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Land grabbing in the Brazilian Amazon: Stealing public land with government approval

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Declaration of Competing Interest

None

CRediT authorship contribution statement

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Land grabbing in the Brazilian Amazon: Stealing public land with government approval

Abstract: We estimate the magnitude of land grabbing - the illegal appropriation of public land - on an active Amazonian frontier, the associated deforestation, and the rates at which these claims were legalized due to changes in the law and downsizing of settlements. Of all land claimed in our 300,689-km^2 study area, 90.5% is non-compliant with Brazilian law and 45.8% is in protected areas. Changes in the law by 2017 reclassified as licit 4.2% of the illicit land claimed in Brazil's Rural Environmental Register (CAR) in 2014 (901 km^2 yr^{-1}). Downsizing settlements made 5266 km^2 available for illegal appropriation. Deforestation in land claims accounted for 35% of the total, and this percentage is likely to grow. Planned future changes in land law will further jeopardize Amazon's natural and cultural heritage legalizing at least 10% of the area in this frontier. Importers of beef, soybeans and other commodities should bar products from land that has been grabbed as a result of changes in Brazil's land laws, reducing the outsourcing of deforestation.
***Keywords**:* Land grabbing, Deforestation, Amazon, Land reform, Undesignated Public Lands

1. Introduction

The rate of Amazonian deforestation dropped sharply in Brazil from 2004 to 2012, part of which was due to government policy interventions and the greening of commodity supply chains (especially in the 2008-2012 period) (Arima et al., 2014; Nepstad et al., 2014; West and Fearnside, 2021). Unfortunately, deforestation has begun to climb again due to eroding environmental governance, now exacerbated by the administration of President Jair Bolsonaro (Ferrante and Fearnside, 2019). President Bolsonaro championed legislative acts that have greatly weakened environmental legislation, and his administration has reduced the surveillance and punishment of illegal activities such as logging and deforestation, a reduction that has been further exacerbated by the COVID-19 pandemic (Vale et al., 2021). Much research addresses the macroeconomic forces (Soares-Filho et al., 2006; Rodrigues et al., 2009) and the microeconomic behaviors (Walker, 2003; VanWey et al., 2007) responsible for the Basin's forest loss. Such studies overlook what takes place prior to tree felling on any given property. Forested land must be appropriated before it is dedicated to agriculture. This has implications for our understanding of Amazonian environmental change, given that one of the main social processes contributing to deforestation remains obscure, namely the formation of illicit private holdings on public land. The term "land grabbing" has different meanings in different contexts (e.g., Agrawal et al., 2019). In this article, we use the term to reflect the illicit appropriation of public land by private interests, free of charge.

Here we address illicit land claims in one of the Amazon Basin's most active development fronts. We examine seven contiguous municipalities (counties) totaling 300,689 km^2 (roughly the size of Italy) in the Brazilian state of Amazonas to estimate the magnitude of such claims, the rate at which they become licit by changes in land law, encroachments into conservation and Indigenous lands, and the amount of deforestation occurring in them. We also show that agrarian-reform settlements are being downsized, presumably to make new areas available for appropriation. These seven municipalities retain extensive forest cover (96%), but agricultural conversion here is rapid and in 2021 accounted for 14.7% of the deforestation occurring in the Brazilian portion of the basin's (INPE, 2021). The prognosis is that deforestation will continue increasing here as a massive development plan gathers steam, namely the *Initiative for the*

Integration of the Regional Infrastructure of South America (IIRSA) (Walker et al., 2019). This initiative began in 2000 and since 2011 has been under the auspices of the South American Council on Infrastructure and Planning (COSIPLAN) of the Union of South America (UNASUR). With a bill in Congress proposing a kind of self-environmental licensing that would unleash infrastructure projects (Ruaro et al., 2021), many planned regional roads will be built making remote forest areas ever more accessible, such as state roads departing from Highway BR-319 in southern Amazonas, known as the spearhead for Amazonian deforestation (Ferrante et al., 2021a,b).

2. Modes of land appropriation

2.1. Federal appropriation of state-government land

When Brazilian Amazonia opened to development in the 1970s, the federal government claimed state-government lands for colonization and biodiversity conservation. The federal agency created for allocating lands during this early period was the National Institute for Colonization and Agrarian Reform (INCRA). At the time, INCRA held jurisdiction over ~30% of Brazil's land, which in Amazonia included appropriating land from state governments in a 100-km buffer on either side of all federal highways, even those only being planned (Decree-Law 1164/1971). Alongside the highways INCRA demarcated land for colonization, as the military government deemed occupation essential to integrating Amazonia with the national economy (Hecht, 1985; Mahar, 1989). Most of the in-migration targeted Pará, Mato Grosso and Rondônia states, all of which are closer to the country's economic center in southern Brazil than is the state of Amazonas. Many rural settlement projects were created along these highways, with small holdings 50-100 ha in size; we will refer to all of these as "*conventional"* settlements. In the 2000s, new conventional settlements were created to accommodate the political demands of landless newcomers (Simmons et al., 2010). In addition, new settlement categories were created to grant usufruct rights to riverine communities. These categories involve communal ownership and are oriented toward renewable resource exploitation such as forest extraction and artisanal fishing and hunting in the interest of minimizing environmental impacts (Yanai et al., 2017). We refer to these as "*communal* settlements."

A second type of land appropriation, executed by government agencies in the public interest, comprises the designation of conservation units for biodiversity conservation. Brazil's conservation units (CUs) are officially grouped into two classes. The "integral protection" type allows only research and tourism. The "sustainable use" type includes categories that allow harvest of non-timber forest products, forest management (for timber) and subsistence agriculture (e.g., extractive reserves, state and national forests, and sustainable-use reserves). The federal government does not appropriate land to allocate to indigenous peoples. Rather, it assists in the formalization of ancestral homelands into officially recognized Indigenous lands (*terras indígenas*). The National Foundation for Indigenous Peoples (FUNAI), which is the federal agency responsible for managing indigenous affairs, does the identification, demarcation and registration of these territories.

2.2. Private appropriation of public land

For the purpose of our analysis, licit private landholdings are (i) holdings in conventional settlement projects (*projetos de assentamento)* within the maximum area (Law 8629/1993 with subsequent amendments), (ii) holdings with a Certificate of Rural Property Registration (CCIR) (Law 4974/1966 modified by Law 10,267/2001), and (iii) land claimed in public lands in

Amazônia that is recognized under a set of rules given by Law 11,952 of 2009 (known as the "*Terra Legal* Law"). Public lands not allocated to colonization or conservation and that are not private are commonly referred to as "vacant land" (*terras devolutas*), or undesignated public lands (UPLs). In theory, such lands cannot be privately appropriated (Federal Constitution, Articles 183 and 191). The *Terra Legal* law contradicts the Constitution and allows the titling of land occupied in UPLs, according to certain prerequisites, granting amnesty for landgrabbers. However, UPLs of type B, known as undesignated public forests, cannot become private agricultural property, given Article 4, Item III of the *Terra Legal* Law, which puts such lands under the terms of Law 11,284 of 2006 governing the use of public forests. These changes have stimulated land speculation throughout the Brazilian Amazon (Bennati and Fischer, 2018), but this appears to be just the beginning. There are inconsistencies due to the multiple modifications and amendments that have been approved to regulate private property in Brazil, especially in the Amazon (Reydon et al., 2015). In a nutshell, these changes have favored the legitimization of illegal appropriation of public land for productive activities at the expense of agrarian reform (Reydon et al., 2015; FAO/SEAD, 2017; Leite et al., 2018).

Private interests not only stake claims on undesignated public lands, but also in Indigenous lands and in areas allocated by the government for biodiversity conservation (Bernard et al., 2014; Begotti and Peres, 2019). Federal law completely prohibits such land claims. Appropriations of private properties have been extensively documented, for example when large-scale ranchers violently dispossess peasant farmers (Simmons et al., 2007). Here, we only consider public lands (both UPLs and land that either federal or state governments have set aside with use restrictions) and Indigenous lands, which are part of the federal union's patrimony. Licit private holdings have a Rural Property Registration Certificate (CNIR) or a title from the National Institute for Colonization and Agrarian Reform (INCRA), presumably updated in the System for Land-Tenure Management (SIGEF). Informal holdings without documentation are quite common. Such claims – typically by poor farmers – are likely to be small compared to identifiable, illicit claims, most of which are associated with large landholders and corporations.

2.3. The Rural Environmental Registry (CAR) as a surrogate for land ownership

The CAR (*Cadastro Ambiental Rural*), or Rural Environmental Register, is a public electronic registry aimed at environmental control, monitoring, and planning. The CAR database integrates environmental information from rural private properties and land claims with respect to land use and land cover (MMA, Normative Instruction 2 of 2014). Although CAR is not an instrument that establishes land ownership (i.e., legalization), many have used it as a land-grabbing instrument that facilitates legalization of illicit claims in public lands (Santos and Galeão, 2018; Greenpeace, 2020; Klingler and Mack, 2020). When a landholder registers with the CAR, a document is generated linking the registration to his or her taxpayer identification number, and this document has been used as a surrogate "proof" of land ownership should a dispute arise. Those registering illicit properties also typically deforest part of the claim and plant pasture as a way of demonstrating "productive use," which in Brazil has often been sufficient to establish *de facto* possession. Between 2019 and 2020, the area of CAR claims in Amazonia's ~500,000 km^2 type B undesignated public forests increased from 23% to 32%, (Azevedo-Ramos et al., 2020; Alencar et al., 2021). These CAR areas encompassed 75% of the area deforested in undesignated public forests, and annual deforestation there grew from 450 km^2 in 2016 to 1950 km^2 in 2020 or 330% for the period (Alencar et al., 2021). The CAR database gives an idea of the magnitude of self-declared claims in public lands, whether licit or not.

3. Materials and Methods

3.1. Southern Amazonas

The region is comprised of seven municipalities (counties) in the southern portion of Brazil's state of Amazonas. With an area of 300,689 km^2 (Fig. 1), southern Amazonas has 33 settlements, both *conventional* and *communal*, covering ~26,600 km^2. The region's conservation units cover ~148,800 km^2, 63.8% of which is allocated to "sustainable use." Altogether, the study area's Indigenous lands cover ~46,000 km^2, supporting 15 ethnicities with a total population of over 11,000 people (FUNAI, 2020; ISA, 2020). UPLs cover 20% of the study area (59,526 km^2) (Supplementary Table 1).

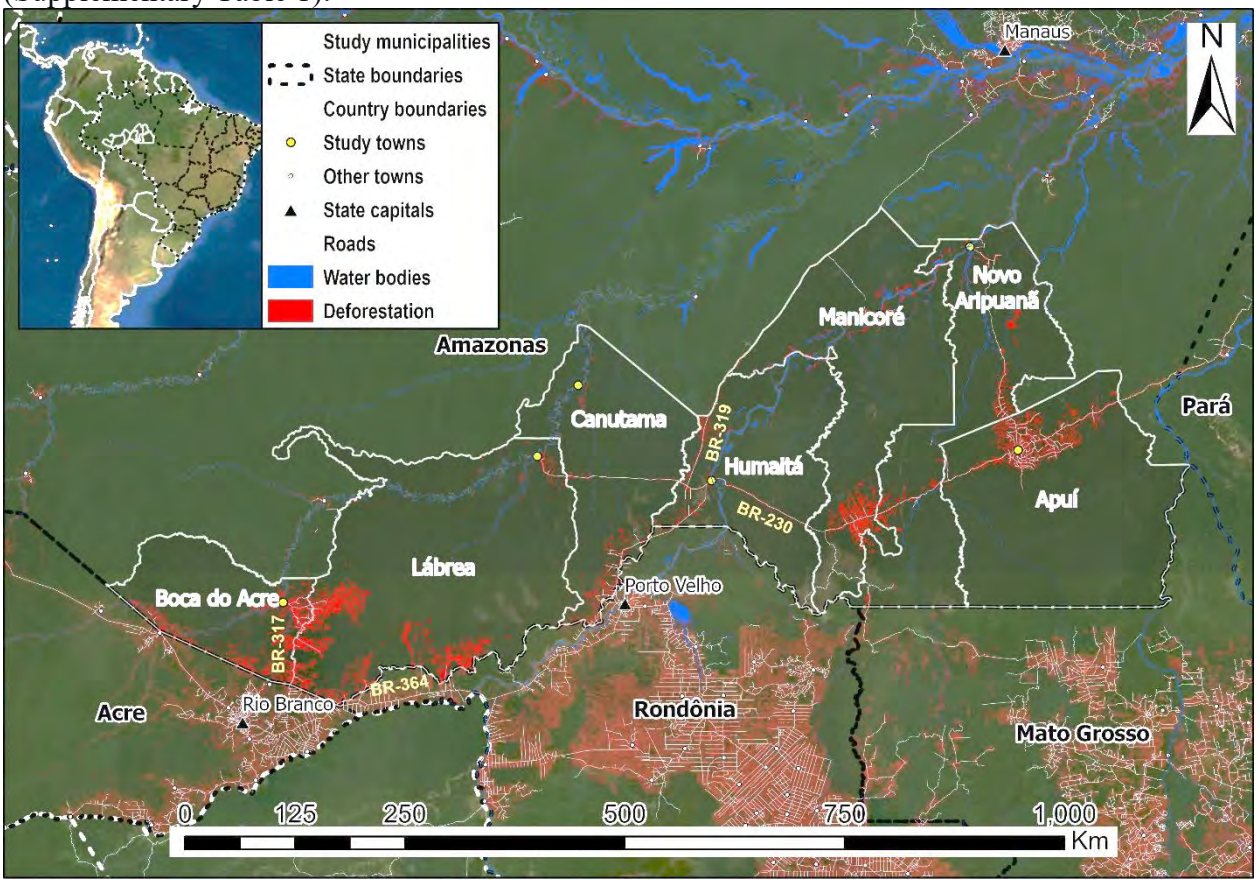

Fig. 1. The study area showing the seven municipalities in southern Amazonas. Deforestation by 2020 is shown in dark red in the state of Amazonas and in lighter red in other states.

The study area, which represents 20% of Amazonas State, had lost 19,525 km^2 of forest by 2021, which represents 63.3% of all of deforestation occurring in the state by that year. In 2020, 80.6% of the new deforestation in Amazonas took place in these seven municipalities (INPE, 2021). These municipalities support a cattle herd of 755,941 animals, with Lábrea, Apuí, Boca do Acre, and Manicoré accounting for most of the herd (IBGE, 2019). There are 13,669 CAR claims in the region totaling ~150,000 km^2, with overlaps between two or more records for 50% of the area claimed (Supplementary Fig. 1). CAR registry overlaps were substantial, presumably a reflection of competing land claims. The area of CAR claims drops to 99,371 km^2 when overlaps are eliminated (Supplementary Table 2). The CAR data provide a lower bound for the

actual amount claimed, given that an unknown number of appropriating individuals avoid registration.

3.2. Data sets and processing for land illicitness.

We used three data sets in the illicitness analysis. First, the Brazilian Agriculture and Ranching Atlas (*Atlas da Agropecuária Brasileira, or* ATLAS) (IMAFLORA, 2021), which integrates multiple public datasets on land registries for public and private land-tenure classes and removes spatial overlaps. For resolving the overlaps, ATLAS uses a hierarchical approach based on the level of legal security of the rights, geospatial precision, and the likelihood of transition from public to private status (Reydon et al., 2018). In removing overlaps, ATLAS also removes many of the CAR registrations in the original CAR database. For example, ATLAS eliminates CAR records overlapping any protected area, titled property, or rural settlement project. Because the objective of our research was to estimate the illegal nature of land claims, we adapted ATLAS to fit this purpose. We removed all remaining CAR polygons from ATLAS in order to compare the remaining subclasses of public land to our second data set: the original CAR data obtained from SICAR (CAR, 2020). We also removed titled privately owned properties registered in the SIGEF (*Sistema de Gestão Fundiária*) or the System for Land-Tenure Management, and in the Terra Legal Program. We kept ATLAS public-land subclasses (Indigenous lands, conservation units in both the integral-protection and sustainable-use categories, settlements, communal territories, military areas, and undesignated public lands and forests).

Our analysis identified inconsistencies in the remaining ATLAS land-tenure subclasses, which included 20,700 km^2 of overlapped areas and 13,600 km^2 of gaps for which there was no land-tenure class assigned. For the overlaps we used the same hierarchical rules presented by Reydon et al. (2018) to remove overlapped polygons (except for three entries, for which we assumed the hierarchy does not apply[1]). We assumed in the analysis that the gaps were UPLs that had not yet been registered. We integrated the geospatial file from the Brazilian Forestry Service listed in the National Registry of Public Forests (SFB, 2021) for separating UPLs into federal and state type B public forests and other UPLs.

Additionally, we reclassified inconsistencies between communal territories (COM) and the subclasses Indigenous lands, agricultural settlements and conservation units, including both conservation units for sustainable use (UCUS) and for integral protection (UCPI) according to information available in the "*Name"* column in the ATLAS dataset, which had the name of the protected area or settlement but was classified as being in the COM subclass instead. Similarly, some entries marked as belonging to the "settlement" subclass were reclassified to "protected areas" when the "*Name*" column indicated that the area belonged to a protected area. Settlements classified as being in the "COM" subclass were usually communal settlements. Our adaptation of ATLAS is presented in Supplementary Figure 2. For the purpose of our analysis, we further disaggregated the “Settlement” subclass into *Conventional* and *Communal* settlements. Lastly,

[1] Terra Legal titled (TLPL) is a higher hierarchy than settlements and conservation units. However, we chose to keep three duplicated entries, among which wrong ones had been deemed to be titled by the Terra Legal program. Thus, we kept 9272 km^2 of PAE Aripuanã-Guariba, 4238 km^2 of Parque Nacional do Acari, and 2220 km^2 of Resex Baratiri, discarding entries titled by Terra Legal.

the third data set used was obtained from the Project for Monitoring Deforestation in the Brazilian Amazon by Satellite (PRODES) of Brazil's National Institute for Space Research (INPE, 2021). These data are in shapefiles of cumulative deforestation up to 2007, yearly deforestation from 2008 to 2020, and deforestation from 2021 priority scenes (which cover the entire study area).

3.3. Defining Illegality of CAR land claims

The classification of land appropriations in accord with the law is set out in the decision tree in Figure 2. Following the above-mentioned laws, we label as "illicit" all CAR claims in protected areas (Indigenous lands, conservation units and military zones) that do not possess a CCIR, presumably based on prior occupation, and those known as Undesignated Public Forests as given by Article 4 of Law 11,952/2009. As per Article 4 of Law 11,284 of 2006, public forests can only be designated for the creation of conservation units, extractive communities, or low impact logging concessions, meaning they cannot become commercial agricultural ventures.

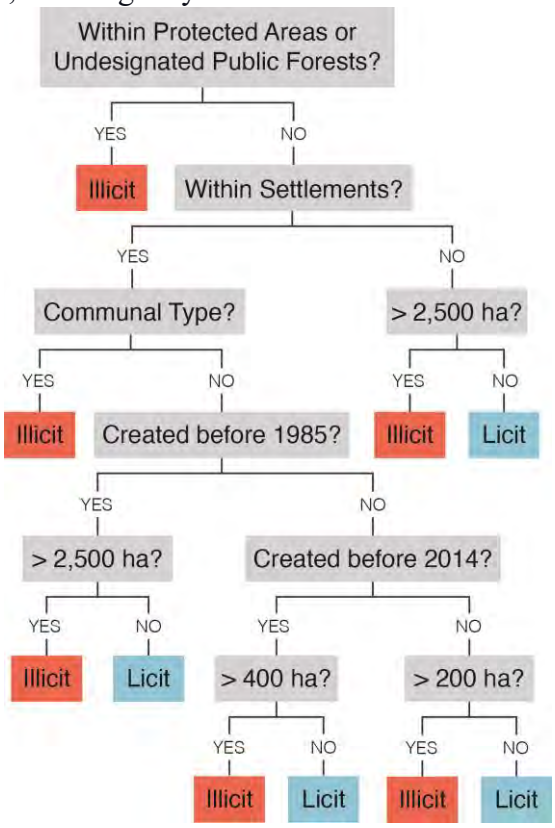

Fig. 2. Decision tree based on current legislation.

Also, to be considered licit a CAR claim must lie outside of communal settlements (INCRA, 2021a). If located in a conventional settlement the legality of a claim will depend on the date of creation of the settlement. A licit CAR claim cannot exceed two fiscal units[2] (or 200 ha in our

[2] Article 18-A of Law 13,001/2014 states that the area cannot exceed 2 fiscal modules. One fiscal module in southern Amazonas corresponds to 100 ha. Before 2014 this limit was 1 fiscal module, or 100 ha in the study area.

study area) if the settlement was created after 2014 (Law 13,001/2014). Law 13,465/2017, Article 40-A, as implemented by Decree-Law 10,952/2020, establishes that for conventional settlements created before 10 October 1985 the landholding is illicit if larger than 2500 ha. This law also states in Article 18-A that, for settlements created between that date and 22 December 2014, licit holdings can be up to 400 ha in area. In contrast, licit claims in UPLs can reach 2500 ha, beyond which they become illicit (Article 6, Item 1 of Law 13,465/2017).

3.4. Computational analysis for land illicitness.

We processed all geospatial data in ArcGIS Pro v.2.7.1, using the *Sistema de Referencia Geocéntrico para las Américas 2000 datum* (SIRGAS 2000) and projected universal transverse Mercator (UTM) planar coordinates. All calculated areas used the Albers conical equal-area projection to minimize area error. We merged CAR data from all seven municipalities to assess the total area covered as well as overlaps among CAR registries. The ArcGIS identity function was used to generate the frequency and area of CAR registries that overlapped each of land subclasses of the adapted ATLAS layer and their overlapped deforestation. We manipulated all tabular data in R v.4.01 (R-project) and exported summary tables. The table output was manipulated to represent the total area covered by CAR registries (the union of area when overlapped) in each ATLAS land class. We excluded CAR areas that overlapped titled private properties (34,361 km^2) and the water, urban, and roads classes (433 km^2). This left 64,642 km^2 of private claims to be analyzed.

Our computational approach is as follows. First, we combine the union of all CAR properties with the adapted ATLAS digital data. We identify as illicit any part of an individual claim or the union of competing claims that intersects an ATLAS subclass deemed inviolable, specifically conservation units, Indigenous lands, communal settlements, and Undesignated Public Forests. The union of all these intersections yields a total of 46,832 km^2, which represents the magnitude of land claimed in restricted areas, which is illicit by laws governing land-tenure and maximum-area thresholds. For the remaining UPLs (other than type B public forests), we combined the union of CAR records with information on claim area sizes and boundaries. If an individual claim presented no overlap, it is considered licit or illicit if the claim was $\leq$ 2500 ha or >2500 ha in area, respectively.

As for the situation with overlaps, consider an example with two claims. If both claims are >2500 ha, then the illicit area claimed is the union of the two claims. If only one of the claims is >2500 ha, then the size of the illicit claim associated with the overlap is the size of the larger claim. We used the same logic for conventional settlements, in which the thresholds were 2500 ha, 400 ha, or 200 ha, depending on the creation date of the settlement. No settlements were created after 22 December 2014 in the study area, and the licit thresholds used were therefore either 2500 ha or 400 ha. The PRODES deforestation data provide a classification of forest-loss area, which we used to determine total forest loss in the study area and in licit and illicit CAR claims.

3.5. Land Illicitness prior to 2014.

For the period prior to 2014 we used the same datasets and computational analysis presented above, except for changing the threshold values at which CAR land claims are considered licit. Here, our analysis of illicitness uses the thresholds of 100 ha for conventional settlements and 1500 ha for UPLs other than type B public forests, beyond which CAR land claims are deemed illicit. We also counted the number of CAR claims that were considered licit or illicit in

conventional settlements and in these UPLs, using the area thresholds of the old law (before 2014) and using the current area thresholds (after 2017).

3.6. Downsizing and elimination of settlement projects.

Two geospatial databases of settlement projects provided by INCRA on its public digital library (INCRA, 2020) were downloaded, one on 7 May 2015 (*see* Yanai et al., 2017), and the other on 20 November 2020. We calculated the difference in area per settlement of these two databases. We classified area changes of less than 1000 ha as "no change," an area increase of more than 1000 ha as "enlarged," a reduction of more than 1000 ha as "downsized," and those settlements that were missing in 2020 as "extinct."

4. Results and Discussion

4.1. Illegal land claims and associated deforestation

Our measurement of illicit CAR claims shows that the majority of the area of individual landholdings is non-compliant with Brazilian Law, as they are either in land-tenure classes for conservation or are larger than the limits on holding size. Figure 3 presents the licit and illicit CAR claims made in each of the federal land classes in the adapted ATLAS dataset and associated deforestation. The area of illicit holdings greatly exceeds licit ones, with 90.5% of the land claimed in the study area being non-compliant. Most of the area illegally claimed fell within UPLs (33.7%, or 21,811 km^2), of which over half of the area was in type B Undesignated Public Forests, three quarters of this area being in federal forests. The remaining area was in public lands not labelled as type B. The areas claimed in conservation units in both the "integral-protection" and "sustainable-use" categories (27,002 km^2) and in Indigenous lands (2620 km^2) aggregates to 45.8%; these claims are completely outside legal bounds (Fig. 4). Illicit CAR claims in settlements represented 10.9% of the area, 8.7% being in the communal type.

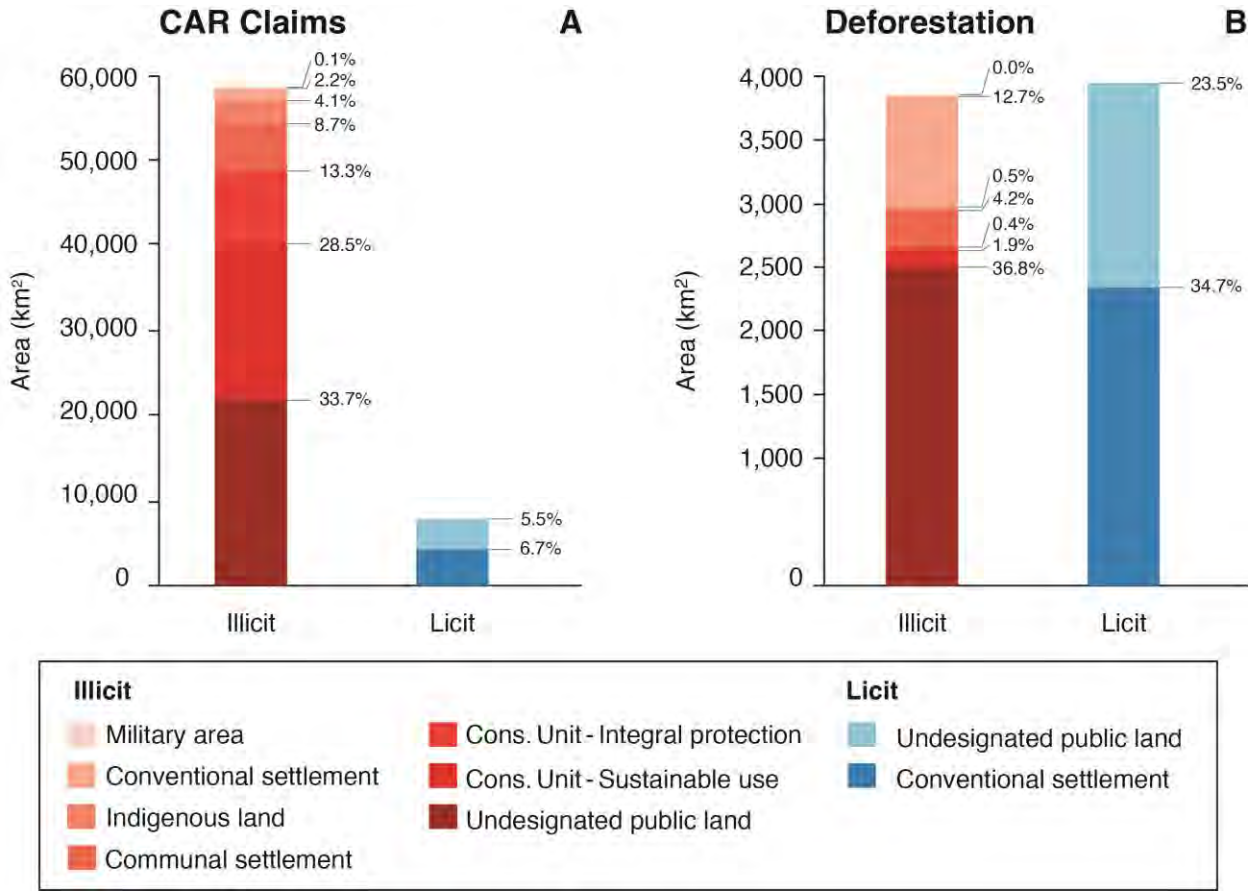

Fig. 3. Licit and illicit claims (A) and associated deforestation (B) by land-tenure subclasses. The total area of licit and illicit CAR claims is greater than the area analyzed by 2.7% due to overlaps between these. Thus, the percentages are calculated using the total area of CAR claims without overlap (64,642 km^2). The same applies to deforested area, where there is a 14.6% overlap between licit and illicit CAR claims, with a total of 6806 km^2 without overlap.

Sustainable-use CUs appear to be the preferred targets for land grabs in ATLAS categories that disallow land claims. Private interests have registered 18,437 km^2 of land in these categories in our study area. Encroachments into the study area's Indigenous lands are concerning because all but one had been "homologated" (officially confirmed by a higher authority) and declared part of the national patrimony prior to 2014, when the federal CAR registry was launched. Similarly, with the CUs: all were created before CAR registrations began, except for four in 2016 created to protect areas subject to illegal occupation north of the Transamazon Highway (BR-230) in Apuí, Novo Aripuanã, and Manicoré. These account for 15% of the CAR area registered in the study area's CUs.

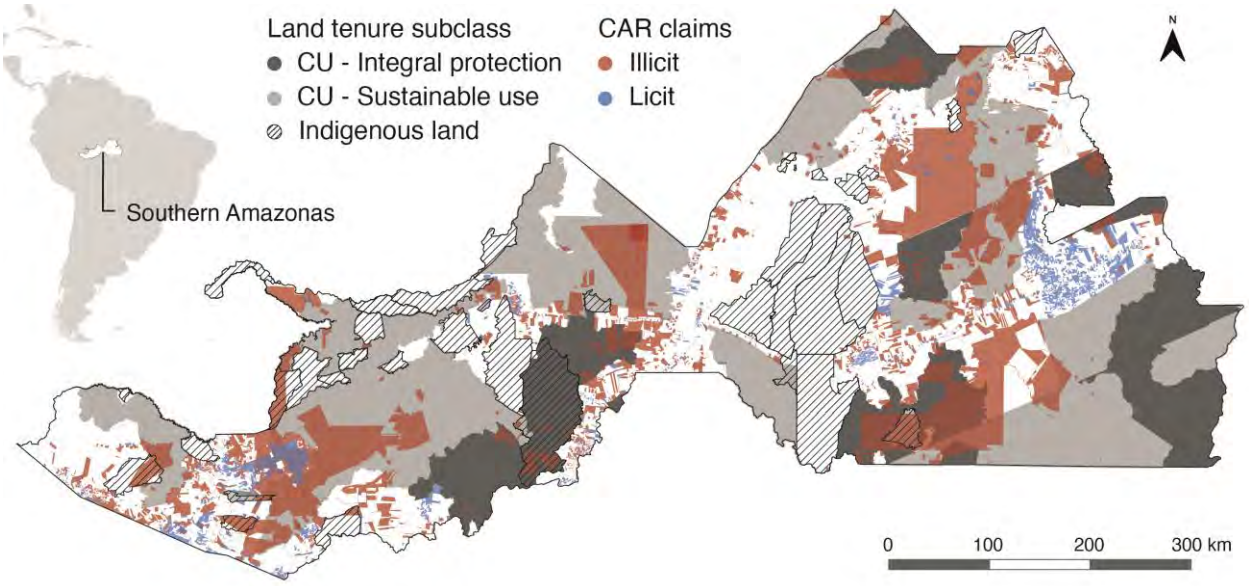

Fig. 4. CAR and protected area overlaps: areas in darker blue show overlap between licit and illicit CAR claims.

Cumulative deforestation by 2021 totaled 19,525 km^2 in the study area (INPE, 2021), of which 35% occurred on CAR claims, the rest being in private properties or in areas not registered in the CAR. As suggested, CAR provides a lower bound for the actual amount claimed, given that many land grabbers would in all likelihood prefer not to publicly reveal their illicit holdings. Although deforestation within CAR claims comprises around one third of the total amount, annual rates have been skyrocketing in southern Amazonas since 2014, when 373 km^2 were deforested compared to 1738 km^2 in 2021, the annual deforest rate almost quadrupling in seven years (INPE, 2021).

There has been a steady increase in the area of deforestation represented by polygons over 100 ha in area, including some that even exceed 1500 ha. Up to 2013, deforestation polygons with over 100 ha averaged 17% of the annual area cleared in southern Amazonas. Between 2014 and 2017 their percentage of the total area deforested increased to 40%, and to 52% between 2018 and 2021 (Supplementary Figure 3). Three out of nine deforestation polygons larger than 1500 ha (average = 2150 ha) cleared from 2019 onward were located within CAR claims. Each of these would be expensive to prepare, as much as US$ 367,650 given costs for clearance and sowing pastures seeds are US$ 171 per hectare[3] (Carrero et al., 2020). Such investments indicate that highly capitalized ventures are increasingly involved in land grabbing. The larger CAR claims in undesignated public lands tend to be located farther from the main road than smaller ones, and these landgrabbers therefore have a key role in pushing the deforestation frontier into the forest (Yanai et al., 2022).

Deforestation on CAR claims in protected areas totaled 190 km^2 by 2021, and average annual deforestation in 2019-2021 when compared to 2013-2018 increased by 167% in integral-protection and 170% in sustainable-use CUs, and by 41% in Indigenous lands (Supplementary Table 3). High deforestation rates are expected to continue due to corporate actors moving their

[3] Carrero et al. (2020) reported that costs of deforestation were 645 BRL per hectare in Apuí. By using the July 2019 average BRL/USD exchange rate (3.778), forest clearing costs ˜ US$ 171 per hectare.

operations to the region (Carrero et al., 2020; Yanai et al., 2020; BBC Brasil, 2021; Ferrante et al., 2021b). History tells us that whenever inflation increases, as is happening in Brazil now, investments in land acquisition also increase.

4.2. Rate of land-grab legitimization.

The legislative actions of Brazil's National Congress have facilitated private appropriation of public land. Specifically, illicit land holdings have been "grandfathered in" as licit ones by changes in land laws governing legal property sizes. These changes began to intensify in 2009 with a series of provisional measures (MPs) that were ultimately written into law. MPs are executive orders that are valid for 120 days. A Congressional coalition favoring agribusiness, the so-called "ruralists" (*ruralistas*), supported the changes, in addition to pardoning illegal deforestation and renegotiating landowner debts estimated at 906 billion BRL, or approximately US$ 268 billion at the time (Soares-Filho et al., 2014; OXFAM Brasil, 2016). MP 458 (now Law 11,952/2009), the first in this institutional campaign, established that private occupation of Amazonian public lands prior to 2004 could be titled upon meeting certain conditions. In 2014, Law 13,001/2014 doubled the amount of land that could be titled in a conventional settlement from 100 to 200 ha.

A pivotal legislative change came with MP 857 (now Law 13,465/2017), which modified over a half-dozen existing laws to ease the granting of land titles for illegally claimed or occupied land. Article 18-A doubled again the landholding limit for settlements created after 1985 to 400 ha, while Article 40-A extended the limit to 2500 ha for settlements created before 1985. Further, the maximum area permitted in UPL areas increased from 1500 to 2500 ha (Article 6, Item 1), extending the date to before 2008, and for all of Brazil. To estimate the "rate of legitimization," we apply the land laws of 2014 to all CAR registrations in 2017 to determine the areas that would have been considered "illicit" in 2014. This shows that 94.7% of the area under CAR registrations in 2017 would have been considered illicit before 2014 (Supplementary Table 4). This percentage drops to 90.5% for these same properties by 2017 because legal changes have reclassified 4.2% of the land that was illicit in 2014 to licit. For the study area, this translates into 901 $km^2\ yr^{-1}$. The number of illicit CAR registries was reduced by 94% between 2014 and 2017 thanks to loosening the requirements (Supplementary Table 5). Most of this change comes from CAR claims within conventional settlements created prior to 1985. Only the PA Rio Juma was created prior to this date in the study area. This PA has been the *locus* of land accumulation and sustains one of the highest deforestation rates of all Amazonian settlements (Carrero and Fearnside, 2011; Carrero et al., 2020). In terms of numbers, the law changes have legitimized 1114 CAR claims in PA Rio Juma, allowing the titling of these holdings if all other requirements are met.

4.3. Rates of settlement downsizing and elimination.

New lands were made available for appropriation as UPLs by either downsizing or entirely eliminating settlements in the study area. Supplementary Table 6 presents the area-change results, with two settlements being extinct, nine downsized, and four enlarged. The downsizing of the PAE-Aripuanã-Guariba, PA Rio Juma and PAE Antimary settlements, together with the elimination of PAF Curuquetê, accounted for ~91% of the total area lost, totaling a net area of 5266 km^2 for all settlements, or a rate of 1053 $km^2\ yr^{-1}$. Much of this land appears with CAR registrations and even titles, ~56% of which may be based on fraudulent documentation (Reydon et al., 2020). Although not part of our analysis, downsizing, extinction, and reclassification to a

lower conservation status affects protected areas in many parts of Brazilian Amazonia, primarily in the states of Rondônia and Pará. For example, as of November 2019, the Brazilian National Congress was entertaining 162 proposals to weaken the protection status of Amazonia's 15 most-heavily deforested Cus (WWF Brasil, 2019).

4.4.Land policy looking forward

President Jair Bolsonaro took office in January 2019 and immediately began dismantling environmental agencies, surveillance systems, and environmental licensing procedures (Ferrante and Fearnside, 2019; Vale et al., 2021). On 10 December 2019, he issued MP 910, which granted "amnesty" to illicit appropriations between 2008 and 2014, with the "amnesty" extending up to 2018 if the claim was purchased from an individual (Sauer et al., 2019). This MP was the foundation for proposed law PL 2633/2020, known informally as the "land grabbers' law" (*lei da grilagem*) (Fearnside, 2020). Although COVID-19 interrupted the approval of the land grabbers' law that year, Congress passed Decree-Law 10,592 in December 2020, which incorporates some of its elements and allows georeferencing to be completed by claimants without government supervision or on-site inspection before titling.

The campaign to approve laws that facilitate land grabbing has been in full swing since the 1 February 2021 congressional elections, as the new presidents of both the Senate and the Chamber of Deputies are aligned with the "ruralists" of the Agribusiness's Parliamentary Front (FPA) (Ferrante and Fearnside, 2021). The FPA's main goals include the passage of these and other PLs that will continue the weakening of environmental-licensing procedures and the downsizing of protected areas and Indigenous lands to unleash infrastructure expansion and attract investment. On 15 April 2021, another blow to Amazonian conservation was struck when the Brazilian Senate passed a bill (PL 4348/2019) increasing the limit for land titling in any settlement to 2500 ha (Senado Federal, 2021a). The Chamber of Deputies now must approve the Senate's modified text. The last report (dated August 2021) considers a vote on this bill to be an urgent matter, and it is likely to be approved (Câmara dos Deputados, 2021). This bill makes available ~206,000 km^2 of settlement lands in Brazil that will "legalize" illegal land acquisition and land concentration in areas once designated for small-scale farming as part of agrarian reform initiatives[4].

The landgrabbers' law (PL 2633/2020) approved by the Chamber of the Deputies was delivered to the Senate in August 2021, where another bill of similar content, PLS 510/2020 (Senado Federal, 2021b), was already under review. They are now being discussed together as a single measure (*apensadas*), and so far, have received 179 amendments that make it even more permissive than originally approved in the Chamber of Deputies, in light of the substitute text proposed by the joint commissions of Environment and Agriculture and Agrarian Reform of 8 December 2021 by Senator Carlos Fávaro (Senado Federal, 2021c).

Both PL 2633/2020 and PLS 510/2020 modify a series of earlier laws, especially Law 11,952 of 2009. As per the last report by Senator Carlos Fávaro, the PLs will boost the legitimation of grabbed lands as never before for three reasons. First, they will not only allow the legalization of undesignated public lands up to 2500 ha if occupied before 2017 (Article 38, Item I, Paragraph II) but they will also open any UPL to public bidding if there is no "social interest" giving

[4] This estimate was calculated by applying provisions of the bill approved in the Senate on 15 April 2021 to substitute PL4348/2019 (Senado Federal, 2021a) to the INCRA's database of settlements (INCRA, 2021b).

preference to the current holder (Article 38, Item II). That is, all UPL land grabs can be legitimized independent of the time of occupation if there is agricultural production and no social or public interest involved. This means that it will legalize an unconstitutional and illegal procedure of public-land destination because it allows the titling of type B undesignated public forests. Our estimate for southern Amazonas is that illegality will be reduced from 90.5% to 80.5% if CAR claims smaller than 2500 ha become legitimized within type B undesignated public forests. Second, they will grant titles up to 2500 ha based on self-declaration with no on-site inspection, which increases the risk of more conflicts regarding land tenure. And finally, the PLs will allow the titling of lands with recent deforestation and would postpone requirement of environmental compliance, as it would accept the CAR registration as a proof of commitment to the environmental laws.

Our specific recommendation is that these proposed laws should be rejected, as should any future proposals to legalize illegal land claims. As a land-use policy, legalization of these claims is a formula for a never-ending cycle of further deforestation with environmental consequences that are both disastrous for Brazil's national interests and for global climate and biodiversity concerns. Blocking the pending legislation is urgent, as in January 2022 the current president of Brazil's Senate let it be known that he plans to have these bills voted and approved in the coming months, and his staff have stated that this is part of his strategy to bolster support for his candidacy in the October 2022 elections for the Brazilian presidency (Machado, 2022). The legalization of illegal land claims and the enactment of progressively more lenient processes for this legalization encourage ever more land grabs, as potential land grabbers correctly see that what is illegal today will be legalized tomorrow and that those who violate land laws will be rewarded in the end. Brazil's current legislation already provides for regularizing the land tenure of small farmers who are long-term residents in the Amazonian interior. What is in question here is the legalization of the many claims, both large and small, that have been proliferating as actors move into undesignated public lands. Brazil must adopt a hardline policy of not legalizing these illegal claims and of removing and punishing those who have breached current laws.

5. Conclusion

The various legislative initiatives presented here forecast a dark future for Amazonia's natural and cultural heritage, particularly as the IIRSA program and regional infrastructure construction gather momentum. They represent an enormous transfer of wealth by paving the way for a concentration of public resources in the hands of a few. Further, the institutional mechanisms transforming illicit into licit landholdings and the provision of more public lands by the downsizing and elimination of settlements and protected areas will stimulate higher deforestation rates if left unchecked. Land grabbing, land speculation and deforestation can be expected to increase even more in a scenario of inflation. Because one of the prime objectives of IIRSA and Brazil's current administration is to expand Amazonia's agricultural and ranching economy, international trade agreements offer an avenue for countering the institutional and investment pressures now building throughout the Amazon. Importers of beef and soybeans should pay attention to recent changes in the legal status of the land that produces these and other commodities. If exports are required to originate from holdings that were licit before the weakening of the laws governing land appropriation, a key deforestation driver would lose its force.

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Land-Grabbing surge in the Brazilian Amazon: Stealing public land with government approval

Supplementary Material

Content

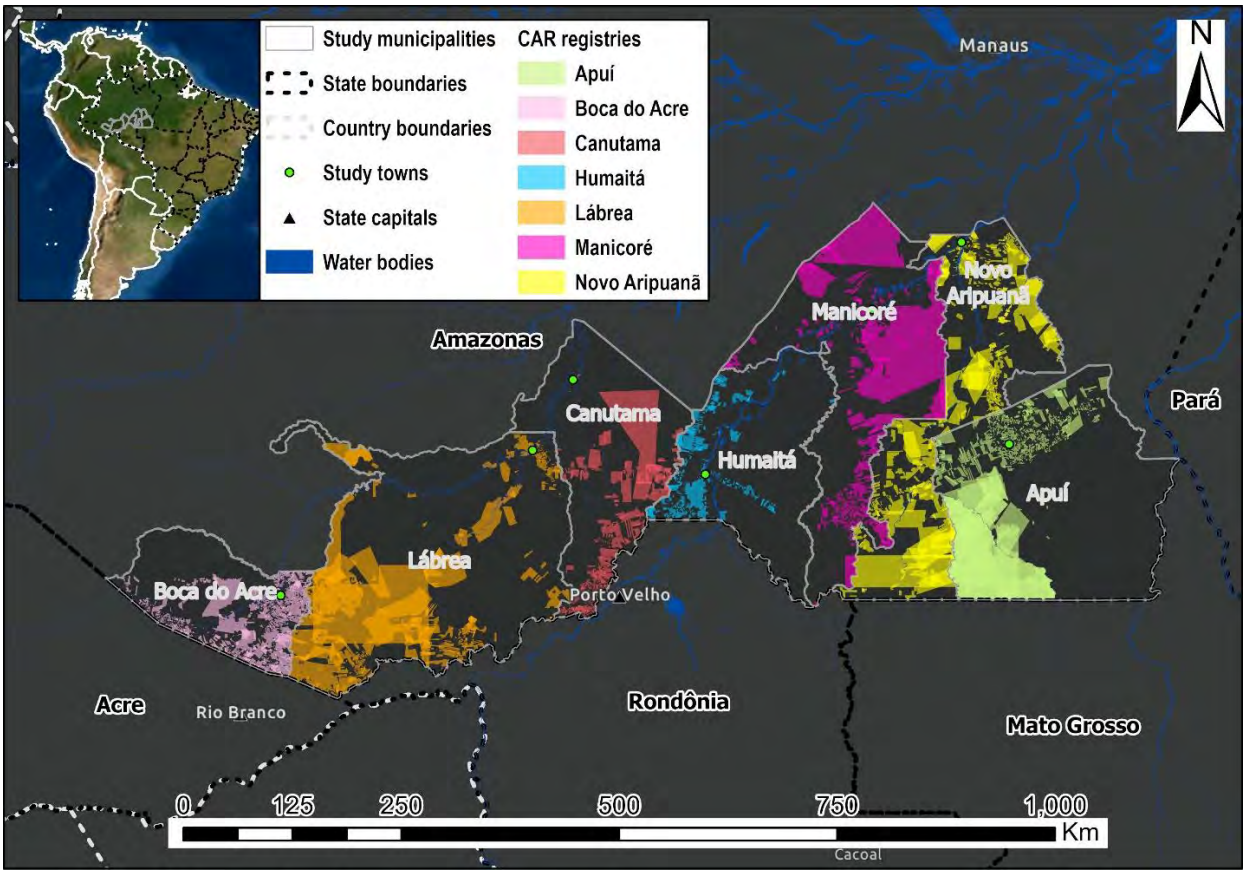

Figure 1. Landholdings declared in the CAR registry. The lighter the color hue, the greater the overlap between CAR records.

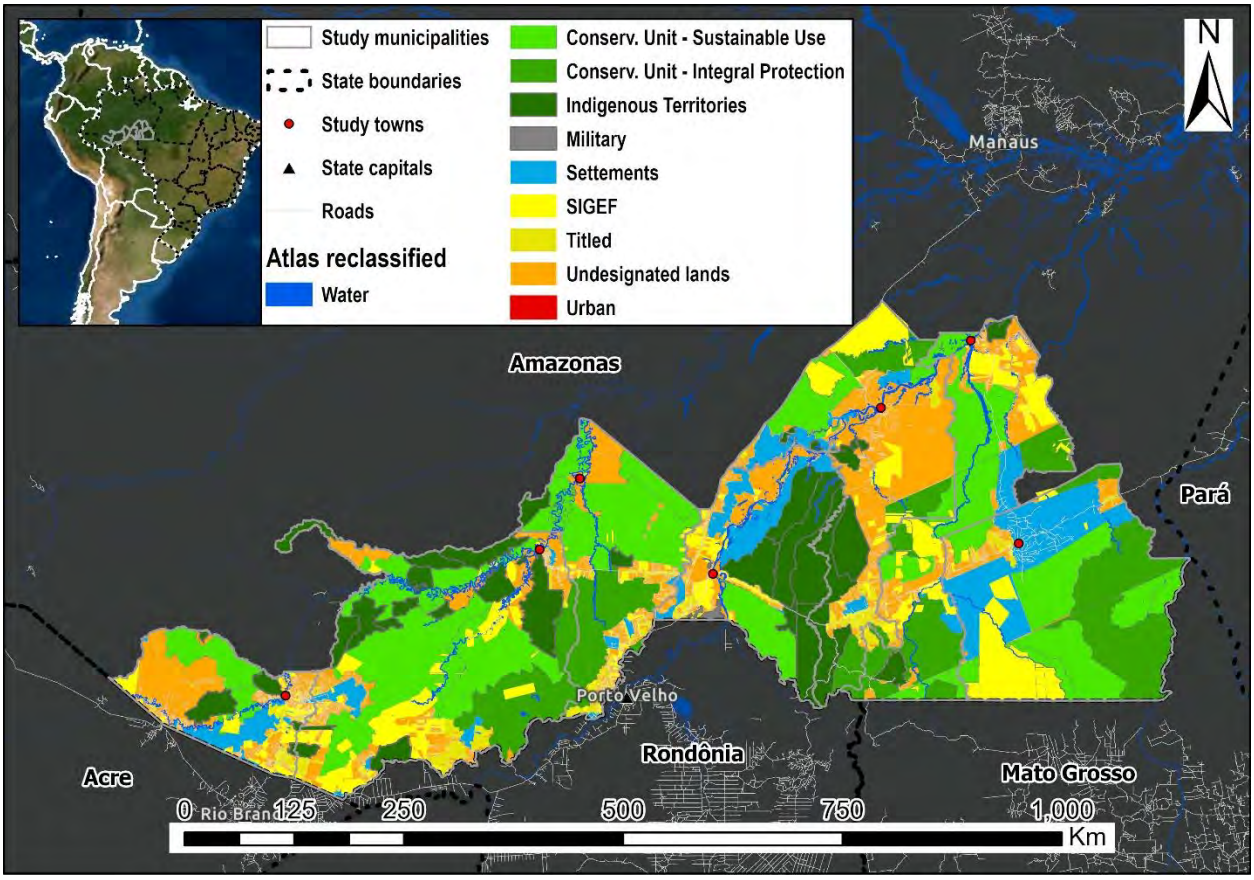

Figure 2. ATLAS corrected for overlapped areas and with reclassified and grouped sub-classes.

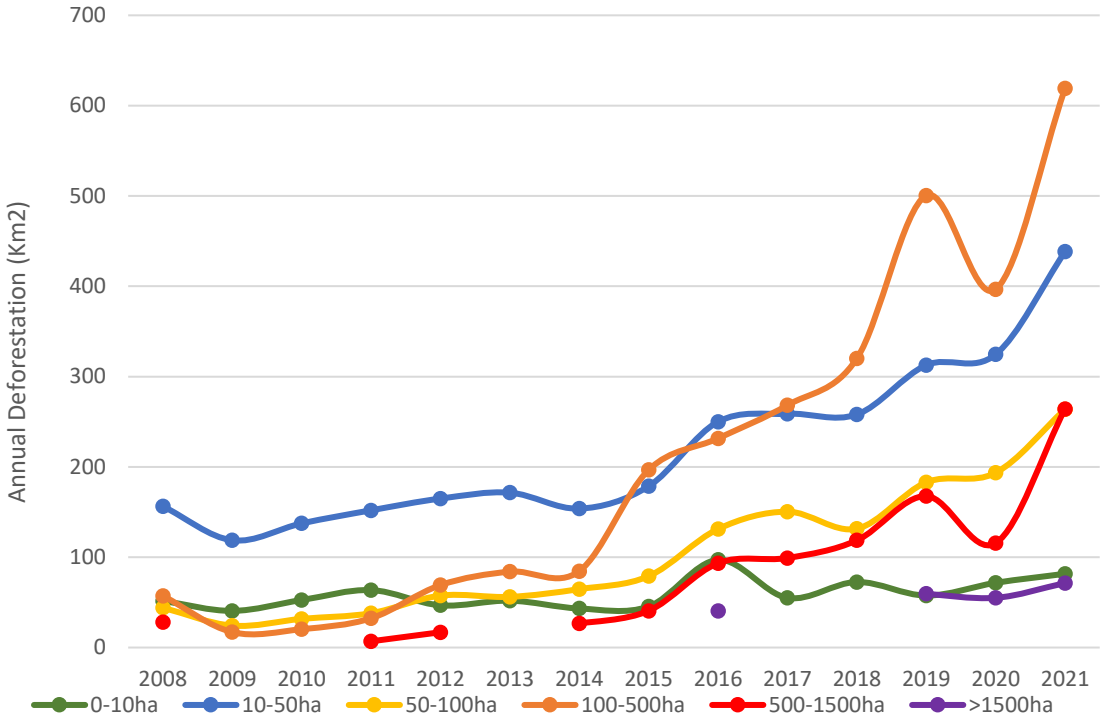

Fig. 3. Annual deforestation in the seven municipalities of southern Amazonas classified by area of clearing (polygon size). Source: INPE (2021) (http://www.terrabrasilis.dpi.inpe.br/app/dashboard/deforestation)

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Table 1. Land Classes and Subclasses reclassified from the ATLAS

Class	Sub-class	Number	Area (km^2)	Percentage
Public -Protected Areas	**Conservation Unit-Sustainable Use**	26	83,119	28%
	Conservation Unit-Integral protection	10	47,181	16%
	Indigenous land	23	38,880	13%
	Military	1	397	0.1%
	Sub-Total	**60**	**169,577**	**56%**
Public - Settlements	**Conventional (PA/PAD)**	14	10,447	3%
	Communal (PAE, PDS)	19	16,117	5%
	Sub-Total	**33**	**26,564**	**9%**
Public - Other	**Undesignated Land**	**-**	**59,526**	**20%**
Private	**SIGEF**	1,799	33,549	11%
	Titled	3,780	7,722	3%
	Sub-total	**5,579**	**41,271**	**14%**
Water, transportation, urban areas			**3,751**	**1%**
Total		**-**	**300,689**	**100%**

Sources: Area (Atlas Agropecuário 2020 - (http://atlasagropecuario.imaflora.org/).

Table 2. CAR records and areas (ha) without and with overlap by municipality in southern Amazonas.

Municipality	Without Overlap		With Overlap		Overlap %
	CAR Records	Area (km^2)	CAR Records*	Area (km^2)	
Apuí	1,667	16,436	1,711	44,319	170%
Boca do Acre	3,349	7,065	3,397	8,358	18%
Canutama	1,550	8,873	1,574	9,834	11%
Humaitá	856	3,200	866	3,624	13%
Lábrea	3,082	24,658	3,158	34,078	38%
Manicoré	1,250	19,482	1,297	20,913	7%
Novo Aripuanã	1,945	19,656	2,031	27,553	40%
Total	**13,669**	**99,371**	**14,034**	**148,678**	**50%**

Source: SICAR (http://www.car.gov.br/publico/municipios/downloads)
* CAR records with overlap that encompass two or more municipalities are counted for each municipality.

Table 3. Average annual deforestation (hectares) in CAR claims within protected areas.

Year	Military	Indigenous Land	CU- Integral Protection	CU - Sustainable Use	Total
2007	52	2080	1835	10324	14290
2008	14	70	300	611	995
2009	0	59	39	321	419
2010	7	48	12	147	213
2011	0	64	15	221	299
2012	8	111	64	36	219
2013	0	31	28	101	160
2014	0	88	16	27	132
2015	0	25	40	98	163
2016	0	114	11	95	219
2017	2	65	0	206	272
2018	16	126	0	136	278
2019	11	109	0	254	375
2020	7	83	23	89	203
2021	0	123	104	552	778
Total	117	3,196	2,486	13,217	19,016
Average 2013-18	3	75	16	111	204
Average 2019-21	6	105	42	298	452
Increase percentage	103%	41%	167%	170%	121%

Table 4. Licit and Illicit areas of CAR claims by government land subclass using land laws prior to 2014.

CAR Claims	Licit		Illicit	
	Area(km^2)	Percentage	Area(km^2)	Percentage
Conventional Settlement	2,094	3.2%	3,504	5.4%
Undesignated Public Lands	2,852	4.4%	22,370	34.6%
Communal Settlement		0.0%	5,645	8.7%
Indigenous Land		0.0%	2,623	4.1%
Cons. Unit - Integral Protection		0.0%	8,571	13.3%
Cons. Unit - Sustainable Use		0.0%	18,433	28.5%
Military Area		0.0%	90	0.1%
Total Area	**4,946**	**7.7%**	**61,235**	**94.7%**
Total area analyzed	64,642			

Table 5. Comparison between licit and illicit number of CAR claims by government land subclass using land laws prior to 2014 and after 2017.

Laws	CAR Claim	Licit	Illicit	Total	Reduction of illicitness from 2014 to 2017
Before 2014	Conventional Settlement	3,235	1,179	4,414	
	Undesignated Public Lands	5561	78	5639	
	Total	8,796	1,257	10,053	
After 2017	Conventional Settlement	4,379	35	4,414	97%
	Undesignated Public Lands	5,561	46	5,639	41%
	Total	9,940	81	10,053	94%

Table 6. List of area changes in settlements from 2015 to 2020 in southern Amazonas

Settlement Name	Area 2015 (ha)	Area 2020 (ha)	Difference (ha)	Change type
PA Acari	150,552	182,374	31,822	enlarged
PA Bandeirante	2,523	2,561	38	none
PA Joana D Arc I	11,265	11,354	89	none
PA Matupi	34,926	34,942	16	none
PA Monte	113,192	111,560	-1,632	downsized
PA PAciá	2,849	10,500	7,652	enlarged
PA Porto Alonso	3,861	3,948	87	none
PA Rio Juma	749,395	665,724	-83,671	downsized
PA Santo Antonio Do Peixoto	8,377	8,458	82	none
PA São Francisco	19,212	19,205	-7	none
PA Tocantins	8,771	8,889	117	none
PA Umari	9,389	9,815	426	none
PAD Pedro Peixoto	1,088	1,225	137	none
PAE Antimary	276,195	222,230	-53,965	downsized
PAE Aripuanã-Guariba	1,054,574	701,132	-353,442	downsized
PAE Baetas	38,800	38,486	-314	none
PAE Botos	101,480	91,189	-10,292	downsized
PAE Floresta Do Ipixuna	29,597	29,594	-4	none
PAE Fortaleza	26,793	26,922	129	none
PAE Jenipapos	40,180	48,537	8,356	enlarged
PAE Lago Do Acará	108,293	108,293	0	none
PAE Matupiri	9,652	7,986	-1,666	downsized
PAE Novo Oriente	18,525	19,424	898	none
PAE Onças	9,462	9,837	374	none
PAE Rio Açuã	13,237	13,304	67	none
PAE Santa Fé	4,772	4,824	52	none
PAE Santa Maria Auxiliadora	35,367	36,112	745	none
PAE São Benedito	77,670	59,861	-17,808	downsized
PAE São Joaquim	193,013	202,103	9,090	enlarged
PAE Terruã	3,204		-3,204	downsized
PAE Uruapiara	40,924	41,293	369	none
PAF Curuquete	40,905		-40,905	extinct
PAR Mário Lobão	14,920		-14,920	extinct
PDS Gedeão	11,353	6,918	-4,435	downsized
PDS Realidade	43,789	42,937	-852	none
Total	**3,308,109**	**2,781,539**	**-526,570**	