Secondary growth deforestation leakage in the Pará beef cattle purchasing zone

Luis Oliveira Junior [1], Jailson S. de Souza Filho [1], Bruno Gama Ferreira [1], Carlos Souza Junior. [1]

[1] Amazon Institute of People and the Environment (Imazon), Belém, Pará, Brazil - (luis, jailson, bruno, souzajr)@imazon.org.br;

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Abstract

Deforestation is a major threat to forest conservation in the Amazon, affecting biodiversity, climate balance, and natural resources. The beef cattle market targets deforestation-free products. This study aims to assess the extension of Secondary Vegetation (SV) in the Pará State, quantify SV deforestation in rural properties, and measure potential deforestation leakage in SV. The study analyzed the SV dynamics at the property level by accessing the CAR database, selecting properties within the Pará State and filtering the database according to criteria. The dissolved CAR layer was used to remove overlapping properties and classify properties by class size. Properties with no deforestation from 2009 to 2022 were selected as potential purchasing zone. SV areas with regeneration ages greater than five years were considered. In 2022, the Pará State had 2.55 million hectares of SV areas over five years of age, with 136,831 properties in the potential purchasing zone of cattle beef. From 2009 to 2022, 45% of selected properties did not have PRODES alerts, however 82% had SV deforestation events between 2009 and 2022. If SV deforestation was a criterion, 51,065 properties would be out of business, and only 10,887 properties were free from SV deforestation. Deforestation analysis showed that not all forest resources are protected. To achieve a deforestation-free beef cattle market, the TAC must include an SV conservation strategy, to protect all forest resources.

1. Problem Statement

Deforestation is the main threat to forest conservation in the Amazon and is critical to biodiversity, climate balance, and natural resources, threatening traditional Amazon people (Fearnside, 2015). Between 1985 and 2022, pasturelands were responsible for 87,5% of all forest conversion in the Amazon biome (Souza Jr. et al., 2020). The beef cattle market is currently the target of customers' concern about products free from deforestation.

Properties with illegal deforestation are removed from the sales market because the main buyers have already agreed to the rules negotiated with Brazil's Federal Public Prosecutor's Office that do not allow beef from illegally deforested areas. Since 2009, this agreement has been legally officialized as a document called Terms of Adjustment of Conduct (TAC in Portuguese) (Barreto & Silva, 2009).

The illegal deforestation supply chain commitments were policies created to help reduce deforestation in this market. However, the deforestation criterion only considers the old-growth forests, leaving secondary-growth forests out of discussion.

Therefore, there is an opportunity to improve the rules and expand the protection of forest resources, including both old-growth forests and secondary-growth in the TAC agreements. Nowadays, the deforestation criterion that allow properties to sell in the beef cattle market only consider deforestation in primary forests, looking for suppliers without PRODES (Brazilian official deforestation data) alerts in their properties (Instituto Nacional de Pesquisas Espaciais, 2024).

Secondary Vegetation (SV) is the vegetation that grows after the forest is clear-cut, followed by land abandonment (Brown & Lugo, 1990). The SV has a vital role in climate change mitigation, provision of ecosystem services, and reduction of the impact of forest fragmentation (Nunes et al., 2020), because of that, it must be considered part of the forest resources.

The objectives of this study are four-fold:

1. Assess the extension of SV in the Pará State within the cattle range purchase zone;
2. Quantify SV deforestation within rural properties that potentially are a source of cattle for slaughterhouse plants;
3. Measure the potential leakage of deforestation in SV;

Understand how much Pará's SV we had in 2022 is between the slaughterhouses and 150 kilometers.

2. Methods

To study the SV dynamics at the property level, we first accessed the most updated CAR (Rural Environmental Registry) database available at the SICAR. We selected the properties inside the Pará State. Second, we filtered the CAR database according to a few criteria established, looking for the potential purchasing zone of the beef cattle market. These filters were applied in three steps:

- Exclusion of all CARs with canceled status;
- Exclusion of all CARs from the rural settlements (i.e., a group of smallholder properties);
- Selection of properties with pasture area greater than 25 hectares (ha).

The filters were intended to exclude canceled CARs that are not able to sell in the beef cattle market. Excluding settlements was necessary because every sale must be connected to a single property to show the origin of the product; And select the properties that have a significant pasture area (we adopt 25 ha) to manage the cattle. To estimate pasture area by property, we used MapBiomas Land Use and Land Cover data from Collection 8 (Souza Jr. et al., 2020).

After the filtering step, we had to remove the overlapping among properties in the CAR database. To solve this problem, we dissolved the CAR layer, adopting a prevalence rule in which the most minor property prevails over the largest. Large properties are sometimes subdivided into smaller parts that could be rented or donated to another person. Finally, we have the dissolved CAR

layer to proceed with the analysis without counting data more than once.

We also used the undissolved CAR version to classify the properties by class size to understand better if SV can vary according to CAR size. We adopt the size classes described in the Monitoring Protocol for Livestock Suppliers in the Amazon (Ministério Público Federal & Imaflora, 2021):

- Class 1: Properties smaller than 100 ha;
- Class 2: Properties between 100 and 499.9 ha;
- Class 3: Properties between 500 and 999.9 ha;
- Class 4: Properties between 1,000 and 3,000 ha;
- Class 5: Properties greater than 3,000 ha;

Next, we combined the dissolved CAR layer with PRODES data to select properties that did not have deforestation from 2009 to 2022 because the Brazilian forest code (Law nº 12,651, 25 March 2012) only considers illegal deforestation events after June 22, 2008. Theoretically, from the forest resources perspective, those properties without PRODES deforestation can sell in the beef cattle market and be considered part of the potential purchasing zone.

After delimiting this zone, we overlapped it with SV data mapped by the FloreSer method (Nunes et al., 2020) and updated recently (Souza Jr. et al., 2023) to understand the extension of SV and if there is an SV deforestation dynamic in those properties. The FloreSer data

We had access to a shapefile with the location of several slaughterhouses in Pará State, published in (Barreto et al., 2023); with this data, we generated a buffer of 150 kilometers from the slaughterhouse location. With those two pieces of information, we ran a proximity analysis to understand how much SV occurred in Pará State between the slaughterhouses and 150 kilometers.

The FloreSer (Nunes et al., 2020) methodology produces annual maps of SV and SV deforestation derived from the time series of land use and land cover (LULC) maps published by Souza Jr. et al. (2023); the LULC mapping uses satellite images from Landsat sensors with 30 meters of spatial resolution (pixel size). Each SV and SV deforestation map provides information about the time of vegetation recovery in years estimated by remote sensing.

FloreSer analysis works pixel by pixel, and the recovery age is the number of consecutive years classified as forest by LULC after changing status from anthropic class. A pixel can recover and, at some point, be deforested. However, if this exact pixel transits to forest cover again, it will be considered SV another time.

We implemented all those methodological steps in the Google Earth Engine platform (Gorelick et al., 2017). This approach allows us to quickly access the data and statistics and check the results in real time.

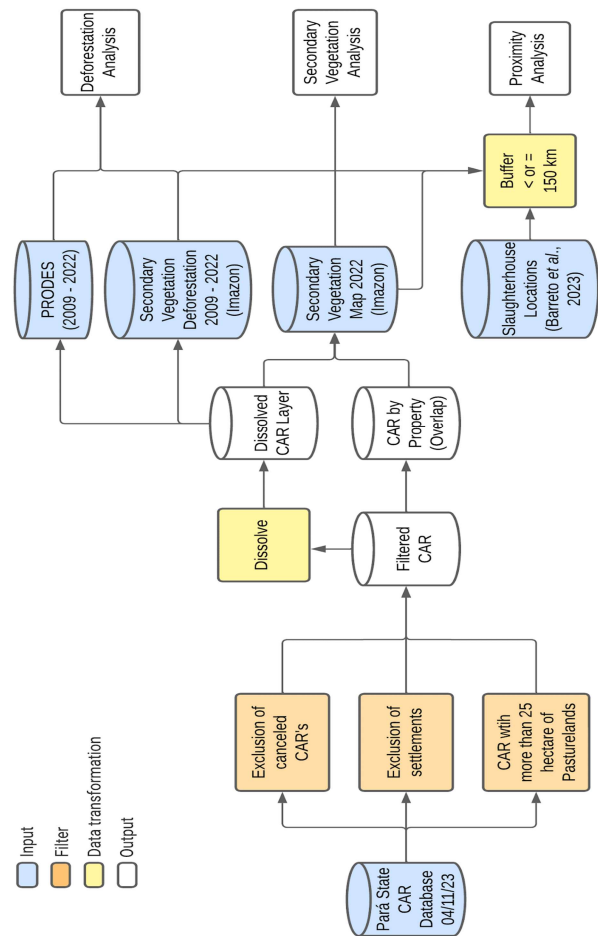Figure 1 summarize all methodological steps for this study:

Figure 1. Methodology workflow.

The Pará State has a specific Normative Instruction (NI) to guide the management of SV areas (cite). The Pará State has a specific Normative Instruction (NI) to guide the management of SV areas (cite). The NI established that SV areas aged between 1 and 5 years could be removed without requesting authorization from the State government's environmental agency (GOVERNO DO ESTADO DO PARÁ, 2015). Following the rules from the NI, we only considered SV areas with regeneration ages greater than five years for this work because these areas are consolidated as SV.

The methodology has a few limitations that could be discussed: it is only possible to map SV areas that started the regeneration process in 1986. The SV mapping uses MapBiomas Land Use and Land Cover (LULC) data as input, so errors in LULC maps can be replicated in the SV maps. It is relevant to point out that the age of SV areas mapped is estimated using the remote sensing approach when the sensors capture the sign of regeneration. Still, age in the field can be greater than in remote sensing estimation.

3. Results

3.1 SV Area Extension

In 2022, the Pará State had 2.55 million hectares (Mha) of SV areas over five years of age. Our analysis showed that the potential purchasing zone of cattle beef had 136,831 properties with 1.4 Mha of SV (age > 5 years) areas, this number of properties is the result after our filtering step. According to the property's classes size, the SV areas variated as follows: Class 5 had the greater SV area: 471k ha (33%), followed by Class 4 and

2 with 320k ha (23%), Class 3 with 152k ha (11%), and Class 1 with 146k ha (10%) as presented in Figure 2.

Figure 2. Occurrence of SV areas by age (2022) and class size in the Pará State in the potential purchasing zone.

In 2022, 68% of SV areas inside the potential purchasing zone had ages between 6 and 20, but only 11% (150,000 ha) had ages more than 30. This time of recovery (> 30) might have some characteristics similar to those of a mature forest. Figure 3 shows the distribution of SV ages classes in each size class in the potential purchasing zone in the Pará State in 2022:
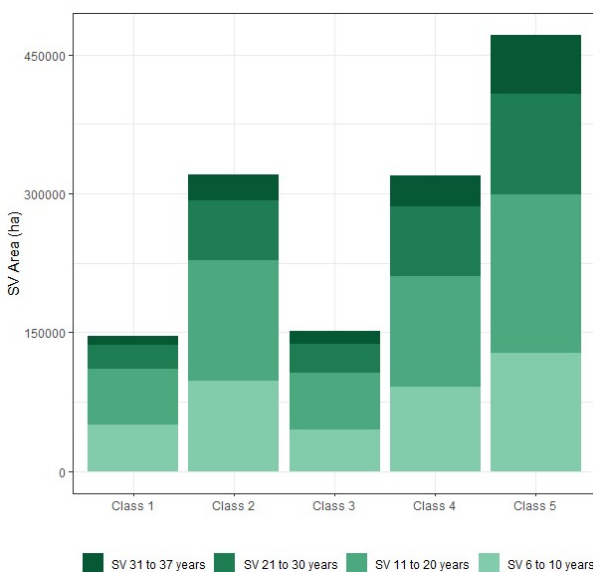

Figure 3. Distribution of SV ages classes in each size class in the potential purchasing zone in the Pará State in 2022.

3.2 Proximity Analysis

Figure 4 shows the occurrence of SV areas inside the Pará State in 2022 and their proximity from the slaughterhouses (Barreto et al., 2023):
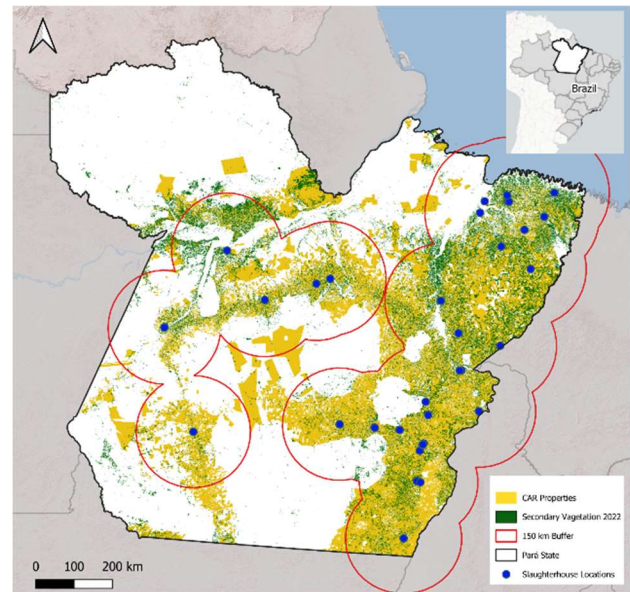

Figure 4. SV areas in the Pará State and their proximity to slaughterhouses.

The proximity analysis showed that in 2022, the beef cattle market could pressure a significant part of Pará's SV areas, 86.5% of which were within 150 kilometers of the slaughterhouse locations.

Most of the slaughterhouses and SV areas are located in the east of Pará State (Figure 4). It is necessary to increase the protection of SV areas in this region so the pressure does not become SV deforestation influenced by the presence of slaughterhouses.

3.3 SV Deforestation

Crossing the PRODES data with the selected properties, from 2009 to 2022, almost 28,000 km² of Pará State was deforested (PRODES, 2024). After the filtering step, 136,831 properties were selected according to the criteria established by these authors. Inside the potential purchasing zone, 45% (61,952) of properties chosen did not have PRODES alerts between 2009 and 2022, so theoretically, they could sell in the beef cattle market if they fulfilled the other established criteria.

However, 82% of these properties had SV deforestation events from 2009 to 2022. We found additional deforestation in SV areas totaling 3,290.15 km² inside these properties with no PRODES deforestation. Figure 5 shows the deforestation statistics if the SV deforestation (areas with an age greater than five years) were considered together with PRODES data as forest loss in the Pará State between 2009 and 2022 inside the potential purchasing zone:
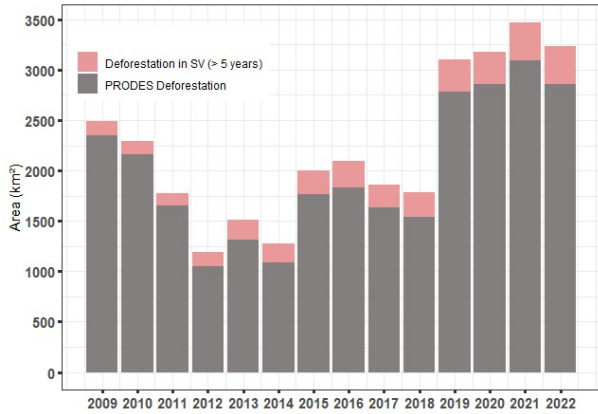
Figure 5. PRODES deforestation plus SV deforestation, from 2009 to 2022 inside the selected properties in the Pará State.

We identified an SV deforestation dynamic inside the properties that do not have PRODES deforestation that should be considered forest loss, mainly because the loss occurred in SV areas with 5 to 36 years of regeneration, as shown in Figure 6.

The results can identify age classes that were more affected during the time series. Figure 6 shows which SV ages were more deforested during the studied period. Most SV deforestation cuts involved SVs between 6 and 20 years old, summarizing 87% of all SV deforestation inside the properties from 2009 to 2022.

Figure 7A. SV deforestation dynamics according CAR class size from 2009 to 2022 inside the selected properties in the Pará State.
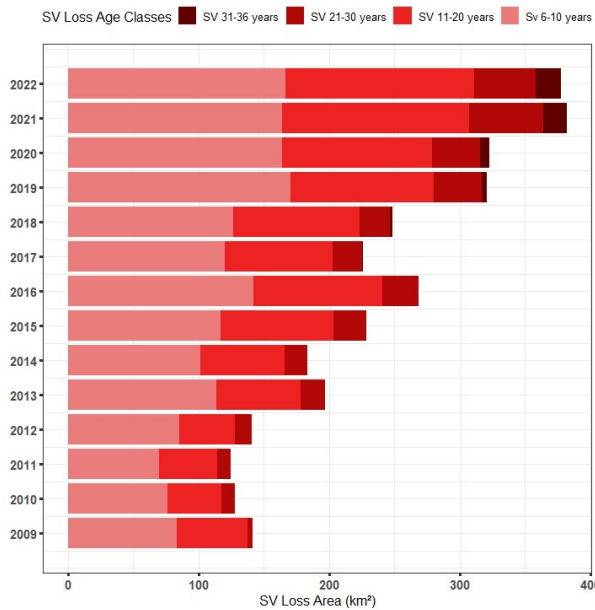

Figure 6. SV deforestation dynamics according age classes from 2009 to 2022 inside the selected properties in the Pará State.

Analyzing SV deforestation by CAR class size, we identified most of it concentrated in classes 1 and 2, more than 70% were observed in those classes. Figure 7A presents the distribution of SV deforestation among the class size of properties, and Figure 7B summarizes the statistics of SV deforestation by CAR size classes from 2009 to 2022 in the Pará State within the selected properties:
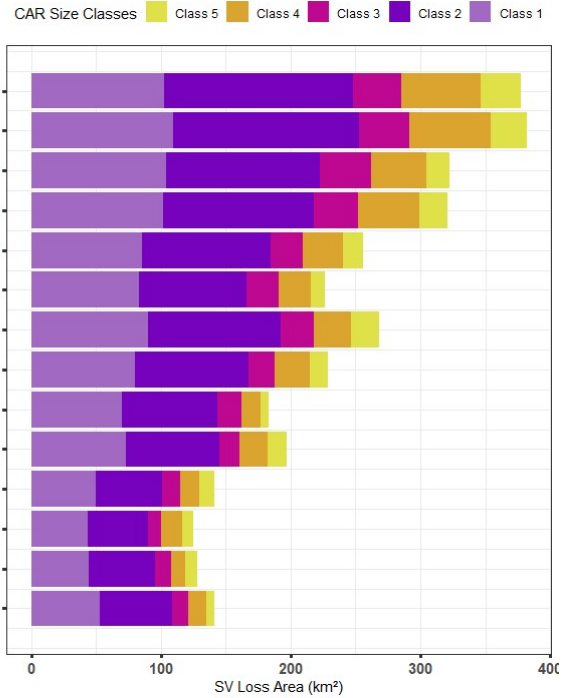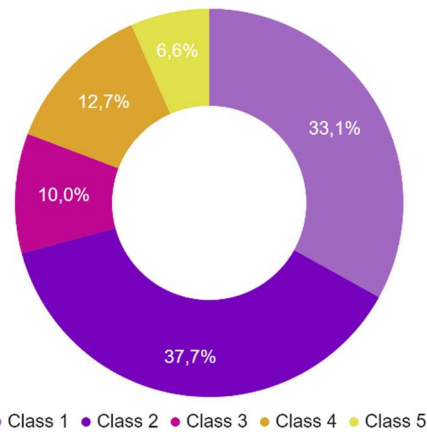

Figure 7B. Sum of SV deforestation dynamics according CAR class size from 2009 to 2022 inside the selected properties in the Pará State.

4. Discussion

In Brazil, the official monitoring systems only monitor and report deforestation in old-growth primary forest areas, however the SV deforestation is still without the necessary attention. The Pará State has 24% of SV areas aged over five years in the Amazon biome (Souza Jr. et al., 2023) and a specific normative instruction about it.

In 2022, almost 87% of SV areas were 150 kilometers from slaughterhouses. The presence of this kind of enterprise should be the subject of research that aims to understand its environmental, social, and economic impacts on the development of SV areas.

Pará is ranked one among the Amazonian States in the SV area in 2022. It had 2.55 Mha of SV, of which 56% were inside the cattle potential purchasing zone. This 56% represented 1.4 Mha of SV areas older than five years in 136,831 rural properties in the CAR system. The management of SV areas (age > 5) must follow the rules established by the specific NI of Pará State. Unfortunately, this was not what we could observe in the results of the SV deforestation analysis.

We identified a significant SV area deforested in the studied period, and probably most of those deforestation events had no authorization from the State environmental agency (SEMAS – PARÁ). The analysis also revealed that even properties that do not have deforestation events in the native forest mapped by PRODES were clearing SV, so not all forest resources were protected inside the potential purchasing zone. Most deforestation (87%) occurred in SV areas between 6 and 20 years old. This behavior compromises the chance of SV reaching characteristics similar to those of a mature forest structure.

From the CAR size class perspective, SV deforestation occurred most in classes 1 and 2. One hypothesis to explain this is the prevalence rule of small against more extensive properties in overlap situations, which are common in the CAR database. However, this result can also indicate a more intense SV deforestation dynamic in smaller properties because the same area might be cut more than once in fourteen years (2009-2022). A deforestation frequency analysis of each pixel can show if the SV areas were removed more often in the properties from classes 1 and 2 than others in the studied period.

The NI from Pará State is not avoiding SV deforestation; the first five years had an intense dynamic of clear-cut SV areas (Nunes et al., 2020) because, until this initial stage of succession, landowners do not need formal authorization from the State government to deforested those areas. Our results showed that the SV areas older than five also suffer from deforestation yearly.

The NI must be revised to increase the protection of SV in the Pará State. Several changes should be made, like requiring authorization from environmental agencies to remove SV areas in the initial stage (1 - 5 years) and improving the requirements to give a license to clear SV in intermediate or advanced stages, making this decision more difficult. It is challenging to protect SV areas if most of them are cut down in the first five years or deforested later without systems monitoring and reporting losses in this type of vegetation. SV deforestation must be included in the TAC as a new criterion for participating in the cattle supply chain to protect them and avoid deforestation leakage.

If SV deforestation were considered a criterion to allow the properties to sell in the beef cattle market, 51,065 would be out of business and forbidden to sell in the cattle supply chain; only 10,887 properties were free from SV deforestation from 2009 to 2022 in the Pará State. In 2022, considering PRODES and FloreSer data, the total deforestation inside the selected properties could be 13% greater than it was, monitoring both old-growth and secondary-growth forest areas.

If the objective is a beef cattle market free from deforestation, the TAC must be updated, including an SV protection strategy to monitor native forests and SV. Landowners should be encouraged to practice forest restoration since SV contributes to carbon sequestration; it connects forest fragments and creates ecological corridors that provide conditions for reestablishing biodiversity and water resources.

5. Conclusion

SV is a crucial actor in forest restoration. Many countries, biomes, states, and municipalities have their own goals to raise the SV area in the following years, and natural regeneration is considered a good path mainly because of its low cost.

Pará State has great potential to be a reference in forest restoration because it already has a significant SV area that can be raised even more, creating corridors to connect forest fragments. However, it is necessary to improve the protection of SV. To do that, we must reinforce the laws that aim to regulate the management of SV, combat SV deforestation, and monitor deforestation in primary forests and SV areas.

The beef cattle market made many efforts to eliminate deforestation from its suppliers, but it is time to improve the TAC conditions to include SV deforestation as a new criterion for selling in the market. Considering only PRODES deforestation is not enough. We have to think outside the box and consider forest resources holistically.

We have a unique opportunity to stop this deforestation leakage in the potential cattle purchasing zone. By improving the environmental criteria in the TACs, we can send a message to the market that we are seeking a product free from deforestation and a more sustainable society.

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