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Patrícia Michele da Luz
(Organizadora)

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APRESENTAÇÃO

A presente obra, que se oferece ao leitor, nomeada como “Ecologia, Evolução e Diversidade” de publicação da Atena Editora, aborda 24 capítulos envolvendo estudos biológicos em diversos biomas do Brasil, tema com vasta importância para compreendermos o meio em que vivemos.

Esses estudos abrangem pesquisas realizadas em ambientes aquáticos e terrestres, com diferentes classes de animais e plantas, relatando os problemas antrópicos e visando melhorias e manejo da conservação dessas espécies e seus habitats naturais. Temos também pesquisas com áreas de botânica, questões ambientais, tratamento de água e lixo.

Atualmente essas pesquisas ajudam a nortear uma melhor conservação sobre ambientes em que vivemos e consequentemente melhoram nossa qualidade de vida, aumentando a qualidade de vida em conjunto com uma sustentabilidade socioambiental.

Este volume dedicado à Ecologia traz artigos alinhados com pesquisas biológicas, ao tratar de temas como a conservação de hábitats, diversas comunidades e populações específicas e sobre qualidades de questões ambientais. Apesar dos avanços tecnológicos e as atividades decorrentes, ainda temos problemas recorrentes que afetam nosso ambiente, causadores de riscos visíveis e invisíveis á saúde de todos os seres vivos. Diante disso, lembramos a importância de discutir questões sobre a conservação desses ambientes.

Aos autores dos diversos capítulos, pela dedicação e esforços sem limites, que viabilizaram esta obra que retrata os recentes avanços científicos sobre conservação e os sinceros agradecimentos dos Organizadores e da Atena Editora.

Por fim, esperamos que este obra possa colaborar e instigar mais estudantes e pesquisadores na constante busca de novas pesquisas para a área de Ecologia e, assim, garantir a conservação dos ambientes paras futuras gerações de forma sustentável.

Patrícia Michele da Luz

SUMÁRIO

CAPÍTULO 11

DEFORESTATION SCENARIO IN THE SUSTAINABLE INCOME STATE FOREST (SFSI) GAVIÃO IN RONDÔNIA, WESTERN AMAZON.

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ABSTRACT: The deforestation of protected areas in Amazon unleashes a series of negative social and environmental factors. Among the most well known are the social conflicts, biodiversity impoverishment, soil degradation and the generation of pollution sources in watersheds, reduction of offered social services, which are not yet considered in studies of environmental impacts, and when considered, don't have its proper economical value or end up undersized, resulting in lost of economic opportunities associated to the unsustainable use of natural resources in areas with conservation interests. This study have for objective to characterize the activities that are not in compliance with the legislation foreseen

in the “Sistema Nacional de Unidades de Conservação - SNUC” (Conservation Units National System), inside and round the “Floresta Estadual de Renda Sustentadas - FERS” (State Forest of Sustainable Income) “Gavião”, in the state of Rondônia. Using a serie of Landsat images, it was found that, when created, the unity had 100% of its vegetation intact. Approximately one decade latter, 8.5% of its vegetal cover was already suppressed, and in 2017, these number rose to 41%. The study showed that the temporary disordered occupation leads to suppression of vegetal cover in areas important to the biodiversity maintenance and environmental services, making the Conservation Units lose its main purpose.
KEYWORDS: Rondônia, Deforestation, Amazon.

INTRODUCTION

Along the evolution, humanity faced extensive geographic spaces with abundance of natural resources, in areas favorable to advance the processes of use, occupation and expansion.

The vision of the environment as an inexhaustible source of resources that came from the industrial revolution triggered exclusively economic development processes, resulting in severe environmental problems due to the unsustainable development model (LIMA et al., 2002).

In the industrial phase, the results from disturbances caused by human actions like the destruction and alteration of biological balance and terrestrial ecosystems are frequent. The intense industrialization process, associated to the population growth presses native areas, generate indiscriminate deforestation and disordered occupation, which are aggravating factors to the environmental imbalance (LIMA et al., 2002). In this context, the main environmental problems are related to the loss of biodiversity, the water cycle alteration and contributions to the global warming (FEARNSIDE, 2005).

The investments in Amazon began around the 70’s (FEARNSIDE, 2005), however, the massive migratory flux to Amazonian lands, only began in the 80’s and 90’s, what promoted the occupation and the need of soil changes for agricultural purposes, construction of urban complexes and exploration of natural resources.

The Amazonian region is historically known by its accelerated deforestation rates. The loss of vegetal cover reached, in the 90’s, around 1.9 million hectares, as stated by Laurence (2000). Besides the considerable reduction between 2005 and 2013 (NEPSTAD et al., 2014), the size of the annual deforestation area still at alarming levels. In 2015 the estimated deforestation rates in the Legal Amazon reached the mark of 5.831 km^2, what, compared to the registered in the previous year, represented an increase of 16%, according to data provided by PRODES/INPE (2017). Comparing to this data to the registered in 2004, a reduction of 79% can be observed, highlighting a significant decrease of the deforestation rate. A few hypothesis can explain what happened, like the recognition of the environmental and financial benefits from the

forest maintenance and even the lack of adequate infrastructure, like the highway paving that makes the load flow unfeasible (NEPSTAD et al., 2014),

The unordered land use tends to generate negative environmental impacts. The state of Rondônia for example, stand out as the third more deforested in the Legal Amazon, losing only to Mato Grosso and Pará states. In the 80's, thousands immigrants reached the state moved by promises of land, a result of occupation policies implanted in the past decades, which initiated an accelerated settlement program, facilitating the occupation processes and attracting people from all around the country. Nowadays the state represents one of most recent agricultural frontiers (SAMPAIO et al., 2003), with its economy concentrated in the agriculture, livestock and mineral and vegetal extractivism.

In order to change this reality, a few normative actions were made in the government sphere, where the forest areas were classified according to its finality and manage type. According to the Law nº 9,985 form 2000, instituted by the SNUC, there are norms and criteria for the creation, implementation and management of Conservation Units (CU's) as Integral Protection Conservation Units or of Sustainable Use (BRASIL, 2000).

In this context, the SFSI belongs to the category of conservation units of direct use, in other words, these are areas where the direct economic use and exploration of natural resources are permitted as long as it occurs planned and regulated by responsible organs (BRASIL, 1988).

The deforestation in the Brazilian Amazon Rainforest has attracted the attention of researches and public authorities in its diverse spheres, in search for policies that involves its measurement and control (CARVALHO et al., 2016). The deforestation increases can be easily associated to the opening and expansion of economic frontiers, an integral part of development strategies from many countries that compose the Amazonian basin (DINIZ et al., 2009). The discussions over the frontiers, however, is a subject that pervades a considerable part of the history from the National States formation, cause its associated, after all, to the incorporation and consolidation from the physic spaces and its domains, carrying interests and needs from the dominant production mode.

The actors and forces that conduce to deforestation varies over time and region, being the medium and large producers the main responsibles, while the small producers can also act as important forces where concentrated (FEARNSIDE, 2005). From the areas occupied by small producers that have in its base a sustainable model, there are the Environmental Protection Areas - EPA (Áreas de Proteção Ambiental - APA), which belongs to the direct use conservation units category, as stated before, but unfortunately this production models contrasts with the reality.

The SFSI Gavião was created by the State Decree nº 7,604 from October 8, 1996, which predicted an area of approximately 440,396 hectares. It is situated in the Rondônia State and has its origin from one of the "block reserves" on phase III from the "POLONOROESTE" (NORTHEAST POLE), a management reserves plan elaborated

in 1996, through the Technical Cooperation from PNUD to PLANAFORO. The SFSI area belongs to the Union, and trails and signalization pillars mark it. The unit is located inside the Settlement Project Cujubim, created in July 7, 1984, consolidated by the resolution 51 from June 6, 2000.

In these areas is legally permitted the sustainable use of multiple forest resources and scientific research, with emphasis in methods for sustainable native forests exploration. That is in conformity with the law nº 9,985 from July 8, 2000, which institutes the SNUC and gives other arrangements in the article 2º, incise I. However, the consequence of this kind of use converges to the biodiversity protectionist ideology and orders area occupation dynamics, guaratiing the sustainable use of resources and common ecological services of private and public areas (BRASIL, 2000).

In practice, these principles are not applied. Deforestation fronts and its dynamic actions are investigated in this work through remote sensing techniques and geoprocessing.

BIBLIOGRAPHIC REVIEW

The Amazonian Hydrographical Basin comprehends an area of approximately 6.3 million square kilometers distributed among Brazil, Peru, Colombia, Venezuela, Guyana, Suriname and Bolivia (IBGE, 2018). These countries have responsibilities over the borders and the management and maintenance of the Amazonian ecosystem and its territories.

In Brazil, the Amazonian biome occupies approximately 5.4 million square kilometers, corresponding to 45% over the national territory, followed by the “Cerrado” (23.92%), the Atlantic Forest (13.04%), the “Caatinga” (9.92%), the “Pampas” (2.07%) and the “Pantanal” (1.76%) (IBGE, 2018). The Legal Amazon comprehend the states of Pará, Amazonas, Rondônia, Roraima, Acre, Amapá and parts of Tocantins, Mato Grosso e Maranhão.

The Amazonian biome is constituted by 1.6 million km^2 of Dense Ombrophilous Forest, 1.3 million km^2 of Open Ombrophilous Forest, 700 thousand km^2 of Savana, while the rest by Semidecidual and Decidual Seasonal Forest, Campinarana, Sapphic Savannah and Pioneer Ecotone Formation (Figure 1) (VELOSO et al., 1991)

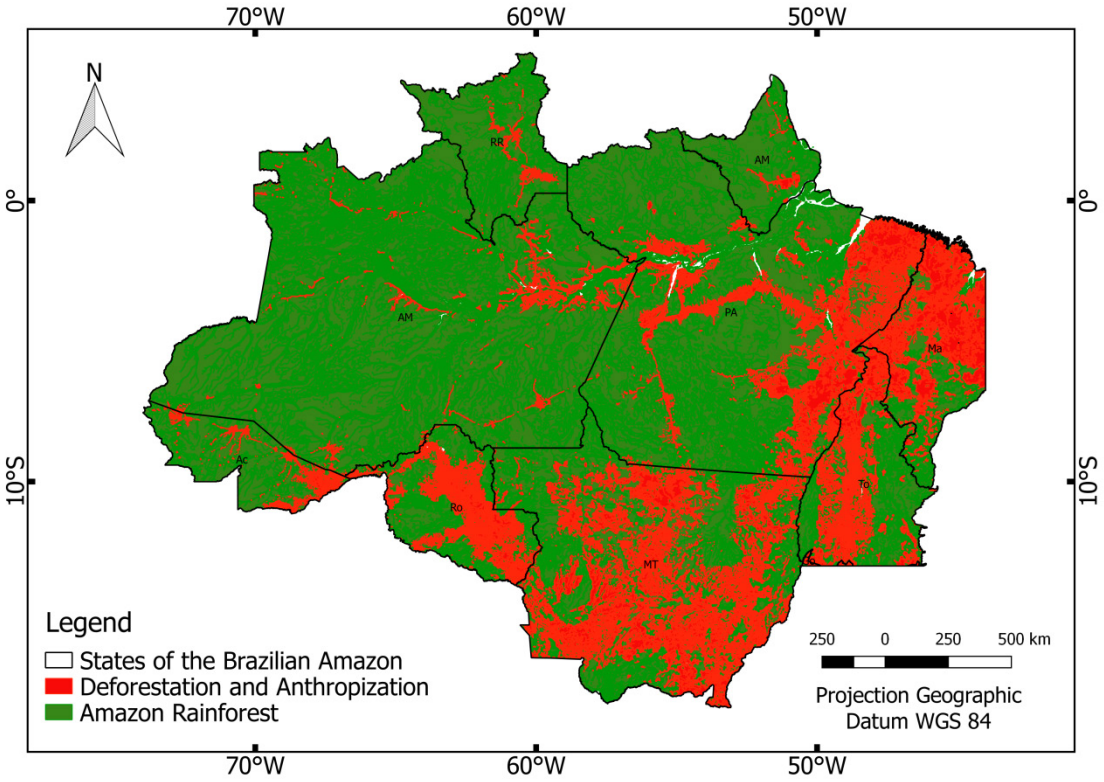

Figure 1. Brazilian Legal Amazon deforestation and anthropization. Source: Prodes/INPE (2017).

Over the years, in the South America occupation and development, most part of the native vegetation outside the Amazonian basin were eliminated, resting only as an example, just 12.5% of the original Atlantic Forest Biome (INPE, 2017). The deforestation activity over the Legal Amazon already reached almost 30 thousand $km^2.year^{-1}$ in 1995 and up to 20 thousand $km^2.year^{-1}$ in 2002 and 2004 (Figure 2).

This scenario has been decreasing over time, with deforestation index per state less than 5 thousand km^2, accumulating, in 2018, an area superior to 420 thousand km^2 of identified deforestation. According to results provided by PRODES/INPE (2017), the Legal Amazon had already loss 22,56% of forest area to shallow cutting, where the states of Mato Grosso, Rondônia and Pará are responsible for 18.41% of this loss. If these values are added to other human activities, the estimations, according to Nobre (2014), can go up to 29.1%.

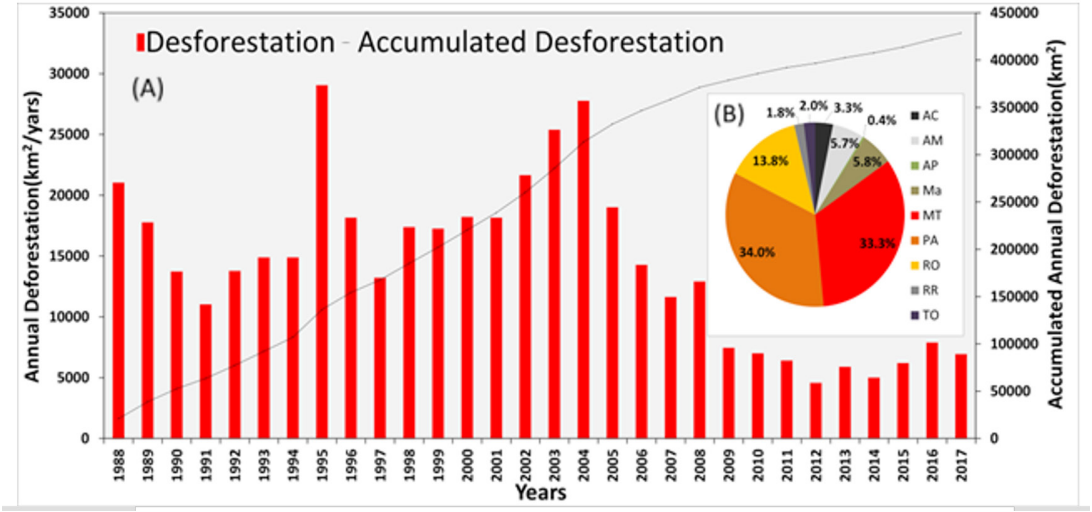

Figure 2. (A) Legal Amazon deforestation evolution. (B) Legal Amazon deforestation percentage per state. Source: PRODES/INPE (2017).

The regions that more suffered with the deforestation processes are: the Southern and Eastern portions of Pará, influenced by the construction of the highway Belém - Brasília; parts of Mato Grosso; and the axis that parts from the Rondônia state Southern region in Vilhena and goes until the Northern region of the state, in Porto Velho (Figure 1).

Exploration and development processes in the Southern Amazonian region were incentivized by the Brazilian government since the military regime, which fomented the construction of the highways: Belém – Brasília (BR-153); Manaus – Boa Vista (BR-174); Cuiabá – Porto Velho (BR–364); Transamazônica (BR–230); Cuiabá–Santarém (BR–163); among others that ramify from these (SORES-FILHO et al., 2006; NEPSTAD, et al., 2014; FEARNSIDE, 2005).

The Rondônia state territorial occupation happened concomitant to the commodities market expansion, which occasioned the consolidation of its economy based on exporting extractive-agriculture, as previously occurred in other economic cycles, such as the rubber, chestnut and cassiterite (Dos Santos, 2014).

With the BR-364 construction in the 60's, which connected Cuiabá to Porto Velho, an intense colonization and exploration processes started in the so called Rondônia Federal Territory, with the occupation of lands along the highway, that, in its turn, incentivized by governmental propaganda, occasioned the intense migratory flux to the region (NUNES, 1997; DOS SANTOS, 2014). In the 70's, with the creation of the Programa de Integração Nacional - PIN (National Integration Program - NIP), the government aimed to integrate the North and Northeast Brazilian regions to the national economy, having as its milestone the construction of the BR's 230 and 163 (CARNIELLO et al., 2010).

Yet in the 70's, with the argument "integrar para não entregar" (integrate to not hand over), under the "Instituto de Colonização e Reforma Agrária - INCRA" (Agrarian Reform and Colonization Institute) coordination, integration projects with the slogan

"Rondônia, um novo Eldorado" (Rondônia, a new Eldorado) were implanted, looking to attract the South-Central country population, obfuscating the local conflicts already in course (DOS SANTOS, 2014).

Inside this migratory processes, not only the "nordestinos", expelled by the dry, but also the Southern-Central people, expelled by the commodities popularization (both under the government flag), ended up incentivizing the deforestation, once the accelerated population growth (14.36% per year), raised even more the demand for natural resources such as wood, arable lands and areas for mineral exploration (SEDAM, 2017).

The highways in this region (Figure 3) are in its final stage of reconstruction, and will promote a great forest devastation. Quick transformation processes of the landscape for pasture use without deep survey studies over the genetic stocks, can cause the extinction of countless fauna and flora species (NEPSTAD et al., 2014).

Nowadays, besides its unpaved stretches and damaged bridges, the BR-319 is perfectly passable. There are strong political signs of commercial and population interests over the BR-319 reconstruction, aiming to provide terrestrial load flow to the industrial production in Manaus and provide access between the capitals of the Rondônia, Amazonas and Roraima states, yet facilitating the access to Caribbean in Venezuela through the BR-174 and the Guyana through the BR-401.

Soares-Filho et al., (2006) shows how alarming are the future scenarios for the Amazonian region, foreseeing countless forms of pressure over the forest, through the construction of highways, hydroelectrics, gas pipelines, besides agriculture and wood exploration; rather considering or not some kind of governance scenario over the deforestation control in the next years.

Soares-Filho et al., (2005) conducting a study covering the Amazonian basin, projected deforestation rates around 680 thousand km^2 util 2050, induced by the influence of opening new highways and reconstructing old ones. Fearnside & Graça, (2009) also highlights that the BR-319 reconstruction will affect the small interfluve of rivers Purus e Madeira, and consequently affect countless endemic species, once the highway will connect cities that are located in these rivers channels.

Fearnside & Graça, (2009), considering the effect of the BR-319 in scenarios with and without the implantation of new Conservation Units (CU's), stated that the deforestation effects without the CU's can reach 5.1 million hectares. While the deforestation stimatives with the CU's this numbers lower to 3.4 million hectares util 2050.

Foreseeing the deforestation impacts in areas considered unclaimed, the Brazilian government established the creation of new CU's around the BR-319 as a tool to promote anticipated preservation, generating restrictions to the advance of occupation led by land invaders. The influence region of the possible impacts upcoming from the BR-319 reconstruction constitutes a territorial space of direct coverage of 164 thousand km^2, which in its turn, is composed by 46.3% of Federal CU's, 24.9% of State CU's,

18.9% of settlements and 9.8% of free areas (SOAVINSKI, 2009).

MATERIAL AND METHODS

The SFSI Gavião is located at the Northeast region of Rondônia State, inside the administrative political limits of Cujubim municipality. When created, in 1996, the vegetation was intact and preserving the hydrographical network as well as its biome found inside its limits (Figure 3).

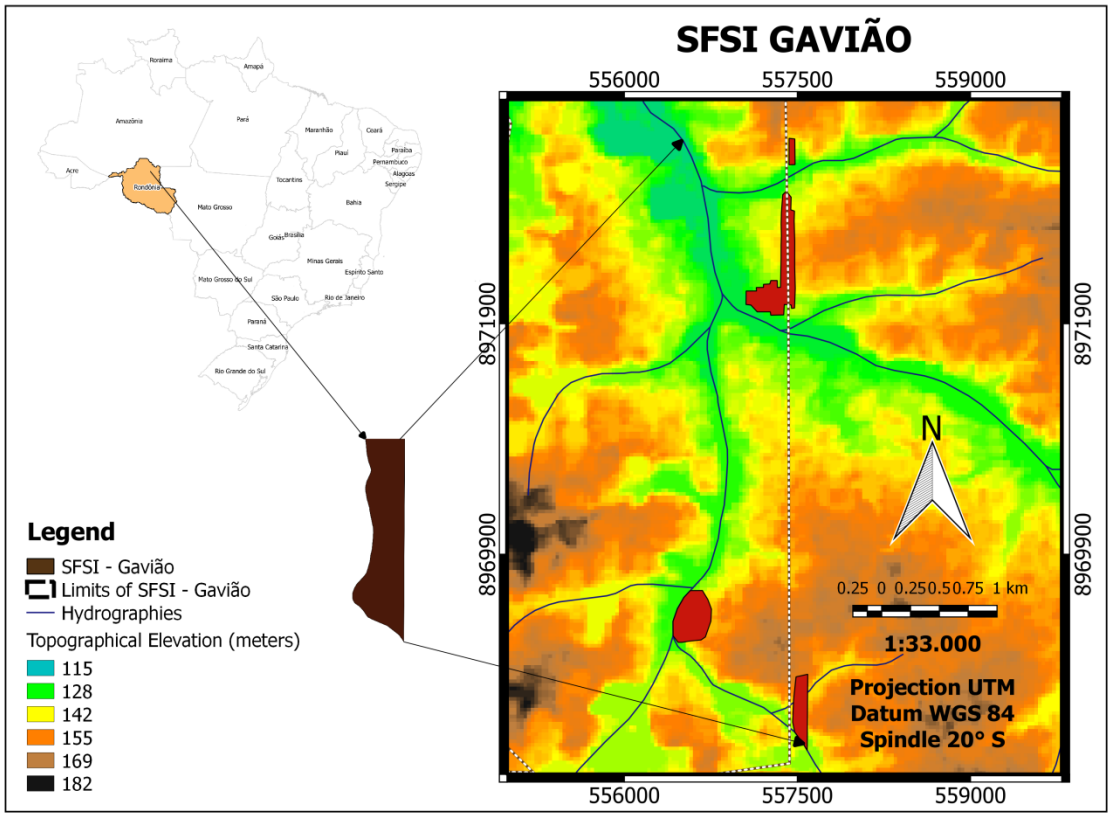

Figure 3. SFSI Gavião location in Rondônia state when created in 1996.

There is the presence of a school close to the SFSI Northwest limit, inside its amortization area (62° 30' 58" W / 09° 14' 58" S). There are also many ranches of small dimensions in the SFSI surroundings, and close to the Southwest region (around 10 km), there is the nucleus urban formation of the Cujubim municipality. Close to the SFSI East limit (1.2 km) lies the rural occupation movement regarding to the year of 2004 (62° 27' 55" W / 09° 19' 23" S).

According to INCRA-RO registers (Locations and Settlements), in the proximities (up to 20 km), other settlements can still be seen, like: the PA Cujubim II, created in December 11, 1995 - consolidated by the resolution 23 from December 5, 2002; the PA Machadinho, created in February 2, 1982 - consolidated by the resolution 28/98 e decree 101 form September 9, 2000; the PA Amigos do Campo, created in January 18, 1999 - in consolidation; the PA Agostinho Becker, created in August 17, 1999 - under structuring; and the PA Renascer, created in August 17, 1999 - under structuring.

A considerable part of its territorial extension is represented by the vegetation type: Open Ombrophilous Forest in lowlands with palm trees (Abp). It can also be observed, in its edges, areas of Open Ombrophilous Forest in submontane with palm trees (Asp) and others that belongs to the Anthropic Unit Category Ap+A = Livestock (pasture) + Agriculture (Figure 4)

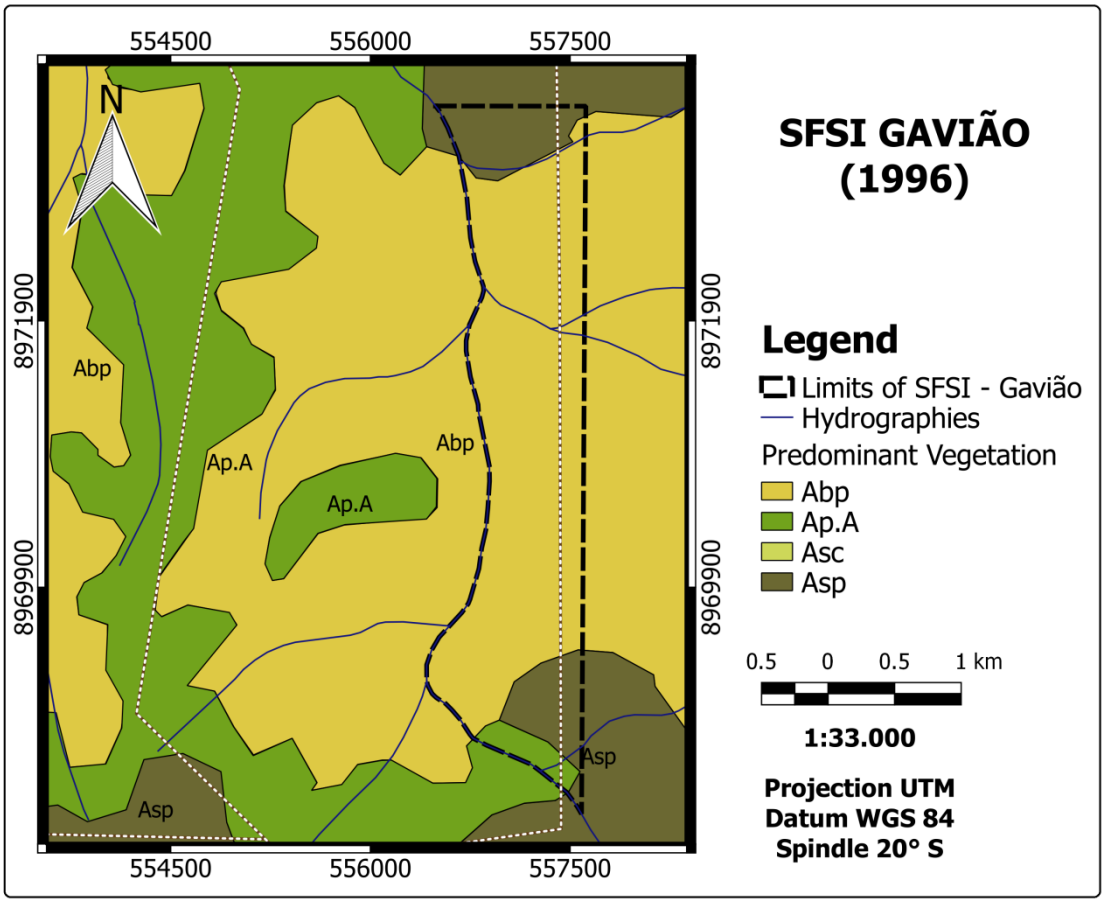

Figure 4. Vegetal cover categories in SFSI limits and surroundings (1996).

To analyze the visual interpretation of the real deforestation situation inside the SFSI, satellite images from years 1996 and 2006 were taken from Landsat 5 Sensor TM, while the images from 2017 were obtained from Landsat 8 Operational Land Imager (OLI). The images were obtained from the U.S. Geological Survey (USGS) available in (http://earthexplorer.usgs.gov/). The chosen scenes do not present clouds and correspond to Orbit/Point 231/67, with passage dates in: July 20, 1996; may 13, 2006; and July 30, 2017.

Data were processed and manipulated in a Geographic Information System (GIS) through the program Qgis 2.8. The correction of the atmospheric effect was done by the Dark Object Subtraction (DOS). After the atmospheric corrections the bands were re-projected to the South hemisphere, cause the obtained images presents in North latitude for Datum WGS84 (World Geographic System 1984) (Latorre et al., 2002)

For the color composition, the bands 6(R), 5(G), 4(B) were used, once it possess equivalent results to the Landsat 5 (composition 5(R),4(G),3(B)). To obtain a image

with better spatial resolution, the 30 meters band merged with the band 8, which have 15 meters of spatial resolution from Landsat 8.

To the visual interpretation, polygons were delimited with the aid of a raster calculator, which has done the sum of deforested areas by the exportation of the metadata from the polygons to the software Excel.

"*In loco*" surveys were done with the aid of formularies, satellite images, a GPS Garmin and other field notes. The region occupants, employees, neighbors and other possible informants were interviewed. Consults to the responsible organs such as IBAMA, INCRA and the Federal Justice were also made in order to identify the occupations and the alteration of natural environment.

The proposed method follows a pattern for the SFSI evaluation in the Rondônia state, looking for assess the classes that composes the whole unit distributed in selective cuts, areas supposedly explored for the extraction of fine woods, formation of natural fields, exposed soil and regeneration areas.

RESULTS

Access roads

The SFSI surroundings are modified and constitutes the Cujubim urban nucleus (10 km). Roads and trails cut its interior, where its main access are lines LH CP-14, LH CA-02 and LH MO-07. This factor favors the access, and by consequence, the unit presents high rates of human occupation with an area of exposed soil around 17,2% of its total area.

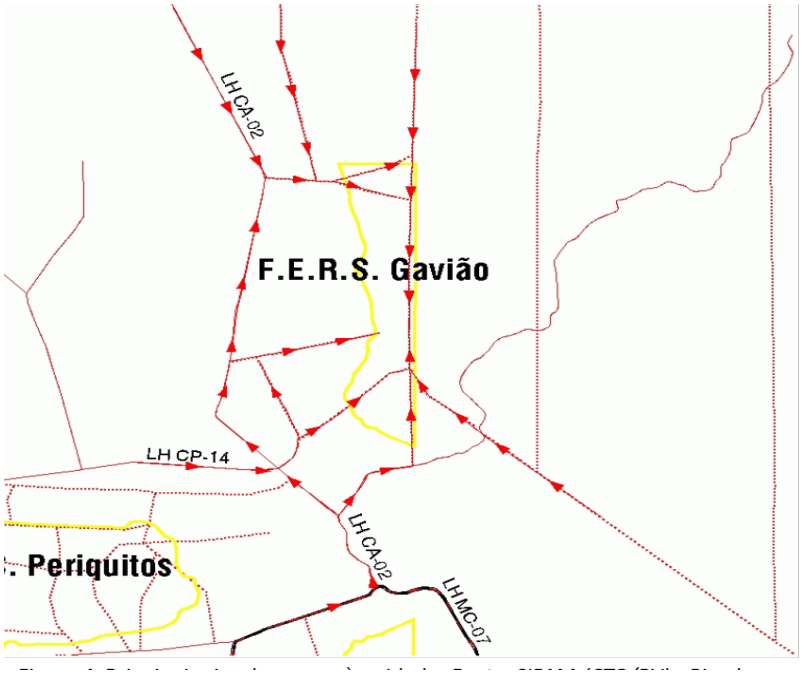

Figure 5. Main unit's access roads. Source: SIPAM (CTO/PV) - Trails; INCRA-RO - Roads and SEDAM-RO - Interurban lines (1:100.000).

Among the main observed consequences over the generated impacts in the

SFSI, the alteration of the hydrological cycle is one of the more concerning. Once the evapotranspiration processes are reduced due to the loss of natural vegetation, micro clime changes are generated through the air temperature and convective currents increases, consequently reducing rain clouds formation.

From a wider point view, it is commented that the Amazon represents an important source of humidity to other regions in Latin America, contributing to the precipitation regime in other areas of the continent. It also represents an important source of humidity to other regions in Brazil as well, such as: Central-West, Southeast and South region, contributing, according to Rocha et al., (2017) to the precipitation regime in these areas. This way, anthropogenic actions can affect the recycling and the hydrological cycle in a micro and macro scale.

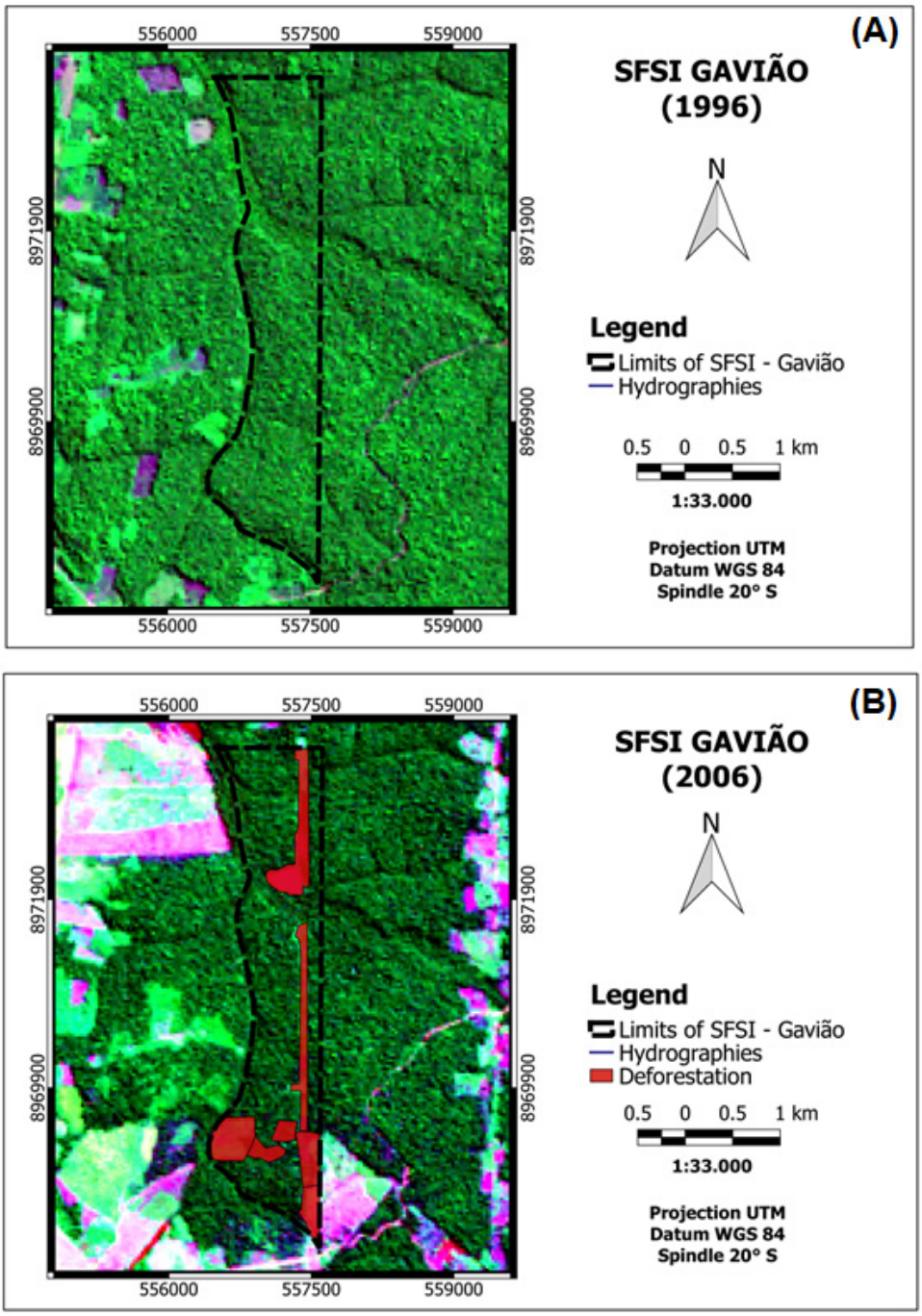

Figure 6. (A) SFSI's vegetal cover in the year of its implantation (B) SFSI's deforestation polygons in 2006 (Landsat 8).

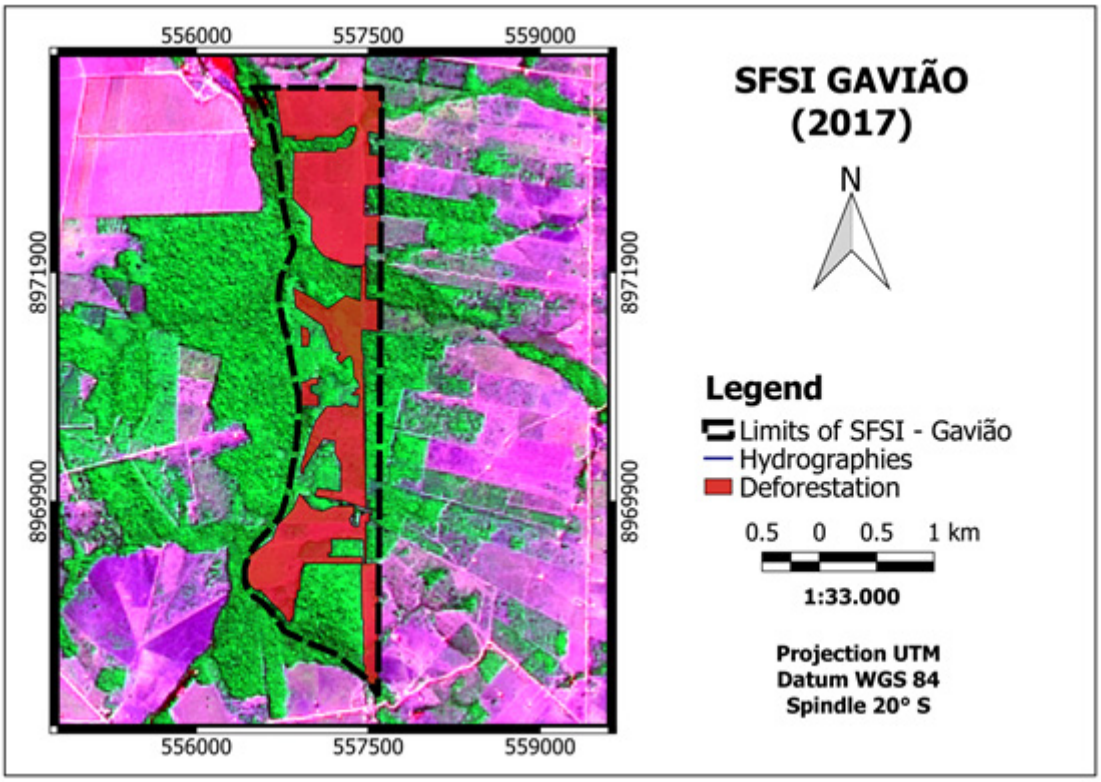

Figure 7. SFSI's deforestation polygons in 2017 (Landsat 8).

The erosion and the silting of water bodies resulting from the suppression of natural vegetation can let the soil uncovered and more susceptible to the erosive processes, leading to its impoverishment and compaction. The eroded material, by its turn, can be washed away to water bodies and consequently arise its water turbidity, what reduces the primary productivity, affecting the whole biodiversity dependent to this ecosystem and altering na natural basin dynamics.

In this study, as result obtained from the images analysis, we concluded that the unit presents high anthropization levels, with an area of exposed soil around 52.7% (Table 1). What can represent a huge problem, once exposed soils are more prone to suffer degradation, being one of the main consequences of this condition, the erosion, which in its turn can promote other major problems, as stated by Resende et al., 2013. In addition, the removal of vegetal cover compromises the soil microbial biomass, interfering in important biogeochemical processes. The tendency of the soil carbon stocks and other humic substances decrease is related, according to Araújo et al., (2011), to the suppression of vegetal cover.

Total Area = 437,2 hectares	1996	2006	2017
Deforestation (hectares)	0	98,4	230,4
Deforestation (%)	0	22,5	52,7

Table 1. SFSI's historical deforestation progress.

For the year of 2017, the deforestation scenario reached the mark of 230.4 hectares, representing 52.7% of the SFSI total area. In comparison to 2006, it had an expansion of 2.34 times the area. Another factor to be taken in consideration is the

lack of ecological corridors, what can heavily prejudice not only the medium and large mammals' dislocation, but also the small mammals, birds, reptiles and invertebrates (BROCARDO & CÂNDIDO, 2012).

Large mammals are important agents in the forest maintenance for spreading seeds (in the case of herbivorous species), and as population controllers (in the case of carnivorous species). Despite, the other non mentioned populations also has very important functions in the forest ecosystem, such as pollination and organic matter decomposition.

The lack of ecological corridors promotes yet the decrease of genic flux between the fauna populations in a general form, what occasions the decrease of the individual's genetic variability, making these populations more susceptible to diseases, genetic fails, and other essential factors for their survival. Some of these threatened populations are very important for human activities (BROCARDO & CÂNDIDO, 2012)

FINAL CONSIDERATIONS

Soil erosion and agriculture walks together. Since humans left nomadism and moved to fixed life systems, there was a need for intensive soil use, implying in a greater exposure to erosion (BERTONI & LOMBARDI NETO, 2008). Poorly managed occupations favors accelerated indexes of erosion, consequently causing soil reserves exhaustion, destroying in a short period what nature took thousands of years to build (MALAVOLTA, 1989).

Rondônia is a clear example of a poorly managed occupation. It suffered accelerated deforestation ever since its creation, never taking in consideration the natural organisms and resources present in its territory. This process is continuous, don's respect CU's limits and it is boosted by the search for fine raw materials that are still abundant in the region. The constant vegetal suppression, if continue, can invariably extinct some fauna and flora species, including those not yet discovered by the science.

For Aaron et al., (2001) the environmental protection areas implanted in the national territory have the function of decrease the deforestation process, especially in the Brazilian Legal Amazon, figuring as an important instrument of public policies. Unfortunately, these results cannot be seen given the little amount of CU's implanted over the country, the failure of the past public policies applied in the region and the growing demand for lands.

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