CAPÍTULO 4

ANALYSIS OF THE TEMPORAL AND TREND INCIDENCE OF FIRE IN CONSERVATION UNITS OF BRAZIL: REGIONAL DYNAMICS OF THE BRAZILIAN AMAZONIA

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ABSTRACT: Fires are causing major disturbances to forests in the Amazon. Its cause is related to the interaction between the climate and changes in land use and cover. A useful tool in this process is the quantification of spatial data, which through mapping can provide information for planning prevention policies. For this, data on land use and cover and deforestation were used from the MapBiomas project for APA Triunfo do Xingu between 1985 to 2019. The meteorological variables and fires were obtained from the Instituto Nacional de Meteorologia and BDQueimadas. With the results, the loss of vegetation cover over 30 years was approximately 4030.73 km2 (23.96% of the territory) and for 2004-2007 6.21% (1044.84 km2), 2008-2011 of 3.62% (608.52 km2), 2012-2015 of 1.40% (236.24 km2). We can conclude that the fires are directly related to the replacement of vegetation cover by pastures in the APA Triunfo do Xingu, generating a great impact on biomass losses. Changes in land use were also responsible for a change in air temperature, increasing over the past few years.
KEYWORDS: Protected areas, Remote sensing, Fires, Amazonia, Climate.

RESUMO: Os incêndios promovem grandes distúrbios às florestas na Amazônia. A sua causa está relacionada à interação entre o clima e as mudanças de uso e cobertura do solo. Uma ferramenta muito útil nesse processo é a quantificação de dados espaciais, que através do mapeamento pode fornecer informações para o planejamento de políticas de prevenção. Para isso, utilizou-se dados de uso e cobertura do solo e desmatamento foram obtidos do projeto MapBiomas para a APA Triunfo do Xingu entre 1985 a 2019. As variáveis meteorológicas e focos de calor foram obtidas do Instituto Nacional de

Meteorologia e BDQueimadas. Com os resultados, a perda de cobertura vegetal durante 30 anos foi de aproximadamente 4030,73 km2 (23,96% do território) e para 2004-2007 de 6,21% (1044,84 km2), 2008-2011 de 3,62% (608,52 km2), 2012-2015 de 1,40% (236,24 km2). Assim podemos concluir que os incêndios estão diretamente relacionados a substituição da cobertura vegetal por pastagens na APA Triunfo do Xingu gerando grande impacto nas perdas de biomassa. As mudanças de uso do solo também foram responsáveis por uma alteração na temperatura do ar, aumentando no decorrer dos últimos anos.
PALAVRAS-CHAVE: Áreas protegidas, Sensoriamento Remoto, Focos de calor, Amazônia, Clima.

INTRODUCTION

Changes in land use of patterns are some of the factors that cause changes in climate in tropical regions (WARD et al., 2014; SPRACKLEN; GARCIA-CARRERAS, 2015; ZEMP et al., 2017). Deforestation and fires, for example, are present issues that directly impact the tropical climate (AYALA et al., 2016), such as increased temperature and reduced rainfall, causing greater sensitivity in ecosystems (SEDDON et al., 2016; GRIFFITHS et al., 2018).

In Amazon, the impact of forest loss related to deforestation can be of a similar magnitude to the warming effects of greenhouse gases (PIELKE et al., 2016). With the absence of forest cover, the processes that occur on the terrestrial surface are altered, including lower rates of evapotranspiration and the regulation of albedo on the ground, which affect the magnitude and form of energy transference to the atmosphere (LEJEUNE et al. ., 2014; DEVARAJU et al., 2015; DEBORTOLI et al., 2016; SILVA OLIVEIRA et al., 2018).

The proportion of latent and sensible heat is balanced by extensive forest areas, which are essential in maintaining the hydrological cycle, cloud formation and precipitation (SYKTUS; MCALPINE, 2016). Land use changes in the Amazon have become a global concern, mainly due to the frequency and intensity of forest fires affecting thousands of hectares of forests, being responsible for the emission of large amounts of carbon into the atmosphere and for losses in the stock of biomass. (SALES et al. 2015; SENIOR et al., 2017; SCOOT et al., 2018; CAMPOS et al. 2020).

Fires promote negative health impacts, economic losses and a threat to biodiversity (ANDRADE FILHO et al. 2017). An increase in the occurrence of fires in the Amazon would further worsen the scenario and compromise policies that seek to reduce the human contribution to climate change (SILVESTRINI et al. 2011). This is due to the fact that fire is widely used in the maintenance of pastures and in agricultural areas, which when it gets out of control, advance into the underlying forests, reaching large areas in years of extreme drought (TASKER; ARIMA, 2016; ARAGÃO et al. . 2018).

Fire usually reaches the forest from fires carried out to convert the forest into agriculture or pasture and to control weeds, but almost always outside the borders of interest

(LAWRENCE et al., 2015; SCHMIDT; ELOY, 2020). Furthermore, with the construction of new roads, remote areas of forest are accessed to expand slash-and-burn agriculture, forestry and livestock farming, consequently causing an increase in the potential conditions for fires to occur (SCOTT et al., 2018).

In view of this perspective, this work analyzes landscape changes, forest fires and their influence on meteorological conditions observed in the Triunfo do Xingu Environmental Protection Area between 2005 and 2015, considering the factors of anthropic and natural origin in temperature variation.

MAIN OBJECTIVES

The objectives of this study were (i) to map the landscape dynamics in the Triunfo do Xingu Environmental Protection Area (APA) for 30 years; (ii) Monitor the deforestation behavior and air temperature variation between 2005 and 2015.

MATERIALS AND METHODS

Study area

The APA Triunfo do Xingu is located in the State of Pará, created through State Decree in 2.612, in 4 of december of 2006, with a total area of 1,679,280.52 hectares with 65% of its area in the territorial portion of the municipality of São Félix do Xingu and 35% in the municipality of Altamira (ITERPA, 2017). It faces a great management challenge, among other factors, because it was created in an area of high population concentration, with great anthropic pressure (Figure 1), with a very degraded and altered territory, and many land conflicts, compared to the others. conservation units created in the Terra do Meio region (COSTA, 2013; IDEFLORBIO, 2017).

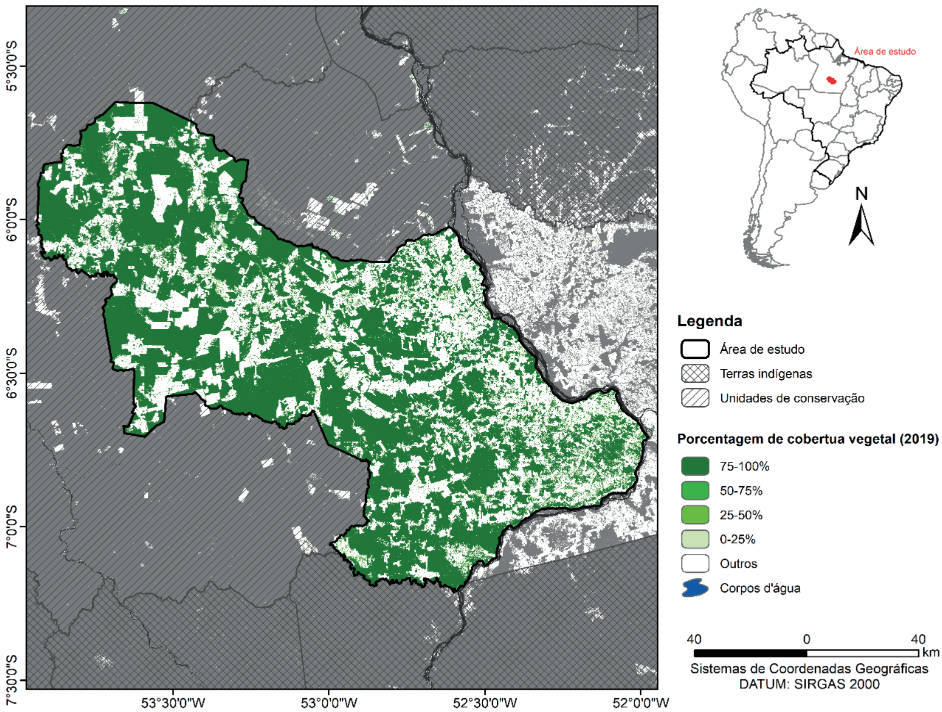

Figure 1: Study area location with percentage of vegetation cover based on the Global Forest Change Dataset (HANSEN et al., 2013).

Dynamics of Land Use and Coverage

An important and promising dataset for mapping agricultural and pasture areas and, consequently, vegetation cover is the MapBiomas project (MAPBIOMAS, 2020). MapBiomas provides Landsat-based maps of land use and land cover aggregated into 5 broad categories (and up to 25 detailed categories) from 1985 to 2019. In APA Triunfo do Xingu, classes are divided into: forest formation, grassland formation, pasture and water bodies.

From the land use and cover change database, a historical mapping of changes was carried out in the period from 1985 to 2015, and consequently, the creation of a more detailed map characterizing the areas of deforestation that encompass different periods: 2004 to 2007, 2008 to 2011, 2012 to 2015, and until 2019. Thus, enabling the identification and quantification of forest loss in each analysis period..

Hot spots

The data on hotspots were obtained from the Center for Weather Forecasting and Climatic Studies and the National Institute for Space Research (CPTEC, 2016; INPE, 2018) by the product called Burn Data Bank (BDqueimadas). Currently, CPTEC uses 31 environmental satellites (polar orbit and geostationary) to compose its observation network in South America (AS). The series of weather satellites are: NOAA, GOES, AQUA (EOS PM-1), TERRA (EOS AM-1), METEOSAT, ATSR and TRMM. These satellites perform orbital imaging across the country in the morning, afternoon, night and dawn. The time series of hotspots obtained from the Amazon corresponds to the period from 2005 to 2015.

RESULTS AND DISCUSSION

Change of use and coverage in APA Triunfo do Xingu

Figure 2 provides a summary of land use and land cover changes in the Triunfo do Xingu APA represented by four-year highlighted images (1985, 1995, 2005 and 2015). It is observed that the change in land cover in APA Triunfo do Xinigu from 1985 to 2015 was extensive. A total of 4030.73 km2 (23.96% of the territory) has undergone intense changes in the last 30 years. MapBiomas land use and land cover maps demonstrated the growing dynamics of human activities in the region that occurred from 2005 onwards, whose landscape changes included the expansion of pastures over the entire territory, as well as deforestation and forest fragmentation in protected areas. adjacent areas and indigenous lands (Figure 3).

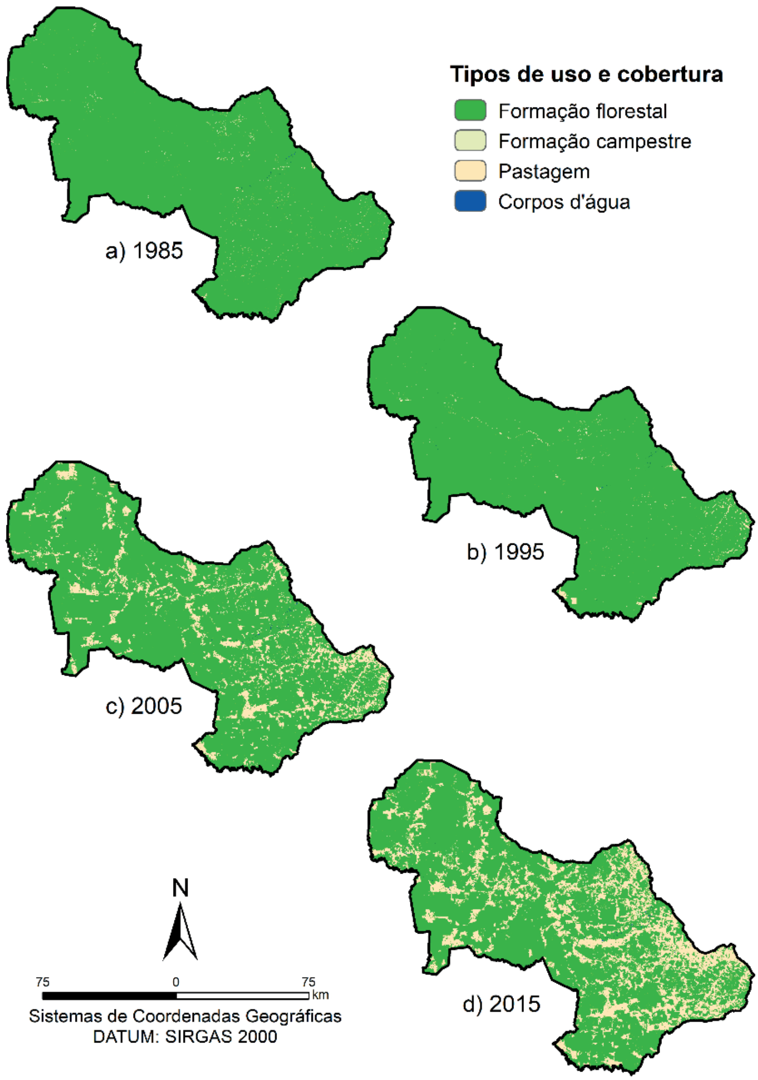

Figure 2: Map of the dynamics of use and coverage in APA Triunfo do Xingu for (a) 1985, (b) 1995, (c) 2005, and (d) 2015.

Considering the period between 2005 and 2015, the territory of the APA of Triunfo do Xingu showed a significant reduction in the percentage of the growing number of pastures with the implementation of the PPCDAm (Figure 3), demonstrating the effectiveness of inspection to address the anthropic causes of deforestation long-term. Among the areas of loss, the percentage of loss of vegetation cover in the year 2004 to 2007 was 6.21% (1044.84 km2), in 2008 to 2011 it was 3.62% (608.52 km2), in 2012 to 2015 was 1.40% (236.24 km2), meaning a gradual reduction of native forests between 2005 and 2015 (Figure 4). However, with the end of PPCDAm in mid-2015, the loss of vegetation cover intensified until 2019 with a loss of 6.32% (1063.72 km2), showing the importance of inspection with articulated actions for territorial land planning, environmental monitoring and control and promotion of sustainable production activities (WEST; FEARNISDE, 2021).

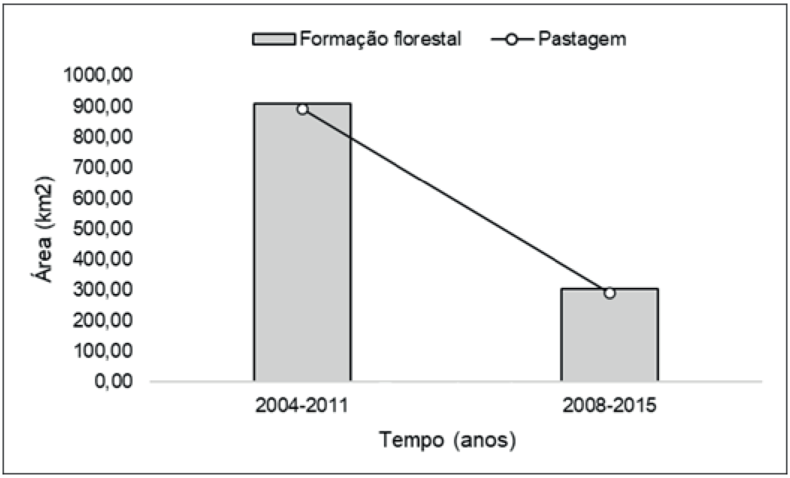

Figure 3: Difference between periods of loss of vegetation cover and gain of pasture in APA Triunfo do Xingu.

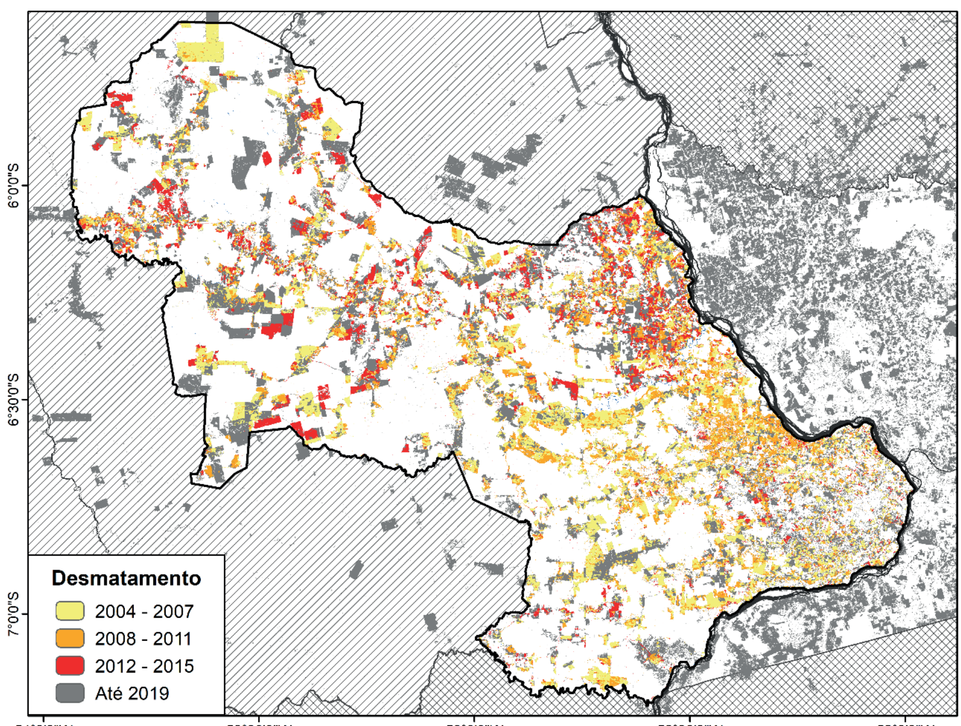

Figure 4: Characterization of deforested areas during the PPCDAm (2005 – 2015).

Changes in air temperature patterns and quantification of hotspots

It is observed that in Figure 5, the orbital monitoring of hotspots recorded a higher occurrence between the years 2005, 2007 and 2015. The temporal variability of hotspots ends up not being a continuous phenomenon, with years with greater concentration than in others, and the APA do Triunfo do Xingu, described by COSTA et al. (2017) is a territorial extension very pressured by human actions of all kinds, such as logging, extensive livestock, among others.

The year with the highest number of hotspots was also characterized by the greatest variation in air temperature, with 28.4°C, compared to the climatological average of 27.3°C. One of the local factors that may have influenced this increase in temperature is the lack of vegetation cover, which influences the prevailing weather conditions through the direct absorption and reflection of incident solar radiation, proven in several studies in the tropics (LORENZ; PITMAN, 2014; SWANN et al., 2015; HANIF et al., 2016; PITMAN; LORENZ, 2016; LOVEJOY; NOBRE, 2018).

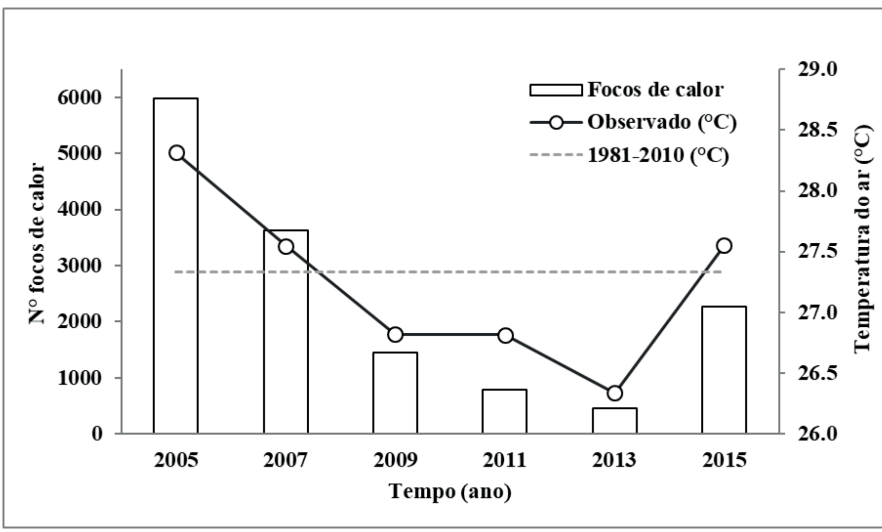

Figure 5: Occurrences of hotspots and air temperature variation, APA Triunfo do Xingu between 2005 and 2015.

It is also noticeable that one of the most important governance instruments at the federal level in Brazil, the Action Plan for the Prevention and Control of Deforestation in the Legal Amazon (PPCDAm) created in 2004, helped to promote a reduction in deforestation (Figure 4).), playing a significant role in containing environmental degradation in conservation units (MMA, 2013; ARIMA et al., 2014; ASSUNÇÃO et al., 2015; CUNHA et al., 2016). Authors such as Santoso et al. (2017) and Jiménez-Muñoz et al. (2016) also highlight that human actions associated with precipitation mechanisms influence the local climate, as observed in 2015, during the occurrence of the El Niño event, classified as strong. This event was capable of causing scarcity of rain, low air humidity and high temperatures, since such action, associated with an increasing rate of hotspots and intense vegetation suppression, contributed to an increase in the annual variation of the temperature above normal, with 28.3°C over APA Triunfo do Xingu.

CONCLUSION

In this study, it was observed that the association of anthropogenic factors contributed to a high annual variation of air temperature in APA Triunfo do Xingu. This demonstrates that the influence of human actions causes an acceleration of impacts at an increasing rate with the removal of vegetation cover if preventive actions and monitoring of deforestation are not implemented, such as the PPCDAm.

Deforestation probably led to a change in the hydrological cycle of the protected area, causing a strong reduction in rainfall, explaining the high temperatures in 2005 and 2007 that were not influenced by precipitation mechanisms.

Therefore, the recycling of moisture must be considered as a key ecosystem service of the Amazon rainforest, in the maintenance of the local climate.

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