# Investment Priority Index in Colombia's Guaviare Department

## Mapping Social Vulnerability, Deforestation Prevalence, and Road Accessibility

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KEOUGH SCHOOL OF GLOBAL AFFAIRS

PASO COLOMBIA
Sustainable Peace for Colombia

## Introduction

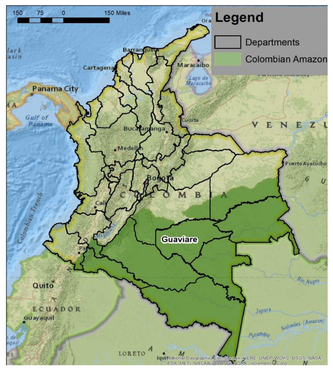
The Colombian department of Guaviare is located within the Amazon rainforest, as shown in **Figure 1**. Guaviare is home to 83,000 people, most of them small-scale farmers, or *campesinos*. Though most of the territory is protected land, Guaviare is Colombia's second-most deforested department.

Before the 2016 Peace Accords, Guaviare was a top coca-growing department. Armed groups paid *campesinos* to clear land and grow coca. The Peace Accords introduced a government program called PNIS, which aimed to transition coca-growing *campesinos* to legal agricultural activities. However, PNIS largely failed, causing food insecurity among already-vulnerable *campesinos* to increase drastically.

Today, without a cohesive crop-substitution regime, many campesinos turn to cattle ranching, as it provides quick economic returns during economic uncertainty. Land-grabbing and cattle raising has intensified deforestation, as *campesinos*, paid by corrupt officials, armed groups and criminal organizations, clear vast tracts of forest for cattle and coca.

**PASO Colombia** is a program of **One Earth Future (OEF)**, an incubator of innovative peacebuilding programs. They work hand-in-hand with communities affected by conflict.

### Fig. 1. Colombian Amazon




PASO works with communities as partners, leaving installed capacities, businesses with cooperative models, and transforming them into promoters of sustainable development in their territories.

In Guaviare, PASO developed *La Red de Paz* (the Guaviare Peace Network), which supports economically vulnerable *campesinos* through environmentally sustainable agricultural projects.

Currently, PASO lacks a systematic approach to identify new beneficiary communities. Our project aims to help PASO target future initiatives to maximize the social and environmental impact of their investments.

**Research Question:** Where should PASO Colombia prioritize their sustainable development programming in Guaviare to reach areas with the highest socioeconomic need, conservation need, and territorial accessibility?

## Methodology

**The rural sector:** Defined by Colombia's census body, each rural sector is about 100-square kilometers. Their boundaries are delimited either by political-administrative limits, natural features, and cultural elements.

To determine where PASO should target their programs, we developed an **Investment Priority Index (IPI).** Each sector receives an IPI score between 0 and 100 based on their combined performance across the following three dimensions: social vulnerability, deforestation prevalence, and road accessibility.

**1. Social Vulnerability Score (SVS):** Each sector receives a score from 0-100 based on overall social vulnerability with higher scores indicating higher vulnerability. Social vulnerability data was collected from Colombia's 2018 Census. The sub-indicators that make up the SVS are:

- Population
- % population with no education
- % households without access to water, gas, electricity, and sewer
- % population dependent (defined conservatively as age 9 and under and age 70 and older)

To determine the subscore of each factor, we multiplied the minimum value by 100 and divided it by the maximum value as shown through the example formula for education:

**Education subscore = 100*(education - education_min)/(education_max)**

We then added each variable's score together and normalized the combined score on a scale of 0-100 using the same formula above. Rural sectors with a population of 0 received a null score and were excluded from analysis. **Figure 2a** shows each sector's performance according to the SVI.

**2. Deforestation Prevalence Score (DPS):** Each sector receives a score from 0-100 based on the estimated number of deforestation alerts originating in that sector according to Global Forest Watch's (GFW) Integrated Deforestation Alert System, which tracks deforestation alerts from three major alert systems: GLAD-L, GLAD-S2, and RADD. Higher scores indicate more frequent deforestation alerts.

GFW data came in raster form and contains deforestation alerts between January 2014 and April 2024. We resampled the image from a cell size of (.0001, .0001) to (.01, .01) converted it to points before joining to our rural sector map.

The resampling reduced deforestation data points from about 11 million to about 1,000. A visual comparison between the high- and low-resolution maps showed that the relative distribution and density of datapoints was preserved after resampling. Therefore, deforestation data points do not correspond 1:1 to deforestation alerts; rather, they provide an estimate of the distribution and density of deforestation alerts.

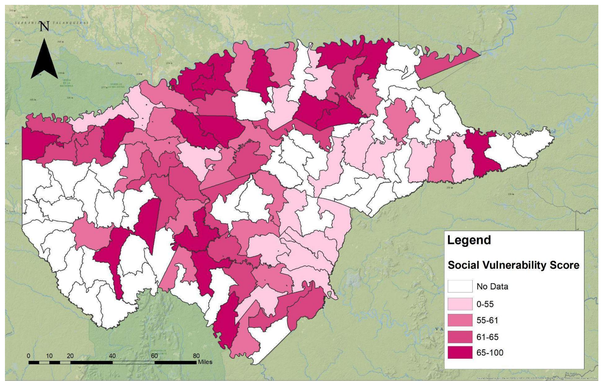
**Figure 2b** shows the distribution of deforestation alerts, as well as new and persistent hotspots of primary forest deforestation from 2002-2023 primary forest loss. A 'hot spot' is an area that exhibits statistically significant clustering in the spatial patterns of loss.

**3. Road Accessibility Score (RAS):** Each sector receives a score from 0-100 based on its proximity to the nearest road network, updated as of April 2024. Sectors with higher scores have closer proximity to roads (100 indicates that a road intersects or touches the boundary of a rural sector).

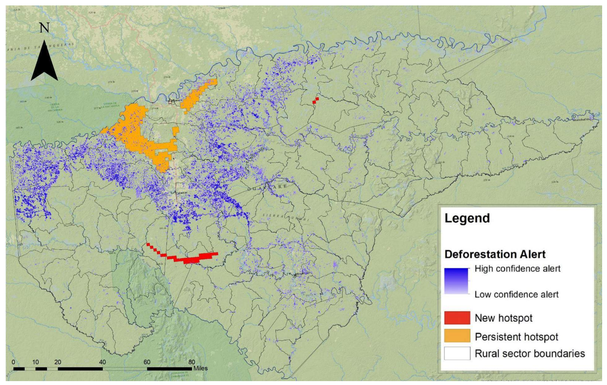
Using the Near Analysis tool, we calculated the distance of each rural sector from any road within the network. Roads within, intersecting, or touching a rural sector, it received a score of 0. We then used the same formula as education to calculate a rank for road access, subtracting this rank score from 100, since lower distances indicate better accessibility. **Figure 2c** shows Guaviare's road network and each sector's performance according to the RAS.

## Mapping Inputs for Investment Priority Index: Social Vulnerability, Deforestation Prevalence, and Road Accessibility

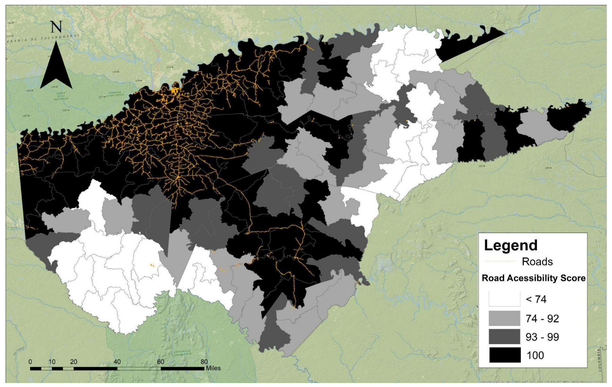
### Figure 2a. Social Vulnerability Score (SVS)




### Figure 2b. Deforestation Prevalence Score (DPS)

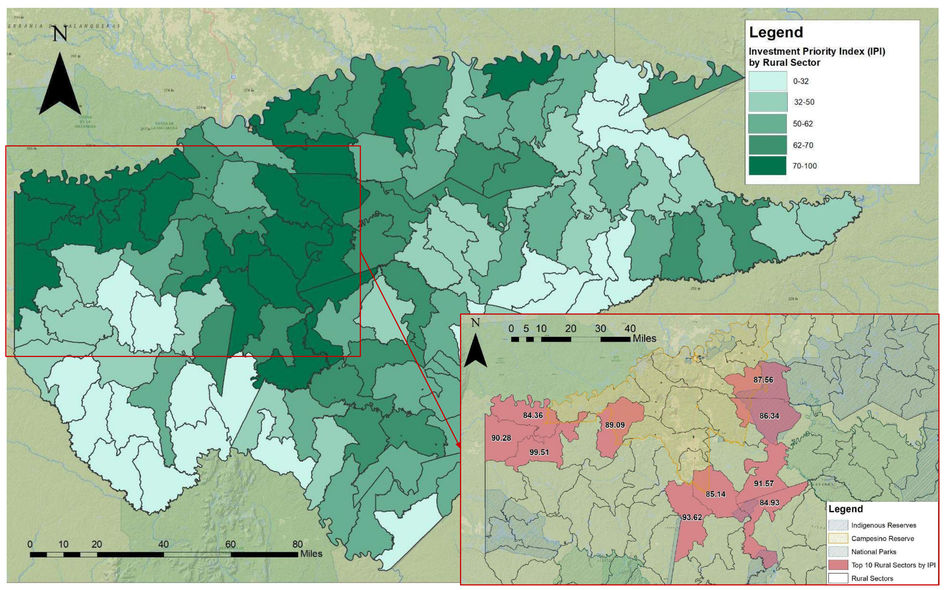



### Figure 2c. Road Accessibility Score (RAS)




## Findings

### Figure 3. Investment Priority Index (IPI)




Based on the three sub-scores above, we calculated a combined Investment Priority Index (IPI) by adding all three sub-scores together and normalizing the raw IPI score using the same equation described in our methodology. As such, the final IPI was generated using the following two steps:

(1) IPI_raw = SVS + DPS + RAS
(2) IPI_normalized = 100*(IPI_raw - IPI_raw_min)/(IPI_raw_max)

**Figure 3** shows the distribution of normalized IPI scores across rural sectors, with darker sectors indicating a higher priority for investment due to high social vulnerability, high deforestation prevalence, and high road accessibility. The call-out box in **Figure 3** highlights the top-10 highest scoring sectors and shows how the sectors overlap with relevant land zoning restrictions.

As **Table 1** shows, the sectors with the 10 highest IPIs have, on average, significantly higher levels of social vulnerability, deforestation, and road accessibility than the overall average.

Four top-scoring sectors partially overlap with a Peasant Reserve Zone (PZR). Unlike Indigenous Reserves, which are considered self-governed subnational territorial entities and can receive transfer funding from the government, PZR's were constituted to ensure mechanisms of participation and consultation of peasant organizations. In these zones, PASO can support campesinos to formalize their land titling and support agricultural initiatives which are based on environmental and food sustainability.

Additionally, four top-sectors partially overlap with an Indigenous Reserve. In Indigenous Reserves, residing non-indigenous campesino farmers cannot obtain formal land titles and the agricultural practices which are allowed are much more restricted than in PZRs. PASO has experience working in both PZR's and Indigenous Reserves as some of the households in the existing Peace Network overlap with both types of zones.

### Table 1. Average Index Scores for Top 10 Rural Sectors vs. All Sectors

| | Investment Priority Index | Social Vulnerability | Deforestation Prevalence | Road Accessibility |
|---|---|---|---|---|
| **Top 10** | **89.24** | **63.97** | **65.70** | **100** |
| **All Sectors** | **53.29** | **38.57** | **12.81** | **86.27** |

## Recommendations for PASO Colombia

1. **Target future interventions to the sectors with the highest IPIs in order to maximize investment impact.**
2. **For sectors that overlap with indigenous territory, design interventions that are compatible with the land-use restrictions on indigenous land, such as no deforestation and inability for campesinos to obtain land titles.**
3. **For sectors that overlap with *campesino* reservations, design interventions that are compatible with the restrictions and privileges granted in the reservations.**

## Conclusion

Guaviare is a complex territory, where *campesinos* experience high levels of socioeconomic vulnerability, natural resources are threatened by deforestation, and the delivery of services is complicated by weak infrastructure. Our IPI can help PASO identify areas where their investments will have the most impact by highlighting areas that have high socioeconomic need and high prevalence of deforestation but are still accessible by roads. The 10 rural sectors we identify have above-average levels of socioeconomic vulnerability, deforestation prevalence, and road accessibility.

One key limitation of this study is that Colombia's most recent Census data is from 2018. Due to the implementation of the Peace Accords in 2016, which included territorial development programs, it is reasonable to assume that population trends and socioeconomic variables may have changed significantly since that time. Future research should incorporate the most recently-available data regarding population distribution and socioeconomic variables.

Another limitation is the lack of data about the presence of armed non-state actors. Our field research confirmed that certain areas of Guaviare are controlled, to varying degrees, by armed groups. However, for this research, we were unable to obtain reliable, updated, georeferenced data indicating areas with strong presence of armed groups. Territorial control by non-state actors would complicate the delivery of services. As such, the top 10 rural sectors we have identified as priorities for investment should be cross-referenced against PASO's knowledge of armed groups.

Finally, although the call-out box in **Figure 3** shows three major land-use designations (indigenous reservations, *campesino* reservations, and national parks), Guaviare's system of land-use categorization includes many other land-use restrictions that would impact project possibilities. However, we were unable to obtain a complete dataset of all land-use restrictions. Future research should take the complete list of land-use restrictions into account.

## Data Sources and Acknowledgements

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