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Guarantee of Access to Land and Maintenance of the Amazon Forest: The Case of Extractive Reserves

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Abstract: The creation of Protected Areas (PAs) has been a global strategy for the preservation and conservation of natural resources, increasingly threatened by human action. In Brazil, from the 1990s onwards, the incorporation of the sociocultural perspective into the creation of PAs was verified, through the creation of Sustainable Use Conservation Units, among them the Extractivist Reserves (Resex), a Protected Area category created from the struggle of traditional populations to guarantee the maintenance of their ways of life. Thus, we analyzed the dynamics of land use and cover of the territory in the five Resex in the state of Acre, Brazil, in order to verify whether the permanence of families living in these areas is associated with low rates of deforestation. Information on land use and cover classes from the MapBiomas Project was used for a multitemporal analysis of forest loss. The results show that the forested area represents 98.7% of the totality of these territories, in addition to revealing the absence of significant changes in the use and cover of these territories. Deforestation totaled 23.5 thousand hectares from the creation of the Resex until 2017, which represents only 0.8% of the total area analyzed. It was found that the Resex are effective for the conservation of the Amazon Forest, capable of reconciling the ways of life of the traditional populations that inhabit these territories with low rates of deforestation.

Keywords: Protected areas, Extractive reserves, Deforestation, Amazonia.

1. Introduction

In Brazil, the military regime (1964 to 1985) was marked by a set of decisive actions for the current model of use and occupation of the Amazon. In that period, the national integration developmental project, implemented and subsidized by the Brazilian government, was responsible for reorganizing the occupation of the Amazon territory. This project was based on the creation of large mining, farming, industrial, and population undertakings, as well as on the expansion of transport and telecommunications networks, resulting in the reconfiguration of the traditional forms of use and occupation of that territory.

Amazon forest remained with a low-level deforestation rate until the beginning of the 1970 because of the predominance of non-timber extractive use of the forest, and due to the lack of trafficable trails, especially during the rainy season (Souza, 2010); with the implementation of the national integration project, deforestation increased rapidly (Becker, 2001; Kirby, 2006; Margulis, 2010; Rosa, 2012; Tristch, 2016). Beside the environ-mental damage caused by deforestation, there were sociocultural issues especially associated with the guarantee of access to land. Since the creation of the national integration project, populations that traditionally inhabited Amazonian territories were losing space for the implementation of large projects (Becker, 2001; Becker, 2005).

This situation demanded the sought for land use alternatives that turns the protection of the environment compatible with the way of life of traditional communities of the Amazonian territory, such as extractive and riverine populations, quilombolas (a traditional community descended from

African slaves (Abreu, 2018), and indigenous people, among others. In this context, the Sustainable Use Conservation Units were created, among which are the Extractive reserves (in Portuguese, reservas extrativistas or Resex), the result of the struggle of traditional populations to guarantee the maintenance of their ways of life.

Protection areas (PAs), known in Brazil as Conservation Units and Indigenous Lands, are territories with relevant natural characteristics, which fulfill the function of safeguarding the integrity of ecosystems, biodiversity, and the environmental services associated with them. In addition, PAs contribute to ensuring the right to permanence, as well as the livelihoods of traditional populations and indigenous peoples who have in-habited these territories for generations (Sistema Nacional de Unidades de Conservação, 2024; Ministério do Meio Ambiente, 2024; Instituto Chico Mendes de Conservação da Biodiversidade, 2024). The creation of PAs has been one of the most widespread instruments for the preservation and conservation of environmentally relevant areas around the world, in order to control the disorderly advance of human actions on natural resources (Rodrigues, 2004a,b; Lovejoy, 2006; Le Saout, 2013).

In Brazil, Conservation Units are regulated by Law No. 9,985, of July 18, 2000, which created the National System of Conservation Units - SNUC, which establishes criteria and norms for the creation, implementation and management of conservation units in the country. These areas are organized into twelve management categories and divided into two large groups: the Full Protection and Sustainable Use areas. In areas of Full Protection, the direct use of natural resources is not allowed, being accessible only for research and visitation purposes. The Sustainable Use Protected Areas, on the other hand, aim to make the conservation of nature compatible with the sustainable use of its natural resources by the populations that traditionally live inside them (Sistema Nacional de Unidades de Conservação da Natureza, 2000).

Protected areas began to be officially created in Brazil in 1937, from the North American perspective of “untouched nature” (Diegues, 2008), coming to acquire its own organization in the form of Conservation Units. This configuration is the result, above all, of the paradigm shift regarding the world standard of nature conservation, based on the conflicting dichotomy between man and nature, allied to the pressure of social movements against the land concentration that threats the mode of life of “forest peoples”.

The North American model of nature conservation, spread worldwide and adopted in countries in Latin America, Africa, and Asia, assumes that every relationship between society and nature is degrading, with no distinction between the different forms of culture. Based on this conception, any form of social life must be excluded from nature protection areas. Therefore, mainly in the 1960s and 1970s, there was the predominance of an esthetic and “biologizing” view of nature (Diegues, 2008).

In the 1980s, criticisms of this global standard of conservation emerged, based on a conflicting dichotomy between man and nature. Such complaints were mainly based on the reality experienced in countries in Africa, Asia, and Latin America, where implemented protected areas were based on the model in question. Several conflicts with local populations were registered in these countries because they were expelled from their homes to preserve nature (Diegues, 2008).

In this sense, in contrast to the predominance of a unidisciplinary and biocentric view, Social Ecology emerged in the 1980s. Social relations began to be incorporated into analyses of environmental issues. The beginning of a process of deconstruction of a limited perception of nature, until then understood from strictly biological parameters, is observed. The gap between the conception of modern science and traditional knowledge has been overcome by social ecology, which has sought to understand biodiversity not only as an exclusively biological concept but also as the result of traditional practices of the com-munities that inhabit natural spaces (Diegues, 2008). Traditional populations include people that develop a way of life in tune with forest ecosystem rules, such as forest extractivists. They deeply know nature biological cycles and adapt their daily life to the logic of the environment, thus creating their own culture (Maciel et al, 2018).

The concept of Extractive Reserve as a form of territorial organization in the Amazon arises from the pressure of several social movements, especially the National Council of Rubber Tappers (CNS, in Portuguese), whose prominent leader, Chico Mendes, was murdered in 1988. It led to international repercussions for the "forest people" demands against the advance of large agricultural projects that threatened to guarantee the maintenance of their ways of life (Ruiz-Perez, 2005; Diegues, 2008; De Almeida, 2018; Allegretti, 2008; Allegretti, 2018). The first Extractive Reserves created in Brazil were in the state of Acre: Resex Alto Juruá, in 1990, followed by Resex Chico Mendes, in the same year, both analyzed in this study.

Resex is the result of this new paradigm, as well as an opposition of traditional Amazonian populations to the developmental policy imposed by the military governments (Fearnside, 1989;

Ruiz-Perez, 2005; Souza, 2006; Gomes, 2018). In this sense, Resex represented an alternative that compatibilized the maintenance of social, cultural, and economic aspects of traditional populations with environ-mental conservation (Schwartzman; 2000; Soares-Filho, 2006; Nepstad, 2008; Instituto Chico Mendes de Conservação da Biodiversidade, 2006), therefore reducing deforestation, a degradation factor always observed both in conventional models of land use and in large agricultural and livestock production projects.

This article analyzes the transformation of the forms of use and occupation of the territory in the five Extractive Reserves existing in the state of Acre, in the Brazilian Amazon, in order to show whether the permanence of families in these areas is expressed in low levels of deforestation.

2. Materials and Methods

The study area includes all Extractive Reserves in the state of Acre, i.e., Resex Alto Juruá, Resex Alto Tarauacá, Resex Cazumbá-Iracema, Resex Chico Mendes, and Resex Riozinho da Liberdade [28−36] (Figure 1).

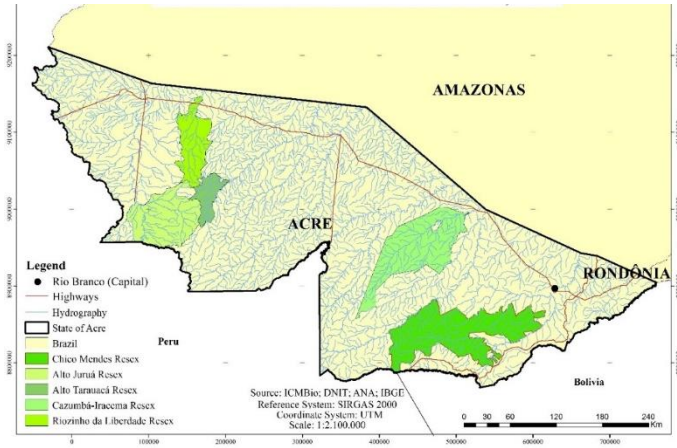

Figure 1. Location of the five Extractive Reserves in the state of Acre, Brazil.

The state of Acre is located in the southwestern portion of the Brazilian Amazon, in the northern region of the country. These five Resex cover an area of 2,7 million hectares (Table 1), corresponding to 18% of Acre's territory, and house around 4,000 families.

Conservation unit	Year of creation	Area (hectares)	Number of families
Resex Alto Juruá	1990	537,983.71	1,177
Resex Alto Tarauacá	2000	150,923.10	165
Resex Chico Mendes	1990	931,458.63	2,139
Resex Cazumbá-Iracema	2002	754,974.77	216
Resex Riozinho da Liberdade	2005	324,903.17	282
Total	–	2,700,243.38	3,979

Table 1. Characterization of the Extractive Reserves in the state of Acre, Brazil.

In order to analyze the dynamics of the land use and cover within the Resex, a multitemporal analysis was carried out based on data from the MapBiomas Project (Projeto Mapbiomas, 2018a,b; Projeto Mapbiomas, 2024, a,b) relating to the Land Use and Coverage Survey in Brazil. The project consists of preparing annual land use and cover maps for all Brazil, using Landsat Mission images, which are available free of charge from 1985 to the present.

For the generation of the land use and cover maps of the five studied Resex, we used the cartographic base of the MapBiomas Collection 3 from the Amazon biome, as well as the limits of each one of the Resex. Each 30-m resolution image from Collection 3 corresponds to one year of the historical series. To cut out the areas of interest, we extracted the images of the year of creation of each Resex (Table 1) and of 2017. For this purpose, we used the raster data extraction tools, from the QGis 2.18 software (QGIS Development Team, 2016), considering a buffer of 10 km of the surroundings. The extracted images were vectorized and the areas of each class quantified, in hectares. Six classes were quantified, as follows: Forest, Non-forest natural formation, Farming, Non-vegetated areas, Water body, and Not observed.

3. **Results**

The results show there were no significant changes of land use in the analyzed Resex. In all of them, native forest predominates in relation to the total area, from the year of their creation to 2017. In addition to native forest, the presence of watercourses and farming and livestock were identified, although in low percentages in relation to the total area. Other non-vegetated areas were also identified, with a low percentage.

The land use and cover classes that showed the most expressive variation were forest and agriculture. In the case of Resex Chico Mendes (Figure 2), there is the greatest forest loss and expansion of agriculture among all the Resex analyzed, both in percentage and absolute terms.

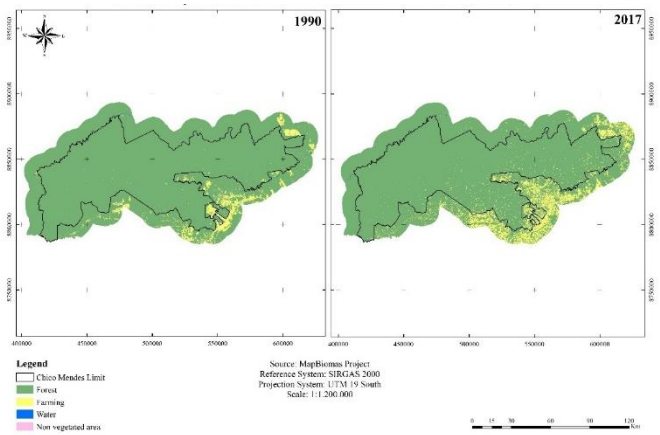

Figure 2. Land use and land cover dynamics in Resex Chico Mendes (1990−2017), state of Acre, Brazil.

In 1990, when Resex Chico Mendes was created, the area of native forest corresponded to 99.55% of the total area; 27 years after its creation, 1.98%, or 18,472.53 hectares, of forest area was converted to agriculture, with an average forest loss of 684 ha year-1. The area set aside for farming corresponds to 2.33%, which in absolute numbers represents 21,717.46 hectares (Table 2).

Table 2. Land use and cover dynamics from 1990 to 2017 in Resex Chico Mendes, state of Acre, Brazil.

Class	1990 (ha)	%	2000 (ha)	%	2017(ha)	%
Forest	927,334.29	99.55	919,672.05	98.73	908,861.76	97.57
Non-forest natural formation	0	0	0	0	0	0
Farming	3,248.57	0.35	11,036.17	1.18	21,718.46	2.33
Non-vegetated area	66.84	0.01	43.79	0.005	298.45	0.03
Water body	869.57	0.09	767.00	0.08	640.24	0.07
Not observed	0.96	0	1.23	0	1.32	0
Total	931,520.24	100	931,520.24	100	931,520.24	100

Resex Alto Tarauacá (Figure 3) presented the second largest forest loss in percentage terms, 0.47% in 17 years, which represents an average of 41.82 ha year^{-1}.

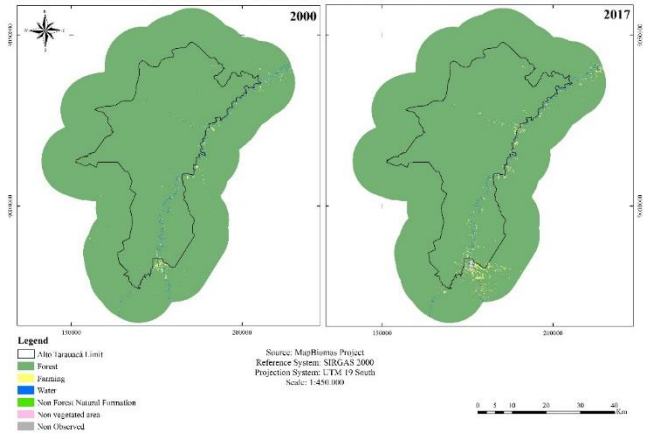

Figure 3. Land use and land cover dynamics in Resex Alto Tarauacá (2000–2017), state of Acre, Brazil.

The area devoted to farming almost tripled in the period analyzed, despite corre-sponding, in 2017, to only 0.73% of the total area of Resex (Table 3). There was a predom-inance of forest around the Resex Alto Tarauacá, limited to the west by the Resex Alto Ju-ruá and to the northwest by the Resex Riozinho da Liberdade. The expansion of farming and cattle raising took place mainly along the banks of the Tarauacá River, east of Resex, where most families live.

Table 3. Land use and cover dynamics from 2000 to 2017 in Resex Alto Tarauacá, state of Acre, Brazil.

Class	2000 (ha)	%	2010 (ha)	%	2017 (ha)	%
Forest	150,991.58	99.30	148,050.4	97.36	150,280.54	98.83
Non-forest natural formation	2.47	0.002	12.19	0.008	5.39	0.004
Farming	390.65	0.26	1,800.31	1.18	1,104.58	0.73
Non-vegetated area	83.29	0.05	1,630.1	1.07	83.3	0.05
Water body	591.3	0.39	565.95	0.37	583.64	0.38
Not observed	0	0	0.35	0	1.85	0
Total	152,059. 29	100	152,059.3	100	152,059.3	100

In Resex Alto Juruá (Figure 4), the conversion of forest to farming was also observed.

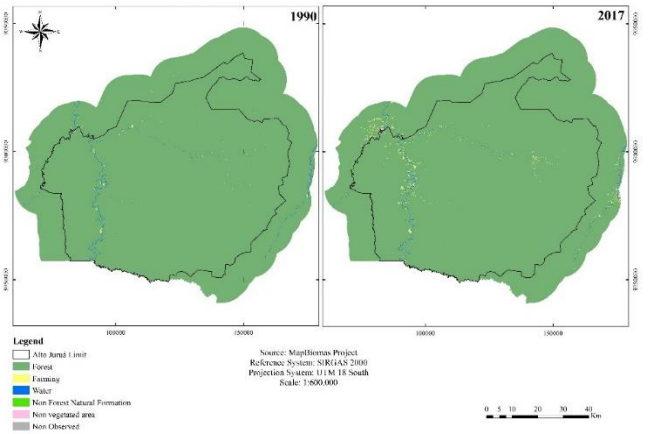

Figure 4. Land use and land cover dynamics in Resex Alto Juruá (1990−2017), state of Acre, Brazil.

From 1990 to 2017, there was forest loss of 0.33%, as well as a threefold increase in the area devoted to farming (Table 4). The annual average of deforestation was 66.8 ha year-1. It appears that agricultural activities are concentrated along the two main rivers that bathe the Resex, rivers Juruá and Tagus, where most families also live.

Table 4. Land use and cover dynamics from 1990 to 2017 in Resex Alto Juruá, state of Acre, Brazil.

Class	1990 (ha)	%	2000 (ha)	%	2017 (ha)	%
Forest	530,261.83	99.45	529,647.31	99.34	528,482.51	99.12
Non-forest natural formation	0	0	0	0	0	0
Farming	983.41	0.18	1,753.07	0.33	2,907.27	0.55
Non-vegetated area	108.81	0.02	228.82	0.04	316.18	0.06
Water body	1,827.87	0.34	1,553.25	0.29	1,474.02	0.28
Not observed	1.76	0	1.23	0	3.71	0
Total	533,183.69	100	533,183.69	100	533,183.69	100

The Resex Cazumbá-Iracema (Figure 5) presented the third largest forest loss.

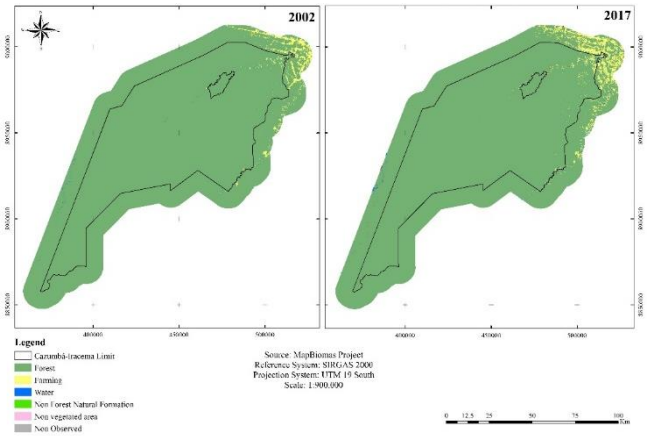

Figure 5. Land use and land cover dynamics in Resex Cazumba-Iracema (2002−2017), state of Acre, Brazil.

In percentage terms, among the analyzed Resex, 0.39% between 2002 and 2017 (Table 5), an average of 197.3 ha/year. As with Resex Alto Juruá, there was a threefold increase in the area allocated to farming, which is concentrated in the northeast of Resex, mainly along the Caeté and Macauã rivers, where the families live. In the surroundings of Resex, also in the northeast region, there is an intense area destined to farming, where BR 364 passes (Figure 1). In the rest of Resex, the forested area remains basically intact, which may also be related to the difficulty of access.

Table 5. Land use and cover dynamics from 2002 to 2017 in Resex Cazumba-Iracema, state of Acre, Brazil.

Class	2002 (ha)	%	2010 (ha)	%	2017 (ha)	%
Forest	749,830.18	99.74	747,565.19	99.44	746,870.55	99.35
Non-forest natural formation	0	0	98.43	0	11.47	0
Farming	1,592.7	0.21	2,589.36	0.34	4,774.81	0.64
Non-vegetated area	48.26	0.006	1,183.14	0.16	20.3	0.003
Water body	310.65	0.04	344.79	0.05	104.48	0.014
Not observed	0.09	0	0.97	0.01	0.26	0
Total	751,781.88	100	751,781.88	100	751,781.87	100

Finally, Resex Riozinho da Liberdade (Figure 6) presented the lowest forest loss among the five PAs analyzed, only 14 hectares in 12 years, or an average of 1.66 ha/year.

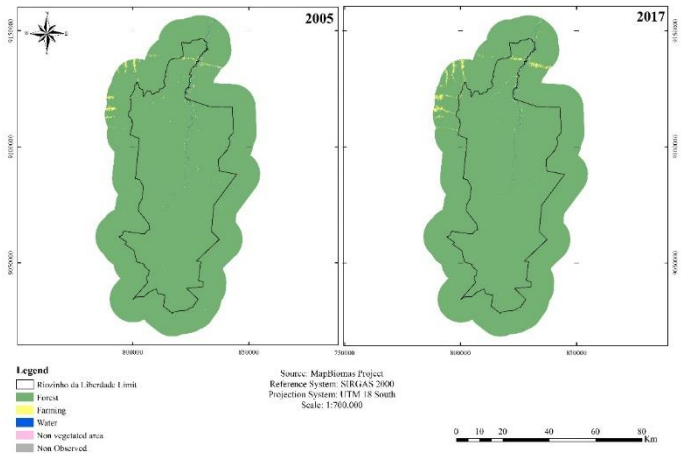

Figure 6. Land use and land cover dynamics in Resex Riozinho da Liberdade (2005–2017), state of Acre, Brazil.

On the other hand, the area destined to farming tripled, occupying previously non-vegetated areas, which presented a fourfold reduction in the analyzed period (Table 6). As in the other Resex, the farming areas occupy mostly the margins of water courses, where the families live. It is also noteworthy that Resex Riozinho da Liberdade is cut to the north by BR 364, where deforestation is concentrated in Resex.

Table 6. Land use and cover dynamics from 2005 to 2017 in Resex Riozinho da Liberdade, state of Acre, Brazil.

Class	2005 (ha)	%	2010 (ha)	%	2017 (ha)	%
Forest	320,967.98	99.61	320,391.63	99.43	320,953.84	99.61
Non-forest natural formation	0	0	0	0	0	0
Farming	798.69	0.25	1,359.29	0.42	984.77	0.31
Non-vegetated area	186	0.06	230.52	0.07	42.15	0.01
Water body	260.84	0.08	232.15	0.07	233.74	0.07
Not observed	2.13	0	2.04	0	1.15	0
Total	322,215.64	100	322,215.63	100	322,215.65	100

In 2017, the Extractive Reserves of the state of Acre occupied about 2.7 million hec-tares, with 98.7% of this area covered by forest, 1.2% by farming, and 0.1% by water bodies (Table 7). The other classes are not very representative, totaling less than 1% of the area.

Table 7. Land use and coverage in the Extractive Reserves of Acre, in hectares, 2017.

Land use and land cover classes	Resex Alto Juruá	Resex Alto Tarauacá	Resex Cazumbá-Iracema	Resex Chico Mendes	Resex Riozinho da Liberdade	Total
Forest	528,482.51	150,280.54	746,870.55	908,861.76	320,953.84	2,655,449.20
Non-forest natural formation	0.00	5.39	11.47	0.00	0.00	16.86
Farming	2,907.27	1,104.58	4,774.81	21,718.47	984.77	31,489.89
Non-vegetated area	316.19	83.3	20.30	298.46	42.15	760.39
Water body	1,474.02	583.64	104.48	640.24	233.74	3,036.12
Not observed	3.71	1.85	0.26	1.32	1.15	8.29
Total Area	533,183.69	152,059.30	751,781.87	931,520.24	322,215.65	2,690,760.76

The five Resex in Acre accounted for 23,600 hectares of deforestation until 2017, which represents a loss of 0.88% of forest area (Table 8).

Table 8. Forest loss from the year of creation of each Resex to 2017.

Conservation Unit	Period	Forest Loss (ha)	Forest Loss (%)	Annual average (ha/year)
Resex Alto Juruá	1990−2017	1,779.33	0.33	66.80
Resex Alto Tarauacá	2000−2017	711.04	0.47	41.82
Resex Cazumbá-Iracema	2002−2017	2,959.63	0.39	197.30
Resex Chico Mendes	1990−2017	18,472.53	1.99	684.00
Resex Riozinho da Liberdade	2005−2017	14.14	0.004	1.16
Total	–	23,569.14	0.88	-

On the other hand, there was the conversion of these deforested areas into farming, which showed an increase of about 24.5 thousand hectares until 2017, which represents a percentage increase of about 349% (Table 9). Forested areas remained basically constant in all Resex, which demonstrates that the permanence of families in these territories occurs in line with the maintenance of the forest.

Table 9. Expansion of farming from the year of creation of each Resex to 2017

Conservation Unit	Period	Increase in area destined to farming (ha)	Increase in area destined to farming (%)
Resex Alto Juruá	1990−2017	1,923.86	195.63
Resex Alto Tarauacá	2000−2017	713.93	182.75
Resex Cazumbá-Iracema	2002−2017	3,182.11	199.79
Resex Chico Mendes	1990−2017	18,469.89	568.55
Resex Riozinho da Liberdade	2005−2017	186.08	23.30
Total		24,475.87	348.96

4. Discussion

In this study, we investigated the dynamics of use and occupation in five Resex in the state of Acre from 1985 to 2017. There were no significant changes in the dynamics of the land use and cover within the analyzed Resex. Native forest predominates in relation to the total area, from the year of their creation to 2017. However, deforestation was detected in all Resex (Table 8). The main drivers of deforestation in the region were roads and urban centers, as well as economic activities in the surroundings. The most evident case is that of Resex Chico Mendes, where the greatest forest loss was registered (684 ha year-1; Table 8). The aforementioned Resex is located close to Rio Branco, the biggest urban center of Acre and also the state capital. Further, Resex Chico Mendes is located along the BR-317, also known as Interoceanic Highway, which plays a significant role as a deforestation facilitating factor. In the other studied Resex, the access to them is mainly by river transport, making access to these territories difficult or even impossible at certain times of the year. The proximity of transport networks is a well-known driver of deforestation in the Amazon; nonetheless, protected areas, such as Resex Chico Mendes, have a strong mitigation effect on this risk (Barber, 2014; Milien, 2021).

In addition to the proximity to the state capital and to the ease of access to the Resex Chico Mendes, it can be seen that the area around it, especially to the south and east of the Resex (Figure 1), is mostly occupied by farming enterprises and, consequently, an intensely deforested area. Therefore, the pressure from the surroundings is a relevant factor for the advance of deforestation in the area, since the highest rates of forest removal in Resex are found in the bordering areas, especially in the south and eastern portions of Resex. Further, in Resex Chico Mendes, there was an increase in farming (Table 9), which is mainly due the formation of pastures for cattle raising, an activity that has been growing inside CMER due the lack of productive diversification of extractivists (Maciel, 2018).

In summary, from the analysis of the dynamics of land use and cover in Extractive Reserves in the state of Acre, it was found that this Sustainable Use Protected Area model indicates that the

maintenance of families occurs in line with low rates deforestation, since forest loss in these territories has totaled less than 1% since their implementation. This finding is extremely relevant, especially when taking into account the intense deforestation process observed in the surroundings of the Resex, in other regions of Acre and in the whole Brazilian Amazon. Despite the weakness of official support by the government, in the planning and management of protected areas, social mobilization and community management processes promoted a more sustainable way of land use, which is evidenced by the low rates of deforestation. Furthermore, we draw attention to the fact that sustainability does not mean non-use. The elaboration of management plans and increased productivity in anthropogenic areas are alternatives to further reduce deforestation.

In this context, protected areas and their forms of management and common use of livelihoods provide income for families with low deforestation rates. Furthermore, we emphasize that alternatives, such as community-based forest management plans, should be developed as a way to generate additional income and contributing to the conservation and maintenance of biodiversity (9. Sistema Nacional de Unidades de Conservação da Natureza, 2000; D'Oliveira & Braz, 2006; Brandão, 2009; Ros-Tonen et al, 2008; Barber et al, 2014; Maciel et al, 2018). Ultimately, Sustainable Use Protected Areas also contribute to the maintenance of forest carbon storage [48−50] and rainfall regimes, among other environmental functions (Fearnside, 1989; Fearnside. 2003; Putz et al, 2008; Ros-Tonen et al, 2008; Maciel et al, 2018), which are important in the context of climate change.

5. Conclusions

The results of the proposed analysis show the suitability of the Sustainable Use Protected Areas model as an alternative to curb deforestation. Extractive Reserves make possible to reconcile the guarantee of access to land with the maintenance of the forest, which demonstrates that sustainable development is possible when there is adequate planning and management for each context.

It was also observed that the proximity of urban centers and land transport networks may influence deforestation in the Resex, although this is significantly lower in these territories due to their difficult access. However, extractivists economical constrains' may foster unsuitable land use, such as pastures for cattle.

It is defended, therefore, that Extractive Reserves are characterized as an alternative for organizing the territory consistent with the environmental reality of the Amazon, which has been fulfilling the function of guaranteeing access to land in line with the maintenance of the forest.

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