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Land grabbing on Brazil's Highway BR-319 as a spearhead for Amazonian deforestation

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Abstract: Brazil faces its greatest period of environmental setback, where "ruralists" (large landholders and their representatives) gain access to government land in the Amazon. New roads are being paved, such as Highway BR-319 connecting Porto Velho in Brazil's notorious "arc of deforestation" to Manaus in relatively intact central Amazônia. This highway acts as a spearhead penetrating one of the Amazon's most preserved forest blocks. Here we report how land grabbing *(grilagem*) is associated with illegal logging in the Amazon on one of the new frontiers of illegal logging in Amazonas via the BR-319 highway. Evidencing the illlegality, lack transparency and control of the territorial order that allows access to public lands through a consolidated invasion with environmental infractions such as illegal logging and deforestation in a lawless landThis is not just a process linked to the highway, as it also involves the actions of government agencies such as the National Institute for Colonization and Agrarian Reform (INCRA). Illegal logging is rampant and areas of government land are being marked out by land grabbers (*grileiros*) for illegal sale to arriving migrants. In addition to poor control and inspection by the agencies, which do not receive funding to perform their functions, the legal process despite environmental legislation requiring an environmental impact assessment (EIA) for "Lot C." which is one of stretches where deforestation is advancing on public land, a judge has authorized paving this stretch without an EIA while deforestation advances, against the proper environmental legislation. Opening BR-319 and its associated side roads represents a path with no return to a tipping point of self-degradation and loss of Amazonia's vital biodiversity and climate-stabilization functions under lack of assistance from scrapped territorial and environmental control agencies

Keywords: Amazon rainforest; conservation units; Indigenous lands; land-use policy; land invasion; land titling; environmental impact; environmental legislation; road ecology; tropical forest

Introduction

Amazonia threatened by Brazil's president

Brazil's current presidential administration has weakened and dismantled environmental and Indigenous agencies to favor "ruralists" (large landholders and their representatives) (Ferrante & Fearnside, 2019). Pressures have increased on the Amazon, where longstanding threats, such as cattle ranches (Fearnside, 2005), soy plantations (Fearnside, 2001), mines (Sonter et al., 2017; Ferrante & Fearnside, 2020a) and hydroelectric dams (Lees et al., 2016) are augmented by plans for new roads and monoculture expansion for large-scale biofuel production (Ferrante & Fearnside, 2018, 2020b). President Jair Bolsonaro took office on 1 January 2019, and between January 2019 and January 2020 deforestation in Brazilian Amazonia increased 74% compared to the same period in the previous year (Fonseca et al., 2020). Annual deforestation rates during the Bolsonaro administration exceed the annual deforestation rates observed in the biome over the last 12 years (INPE, 2021), reflecting the reversal in the public policies for protection of the Amazon.

President Bolsonaro has claimed that foreigners, especially Chinese, are planning to occupy the Amazon, and this argument has been central to justifying his own plans to occupy the region by building roads and stimulating agribusiness (Dias, 2019). The president's discourse has stimulated illegal deforestation, burning, invasions of conservation units (protected areas for biodiversity) and Indigenous lands, as well as attacks on environmental inspection agents (Ferrante & Fearnside, 2019, 2020a; Hanbury, 2019; HRW, 2019). COVID-19 and militarization of environmental control now provide smokescreens for these events (Ferrante & Fearnside, 2020c). A boom in the market for bulldozers indicates a scenario of more deforestation ahead due to the expansion of agribusiness (ClimaInfo, 2020). Cumulative deforestation in Brazilian Amazonia has already reached a level that is approximately at the limit that the forest can tolerate without crossing a "tipping point" leading to environmental collapse (Lovejoy & Nobre, 2018; Walker, 2021).

Land grabbing

A series of measures that facilitate land grabbing has been promoted by Brazil's president with support from the ruralist voting-block in the National Congress (See Supplementary Material). "Land grabbing" (*grilagem*) in Brazil refers to illegal appropriation of large areas of government land (almost always under Amazon rainforest), after which these areas are often "regularized" (frequently by corrupt means) and, with or without "regularization," the areas are usually later subdivided and sold (Brito et al., 2019). Note that this differs from the use of the term in Africa or Asia, where "land grabbing" refers to buying up of local agricultural land by foreign interests for export crops (Oliveira et al., 2021). In Brazil, land grabbers (*grileiros*) often hire gunslingers (*pistoleiros*) to violently expel any small farmers or other claimants (Fearnside, 2008).

On 10 December 2019 President Bolsonaro issued a provisional measure (MP-910), which allowed legalizing land claims up to 15 fiscal modules (1500 ha in Amazonia) through a mere "self-declaration" of ownership and, with the exception of special cases where there are indications of infractions, without any form of on-site inspection (PR, 2019). This has the effect of legalizing "land grabbing" in the Amazon (Branford & Borges, 2019). MP-910 was in effect for 120 days, after which the provisional measure was transformed into a proposed law (PL-2633/2020) (Câmara dos Deputados, 2020). When passed, this will be the third "land grabbers' law," the first two, in 2004 and 2017, having successively eased the restrictions on regularizing illegal land claims (Fearnside, 2020). Rodrigo Maia, the president of the Chamber of Deputies who allowed MP-910 to expire, did not allow either this bill or the bill (PL-191/2020) submitted to the National Congress by President Bolsonaro that would open Indigenous lands to mining, dams and agribusiness to be brought to the floor for a plenary vote. This suddenly changed on 1 February 2021 when the presidencies of both houses of the National Congress were won by the "Centrão" coalition of political parties that supports Bolsonaro on issues related to the "ruralist" agenda, making rapid approval likely (Ferrante & Fearnside, 2021). Similarly, a bill in the senate (PL-510) is moving forward that would also legalize claims based on self-declaration and without inspection (Senado Federal, 2021). The maximum area that can be legalized per claimant has successively increased: from 100 ha to 1500 ha in 2009 and to 2500 ha in 2017 (Fearnside, 2021).

Highway BR-319 a spearhead for Amazonian deforestation

One of the ways to give access to land for expansion of agribusiness in the Amazon is reconstruction of Highway BR-319 connecting Porto Velho in the state of Rondônia, to Manaus in the state of Amazonas, thus linking the "arc of deforestation" to vast areas of intact forest (Ferrante & Fearnside, 2019, 2020d; Mataveli et al., 2021; Andrade et al., 2021; Ferrante et al., 2021). The highway was built in the early 1970s and abandoned in 1988. A proposed reconstruction of the "middle section" of the highway has yet to be approved – a first environmental impact assessment (EIA) was submitted in 2009 and rejected as completely inadequate, and a second EIA was submitted in 2020 and is rapidly progressing towards approval under strong political pressure. In 2014 a means of circumventing the EIA requirement was found that would allow a "maintenance" program for the road; the program has made the road passable, although not paved, and has caused a substantial environmental impact (Fearnside, 2018). The "maintenance" program was announced in 2014 and began in practice in 2015 (Meirelles et al., 2018). In practice, this program is not restricted to "maintenance," having also replaced bridges with new ones compatible with the planned reconstruction and upgraded the road in various ways that facilitate migration of deforestation actors. Bus service between Manaus and Porto Velho was reestablished in 2017, with the exception of the rainiest months.

It has been estimated that BR-319 and planned side roads will generate an increase of the deforested area by more than 1200% by 2100 in the region between the highway and Brazil's border with Peru (dos Santos Júnior et al., 2018). The planned AM-366 road would connect to BR-319, opening this "Trans-Purus" region to entry of land-grabbers and other actors (Fearnside et al., 2020). AM-366 would traverse a vast area of undesignated public land (*terras devolutas*), which is the category that is most vulnerable to land grabbing (Azevedo-Ramos et al., 2020). The 15 December 2020 approval by the Brazilian Senate of a proposed law allowing foreign companies and individuals to buy rural land (Senado Federal, 2020) could further increase pressure on this critical area.

Reconstructing the highway was a campaign promise by then presidential candidate Bolsonaro (Ferrante & Fearnside, 2019). BR-319 was abandoned due to lack of economic viability, and it still lacks an economic-viability study (EVTEA). The reconstruction project also lacks the consultation with Indigenous peoples required by International Labour Organization (ILO) Convention 169 and by Brazilian Law No. 10,088/2019 (formerly No. 5051/2004), with at least 63 officially recognized Indigenous lands impacted (Ferrante et al., 2020a). Two sections of the highway are to be reconstructed: the "middle section" (km 250 to km 655) and "Lot C" (km 198 to km 250). On 5 August 2020 DNIT submitted the EIA for the "middle section" of Highway BR-319 to IBAMA, and, after analyzing the report, IBAMA requested complementary information in February 2021. DNIT announced that it would have this information by the end of March, and, although delayed, the process will undoubtedly be completed soon.

Unlike the "middle section," the "Lot C" stretch never had an EIA prepared, despite a unanimous court decision on 15 December 2014 that an EIA is constitutionally required for this section (TRF-1, 2015). On 28 January 2019 a judicial decision rejected a request by DNIT to remove the embargo on reconstructing "Lot C" without an EIA (TRF-1, 2019). Nevertheless, on 24 June 2020 DNIT opened bidding for reconstructing "Lot C" (DNIT, 2020), and on 20 August a judge rejected a request to suspend the bidding made by the Federal Public Ministry (Campinas, 2020). The Federal Public Ministry is a public prosecutor's office created by Brazil's 1988 constitution to defend

the rights of the people, including the right to an "ecologically balanced environment." DNIT's simply ignoring the requirement for an EIA was characterized by the Federal Public Ministry as being in "bad faith" (Ferrante & Fearnside, 2020d). On 30 June 2020 the Federal Public Ministry submitted a suit requesting the court to halt the bidding for "Lot C" (JF, 2020), but the case languished in the hands of one of the judges, a contract was signed with a construction firm in December 2020, and finally on 1 March 2021 a decision was rendered upholding the original prohibition of reconstructing "Lot C" without an EIA, thus suspending the construction contract (Campinas, 2021; TRF-1, 2021). Coincidentally the decision was rendered just 10 days after a publication by the present authors (Ferrante et al., 2021) exposing this situation. Politicians in Manaus were vociferous in criticizing the judge responsible (Elander, 2021), and on 7 April 2021 the head of Brazil's Superior Court of Justice reversed the decision and allowed reconstruction of "Lot C" to go forward (STJ, 2021).

The 7 April 2021 decision releasing the reconstruction of "Lot C" was given by Judge Humberto Martins, who maintains a close relationship with the Bolsonaro family, and on 23 April 2021 one of the president's sons revealed in an interview that Martins is one of the two top candidates to be Bolsonaro's appointee to fill a seat on Federal Supreme Court that will become available on 5 July 2021 (Carvalho & Giovanaz, 2021). Among his decisions favorable to the Bolsonaro family, Humberto Martins requested, on his own initiative, an investigation into the "disciplinary conduct" of the judge who is responsible for prosecuting the "Queiroz" case, which is one of the biggest corruption scandals surrounding the Bolsonaro administration and the president's family (Onofre, 2020). As a prominent campaign promise, reconstructing Highway BR-319 is a personal priority for president Bolsonaro (Ferrante & Fearnside, 2019).

The motivations for judicial support for circumventing environmental legislation are unknown. Coincidentally, judge Martins justified his decision using the same fallacious talking points that have been employed by politicians in Manaus, such as that the highway is urgently needed to allow oxygen transport to Manaus in the COVID-19 pandemic (STJ, 2021). The political convenience of blaming the January 2021 oxygen crisis in Manaus on the lack of BR-319 is clear, as this argument frees the local authorities of responsibility for not having arranged in a timely manner for oxygen shipments by the normal freight route (barges coming up the Amazon River from Belém) despite having over two months' notice that oxygen supplies would be insufficient (Fearnside et al., 2021).

The judicial decision granting clearance for reconstructing and paving "Lot C" without an EIA was based on the argument that lack of the road represents a serious harm to public order, security, economy and health (STJ, 2021). The data from the present study show that these justifications are fallacious, since the "maintenance" program and the promise of paving have increased environmental crimes and the insecurity of traditional peoples in the areas affected by Highway BR-319. Invasion of the Apurinã do Igarapé São Jorge Indigenous Land and an illegal side road crossing the Apurinã do Igarapé Tauamirim Indigenous Land are examples (Fearnside et al., 2020a), as is an illegal side road from BR-319 entering an extractive reserve used by the Mura Indigenous people (Fearnside et al., 2020b).

The economic justification is also fallacious, since economic and logistical studies show that transporting freight to São Paulo by Highway BR-319 would be more expensive than other modes (Teixeira, 2007; Fleck, 2009). The public-safety argument is contradicted by the illegal deforestation that has increased along the highway as the road has become more passable, as we show in this paper. Improvement of the highway has also been accompanied by increasing illegal logging (Andrade et al., 2021). This is

also a factor that impacts industry according to the Federation of Industries of the State of Amazonas (FIEAM) (MPF, 2020).

The justification for reconstructing the highway to guarantee public health is not supported, since expenditure on the highway would be much higher than the cost of improving the health systems in the municipalities (counties) along the highway. Paving the highway does not ensure conditions for improvement of the health system. The precarious state of public health systems in municipalities that are interconnected by highways in the Amazon is well known (Sawyer, 2001).

The present study aims to show that the current lack of enforcement of environmental and Indigenous legislation and the overturning of judicial decisions requiring environmental studies for both sections of Highway BR-319 that are planned for reconstruction make this highway a spearhead for deforestation in one of the most preserved regions of the Amazon. Land grabbing, which is already underway, is central to this deforestation process.

Methods

To assess deforestation along Highway BR-319 we used data from the Deforestation Monitoring Project in the Brazilian Amazon (PRODES) of Brazil's National Institute for Space Research (INPE, 2021) for buffers of 40 km and 150 km on each side of the road for the "middle section and "Lot C" (Figure 1A). To test whether Highway BR-319 influences deforestation we compared the annual deforestation rates in the Brazilian Amazon as a whole with the rates in the two buffers. Comparison with Brazilian Amazonia as a whole allows the effect of the highway to be differentiated from the region-wide variations in deforestation rate stemming from economic and other factors. We standardized the annual deforestation rate for each of the three categories (Brazilian Amazon, 40-km buffer and 150-km buffer) in relation to the area of each category, creating an index of deforestation proportional to the area. The trends in deforestation rates for each area were quantified by linear regression and the slopes of the regression lines were compared using the t-test. This allows determining whether the change in deforestation rate with time in the three categories differed during the period since the BR-319 "maintenance" program began in 2015. Deforestation in this period would have influence from both the "maintenance" program itself and the promise of reconstructing and paving the highway. Deforestation along BR-319 in this period would reflect the land grabbing and migration that have been stimulated by improved access and by the political promises of highway reconstruction.

We documented 14 sites of illegal deforestation on the "middle section" of Highway BR-319 that we observed *in loco* in 2019 (Figure 1B), and we compared these observations with public data from the Land-Tenure Network (*Malha Fundiária*) database of the National Institute of Colonization and Agrarian Reform (INCRA) and with and the agency's Land-Tenure Management System (SIGEF: *Sistema de Gestão Fundiária*) and the Rural Environmental Registry (CAR). The INCRA land-tenure database consists of information from the titling and regularization process (georeferencing, registration in the SIGEF, an INCRA evaluation and a "descriptive memorial" that includes data on applicants and supervisors). Our understanding of the land-occupation process and possible land conflicts also comes from informal conversations with actors active in deforestation and land grabbing, in addition to community members of traditional and Indigenous populations in or near the affected areas.

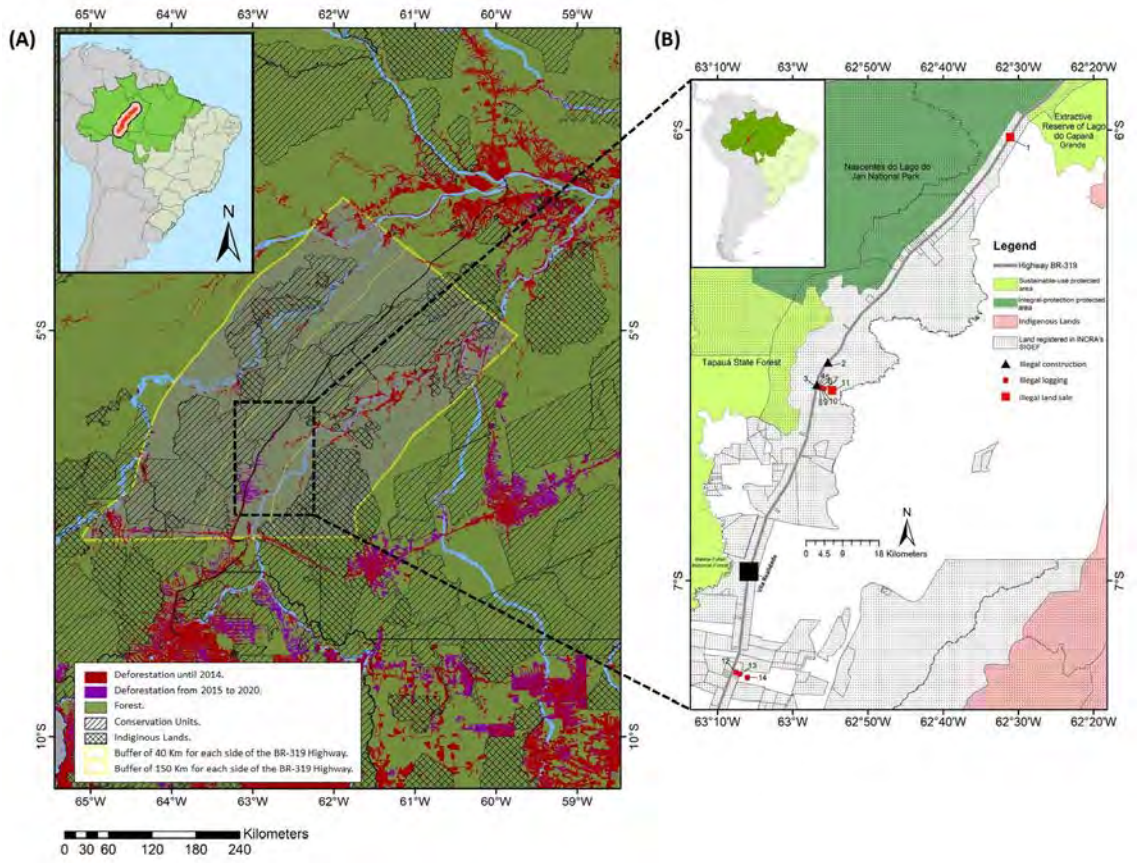

Figure 1. (A) Cumulative deforestation along Highway BR-319 from 1988 to 2020 (PRODES data). Deforestation in red represents cumulative deforestation from 1988 to 2014 before the highway "maintenance" program began. Deforestation in purple represents cumulative deforestation from 2015 to 2020 (i.e., during the "maintenance" program). (B) Points with land grabbing, illegal logging, illegal mineral prospecting and illegal land sales observed on Highway BR-319. Numbers in the figure are described in Table 2. The inset map of South America shows Brazil's "Amazon Biome" region in green, Highway BR319 as a black line, and the area of the larger map as a red rectangle.

Results and Discussion

For the entire BR-319 highway 89,328 ha was deforested between 1988 and 2020 within the 40-km buffer, and 300,116 ha was deforested when considering the 150 km buffer. After the highway "maintenance" program began in 2015, PRODES data show highly significant increases in deforestation for both the 40-km ($p = 0.00006$; $R^2 = 0.98$) and 150-km ($p = 0.0017$; $R^2 = 0.93$) buffers (Figure 2A-D), indicating that the increase in deforestation is linked to the "maintenance" program and to the political promise of reconstructing and paving the highway. For the 150-km strip, deforestation had been falling over the 2010-2013 period that immediately preceded the "maintenance" program (Figure 2C). The increase in deforestation can be attributed to the "maintenance" program and to the promise of paving the highway because, when the deforestation trend within a given distance from the road (either 40 km or 150 km) is compared with the trend in the entire Brazilian Amazon, the areas of influence of the highway have higher rates of growth of deforestation as shown by the slopes of linear regressions, and deforestation in the BR-319 area increased steadily over the entire 2015-2020 period, while for Brazilian Amazonia as a whole the deforestation rate

remained at a much lower level until it jumped in 2019 and 2020 under the influence of the Bolsonaro administration (Figure 2).

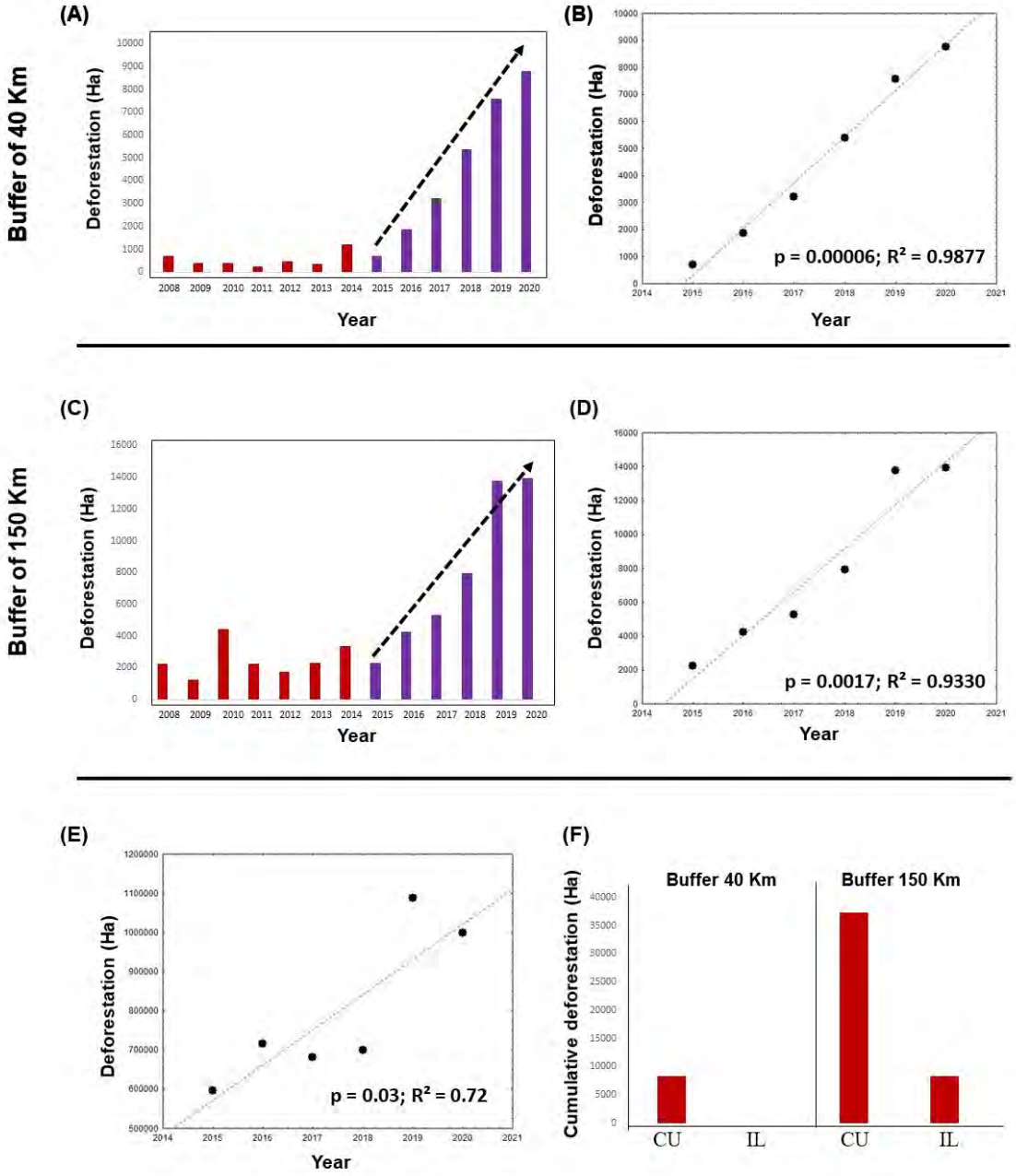

Figure 2. (A) Annual deforestation within 40 km of Highway BR-319. (B) Annual deforestation in a 40-km buffer for each year of the highway's "maintenance" period. (C) Annual deforestation within 150 km of the highway. (D) Annual deforestation in the 150-km buffer for each year of the highway's "maintenance" period. (E) Annual deforestation in the entire Brazilian Amazon. (F) Cumulative deforestation in conservation units (CUs) and Indigenous lands (ILs).

The comparison of the slopes of the linear regressions showed that the 40-km buffer had a deforestation rate 2.5 times higher than the rate in the Brazilian Amazon as a whole ($p = 0.02$). The deforestation rate in the 40-km buffer was also significantly greater than that in the 150-m buffer ($p = 0.00005$) (Table 1). This shows that the "maintenance" program and the promise of paving "Lot C" and the "middle section"

have influenced deforestation within 40 km of the highway, this increase in deforestation being much higher than both that observed for the interfluve between the Purus and Madeira Rivers (the 150-km buffer) and the deforestation rate for the entire Brazilian Amazon.

Table 1. **Comparison of deforestation rates in the areas of influence of Highway BR-319 in relation to the Brazilian Amazon as a whole.**

	BRAZILIAN AMAZON	150-KM BUFFER	40-KM BUFFER
SLOPE:	0.0175	0.0178	0.0449
YEARS (N):	6	6	6
SE (REGRESSION):	0.0226	0.0100	0.0105
SE (SLOPE):	0.0054	0.0024	0.0025
		Comparison between the areas	
	Amazon vs. 150-km buffer	**Amazon vs. 40-km buffer**	**40-km buffer vs. 150-km buffer**
DIFFERENCE:	0.0004	0.0274	0.0270
SE (DIFFERENCE):	0.0059	0.0059	0.0035
T-STATistic	0.0621	4.6037	7.8002
p:	0.952	0.002*****	0.00005*****

* Significant values.

Deforestation has been stimulated by the "maintenance" program beyond the 40-km distance that the environmental agency's internal norms consider to be directly impacted for the purpose EIAs for Amazonian roads (MMA, 2011: Anexo II, 2015), and this "maintenance" program was not even considered sufficiently significant to be required to have an EIA. In the municipality (county) of Tapauá an illegal side road that begins beyond the 40-km range is currently progressing to connect to BR-319, cutting through an Apurinã Indigenous land and a national park (Figure 3A-C; Fearnside et al., 2020). Deforestation is also occurring in conservation units and Indigenous lands (Figures 1A and 2F). In Indigenous lands this deforestation has been caused by invaders, as in the case of the Tapauá side road (Fearnside et al., 2020).

Figure 3. Sign demarcating the Apurinã do Igarapé São João Indigenous Land and forest cut by land grabbers in the municipality of Tapauá. (B) Opening of an illegal side road to connect Tapauá to Highway BR-319; here the side road follows the edge of the Apurinã do Igarapé São João Indigenous Land, after which it crosses the Apurinã do Igarapé Tauamirim Indigenous Land and the Nascentes do Lago Jari National Park. (C) Deforestation by land grabbers inside the Apurinã do Igarapé São João Indigenous Land. (D) Illegal deforestation at Point 8 on Highway BR-319. (E) Illegal deforestation at Point 9 on Highway BR-319. (F) Deforestation carried out for the occupation and sale of land at Point 11 on Highway BR-319. Photos A-C by Chief Waldomiro of the Apurinã People; D-F by Maryane Andrade.

No significant deforestation, including that in Indigenous lands, has been caused by Indigenous people themselves, contrary to President Bolsonaro's claim that Indigenous people are to blame for the recent surge in deforestation and fire in Amazonia (see Ferrante et al., 2020b). In addition, when comparing deforestation within protected areas, Indigenous lands, conservation units (in both the "integral protection" and "sustainable-use" categories) and military areas along BR-319, there is less deforestation in Indigenous lands than in the other protected-area types (Figure 2F), demonstrating that the Indigenous people have better protected their territory than the federal government.

By comparing field observations with INCRA data we found a pattern of illegal deforestation and illegal appropriation and titling. We also saw land grabbing, subdivision of deforested areas, intimidation and illegal constructions (Table 2, Figure 3 and Supplementary Material, Figure S1). All 14 points analyzed showed some type of irregularity, and actors with strong influence on land grabbing in the region were identified. We also observed a discrepancy between INCRA's Land-Tenure Network

database (“*Malha Fundiária”*) and the agency's Land-Tenure Management System (SIGEF: *Sistema de Gestão Fundiária*), showing that INCRA's public databases conflict with the internal database. This clouds the land-titling process in the Amazon and illustrates a general lack of transparency. According to INCRA's SIGEF, all of the plots of land (“*glebas*”) in which Points 1 through 13 are located were submitted for certification and were certified by INCRA after 2015. This was the year of the new promise to reconstruct and pave Highway BR-319 (Meirelles et al., 2018). According to INCRA's Land-Tenure Network, Points 4 to 11 had been titled in 1984 with title delivery in 1988. However, these areas were only occupied after 2015 as indicated both by satellite imagery and by the observations of INPA researchers who studied these PPBio plots from 2015 onwards. One of the titles was issued in 2000 in the name a person other than the original holder, and according to INCRA's SIGEF, the lot is held by yet another person.

Table **Table 2. Status of points observed on Highway BR-319**

Reference number on the map (Figure 1)	Distance from the edge of the highway (m)	Type of infraction observed	Type of occupation
1	10	Illegal land sale*	Irregular
2	45	Illegal construction	Irregular
3	48	Illegal construction	Irregular
4	519	Illegal logging	Irregular
5	620	Illegal logging	Irregular
6	755	Illegal logging	Irregular
7	1,010	Illegal logging	Irregular
8	1,150	Illegal logging	Irregular
9	1,215	Illegal logging	Irregular
10	1,892	Illegal logging	Irregular
11	3.950	Illegal land sale *	Irregular
12	1,010	Illegal logging, illegal mineral prospecting	Irregular
13	2,115	Illegal logging, illegal mineral prospecting	Irregular
14	3,990	Illegal logging, ilegal mineral prospecting	Irregular

*These lots were being sold despite being government land. Even after obtaining a title from INCRA, sale is not legally permitted until the land has been occupied for an additional 10 years (PR, 2017).

Through informal conversations we identified an illegal invasion process at Point 1, where the land was resold to the current occupants by a land-grabber's agent who was responsible for deforesting the area. This area does not have any land-titling record or even a request for titling in the SIGEF, and there is also no CAR. The same land-grabber responsible for the invasion of Point 1 built two other houses on the side of the road (Figure 1: Points 2 and 3); Point 2 has no land title or registration record and is for sale. At Point 3, in conversation with the land-grabber's agent, he admitted the invasions and that he lives in the house at this point, but it belongs to his *patrão* or "boss" (i.e., the land-grabber himself) who lives in the city of Humaitá, this being the person to whom the most recent titles of lots were granted and where Points 3 to 11 are located. The "descriptive memorial" in INCRA's Land-Tenure Network indicates that the title to the lot in which Point 3 is located was awarded by INCRA in 2018, with the delivery of the title in 2019. The title to the lot and the record of delivery of the title by INCRA can be found in INCRA's Land-Tenure Network.

The land-grabber's agent accompanied our team at Points 4 to 11 and, according to him, he is aware of the illegalities that have been committed and said that he has already been arrested and that a new arrest would only be a matter of time. However, according to the SIGEF's descriptive memorial, the area where Points 4 through 11 are located is not certified and lacks the required inspection to be eligible for titling; the requests for titling are in the same name that appears for the landholding where Point 3 is located -- the presumed "boss" of the land-grabber's agent. This process is worrying because it shows the advance of land grabbing and subsequent sale and deforestation on the edges of Highway BR-319, which has the potential to expand deforestation on a large scale affecting the forest's ecosystem services and the global climate (Fearnside, 2020; Fearnside et al., 2020).

At Points 4 to 10 we observed illegal logging, with trails for dragging the logs and log-storage decks in the forest (Figure 3C-E). What is observed in the area does not follow any of the criteria required for legal forest management (MMA, 2006). In addition, Brazil-nut trees (*Bertholletia excelsa*) were being cut, which is prohibited (PR, 2006). The logging is carried out under the command of the land-grabber's agent mentioned for Points 1 through 11. These areas are the locations of permanent plots for monitoring fauna and flora by the PPBio-INPA program. The land-grabber's agent even showed curiosity about the presence of researchers in the area and tried to intimidate one of the researchers, always carrying a gun in his hands when walking on the trail. At Point 11 we observed an invasion process with the removal of vegetation and subdivision of the land for sale.

We observed that, for this section of BR-319, the land-grabber's agent has invaded areas both on the edge of the highway and in land more distant from the road, removing vegetation, building houses and reselling land, and that this agent has a "boss" who has been acting to obtain land titles but does not live in any of the areas, as is required by Normative Instruction No. 100 of 30 December 2019 (INCRA, 2019). It is worrying that two different INCRA databases (the Land Register in INCRA's SIGEF and "land-tenure network" "*malha fundiária*") present discrepancies in the name of the landholder, demonstrating flaws in the system that can assist the land-grabbing process.

At Points 12, 13 and 14 we observed illegal logging and mineral prospecting. According to the SIGEF descriptive memorial, the areas where Points 12 and 13 are located are not certified and have their titles pending. Point 14 is located in government land (*terras da União*) according to the Land Register in INCRA's SIGEF and in the

SIGEF descriptive memorial, although the area has a CAR, which characterizes an attempt to declare occupation in order to request title.

According to Normative Instruction No. 100 of 30 December 2019 on land regularization in Brazil, an applicant must prove that he or she occupies the area and that there has been "direct, gentle and peaceful" productive use of the area by the applicant or by his or her predecessors since before 5 May 2014 (INCRA, 2019). The 5 May 2014 limit was established on 15 March 2018 (PR, 2018), prior to which the limit was 22 July 2008 (PR, 2009). The term "direct" means that the claimant himself or herself must be living on the land in question, which is not the case for most large land-grabbers, as we observed here. The date requirement is also not met for areas we observed *in loco*, where the first deforestation occurred after 2014. According to INCRA's land-tenure network database, many areas are larger than the 2500-ha limit established in 2019 for land regularization (INCRA, 2019).

INCRA's Normative instruction No. 100 specifies that a prior on-site inspection (*vistoria prévia*) is mandatory prior to regularization if the land claim in question shows signs of fraudulent "fractioning" (subdivision into smaller land claims to fit within the legal limits on area) or if there are no signs of human occupation prior to 5 May 2014 (INCRA, 2019). All of these conditions barring land regularization were observed in the area of the present study.

For Points 1 to 11 we identified actions by the same land-grabber's agent, with 9 of these points being georeferenced. These sites were spread over a distance of 150 km. This land-grabbing agent told one of us that he sells land on behalf of his "boss" in Humaitá (the municipal seat) and offered to sell us land for R$3000 (US$729.92) per hectare if located beside Highway BR-319 and for only R$20 (US$4.86) per hectare if located at a distance from the highway, provided that the buyer cuts down the forest and occupies the site. Such a low value per hectare exposes his probable real intensions: establishing initial occupations and clearings in the area at a distance from the road so that the remaining land can be sold to later arrivals at a much higher price, and also increasing occupation of areas both near and far from the road as *faits accomplis* in order to obtain political support for legalizing much larger areas. The land-grabber's agent stated that his goal is to deforest and populate the entire area along Highway BR-319, presumably referring to the sparsely occupied "middle section" that extends for 406 km.

According to presidential decree of 2009 and Normative Instruction No. 100 on land regularization in Brazil, it is required that there be a public consultation prior to land regulation in "areas of social interest," as is the case for BR-319. Social-interest status was determined by the Federal Public Ministry. We observed an area for which INCRA had issued titles dated 2 August 2018 that had not had a public consultation, which indicates that the titles are illegal. In addition to the public hearing, all land regularization in an "area of social interest" after 15 March 2018 is required to be approved at a meeting of a group of agencies that includes the Ministry of the Economy, the National Foundation of the Indian (FUNAI), the Brazilian Forest Service (SFB) and the state environmental agencies (PR, 2018), but no such meeting has been held to date and no regularization has been approved by the group.

The processes of occupation and land grabbing are intrinsically linked to the beginning of highway "maintenance" program in 2015, since the locations of the deforestation that we visited and georeferenced were in lots that had received approval in INCRA's SIGEF after 2015. Titles currently being granted by INCRA are in violation of the agency's own regulations because granting these titles violates the legal

parameters that INCRA established in 2009 and maintained in the subsequent versions issued in 2018 and 2019 (PR, 2009, 2018; INCRA, 2019), making these titles illegal.

One of the political arguments for the paving of the BR-319 highway is that the highway would improve access for inspections and thus restrain environmental infractions, but we show that the opposite effect is more likely: greater traffic is responsible for land invasion and deforestation. This is already apparent on the BR-319 where a highway "maintenance" program has spurred deforestation but not resulted in governance to control environmental crimes (Santos, 2020).

The results described here show that the titling of illegal land claims on BR-319 intensified after the paving plans were announced. This suggests that paving will not bring governance, but rather will increase deforestation and land grabbing in the region. While titling of illegal land claims is often portrayed as a means of slowing deforestation by removing the motivation to clear in order to justify titles, a recent study using satellite data to document deforestation in 10,647 landholdings between 2011 and 2016 shows clearly that the opposite effect has resulted from Brazil's "*Terra Legal*" land-titling program, with titled small and medium landholders increasing their deforestation and large landholders being unaffected (Probst et al., 2020). Reforms to approve land regularization by the federal government reward those who have committed environmental crimes and stimulate land grabbing by creating the expectation of future pardons (Fearnside, 2020b; Maisonnave & Almeida, 2020).

On 2 December 2020 the Ministry of Agriculture (MAPA) and INCRA published a joint ordinance that will outsource to the Brazilian municipalities the process of land regularization of federal government land (MAPA & INCRA, 2020). The ordinance is an incentive to land grabbing in the region, since municipal governments in Brazilian Amazonia are often complicit in environmental crimes. For example, the government of one of the municipalities along BR-319 (Tapauá) has been using its bulldozers to open an illegal side road connecting to the highway, cutting through an Indigenous land and a national park (Fearnside et al., 2020). In 2018 in the municipality of Humaitá (which encompasses the southern portion of Highway BR-319), the mayor and members of the municipal council were arrested for their involvement in an attack that set fire to the local offices of IBAMA and of the Chico Mendes Institute of Biodiversity (ICMbio) (Farias, 2018).

In addition to the illegal processes observed in the present study, Brazilian legislation has been violated by government actions such as an official call for bids and subsequent signing of a contract with a construction company for paving "Lot C" without environmental studies being completed, putting the region's biodiversity and ecosystem services at risk (Ferrante & Fearnside, 2020d; Ferrante et al., 2021). Such actions need to be revoked and not repeated. Given that the lower court decision requiring environmental studies for "Lot C" has now been overturned by the head of the Superior Court of Justice, the option that remains is an appeal to the Federal Supreme Court. This would be justified given the unprecedented environmental collapse that reconstructing BR-319 could cause, especially in the absence of environmental studies and consultation with Indigenous peoples (Ferrante et al., 2021).

The data from the present study show that "Lot C" and the "middle section" are being targeted by specialized land-grabbing gangs and that illegal land claims have often gained recognition by INCRA, which is the agency responsible for inspecting and preventing illegal occupations. The bidding and construction contract for "Lot C" without prior environmental studies and consultation with Indigenous peoples must be questioned, and the involvement of federal deputies and judges merits investigation by the appropriate authorities.

It is also necessary to immediately suspend the ordinance published on 2 December 2020 (MAPA & INCRA, 2020) that outsources to municipalities the regularization of claims to federal government land because it can be expected to greatly increase the legalization of land that is being illegally occupied in the Amazon, such as the areas claimed through the land grabbing documented in the present study. The involvement of public authorities in the process of legalizing irregularly occupied areas adds to the need to suspend the paving and maintenance of Highway BR-319 until environmental and economic-feasibility studies have been completed and approved for both the "middle section" and "Lot C" and the consultation of all impacted Indigenous peoples has been carried out.

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Supplementary Material

Land grabbing on Brazil's Highway BR-319 as a spearhead for Amazonian deforestation

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Attempts to “flexibilize” land titling to legalize land grabbing in the Amazon

On 5 February 2020, President Jair Bolsonaro submitted a proposed law (PL 191/2020) to the National Congress (Congresso Nacional, 2020). If passed (as is likely), it would open indigenous lands to mining activities and agribusiness for non-indigenous people, with disastrous consequences both for the indigenous people and for the Amazon forest (Ferrante & Fearnside, 2020). Brazil’s Indigenous Lands protect more Amazon forest than do federal conservation units (Nogueira et al., 2018).

A provisional measure (MP901) has been also presented by President Jair Bolsonaro, which would reduce the percentage of the areas of rural properties that Brazil’s Forest Code requires to be maintained as a “legal reserve” from 80% to 50% in the Amazonian states of Roraima and Amapá (Congresso Nacional, 2019). This would be likely to presage a similar change for other Amazonian states. Although this provisional measure has also expired, it is worrisome that a proposed law may be drafted to implement the same provisions, as in the case of MP910.

In addition to measures that facilitate land grabbing and encourage deforestation on public lands (Ferrante & Fearnside, 2019), the federal government has taken steps to open indigenous lands to agribusiness. Among these is Normative Instruction No. 9/2020 signed by the head of the National Foundation for the Indian (FUNAI) on 24 April 2020, which regulates the issuing of the “Declaration of Recognition of Limits” document, allowing occupation and even sale of areas in indigenous lands (Batista, 2020; FUNAI, 2020). Indigenous lands are under great pressure from agribusiness, loggers and mining (both by large enterprises and individual “wildcat” miners), and murders of indigenous leaders have increased substantially for this reason (Hanbury, 2019; HRW, 2019). Normative Instruction No. 9/2020 would regularize the invasion in indigenous lands and of the lands that are legally protected for other traditional peoples.

At a ministerial meeting on 22 April 2020, environment minister Ricardo Salles opined that the government should seize the “opportunity” presented by media's attention being focused on the COVID-19 pandemic in order to approve “infra-legal” changes to regulations on the environment and on regularization of illegal land claims, calling for the government to “let the herd of cattle pass through,” the “cattle” referring to the changes to gut regulations (Youtube, 2020).

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Map of land in the Rural Environmental Registry (CAR) in the study area

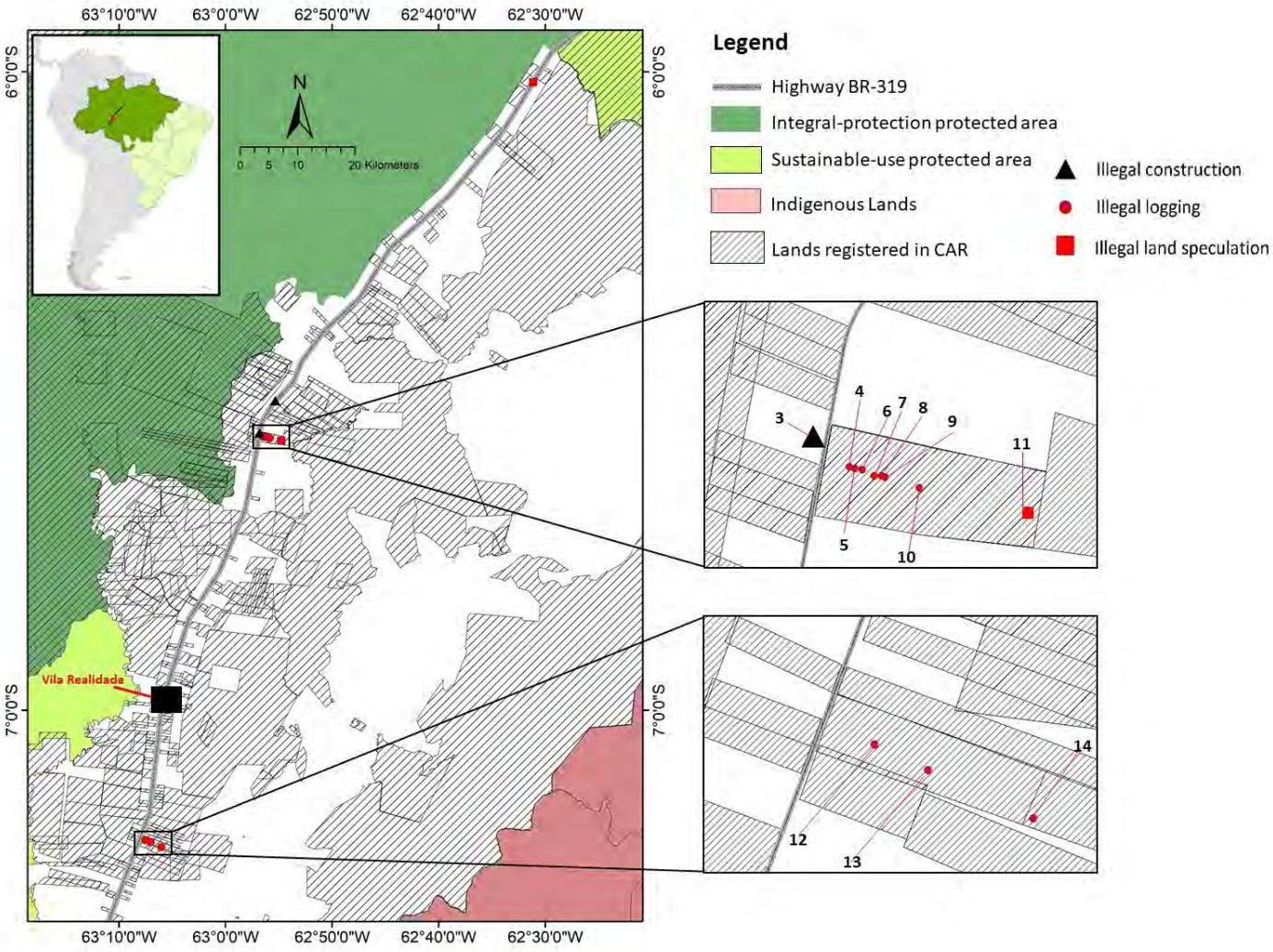

Figure S1 Land in the Rural Environmental Registry (CAR) in the study area. Numbers in the figure are described in Table 1 in the main text. The inset map of South America shows Brazil's "Amazon Biome" region in green, Highway BR319 as a black line, and the area of the larger map as a red rectangle.