared forests for land grabbing, agriculture, and resource extraction (Ganzenmüller et al., 2022; Prem et al., 2020; Sanchez-Cuervo & Aide, 2013). Similarly, the National Liberation Army (ELN, for its abbreviation in Spanish) has caused local environmental degradation through illegal mining and coca cultivation (Álvarez, 2003). After 2016, various illegal armed groups—including FARC dissidents—expanded into former FARC territories, exploiting forests for resource extraction and coca farming (Clerici et al., 2020; Pirela Rios et al., 2023; Rodríguez de Francisco et al., 2021). Unlike FARC-EP, these smaller groups do not rely on forest cover for protection, reducing their interest in preserving forests (Velez et al., 2025). The Estado Mayor Central (EMC), formed by FARC-EP dissidents, has even used deforestation as a bargaining tool in peace talks, initially restricting and later allowing forest clearing to pressure the government (Corredor-García & López Vega, 2024; Inside Climate News, 2024; The Guardian, 2024). Additionally, drug cartels—though not strictly armed political groups—have accelerated deforestation through coca cultivation and land acquisition for money laundering (Mejía, 2016; Murillo-Sandoval et al., 2020, 2023).

The Territorial Focus Development Program (PDET, for its abbreviation in Spanish) is a key initiative for the economic development of municipalities formerly controlled by FARC-EP and associated with illicit crop economies. Their main components include financial support for rural development through land redistribution, infrastructure improvement, and encouraging a shift from illegal activities to sustainable commercial agriculture. Achieving these goals depends on sustained government commitment to uphold the financial viability of the 2016 Peace Agreement.

Although deforestation is typically portrayed as a negative issue in literature and public debate due to its impact on biodiversity and climate mitigation, local farmers and indigenous communities offer different perspectives. For them, the Peace Agreement provided access to land formerly controlled by guerrilla groups, enabling socio-economic empowerment. Deforestation is often seen as a means to economic independence and small-scale farming, adding complexity to academic and public debates on the issue (Amador-Jimenez et al., 2024).

Despite scientific progress in understanding the interplay of armed conflict and environmental degradation, much uncertainty remains regarding the questions: (i) What are the socio-environmental transformations resulting from the increased forest loss after the Peace Agreement? (ii) How have socio-environmental transformations in the context of the implementation of the Peace Agreement either fostered or prevented deforestation? To investigate these questions, we conducted a systematic literature review examining the complex interactions between land cover changes, sociopolitical dynamics, and economic development before (2012–2016) and after (2016–2022) the Peace Agreement. The review primarily focuses on deforestation,

as it is the most extensively studied land cover process in the country and has been significantly affected by armed conflict. Our research evaluated methodological approaches used to study conflict (or peace) and environment relationships, distinguishing between social, environmental, and interdisciplinary perspectives, as well as between *top-down* and *bottom-up* methods.

1.1 | Study disciplines and scaling approaches

The study of land cover dynamics is inherently multidisciplinary, spanning multiple fields and scales of analysis. For this study, we group these disciplines into two overarching categories: (i) environmental sciences and (ii) social sciences. Within each category, approaches are further classified as either *top-down* or *bottom-up*, reflecting their scale and perspective (Figure 1). This study clarifies these terms according to their meaning within each discipline. In environmental sciences, *top-down* approaches rely on remotely collected data from drones and satellites, providing information on forest cover, climate variables, and human-made infrastructure like roads, cattle ranches, and mines. Conversely, *bottom-up* methods involve direct field data collection through surveys, on-site measurements, and participatory approaches that engage local communities, revealing information such as species inventory and the community's willingness toward political agendas with environmental goals.

In social sciences, a *top-down* approach typically applies pre-existing criteria and indicators (C&I) adapted by experts to local contexts (McDougall et al., 2013; Prabhu & Colfer, 1996) or includes theoretical concepts linking deforestation to economic or temporal factors. In contrast, *bottom-up* approaches actively engage local communities through participatory processes, allowing them to propose C&I based on their own knowledge and experiences (Prabhu et al., 1999). Recently, postcolonial and decolonial perspectives in social sciences have gained relevance by criticizing the dominance and epistemic extraction rooted in colonial hierarchies that shape knowledge production about countries in the so-called Global South. These perspectives point to the relevance of diverse knowledge systems, such as Indigenous knowledge, and advocate for equitable and just collaboration between scholars and local communities (Amador-Jimenez et al., 2024; Ramos & Romero, 2025).

In both environmental and social disciplines, *top-down* definitions align with a “distant” perspective, covering broad spatial or jurisdictional scales, while *bottom-up* methods offer localized, “direct” insights into underlying drivers and mechanisms. For example, in environmental sciences, *top-down* methods like satellite-based remote sensing enable global-scale mapping of burned areas (e.g., Chen et al., 2023; van der Werf et al., 2010), revealing spatial patterns and trends (e.g., Andela et al., 2017; Zheng et al., 2021), but often fail to explain local deforestation drivers. Social sciences *top-down* approaches include theoretical concepts like the environmental Kuznets curve or the forest transition hypothesis, which attempt to establish relationships between deforestation rates or forest area and economic factors or time (Indarto & Mutaqin, 2016). However, these models do not

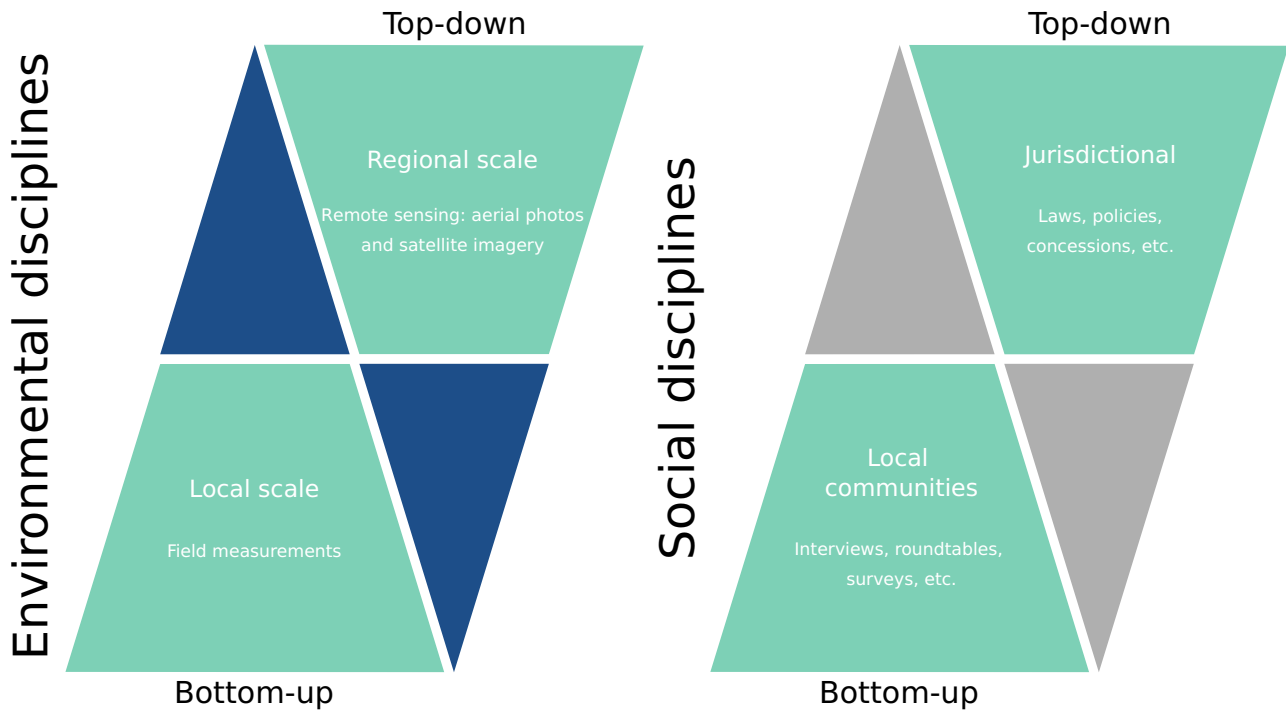


FIGURE 1 Schematic representation of *top-down* and *bottom-up* approaches in environmental and social disciplines.

universally explain deforestation, as drivers vary widely by country and biome (Flores et al., 2024). Conversely, *bottom-up* approaches in both environmental and social sciences involve direct contact with the subject of study. In environmental sciences, *bottom-up* approaches involve field data such as forest inventories or flux measurements, while social sciences use community-level surveys to understand local factors in deforestation. Although these methods provide rich case-specific details, scaling up their findings to larger ecosystems or jurisdictions remains challenging. We consider the Peace Agreement a social-based *top-down* initiative, as it was signed by the government and FARC-EP, affecting multiple municipalities impacted by armed conflict.

Beyond environmental and social disciplines, interdisciplinarity is an increasingly prominent approach for analyzing complex phenomena such as deforestation, as it integrates knowledge and methods from multiple disciplines to provide a more comprehensive understanding of a problem (Stember, 1991).

2 | METHODOLOGY

We used a PRISMA-based (Page et al., 2021) protocol (see Methods S1) to systematically review the socio-environmental transformations resulting from land cover changes linked to the Peace Agreement, with particular emphasis on deforestation, and how these transformations have modified land cover dynamics. In March 2023, we searched peer-reviewed and gray literature across the international bibliographic databases Web of Science (WoS), Scopus, SciELO, and Google Scholar. Additionally, we explored governmental web portals

such as the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM), Ministry of Environment and Sustainable Development (MADS), Amazonic Institute of Scientific Research (SINCHI), and Instituto Humboldt, along with nongovernmental organization reports from organizations like Foundation for Conservation and Sustainable Development (FCDS), United States Agency for International Development (USAID), Wildlife Conservation Society (WCS), and World Wildlife Fund (WWF). The document screening process for Google Scholar was confined to the first 250 results sorted by relevance. Our search focused on literature published from January 2010 to April 2023.

The search strings were developed using a set of keywords derived from the main research questions. These keywords were categorized as follows (CEE, 2013): (i) Population: (forest OR land cover OR land use) AND Colombia; (ii) Intervention: peace agreement OR conflict OR peace treaty OR peace deal; (iii) Comparator: environment* AND (soci* OR economic* OR politic*); and (iv) Outcome: (deforestation OR land change) AND (forest loss OR poverty OR political preference OR inequality). The keywords were combined into search strings using the Boolean operator “OR” for similar terms and “AND” to connect the main headlines (i.e., population, intervention, comparator, and outcome). The search was conducted in both English and Spanish. Search records were imported into a reference manager, and duplicates were removed (Figure 2). Then, all documents underwent a three-stage screening process conducted by at least two reviewers: (i) title and keywords, (ii) abstract, and (iii) full-text levels. If the initial two reviewers disagreed on the relevance of any document at any stage, a third reviewer was brought in to decide. From each document, we extracted key bibliographic information, including the title, authors, journal or publisher, DOI, and publication year. We also

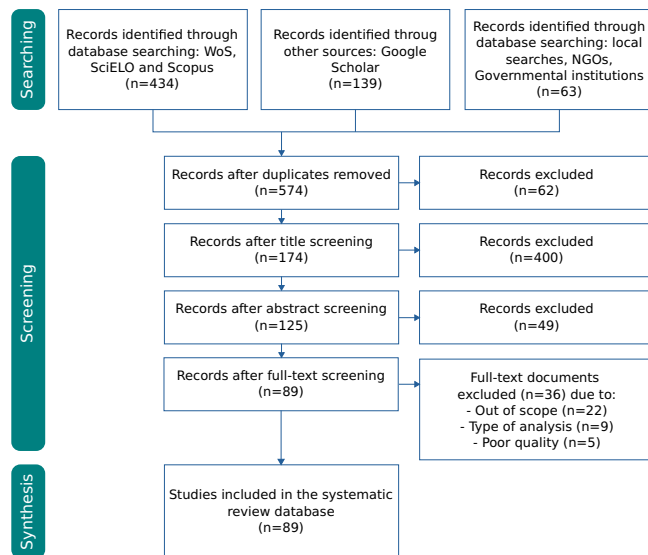


FIGURE 2 Flow diagram of the systematic literature review. Records excluded after full-text screening include “out of scope,” referring to deforestation and other land cover changes caused by processes unrelated to armed conflict; “type of analysis,” referring to studies in which there is no clear description of changes in land cover or deforestation or the sociopolitical variables related to the changes; and “poor quality” referring to studies in which methods or measures are not justified. WoS stands for Web of Science, SciELO for Scientific Electronic Library Online, and NGOs for nongovernmental organizations.

recorded details under specific categories: (i) headlines: population, intervention, comparator, outcome, research objectives, and main findings; (ii) spatial and temporal scales: municipality, department or country, study times, and duration; (iii) approach: bottom-up, top-down, and combination; (iv) discipline: environmental sciences, social science, or interdisciplinary; (v) definitions: deforestation and cover change; (vi) direction of relationship analyzed: forest/land cover changes resulting in socio-environmental transformations, socio-environmental transformations leading to forest losses or gains, and both directions; and (vii) socio-environmental transformations (see Methods S1 for more details). A template was created for the reviewers to fill in and facilitate information gathering during the third screening stage (see Dataset S1).

The studies included in the review comprise primary studies examining quantitative and qualitative changes in deforestation and other land cover dynamics in Colombia. We considered studies using *top-down* and *bottom-up* approaches from social and environmental perspectives. We excluded studies that associate land cover changes with processes unrelated to armed conflict, such as land transfers to peasants or multinationals, as they are outside the scope of this analysis. To assess the quality of studies that meet the inclusion criteria, we looked for those that could answer the following questions affirmatively: (i) Is there a clear description of land cover changes? (ii) Are sociopolitical variables directly related to the changes in land cover and deforestation rates? (iii) Are the outcome-assessment methods and measures justified?

3 | RESULTS

The literature search retrieved 636 records from WoS, SciELO, and Scopus; 139 from Google Scholar; and 63 from local searches, NGOs, and governmental institutions. After removing duplicates, 574 records remained in the database. Following a relevance selection at the title, abstract, and full-text screening stages, the final selection consisted of 89 documents (Dataset S2 and S3) that analyzed the relationships between socio-environmental variables and land cover changes in the context of the armed conflict in Colombia, published between 2010 and 2023 (Figure 2). Most of the studies were conducted at the national level (54%), followed by the regional (23%), departmental (11%), and municipal (7%) levels. Among the records that do not cover the entire country, the majority are focused on the Amazon (53%) and Andean (22%) regions; the remaining 25% of the studies are for the Pacific, Orinoquia, and Caribbean regions. National-level studies tended to identify the main direct drivers of land cover changes as agriculture, cattle ranching, land grabbing, infrastructure, illicit crops, mining and resource extraction, and fire. The indirect drivers included the presence of armed groups, policies and land recovery strategies, socio-economic conditions, protected areas, the international war on drugs, poverty, the COVID-19 pandemic, and lack of governance and services (Figure 3). Across all regions, cattle ranching and illicit crops are consistently identified as direct drivers, while the presence of armed groups acts as an indirect driver. Socio-economic conditions and land recovery strategies are recognized as indirect drivers, while agriculture is considered a direct driver, both at the national level and in four of five regions.

In terms of timing, 32 studies (34%) examined the problem before the Peace Agreement, 18 studies (20%) focused on the period after, and 41 studies (46%) compared both periods. Most studies (62%) explored how social-environmental transformations lead to forest loss or gain, while 25% investigated how changes in forest/land cover result in socio-environmental transformations. Ten percent of the studies analyzed both directions. Since the signing of the Peace Agreement, there has been a notable increase in research interest on the relationships between deforestation or changes in land cover and armed conflict (Figure 4a). The average number of publications per year in the 4 years preceding the signing (2012–2015) was two per year, while in the 4 years following it (2017–2020) was 11.3 publications per year, representing an increase of over 550%. Of these analyses, 31 studies (35%) were conducted from environmental disciplines, 19 studies (21%) from social disciplines, and 39 studies (44%) were classified as interdisciplinary (Figure 4b). Before the Peace Agreement, 60% of publications were in social sciences and 20% in environmental sciences. After the agreement, environmental sciences and interdisciplinary studies became predominant (Figure 4b). This shift reflects a growing interest in analyzing deforestation from interdisciplinary perspectives, with such studies increasing from virtually zero pre-agreement to an average of six publications per year after the signing of the Peace Agreement.

Fifty studies (56% of the total) employed *top-down* approaches, while only 10 studies (11%) used *bottom-up* approaches, and

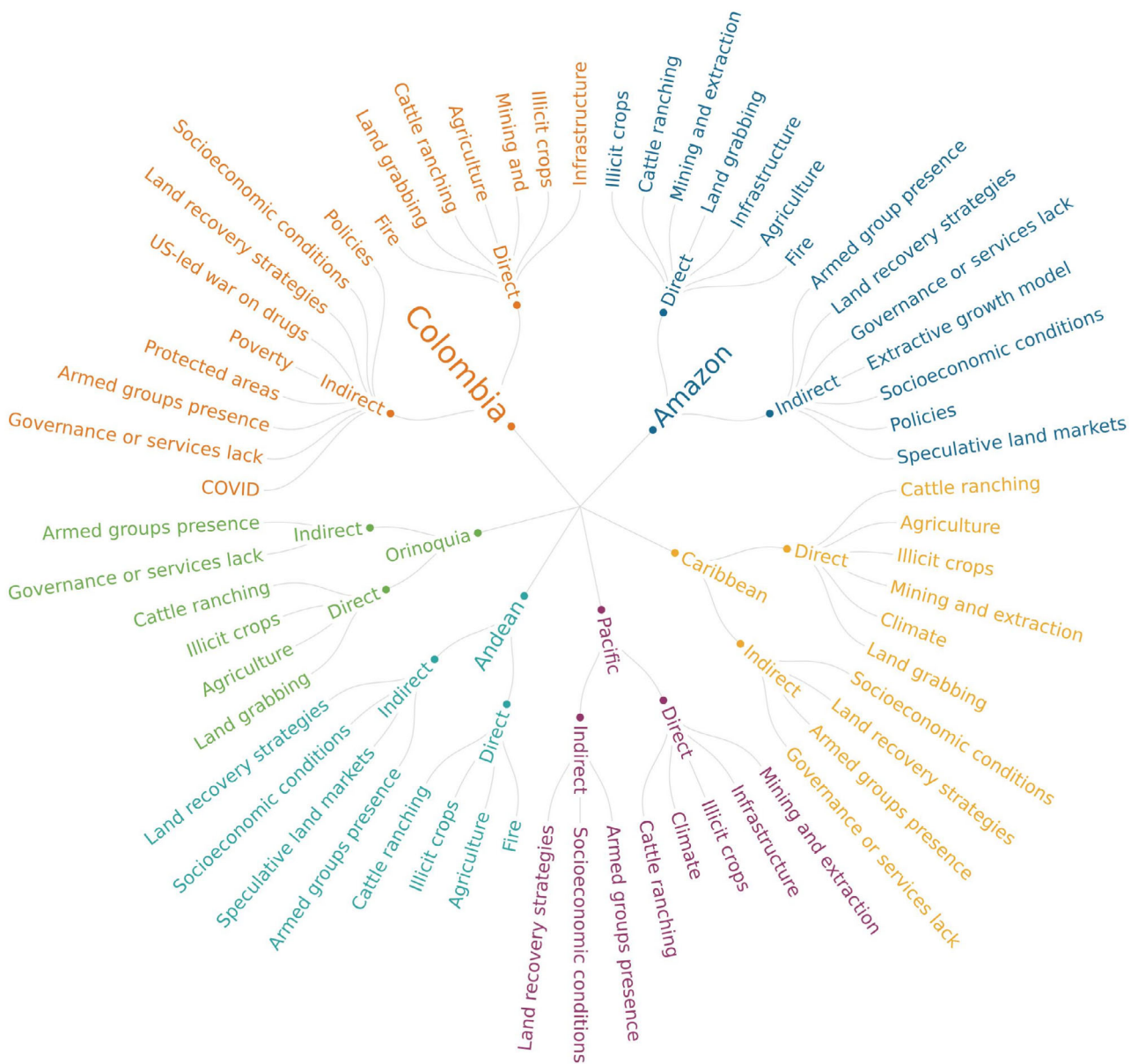


FIGURE 3 Direct and indirect drivers of land cover changes in Colombia by regions. Colors distinguish the country-level and each geographic region. The title's font size proportionally indicates the number of studies in each level, with the country-level being the most studied, followed by the Amazon, and the Pacific and Orinoquia regions being the least.

24 studies (27%) used a combination of both approaches (Figure 4c). Before the Peace Agreement, half of the publications combined *top-down* and *bottom-up* approaches. After the agreement, *top-down* methodologies became predominant, while *bottom-up* approaches increased only in social sciences, rising from zero publications between 2012 and 2016 to 1.7 per year after 2016 (Figure 4c). Of the 10 *bottom-up* publications identified, none were interdisciplinary, one was in environmental sciences, and nine were in social sciences, representing nearly half of all social sciences publications (Figure 4c). Although no *bottom-up* approaches were identified before the agreement, one study per year combining *bottom-up* and *top-down* approaches was published between 2012 and 2016, increasing to 3.2 per year after the signing.

3.1 | Study disciplines

Studies on land cover in Colombia exhibit distinct approaches based on academic disciplines. Social scientists generally provide a historical perspective, examining the diverse impacts of several armed groups on deforestation over time (Fergusson et al., 2014; Maher, 2015). In contrast, environmental scientists focus primarily on recent trends of deforestation, particularly those observed after the Peace Agreement (Forero Riaño & Polanco Puerta, 2021; Murillo-Sandoval et al., 2021). Interdisciplinary studies offer a balanced approach, combining historical context with analysis of recent dynamics to provide a more comprehensive understanding of deforestation patterns and their underlying causes (Arias-Gaviria et al., 2021; Cantillo & Garza, 2022;

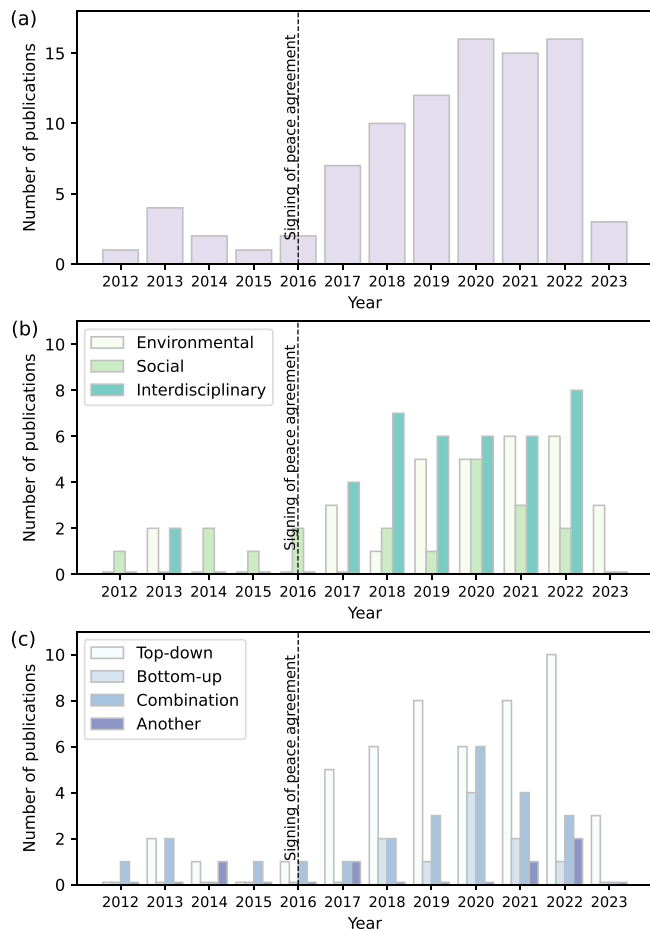


FIGURE 4 Number of publications per year, categorized by (a) total number, (b) discipline, and (c) approach. The vertical dotted lines indicate the year of the Peace Agreement signed between the Colombian Government and the Revolutionary Armed Forces of Colombia—People's Army (FARC-EP).

FIP & Adelphi, 2021). Research across the considered disciplines reveals an intricate interplay of social, economic, conflict-related, and environmental factors driving deforestation in Colombia (Fergusson et al., 2014; Ganzenmüller et al., 2022; Murillo-Sandoval et al., 2021; Negret et al., 2019). There is a consensus among disciplines that the primary factors of deforestation include cattle ranching, illicit crop cultivation (especially coca), land grabbing, mining activities, wildfires, and agricultural expansion (Castro-Nunez et al., 2017; Ceron et al., 2018; Davalos et al., 2021; ICG, 2021; Maher, 2015; Morales, 2017; Murillo-Sandoval, 2023; Olaya et al., 2022; Pérez-Rincón et al., 2022; Smith et al., 2014; Tebbutt et al., 2021). These direct causes are further exacerbated by indirect drivers such as armed conflict, migration, lack of effective governance, speculation, inequality, and poverty (Botero-García et al., 2019; Herrera Arango et al., 2018; Hoffmann et al., 2018; Olaya et al., 2022). Social studies emphasize social, economic, and political factors driving deforestation, providing nuanced insights into the impact of armed groups and diverse stakeholder perspectives. For instance, studies by Graser et al. (2020) and Tebbutt et al. (2021) reveal varying stakeholder opinions on the relationships

between ranching, roads, and illicit crops in Amazonian protected areas, and their effects on wildfires—a major cause of deforestation. Pedraza Jiménez and Guerra (2019) argue that both legal and illegal activities commodify nature and threaten ecosystems under the premise of economic necessity, often victimizing civil society members who oppose these activities. In contrast, environmental sciences focus on quantitative data and specific environmental impacts. Murillo-Sandoval et al. (2021) reported a 40% loss of stable forest cover in the Andes–Amazon region from 2012 to 2019. Clerici et al. (2020) found that protected areas, including national parks, have been severely impacted by illegal deforestation since the Peace Agreement. Forero Riaño and Polanco Puerta (2021) noted an alarming 1176% increase in deforestation rates within the National Natural Park Tinigua after the Peace Agreement, compared with pre-agreement levels, resulting in a loss of 25% of its protected forests within just 4 years (2018–2021). Armenteras et al. (2018) concluded that fires increased sixfold in Colombia's biodiversity hotspots following FARC-EP's demobilization, with a 50% rise in deforestation probability in 2018.

Interdisciplinary studies have offered broad perspectives, incorporating elements from both social and environmental sciences (Arias-Gaviria et al., 2021). For example, Rincón-Ruiz and Kallis (2013) found that government efforts to contain coca production, particularly through fumigation with herbicides, have inadvertently displaced coca crops to new regions, often including primary forests of high environmental significance and disproportionately affecting indigenous and Afro-Colombian communities. The studies by Suarez et al. (2018), Camargo et al. (2020), Moreno et al. (2020), and Krause et al. (2022) indicate that the resulting homogeneous agricultural landscapes, combined with resurgent armed groups competing for control over mineral and drug markets, increase community vulnerability and pose obstacles to environmental protection and sustainable peace. Guerrero-Pineda et al. (2022) projected that continued agricultural expansion could lead to a 35% to 52% increase in biodiversity loss by 2033, exacerbating the current situation where 45% of Colombia's endemic trees and shrubs are at risk of extinction, highlighting the urgent need for increased conservation efforts.

Across disciplines, researchers recognize the significant impact of armed conflict on deforestation, with the 2016 Peace Agreement making a critical turning point that led to increased deforestation rates (Murillo-Sandoval et al., 2020; Negret et al., 2019; Suarez et al., 2018). Social studies by Fergusson et al. (2014), Maher (2015), and Van Dexter and Visseren-Hamakers (2020) highlight the complex effects of armed groups on forest conservation, noting that while paramilitary factions historically diminished forest cover through displacement and illicit activities, FARC-EP's presence sometimes inadvertently contributed to conservation efforts. Social studies have identified the Peace Agreement as an opportunity to implement new strategies against deforestation (Díaz et al., 2016). However, as mentioned by Van Dexter and Visseren-Hamakers (2020), the state's failure to fulfill its promises and the imposition of inefficient agribusiness models have instead led to increased deforestation rates. This situation has forced peasants to clear land for cattle ranching, coca cultivation, and other agricultural alternatives as their only economic options. Le Billon et al. (2020) argue

that the prioritization of large-scale agricultural reforms over local farming practices has left many rural communities with limited development opportunities, worsening environmental degradation and socio-economic vulnerabilities. Van Dexter and Ingalls (2022) indicate that the push for agro-industrial development under the banner “territorial peace” has disrupted local communities and consolidated control through agro-technologies. Despite the emergence of initiatives aimed at reducing deforestation through financial incentives, such as *Reducing Emissions from Deforestation and Forest Degradation (REDD)* Early Movers, REDD+, and *Visión Amazonia*, these programs have not fully achieved their goals. Furumo and Lambin (2020) identify overlaps in governance areas, including domestic policy and sustainable supply chains, as contributing factors to their limited success. Krause (2020), Rodríguez de Francisco et al. (2021), and Krause et al. (2022) attribute this failure to the initiatives' focus on peasants and indigenous communities while neglecting influential political actors, large landowners, and cattle ranchers. Additionally, these programs often overlook larger structural issues, such as global market demands for agricultural products, oil, minerals, and coca, which play a significant role in driving deforestation.

Environmental studies have documented a significant rise in deforestation rates within protected areas following the Peace Agreement (Murillo-Sandoval et al., 2021, 2023; Quiroga Angel et al. 2022). These studies attribute this surge primarily to the re-emergence of previously suppressed agricultural expansion opportunities in formerly armed conflict-controlled regions, with forests being converted into cattle pastures and illegal coca cultivation. Besides, they emphasize the lack of state control in addressing the socio-economic forces behind forest loss. Salazar et al. (2022) point out that the government transition in 2018 coincided with worsening socio-economic, security, and environmental conditions, potentially exacerbating negative environmental outcomes. In response to escalating deforestation in protected areas, the 2018–2022 Colombian government launched “Operation Artemisa” in 2019, a controversial large-scale military intervention that led to detentions, infrastructure destruction, and material confiscation used for illegal deforestation and logging (MADS, 2022; Mongabay, 2022). While this operation achieved some short-term reductions in deforestation rates (MADS, 2022), Rodríguez de Francisco et al. (2021) acknowledged that it failed to address the underlying social drivers of forest loss. Environmental studies uniquely provide detailed quantitative data on the increased deforestation in protected areas post-Peace Agreement, offering a crucial perspective on the scale of this environmental challenge.

Interdisciplinary studies offer a more nuanced perspective of deforestation in Colombia, emphasizing that the impact of conflict depends on local context, time, and location (Amador-Jimenez et al., 2024; Arias-Gaviria et al., 2021; Bautista-Cespedes et al., 2021; Cantillo & Garza, 2022; FIP & Adelphi, 2021; Moreno et al., 2020; Rincón Ruiz et al., 2013). Castro-Nunez et al. (2017) and Morales (2017) reveal the dual role of coca cultivation and mining, which contribute to forest loss while also funding insurgent groups linked to deforestation. Suarez et al. (2018), Rios et al. (2022), and FIP and Adelphi (2021) suggest that the factors driving deforestation associated with armed conflict have not only led to environmental

degradation but also increased violence against local communities and environmental defenders, particularly in the Amazon. Notably, interdisciplinary research by Negret et al. (2019) and Moreno et al. (2020) uniquely highlights that Indigenous territories have shown greater resilience to deforestation. Their results reveal that Indigenous reserves experience lower deforestation rates compared with other areas. Specifically, the deforestation rate per unit area in Indigenous reservations (0.28%) is lower than in National Natural Parks (0.47%) and 2.6 times lower than in their surrounding areas of influence.

Social studies on deforestation and environmental degradation in Colombia highlight the need to balance economic development and conservation. These studies also identify tensions between international conservation pressures and demands for domestic resource extraction (Krause, 2020) intensified by the post-conflict transition, conflicting with extractive economic models (Graser et al., 2020; Pérez-Rincón et al., 2022; Smith et al., 2014). Community-based approaches employing *bottom-up* strategies are emphasized to integrate conflict victims into conservation agriculture (Ojeda, 2012; Suarez et al., 2018), such as the “Working with People” model in La Macarena region, which involves local populations in designing alternative development projects to replace illicit crops (Ceron et al., 2018). Preserving Amazonian agrobiodiversity is explored as a form of resistance against violence and the imposition of capitalist-oriented development that threatens their soils, seeds, crops, and overall agrobiodiversity (Lyons, 2015). Strengthening law enforcement and sanctions is deemed essential to control illegal land grabbing, driving post-conflict deforestation (Furumo & Lambin, 2020). Both social and interdisciplinary studies underline the importance of state intervention and institutional strengthening in addressing deforestation in Colombia (Furumo & Lambin, 2020; Olaya et al., 2022). Díaz et al. (2016) suggest that effective state intervention could potentially save 7.1 billion pesos (~1,700,000 USD) annually through environmental benefits. Salazar et al. (2018), Garcia Corrales et al. (2019), and Olaya et al. (2022) advocate for strengthening local institutions and increasing state presence in remote regions, as it is crucial for regulating natural resources use and preventing further deforestation, particularly as much of the deforestation in Colombia occurs on state-owned land. Interdisciplinary studies also encourage the regeneration of deforested areas, implementation of regenerative agricultural practices, and promotion of agricultural and livestock production methods that coexist with biodiversity conservation (Baptiste et al., 2017; Guerrero-Pineda et al., 2022; Moreno et al., 2020). These studies also emphasize the importance of implementing land distribution schemes to reduce land concentration, a challenge associated with severe inequalities and rural poverty outlined in the Peace Agreement, and stress the need to address the root economic causes of deforestation (Borrero Morales, 2017).

3.2 | Analysis approaches

Both *top-down* and *bottom-up* approaches recognize the complex interplay of factors driving deforestation in Colombia, including social,

economic, and environmental aspects, and highlight the significant impact of the 2016 Peace Agreement on deforestation patterns (Graser et al., 2020; Murillo-Sandoval et al., 2020, 2023; Tebbutt et al., 2021). Cattle ranching and agricultural expansion are consistently identified as major drivers of deforestation, acknowledging the role of coca cultivation (Rodríguez de Francisco et al., 2021; Tebbutt et al., 2021). Furthermore, there is a consensus on the challenges in implementing effective conservation strategies and governance in the post-agreement period (Cantillo & Garza, 2022; Mendoza, 2020; Suarez et al., 2018; Van Dexter & Visseren-Hamakers, 2020). The main distinction between *bottom-up* and *top-down* approaches often aligns with the disciplinary focus of the analyses. Social studies tend to employ *bottom-up* approaches, while environmental studies typically use *top-down* methods. This is reflected in the reviewed results, which show that 9 out of 10 identified *bottom-up* publications were in social sciences studies (Figure 4c).

Bottom-up approach studies, such as those by Suarez et al. (2018) and Graser et al. (2020), focus on local community perspectives, grassroots initiatives, and local solutions like silvopastoral systems. In contrast, *top-down* approaches emphasize quantitative analyses through remote sensing techniques and large-scale policy impacts, stressing the need for effective governance and conservation strategies without specifying particular solutions (Clerici et al., 2020). It's worth noting that the definition of *bottom-up* differs between social and environmental sciences (see Section 1.1), resulting in most identified bottom-up studies concentrating on local community engagement and participation.

Following the Peace Agreement, both approaches have provided insights into the changing dynamics of deforestation. *Bottom-up* research by Graser et al. (2020) highlights increased threats to social-environmental leaders (see fig. 1 in Global Witness, 2023) despite some improvements in physical security and economic interest. *Top-down* studies offer more detailed analyses of landscape connectivity and protected areas. Studies such as those by Borrero Morales (2017), Fagua et al. (2019), Negret et al. (2019), Bautista-Céspedes et al. (2021), Quiroga Angel et al. (2022), and Murillo-Sandoval (2023) have identified road improvement, the transition from coca crops to commercial agriculture, and the expansion of the agricultural frontier as factors contributing to increased deforestation after the Peace Agreement. Although coca cultivation was found to be the strongest predictor of annual deforestation rates by Negret et al. (2019) and Quiroga Angel et al. (2022), after the Peace Agreement, Borrero Morales (2017), Mendoza (2020), and Murillo-Sandoval et al. (2023) suggest that other licit economic activities, such as agricultural expansion, may be the most significant drivers of forest loss. These deforestation patterns have broader implications, impacting landscape connectivity and challenging the conservation goals of Colombia's National System of Protected Areas (SINAP, for its abbreviation in Spanish). Recent quantitative analyses have focused on changes in landscape connectivity, examining how deforestation alters the landscape's capacity to facilitate biological corridors, support key ecological processes, and maintain gene flow. For example, in the Andes-Amazon Transition Belt, Murillo-Sandoval et al. (2022) identified a significant loss of connected

habitat between 2000 and 2020, exceeding the loss of available habitat. This has resulted in greater fragmentation and isolation of forest patches, increasing the cost of species movement in the transition zone between the Andes and Amazon biogeographical regions. Similarly, Clerici et al. (2020) identified the conservation and restoration of the Picachos-Tinigua-Macarena-Chiribiquete biological megacorridor, which links the Andes and Amazon biogeographical regions, as crucial for preserving species dispersal and biodiversity.

Regarding government initiatives, *bottom-up* studies such as those by Van Dexter and Visseren-Hamakers (2020) and Rodríguez de Francisco et al. (2021) have raised concerns about programs like REDD Early Movers, suggesting they overlook large-scale drivers of deforestation. Suarez et al. (2018) identified that victims of conflict are willing to participate in Land Recovery Strategies by sharing local ecological knowledge and providing manual labor, although they would prefer monetary compensation for their involvement. Graser et al. (2020) mentioned that affected communities have proposed alternative production systems to reduce deforestation, such as implementing silvopastoral systems and intensifying cattle production rather than further expansion. Suarez et al. (2018) suggested that these types of solutions may incorporate strategies to increase and improve employment opportunities for those directly impacted by the armed conflict, addressing both environmental and socio-economic concerns in affected regions. *Top-down* approaches have highlighted that deforestation in Colombia has historically involved protected areas. For example, Clerici et al. (2020) have shown that Colombian natural parks experienced a 177% rise in deforestation rates following the Peace Agreement, emphasizing the need for enhanced institutional capacity to ensure effective conservation. Furthermore, remote sensing techniques, as a *top-down approach*, are commonly employed to evaluate the impact of the Peace Agreement, a social-based *top-down* initiative, on land use changes and deforestation patterns in Colombia (Armenteras et al., 2018; Liévano-Latorre et al., 2021; Murillo-Sandoval et al., 2021).

4 | TOWARDS AN INTEGRATIVE PERSPECTIVE

Research examining how land cover changes relate to armed conflict in Colombia has increased notably since the 2016 Peace Agreement. Studies have predominantly focused on national-level analyses, with Amazon and Andean regions receiving more attention than the other regions. This emphasis is likely a result of these regions experiencing the greatest forest loss and being recognized as critical biodiversity hotspots with far-reaching ecological and climatic consequences (Rodríguez de Francisco et al., 2021). However, such research bias may influence policy-making and funding priorities, risking the neglect of other important but less-studied regions (Mejía-Rentería et al., 2018). Expanding social and environmental research in these less-studied areas of Colombia could be essential to achieve a more comprehensive understanding of land cover change and design effective solutions.

Since the 2016 Peace Agreement, studies on land cover changes and armed conflict have shown a shift toward interdisciplinary and environmental science perspectives (Figure 4a,b). Methodologically, recent research trends show a predominance of *top-down* approaches, especially in environmental sciences, while *bottom-up* methods have slightly increased, but remain limited to social sciences (Figure 4b,c). This imbalance, particularly evident between 2012 and 2023, suggests a gap in incorporating local knowledge and practices into policy recommendations on deforestation. Out of 89 reviewed documents, 16 employed a multidisciplinary perspective using elements from both *top-down* and *bottom-up* approaches. Notably, only two of these integrative studies were conducted before the Peace Agreement, indicating a growing recognition of the need for more comprehensive analyses. However, such integrated approaches remain in the minority, underlining the need for more research that incorporates diverse scientific knowledge and methodologies to fully understand the complex relationship between deforestation and conflict in Colombia. Bottom-up approaches could enrich biological and environmental data collected remotely, while fostering collaborations between scientists—from both environmental and social sciences—and local communities. One example is the use of camera traps to monitor biodiversity, including in the understory, which is difficult or impossible to assess with unmanned aerial vehicles (UAV), particularly via citizen science initiatives (Terán-Sánchez et al., 2021). Similar approaches could be used for monitoring species and their relationships with the environment via e-DNA (Marín et al., 2024) or gathering indicators of soil health not detectable by UAV, such as decomposition and stabilization rates via the Tea Bag Index (Middelani et al., 2023).

In addressing the two specific questions of this study, complementary responses emerged from the different disciplines and approaches.

Figure 5 summarizes the socio-environmental transformations found in the studies we reviewed. It is divided into transformations that led to an increase in forest loss after the Peace Agreement (Figure 5a), and transformations in the context of the implementation of the Peace Agreement that have fostered or prevented land changes (Figure 5b). Each panel illustrates transformations identified from social, environmental, and interdisciplinary perspectives, with overlapping areas representing transformations recognized by multiple disciplines. Only nine studies evaluated both the socio-environmental transformation resulting from increased post-agreement deforestation and the socio-environmental transformation causing changes in deforestation patterns (Arias-Gaviria et al., 2021; FIP & Adelphi, 2021; Hein et al., 2020; ICG, 2021; Le Billon et al., 2020; Martin & Pedraza, 2022; Moreno et al., 2020; Pérez-Rincón et al., 2022; Van Dexter & Visseren-Hamakers, 2020). These were primarily intradisciplinary, and none were purely environmental. Twenty studies focused on the first question, only from environmental (e.g., Agudelo-Hz et al., 2023; Sierra et al., 2017; Unda & Etter, 2019) and interdisciplinary (e.g., Bautista-Céspedes et al., 2021; Canavire-Bacarrea et al., 2018; Ganzenmüller et al., 2022) perspectives and mainly using *top-down* approaches. Fifty-five studies addressed the second question across all combinations of approaches and disciplines (e.g., Anaya et al., 2020; Murillo-Sandoval et al., 2021; Quiroga Angel et al., 2022).

The findings reveal a consensus across disciplines that increased deforestation negatively impacted the efficient distribution of economic development and ecosystem services, with interdisciplinary studies uniquely highlighting land conflicts and positive transformations like regenerative livestock practices, conservation efforts, and limitations of mining titles (Figure 5a). All disciplines identified common factors modifying deforestation dynamics as a result of the Peace

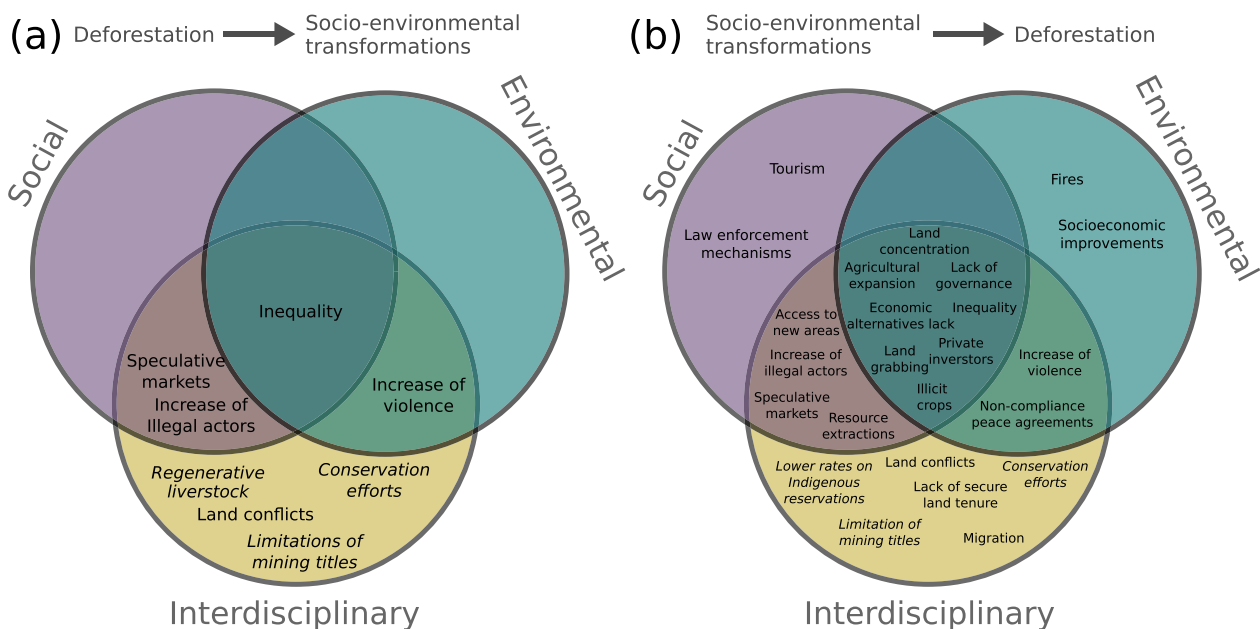


FIGURE 5 Compilation of the (a) socio-environmental transformations resulting from increased deforestation and (b) socio-environmental transformations either fostering or preventing deforestation following the Peace Agreement in Colombia, according to the different discipline perspectives. Overlapping areas represent transformations recognized by multiple disciplines.

Agreement, such as agricultural expansion, lack of governance and economic alternatives, inequality, land grabbing, and the rise in illicit crops. However, certain factors were discipline-specific: Social studies uniquely identified tourism and law enforcement mechanisms; environmental studies highlighted fires and socio-economic changes; and interdisciplinary research recognized land conflicts, migration, and lower deforestation rates on indigenous reserves (Figure 5b). Importantly, many socio-economic factors appeared as both consequences and drivers of deforestation (Figure 5a,b), indicating a complex feedback loop that complicates analyses and the finding of solutions. For example, inequality plays a central role: Large landowners and illicit actors expand agricultural and cattle ranching frontiers through deforestation to consolidate wealth and control, often displacing Indigenous and peasant communities and deepening social and economic exclusion. At the same time, deforestation reduces local livelihoods and weakens governance, further entrenching inequalities and limiting opportunities for marginalized groups (Salazar et al., 2022; Sánchez García & Wong, 2024).

Our review reveals several significant socio-environmental transformations in post-conflict Colombia. The ceasefire and demobilization of FARC-EP led to increased deforestation by legal and illegal entities, causing substantial environmental damage in previously protected areas (ICG, 2021). This environmental degradation is closely linked to new forms of violence, particularly against local communities, social leaders, and environmental defenders in the Colombian Amazon (FIP & Adelphi, 2021). Conservation strategies have shifted, with some regions implementing nature conservation measures and sustainable farming practices. Social perceptions have also changed, with peasants now often viewed as environmental threats, while indigenous communities are seen as environmental stewards. These shifts have impacted land rights and social dynamics, creating new opportunities for some groups while challenging others' property rights. New armed actors are using local authorities such as "Juntas de Acción Comunal" (JACs) as the most efficient way to establish order, further complicating land governance in former conflict zones (Hein et al., 2020).

Among the main identified factors promoting deforestation is the power vacuum left by FARC-EP's withdrawal, leading to increased illegal activities and land grabbing (ICG, 2021). The expectation of favorable land tenure policies has fueled speculative land markets, while weak governance and limited institutional resources have hindered efforts to curb forest loss (FIP & Adelphi, 2021; ICG, 2021; Murillo-Sandoval et al., 2020; Olaya et al., 2022). The prevailing economic model favoring large-scale monocultures and extensive cattle ranching has also contributed significantly to deforestation (Herrera Arango et al., 2018; Murillo-Sandoval et al., 2020). Conversely, some factors have helped prevent forest loss. Indigenous reserves have shown slower deforestation rates, presenting opportunities for sustainable biodiversity initiatives (Moreno et al., 2020). The peace process has brought increased national and international attention to environmental issues, potentially leading to more conservation efforts. The post-conflict scenario offers opportunities for implementing sustainable land use interventions at the regional level, while an increased focus

on environmental education could help prevent deforestation in the long term (Agudelo-Hz et al., 2023; Moreno et al., 2020).

Future pathways to comprehensively address land cover change, particularly deforestation, in contexts shaped by armed conflict and deep-rooted social inequalities require research and policy frameworks that bridge both *top-down* and *bottom-up* approaches and integrate multiple disciplines. These pathways include integrative strategies that combine remote sensing and national monitoring systems with community-driven local data collection. The use of emerging technologies such as AI and machine learning could serve as bridges, linking local knowledge with large-scale monitoring while enhancing the traceability and practical use of environmental alerts by government authorities. Essential to this is establishing feedback loops that ensure communities see their contributions reflected in formal monitoring and policy actions, preventing disconnection and disillusionment. Furthermore, creating mechanisms to ensure continuous information flow across local, regional, and national levels, alongside sustained partnerships among communities, academic institutions, and state actors, will be critical for effective environmental governance and peacebuilding.

The complex interplay of socio-economic factors, governance challenges, and land tenure issues that have either fostered or hindered deforestation in Colombia's post-conflict context underscores the need for comprehensive, multifaceted strategies addressing these drivers. Environmental research benefits greatly from incorporating diverse perspectives, emphasizing the value of integrating social, political, and ecological viewpoints in studying environmental issues. By fostering these interdisciplinary connections and bridging various knowledge systems, an integrative approach holds the potential not only to deepen our understanding of the intricate links between deforestation, conflict, and social conditions but also to establish durable solutions that align ecological restoration with social justice.

5 | KEY REMARKS AND IMPLICATIONS FOR SOCIETY AND POLICY

Arguably, the most complex socio-economic and environmental challenge of Colombia since the mid-2000s has been and continues to be the armed conflict. The so-called "Total Peace," a term that summarizes the attempts of the current government (2022–2026) to negotiate peace deals with all actors involved in the armed conflict, has produced few results and has, on the other hand, further slowed down the implementation of the Peace Agreement signed with FARC-EP in 2016. The ongoing deterioration of safety conditions has immeasurable consequences on the environment, the most notorious and tragic being that Colombia continues to be the most deadly country for land and environmental defenders (Global Witness, 2023). In this complex context, strengthening governance at the regional and local levels is essential to improve forest management and law enforcement. Regional cooperation with neighboring countries, especially within shared ecosystems like the Amazon and Andes, is also vital for coordinated conservation and sustainable development.

Colombia is a well-researched case in the study of relationships between armed conflicts, peace agreements, and nature, with a widespread landscape of both nationally and internationally driven studies (e.g., Clerici et al., 2019; Liévano-Latorre et al., 2021; Murillo-Sandoval et al., 2022; Prem et al., 2020). The products of this research have had consequences at the national political level and may be valuable for other societies currently experiencing armed conflict. In 2022, Colombian voters elected a government highly vocal on environmental and peace-related issues. In 2024, the COP16 summit on the Convention of Biological Diversity (CBD) in Cali, Colombia, initiated widespread mobilization among civil society organizations as well as an increased perception of Colombia on the international scene. Moreover, in October 2024, Colombia took over the secretariat of the Amazon Cooperation Treaty Organization. The awareness provided by scientific research (and journalism), as well as a global momentum on environmental activism, could have contributed to that outcome.

Some decisions of the Petro government (2022–2026) could hardly be conceived without the knowledge generated by years of top-down monitoring of forest cover and other environment-related variables, as well as by social and environmental *bottom-up* studies, including those with Indigenous communities' participation. One example of such decisions is the recent signing of a law that recognizes the crucial role that Indigenous communities have had for decades in the protection of nature (Hernández Marentes et al., 2022) and grants environmental powers to their authorities (MADS, 2024). The approval and effectiveness of such a law remain to be observed, but in general, it could serve as an example of the impact that long-term interdisciplinary scientific efforts can have on policy and society. Moreover, the adoption of a revised work program for Article 8j of the CBD, the establishment of a permanent subsidiary body for Indigenous groups as well, and the acceptance of people of Afro-descendant as their statutory group are successful at the COP16 in Cali in 2024 are closely linked to scientific studies in combination with strong lobbying.

Understanding the dynamics of ecosystems, beyond their abiotic and biotic boundaries, biological richness, and vulnerabilities to stressors and environmental change, is a must if we want to optimize social/human relationships with the environment (including the production of wealth in sustainable and socially responsible manners) and prepare for the changing climates now and in the future. For this, societies have the opportunity to prioritize how they spend their limited resources. In Colombia, national governments have historically dedicated less than 0.5% of Gross Domestic Expenditure on Research and Development (GERD), that is, less than half the GERD invested by neighboring countries like Brazil. In 2023, the current government increased this expenditure to almost 1%, but the decision was quickly reversed, and in 2024, the Colombian GERD returned to below 0.5%. This pattern reflects that investing in science has never been a political priority in Colombia. As the country moves forward, voters and politicians will continue to have the opportunity to reassess and potentially change this approach, recognizing the critical role of scientific investment in addressing environmental challenges and promoting sustainable development.

6 | CONCLUSIONS

Our literature review on the effects of armed conflict and the signing of the Peace Agreement on deforestation in Colombia, led us to the following conclusions:

1. There is increasing interest from both the environmental and social sciences in understanding how the armed conflict and the Peace Agreement signed between the Colombian government and the FARC-EP have shaped deforestation and environmental degradation in Colombia. The number of studies and publications on this topic has increased tremendously in recent years. While environmental sciences tend to use mostly *top-down* monitoring approaches, social sciences tend to use *bottom-up* approaches, gathering information directly from communities, policymakers, and environmental groups. There is also an increase in interdisciplinary studies combining both *top-down* and *bottom-up* methods, which shows the importance of holistic approaches in addressing the complex interrelations of social and environmental factors leading to deforestation.
2. It is now well established, through multiple methodological approaches, that the signing of the Peace Agreement in 2016 led to a significant increase in deforestation and environmental degradation in Colombia. Although studies have focused mostly on the Andes and Amazon regions, deforestation and environmental degradation are also documented in other areas, such as the Chocó and the Caribbean regions. Greater attention is needed for these and other less-studied areas that hold high ecological importance.
3. The underlying causes of deforestation and environmental degradation are diverse, but there is a general agreement among many previously published studies that the power vacuum left by armed actors after their abandonment of many regions was not properly filled by the State, leading to uncontrolled forest loss and degradation. Reactionary measures by the State, such as armed operations in conflictive deforestation zones, did not have major success in stopping deforestation; on the contrary, it has led to major problems regarding human rights and the safety of environmental activists.
4. Although many factors contributing to deforestation in Colombia are local, external factors such as the international demand for gold and cocaine continue to be key drivers for forest clearing and social conflict. Several previous studies report the failure of international aid programs to combat deforestation in Colombia, which suggests that traditional support programs to local farmers for alternative crop cultivation and forest conservation may not be as effective as long as international demand for resources from these regions continues to exist. In contrast, Indigenous communities have often demonstrated greater success in protecting forests and biodiversity, highlighting the need to better understand the social, cultural, and governance factors behind these achievements.

Our analysis of the armed and social conflict in Colombia may seem unique for this country. However, we believe that the social,

economic, political, and environmental interactions may offer important insights for other countries. As the world now enters a stage of increased polarization and conflict in many regions, we believe that the Colombian conflict may serve as an important case study for the understanding of the dynamics between armed conflict and environmental conservation in other parts of the world.

AUTHOR CONTRIBUTIONS

All authors conceived the ideas during the workshop “Environmental Change due to Socio-Economic Change. How can we explain the linkages between natural and political systems in the context of rapid socioeconomic change?” E. Muñoz and S. Botía led the review and manuscript writing. Estefanía Muñoz, Santiago Botía, Jesús A. Anaya, Nicola Clerici, Lina M. Estupinan-Suarez, Carlos A. Sierra, Andrés Tangarife-Escobar, and Alejandro Salazar conducted the literature review. Estefanía Muñoz, Santiago Botía, Jesús A. Anaya, Lina M. Estupinan-Suarez, Isabel Lopera, Solveig Richter, Carlos A. Sierra, Andrés Tangarife-Escobar, and Alejandro Salazar wrote the initial draft. All authors contributed critically to the drafts and gave final approval for publication.

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CONFLICT OF INTEREST STATEMENT

We (all coauthors) have no competing interests to declare.

DATA AVAILABILITY STATEMENT

We provide our collated data in Datasets S1–S3 and the review protocol in Methods S1.

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