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Report on underlying drivers of deforestation in Colombia



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In the frame of AgriLAC resiliente, a framework to integrate climate change mitigation priorities (through low emission food systems) and development priorities will be developed. To inform the development of this framework, a non-systematic literature review has been carried out in order to understand the underlying causes of deforestation in Colombia, and how they can be linked to the food systems dimensions. This report presents the main findings of the literature reviewed.

Methods

A non-systematic literature review on underlying drivers of deforestation in Colombia was carried out to identify the most important underlying drivers mentioned in the literature. The articles were obtained through two searches. One in Scopus database using a combination of the following keywords in abstract, title, or keywords: : *deforestation, forest loss, forest cover change, agricultural frontier; driver, cause, factor, force, agent; underlying, indirect; demographic, economic, technology, policy/political, institution and social, Colombia*. The second search was conducted in the Scielo database using the Spanish version of the words abovementioned. Additionally, 9 articles that were not yielded, but the authors were aware of, were included in the final database. We include peer review articles, book chapters and reports in this review. We then reviewed the titles of the resulting 140 articles to ensure that they were relevant to the main topic of the search. This process reduced our database number to 55.

We then retrieved the full documents to ensure they included information on underlying drivers of deforestation in Colombia. After this process, we have 32 articles that have been thoroughly reviewed (figure 1).

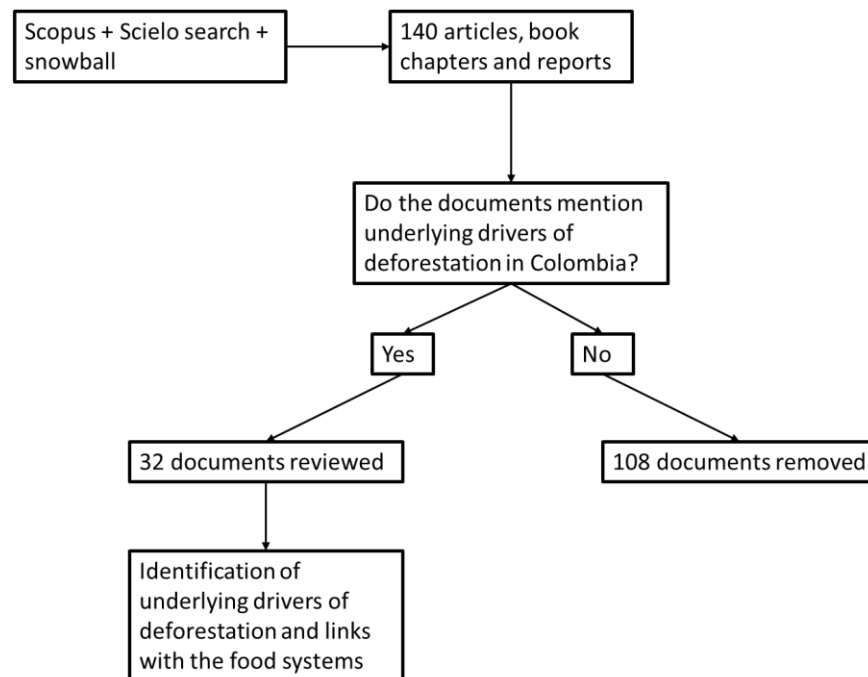


Figure 1. methodological scheme

Drivers classification

We followed the framework proposed in the study on "Global and regional analysis of underlying drivers of deforestation" for classifying the underlying drivers of deforestation. This framework proposes an adaptation to the framework from Geist and Lambin (2002) in order to better understand how drivers of deforestation can affect or are affected by the food systems. The framework consists of three dimensions of the food system, one dimension not related to food systems and 15 categories for the underlying drivers.

- Demand / consumer
 - Population and development changes
 - Price changes
 - Public attitudes, values, beliefs towards forests/nature
 - Consumers' income
 - Growing attention paid to diet
 - Growing concern for food safety
- Production / supply
 - Poverty-related factors
 - Access to infrastructure
 - Environmental factors
 - Technological innovation
 - Wood sector related drivers
- Trade / distribution
 - Market-related changes
 - Trade-related factors
 - Private and foreign public investments
- Policies not related to trade
 - Policies and land-related issues

Two additional categories were added to the dimension of Policies not related to trade to better reflect the Colombian context and placed under the policies not related to trade dimension:

- Armed conflict
- Antidrug policy

Results

The underlying drivers of deforestation most mentioned in the literature reviewed correspond to: (1) population and development changes (18 documents); (2) policies and land-related issues (19 documents); (3) armed conflict (17 documents); (4) access to infrastructure (13 documents); (5) environmental factors (12 documents). Table 1 summarizes the documents reviewed by providing additional information, regarding the number of articles per category, and the indicators used in the literature.

Table 1. Underlying drivers of deforestation in Colombia identified through the non- systematic literature review.

| Food system dimension | Underlying drivers | # Of documents | % Quantitative or GIS | Example of indicators used in the literature |
|-----------------------|----------------------------------------------------------|----------------|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Demand / Consumer | Population and development changes | 18 | 72% | Population displacement/migration (Dávalos et al., 2016), Population growth rates (Fagua et al., 2019), number of inhabitants (Armenteras et al., 2013), urban and rural population density (Cantillo & Garza, 2022). |
| | Price Changes | 2 | 50% | Land price (Ruiz et al., 2011). |
| | Public attitudes, values, beliefs towards forests/nature | 2 | 100% | Motivations to protect forests, measures of motivation (Rueda et. al., 2019) |
| | Consumers' income | 0 | NA | NA |
| | Growing attention paid to diet | 0 | NA | NA |
| | Growing concerns for food safety | 1 | 100% | Cultivated land and crop type (Ramirez et al., 2011) |
| Production / supply | Poverty related factors | 9 | 66% | Lack of environmental education (Hoffmann, et al., 2018), lack of alternatives (Hoffmann, et al., 2018), unsatisfied basic need (Armenteras, et al., 2013), income (GDP) (Cantillo & Garza 2022), multidimensional poverty (NBI) (Cantillo & Garza 2022). |
| | Access to infrastructure | 13 | 84% | Paved and unpaved roads (Fagua, et al., 2019), river density (Fagua, et al., 2019), distance to development and colonization projects (km) (Davalos, et al., 2016), distance to settlements (Chadid, et al., 2015), distance to rivers (Negret, et al., 2019). |

| | | | | |
|--------------------------------------|-----------------------------------------------|----|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| | Environmental factors | 12 | 91% | Mean of topographic slope (Fagua, et al., 2019), standard deviation of altitude (Fagua, et al., 2019), mean annual precipitation (Fagua, et al., 2019), mean annual temperature (Fagua, et al., 2019), slope (Etter & McAlpine, 2007), annual precipitation (Armenteras et al., 2013), water scarcity in dry years (Armenteras et al., 2013), soil fertility (Etter & McAlpine, 2007), moisture availability index (Etter & McAlpine, 2007). |
| | Technological innovation | 0 | NA | NA |
| | Wood sector related drivers | 3 | 66% | Tree felling (Arias- Gaviria, et al., 2021) |
| Trade / distribution | Market related changes | 2 | 50% | International and national market price (Arias-Gaviria, et al., 2021) |
| | Trade related factors | 3 | 66% | Quantity of imports and exports of palm oil (Furumo & Aide, 2017), annual production (Furumo & Aide, 2017), oil traded between LAC countries, and out of the region (Furumo & Aide, 2017). |
| | Private and foreign public investments | 1 | 0% | Praderization (Rodriguez - de- Francisco, et al., 2021) |
| Policies not related to trade | Policies and land-related issues | 19 | 68% | State presence index (Prem, et al., 2020), proximity to military bases (Prem, et al., 2020), lack of state sovereignty (Hoffmann, et al., 2018), centralized political system (Hoffmann, et al., 2018), non-implementation of environmental laws (Hoffmann, et al., 2018), index of municipal fiscal (Cantillo & Garza, 2022), management and administrative performance (Cantillo & Garza, 2022). |
| | Armed conflict | 17 | 76% | Presence of illegal groups (Prem, et al., 2020), violent actions as a proxy of illegal armed group presence (Cantillo & Garza, 2022), number of armed actions per area (Negret, et al., 2019) |
| | Anti-drug policy | 7 | 57% | Fumigation of illegal crops (Arias-Gaviria et al., 2021), coca eradication (Davalos, et al., 2016), illicit crop eradication policies (Chadid, et al., 2015), Glyphosate aerial spraying Cantillo & Garza, 2022) |

When considering the three dimensions of the food systems, Figure 2 shows that the most frequently reported drivers were classified under the production / supply dimension. Followed by drivers in the demand / consumer dimension, and drivers in the trade / distribution dimension. However, it is important to note that, overall, the dimension that does not relate to food systems was the most frequently mentioned in the literature reviewed.

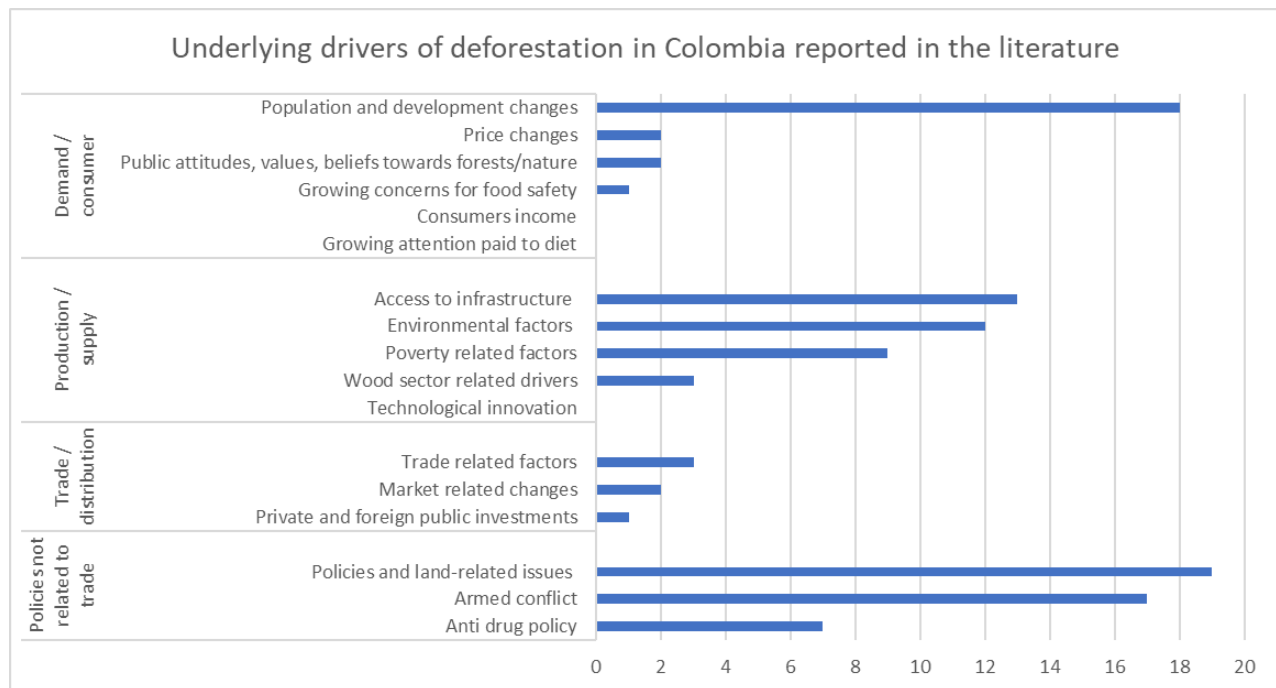


Figure 2. Underlying drivers of deforestation in Colombia organized under the conceptual framework categories and dimensions.

Most of the documents reviewed focused on the subnational level (58%), 25% on the national level, and 16% included analysis at the national and subnational level. Nevertheless, the results cannot be disaggregated at the regional level due to the limited number of articles per region.

Discussion

According to the literature reviewed, the underlying drivers of deforestation in Colombia are diverse and can vary depending on the region analyzed. However, drivers are mainly propelled by economic forces, whether related to armed conflicts, infrastructure development or poverty. However, these drivers can be exacerbated or mitigated by aspects related to state presence and monitoring (Prem et al., 2020) and local governance mechanisms (Arias-Gaviria et al., 2021).

Demand / consumer dimension

Our results indicate that the most frequently mentioned driver for the demand/consumer dimension was population and development changes. Driver that includes demographic changes as well as changes associated with the population lifestyle (Castro-Nuñez et al., 2022). Andrade & Gonzalo (2011) emphasize the importance of policies to stimulate the occupation and use of the territory as one of the drivers of the expansion of the agricultural frontier into forested lands. In the case of the Amazon Region, the cause of deforestation is fostered by settlers who come from the interior of the country (Armenteras et al., 2013; Etter et al., 2006; Ruiz et al., 2011). Other authors suggest that population

pressure is an important underlying driver of deforestation, besides the migration and colonization process (Cantillo & Garza, 2022). However, this driver is never considered to be the only reasons for deforestation, in all the articles mentioned it is also paired with other drivers such as armed conflict.

Production / supply dimension

Our results suggest that the most frequently mentioned drivers for the production / supply dimension were: (1) access to infrastructure, which includes access to markets, urban settlements, and accessibility, and (2) environmental factors, which include agro-ecological conditions, land quality, climatic factors, and biophysical factors. Access to infrastructure has been identified as a driver that can have both positive and negative effects on deforestation. If the infrastructure is planned and aims to satisfy the needs of the population, it could have a positive effect on deforestation. However, if it is unplanned and lacking of a proper license process can lead to deforestation, such as the building of roads which facilitate the access to forested areas (Arias-Gaviria et al., 2021). The distance to centers of regional importance and the main rivers influenced the specialization of corn and pasture. These crops are associated as the main causes of deforestation in the Urabá region between 1980 and 2000 (Ramírez Sosa & Orrego, 2011). In addition, (Chadid et al., 2015) found that the distance from the settlement has a negative impact on deforestation. The closer an urban area is, the greater the probability that forests are converted to pastures. Furthermore, the authors mention that the probability of conversion from forest to pasture decreases in high and very mountainous areas. Muñoz Gomez et al., (2018) identified that factors such as shifting cultivation, along with elevation, slope, soil fertility, temperature, and precipitation, have influenced deforestation and fragmentation of high-Andean forests.

Trade / Distribution

This was the dimension which was less frequently mentioned. However, Rodríguez-de-Francisco et al. (2021) mention that the Amazon region is currently experiencing a push for agribusiness expansion, which could further deforestation in the region. Arias-Gaviria et al., (2021) also points out that the demand for commodities and international and national market prices are an underlying driver of deforestation.

Policies not related to trade

Post-conflict dynamics have facilitated economic drivers of deforestation. For example, Prem et al., (2020). found that municipalities with FARC presence experienced a differential increase in massive (large-scale) deforestation relative to granular (small-scale) deforestation after the peace agreement. This suggests that deforestation during FARC control was carried out mostly by small farmers, while the ceasefire may have opened up areas to large economic interests engaging in deforestation-driving activities. In territories such as the Amazon, the accelerated fragmentation of the landscape has been caused by historical-social factors, such as violence and the absence of State figures, together with land grabbing and non-compliance with peace agreements (Meza & Armenteras, 2018).

Conflict-related drivers are complex and have been difficult to tease out. Empirical studies focused on Colombia have found varying and sometimes contrasting results regarding the degree to which armed conflict and coca cultivation drive deforestation (Ganzenmüller et al., 2022; Negret et al., 2019; Sánchez-Cuervo & Aide, 2013). For instance, Negret et al., (2019) found that armed conflict intensity and proximity to coca plantations had a notable, positive association with deforestation; however, when these variables were combined with other driver variables of interest, their association with

deforestation diminished. In contrast, Davalos et al., (2021) found that coca cultivation and its countermeasure, aerial fumigation, indirectly drive deforestation by directly propelling conflict that in turn promotes deforestation. On the other hand, Fagua et al., (2019) found that deforestation hotspots highly overlapped with coca crops distribution. Interestingly, the authors found that deforestation areas were frequently followed by secondary vegetation, suggesting that forests are cleared for coca cultivation that is eventually eradicated by authorities, giving way to secondary vegetation growth.

As mentioned, the deforestation process in Colombia is complex. Therefore, in order to understand it, it is necessary to analyze the full range of direct and underlying drivers of deforestation, its links and specificities for each region in Colombia, in order to recommend strategies to successfully reduce deforestation rates.

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