

**Analysis of the vegetation area and heat spots in the Porto Seguro settlement in Marabá-PA****Análise da área de vegetação e manchas de calor no assentamento de Porto Seguro em Marabá-PA**

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**ABSTRACT**

Sustainable Development Projects (PDS) are settlements aimed at environmental conservation, through agricultural production activities associated with sustainability. However, many settlements suffer from anthropogenic activities (such as deforestation and burning) to prepare the soil. For this reason, this study aims to analyze the period from 2003 to 2018 at three-year intervals with the generation of thematic maps, which represent the variations of vegetation, anthropized areas and heat spots in relation to the occupation and management of the settlement area. For this, images from the Landsat 5/8 satellite from the INPE image catalog and data from BDQueimada were used, which were treated in the QGIS software using the Supervised Classification (SCP) method. Thus, resulting in the computation of 84 heat spots, 9.25 km<sup>2</sup> of anthropized area in the studied period. It should also be noted that in the period from 2015 to 2018, the greatest number of heat spots was observed, even with the reduction in the evolution of anthropized areas. So, it is possible to detect with this study the evolution in the hotspots

and reduction of vegetation, from the use of geotechnologies to detect these points that offer conservation risk to the vegetation of the settlement.

**Keywords:** Burned, Anthropized Areas, Thematic Map, Geoprocessing.

## **RESUMO**

Projetos de Desenvolvimento Sustentável (PDS) são assentamentos que visam a conservação ambiental, através de atividades de produção agrícola associadas à sustentabilidade. Entretanto, muitos assentamentos sofrem com atividades antropogênicas (tais como desmatamento e queimadas) para preparar o solo. Por esta razão, este estudo visa analisar o período de 2003 a 2018 em intervalos de três anos com a geração de mapas temáticos, que representam as variações de vegetação, áreas antropizadas e manchas de calor em relação à ocupação e manejo da área dos assentamentos. Para isso, foram utilizadas imagens do satélite Landsat 5/8 do catálogo de imagens do INPE e dados do BDQueimada, que foram tratados no software QGIS utilizando o método de Classificação Supervisionada (SCP). Assim, resultando no cálculo de 84 pontos de calor, 9,25 km<sup>2</sup> de área antropizada no período estudado. Deve-se notar também que no período de 2015 a 2018, o maior número de manchas de calor foi observado, mesmo com a redução na evolução das áreas antropizadas. Assim, é possível detectar com este estudo a evolução nos pontos quentes e a redução da vegetação, a partir do uso de geotecnologias para detectar estes pontos que oferecem risco de conservação para a vegetação do assentamento.

**Palavras-chave:** Queimadas, Áreas Antropizadas, Mapa Temático, Geoprocessamento.

## **1 INTRODUCTION**

The settlement projects that propose the interrelation of socio-economic-environmental means, corroborate the adequacy of local populations and in the diffusion of low environmental impact activities based on the aptitude of the involved areas in agrarian reform project (BRASIL, 2000). Beyond that, the Sustainable Development Project (SDP) aims a standard for the prevention and minimization of environmental impacts originating from the activities developed by it (OLIVEIRA et al, 2013).

Therefore, many landowners in settlements aim to adopt the agroforestry systems (SAF's), because it is a technique that matches native forest species with agricultural crops or even livestock activities such as herds (LIMA et al, 2010). Thus, the usage of SAF's in lots of settlements, contributes positively to soil decompression, increased infiltration, soil moisture retention, decreased of carrying nutrients and erosion process control (JUNQUEIRA et al, 2013).

Following this, the substitution of harmful techniques to the environment (like deforestation and burning for cleaning of pasture and cultivation areas), for the usage of sustainable productive models defended by the SDP, contribute to the mitigation of several negative impacts on the environment, as species extinction, soil erosion, increased crop resistance to pest attack and plant growth/development improvements (MESQUITA, 2013).

It is important to note that through the use of geotechnologies, it becomes increasingly possible to monitor human activities in settlements such as burning and deforestation, contributing with the elaboration of action plans and prevention of these impacts (FARIAS et al, 2018).

Geotechnologies are efficient in detecting heat spots and deforestation caused by cutting and burning, through images generated by satellite sensors (PEREIRA et al, 2012). As also, smooth the development of studies aimed at analyzing the evolution of the percentage of heat spots and deforestation registered in the Amazon region (ALONSO et al, 2019).

Therefore, this research in the SDP settlement located in the municipality of Marabá in southeastern Pará, becomes relevant because it analyzes the evolution of deforestation and fires, investigating through SAF's cultivations, the benefits of sustainable agriculture due to the conservation of vegetation present in the study area.

## **2 AIM**

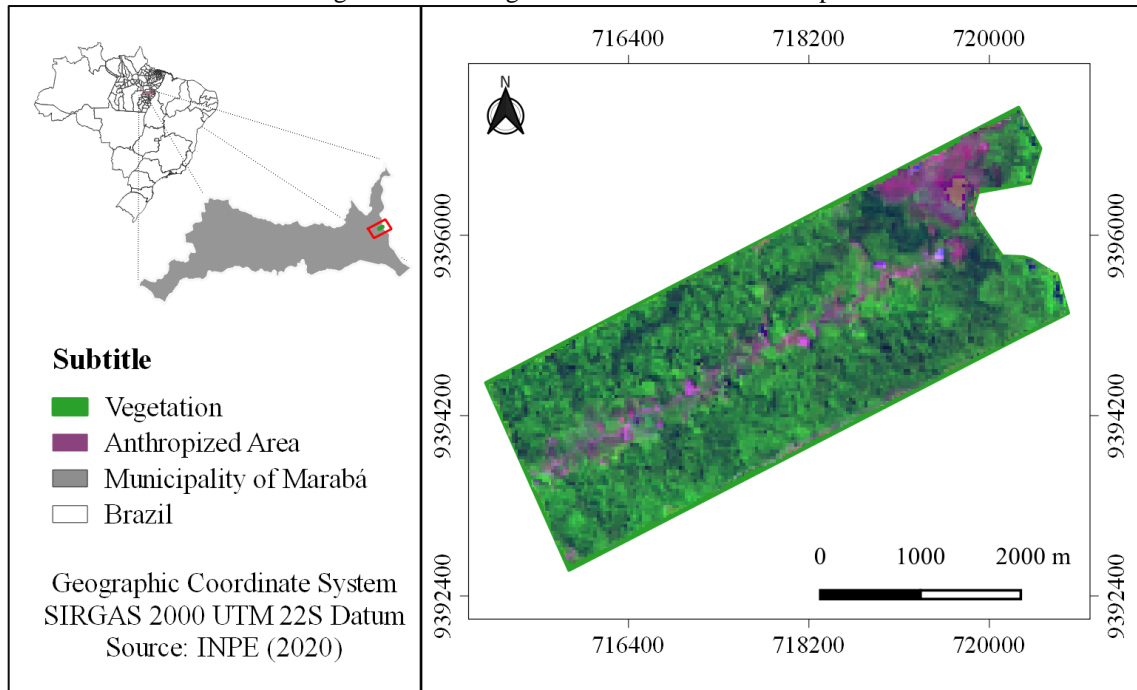
The study aimed to carry out the multitemporal analysis from 2003 to 2018 (with breaks from 2003-2006, 2007-2010, 2011-2014 and 2015-2018). Which made it possible to generate thematic maps of vegetation variation, anthropized area and heat spots in relation to family farming practice using SAF's, occupation and management of the SPD Porto Seguro settlement area in the municipality of Marabá-PA.

## **3 METHODS AND MATERIALS**

### **3.1 CHARACTERIZATION OF THE STUDY AREA**

The Sustainable Development Project (SDP) Porto Seguro, is located at Latitude 5 ° 28'26.20"S and Longitude 49 ° 2'17.53"W, on the BR-155 highway and 14 km from the municipality of Marabá, placed in the southeastern region of the state of Pará (Figure 1). Being a constituent part of the Amazon biome, characterized by the presence of open ombrophilous forests, elevation of 139m and humid tropical climate according to the Köppen-Geiger classification with "Aw" types (COSTA et al, 2018).

Figure 1. Porto Seguro Settlement Location Map.



Source: Authors (2020).

Still on SDP Porto Seguro, it was the first agricultural settlement with a sustainable development project recognized by the National Institute for Colonization and Agrarian Reform (INCRA) in 2010 (BRASIL, 2019). So, the settlement shelters 37 families in an area of 1,069 ha (that is 10.69 km<sup>2</sup>), which develop agriculture associated with agricultural cultures, livestock and native species through the Agroforestry System (SAFs) (ALMEIDA, 2018).

### 3.2 DATA ACQUISITION

For the analysis of vegetation, images were obtained from orbit 223 and point 064, from the period 2003-2018 on the digital platform of the Image Catalog of the National Institute for Space Research (INPE). This way, for the period from 2003 to 2013, scenes from the Landsat 5 / TM satellite with band 3, 5, 7 and spatial resolution of 30m were used as well as the period from 2014 to 2018 operated with the Landsat 8 / OLI satellite with bands 4, 6, 7 and 15m spatial resolution.

The vector files (points) of heat spots also from the period 2003-2018, in *shapefile* format, were obtained from INPE's Burned Database (BDQueimadas) platform, from the AQUA M-T and TERRA M-T satellites using the MODIS sensor.

### 3.3 DATA PROCESSING

After the acquisition of matrix data and *shapefile*, using the QGIS software version 3.8 It, the Coordinate Reference System (SRC) of the Landsat images of the Datum WGS84 was redesigned for SIRGAS 2000 UTM South Zone 22. In addition, the Semi-Automatic Classification (SCP) *plugin* was used to apply the Supervised Classification of *raster* files. Because, with supervised classification, it is possible to segment images with different spectral bands in classes of interest (BARROS; PAMBOUKIAN, 2017).

Thus, with the selection of images, a *Merge* was created (converting several *rasters* into one) using the *Band set* tool. Generating, *raster* files from the junction of images from the periods 2003-2006, 2007-2010, 2011-2014 and 2015-2018. Thus, a *raster* is composed with different combinations of band and desired classes (SANTOS, 2017).

With the creation of the *raster* files, the matrix was cut out of the image in the shape of the boundary polygon of the Porto Seguro settlement area, to then perform the color composition of the image in *Red*, *Green* and *Blue* (RGB). In this way, it was possible to select regions of interest and define the vegetation classes and anthropized area using the *Classification* dock tool.

The heat spots from the vector files (2003 to 2018), were selected from the *shapefile* of the municipality of Marabá and grouped in 4 databases (2003-2006, 2007-2010, 2011-2014 and 2015-2018), bounded to the perimeter of the SDP Porto Seguro polygon.

With the treatment of matrix and *shapefile* data and elaboration of thematic maps, the analysis of the temporal distribution (2003-2018) of the behavior of the sources of heat and vegetation in relation to the agroforestry system was made. By calculating the vegetation area (by the *raster* reclassification method by *Grass* mode and *r.reclass* algorithm and by converting pixels to vector data also by *Grass* mode and *r.to.vect* algorithm), modified area by human actions and analysis of the sustainable family farming system.

### 3.4 DATA ANALYSIS

After the data acquisition and treatment steps, the numerical data of heat spots and areas that suffered with the process of environmental change due to anthropic action, identified in the period from 2003 to 2018 studied in the SDP settlement were quantified, by arithmetic means using Excel software.

**4 RESULTS AND DISCUSSION**

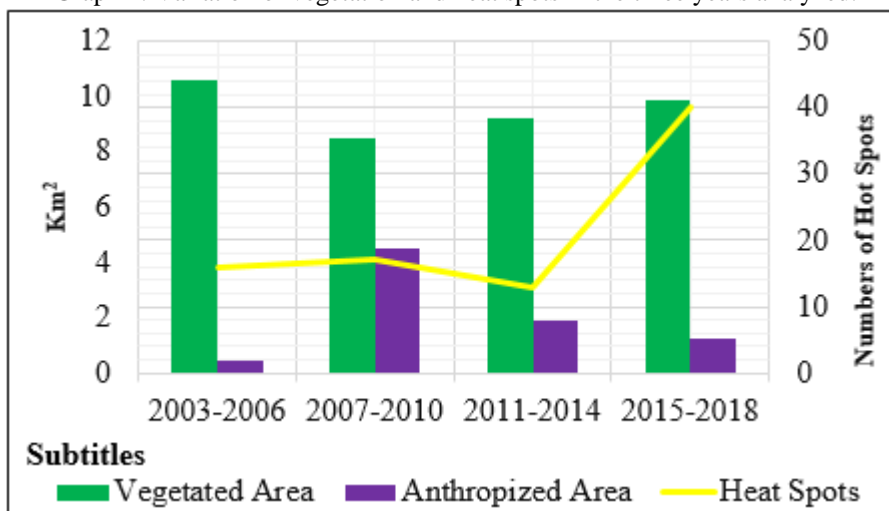
With data processing on vegetated area, anthropized area and heat spots, can be observed the evolution of these data according to the three-year periods analyzed from 2003-2006, 2007-2010, 2011-2014 and 2015-2018 (Table 1). Therefore, it is possible to identify a variation between the periods and verify that there was a significant reduction in vegetation in the 2007-2010 triennium with 4.53 km<sup>2</sup> of anthropized area, being the period from 2003 to 2006 with the highest record of conservation of vegetation (10.56 km<sup>2</sup>) and about 40 heat spots (that characterizes the fires in the settlement area) recorded in the years 2014-2018 characterizes the main peak for this data (Graph 1).

Table 1: Data from the vegetation area, anthropized area and heat spots in the three years analyzed.

| AREA                    | 2003-2006 | 2007-2010 | 2011-2014 | 2015-2018 |
|-------------------------|-----------|-----------|-----------|-----------|
| <b>Vegetation Area</b>  | 10,56     | 8,51      | 9,18      | 9,83      |
| <b>Anthropized Area</b> | 0,48      | 4,53      | 1,86      | 1,21      |
| <b>Heat Spots</b>       | 16        | 17        | 13        | 40        |

Source: Authors (2020).

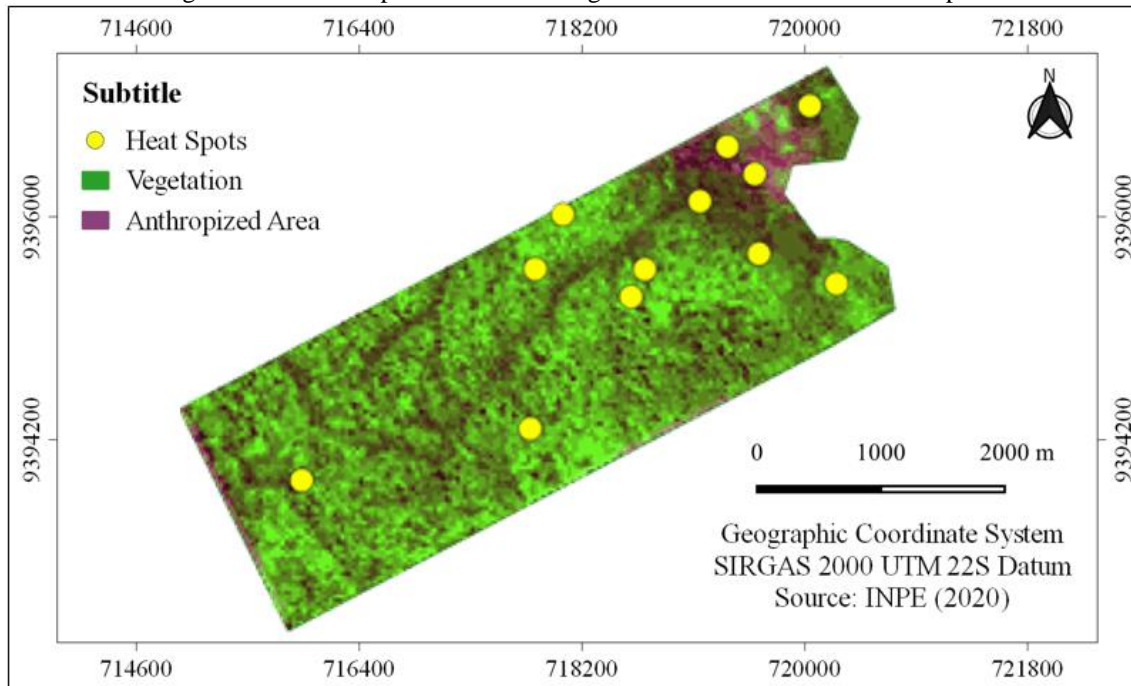
Graph 1: Variation of vegetation and heat spots in the three years analyzed.



Source: Authors (2020).

When analyzed, the period from 2003 to 2006 showed an extension of 10.56 km<sup>2</sup> of vegetation, which is equivalent to 95.70% of the settlement area. Furthermore, this vegetation is considered to be initial, due to the absence of agrarian conflict in the SDP Porto Seguro region. Also, 16 heat spots were detected in the same period, with the years 2004 (8 spots) and 2005 (6 spots) showing a higher concentration of hot spots (Figure 2).

Figure 2. Variation of vegetation and heat spots in the Porto Seguro SDP Settlement area for the period from 2003 to 2006.



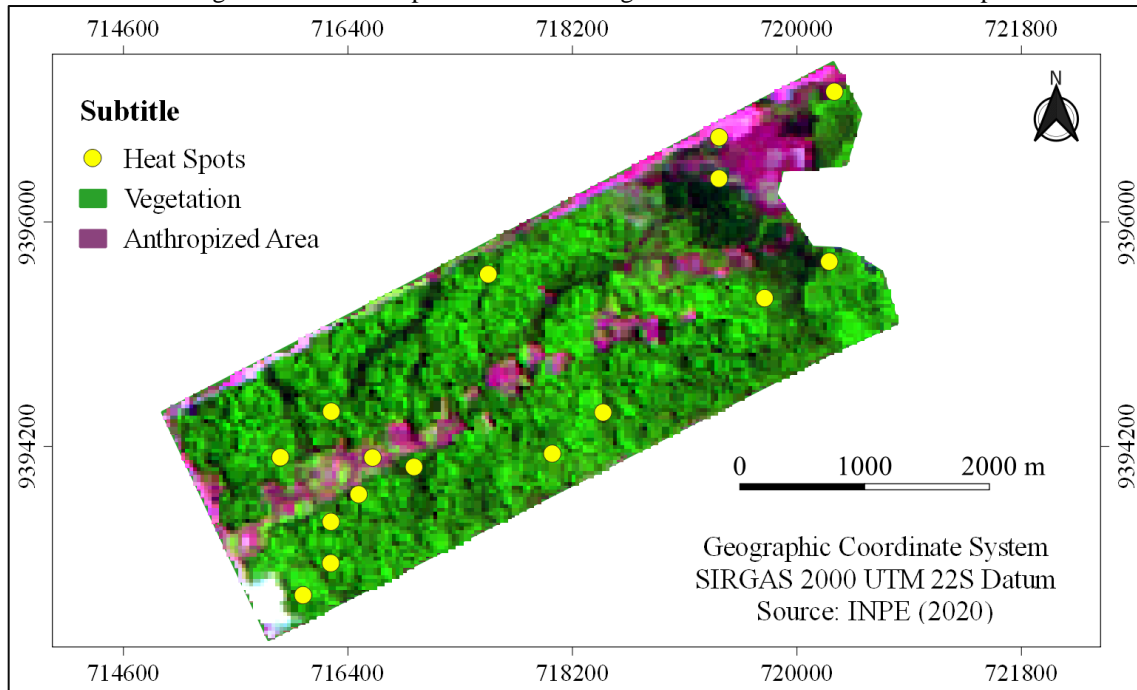
Source: Authors (2020).

About agrarian conflicts, Congilio and Moraes (2016) affirm that these have consequences of deforestation, due to the disordered appropriation of areas destined to agriculture and livestock by cutting and burning activities. At the expense of that, in the period from 2007 to 2010 there was a reduction in vegetation of 2.35 km<sup>2</sup> (22.95%), which compared to the previous period (0.48 km<sup>2</sup>) there was an increase of 2.06 km<sup>2</sup> (18.65%).

Regarding heat spots, 17 points were found that corroborate the increase of hot spots when compared to the records of the past period. Furthermore, the location of the hot spots is directly related to the anthropized areas (Figure 3), in other words, the anthropic changes in 2007 show the intensification of the actions of occupation of the area by 120 families with the support of the Pastoral Land Commission (CPT).



Figure 3. Variation of vegetation and heat spots in the Porto Seguro SDP Settlement area for the period 2007 to 2010.

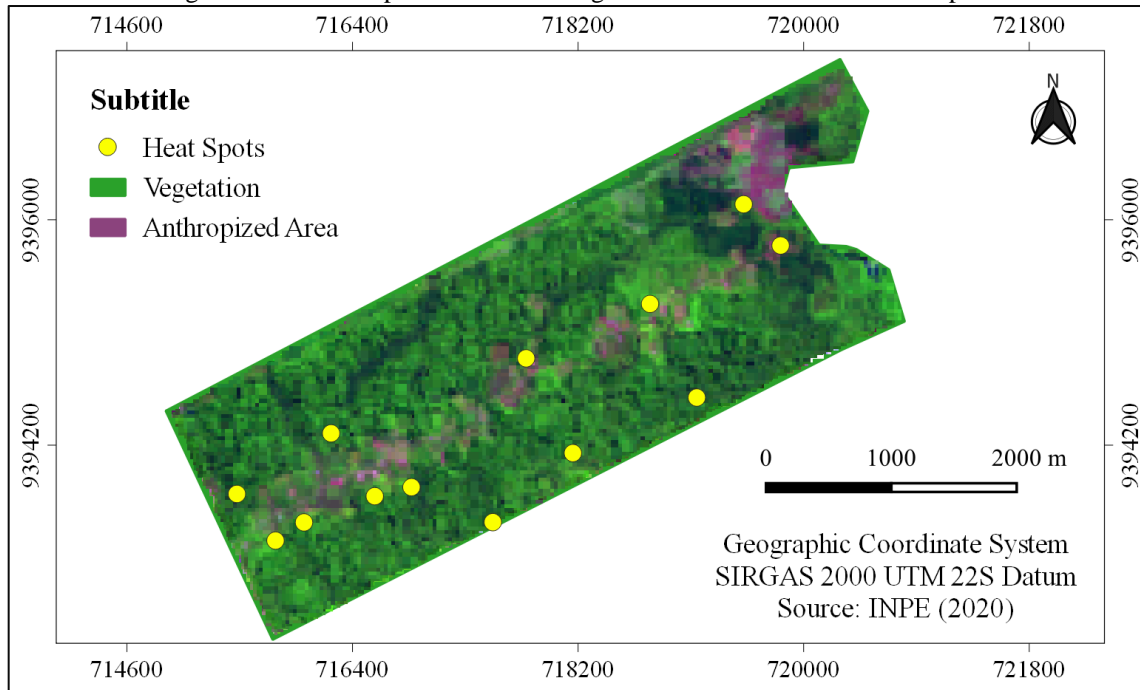


In 2010, as long as Ordinance 477/1999 of the Institute itself, INCRA recognized the settlement as a sustainable development project, which considers the settlement to be able to develop traditional extractive activities that enable the production of family farming and conservation of the environment (BRASIL, 2019).

As a consequence of this regulatory action, the period from 2011 to 2014 showed an evolution in the conservation of vegetation, compared to the period 2007-2010, there was a reduction of anthropized area of 1.86 km<sup>2</sup>, about 16.90% (Figure 4). This affects the adoption of sustainable SAF practices, which favor the maintenance of soil quality and, consequently, the regeneration of anthropized areas (TORRALBA et al, 2016).



Figure 4. Variation of vegetation and heat spots in the Porto Seguro SDP Settlement area for the period from 2011 to 2014.



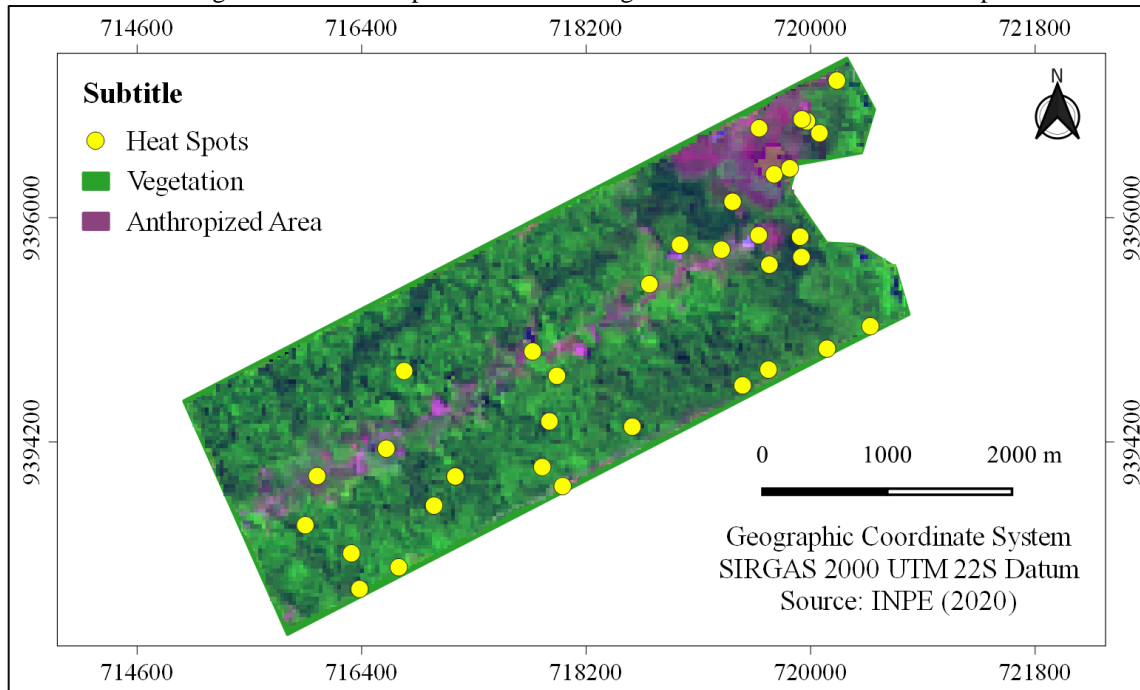
Source: Authors (2020).

In accordance with this Silva, Cavalcante and Silva (2016), emphasizes that sustainable family farming supports the maintenance of the environment, without the use of pesticides, crop variations and production of small crops that favor the implantation of natural nutrients in plants such as nitrogen in the soil, like beans, which is typical of farming in families settled (ALTIERI; MONZOT; PETERSEN, 2012) (FELICIANO et al, 2018).

As for the heat spots, for this period it was the lowest recorded in the whole multitemporal series with 13 spots, having the highest concentration in the year 2012. This drop represents a change in the way of preparing the soil, which leaves the use of slash and burn by techniques with less environmental impact, such as a *silvopasture* that adds up cattle raising in relation to pasture and forest (WILSON; LOVELL, 2016).

In the period from 2015 to 2018, there was a further reduction in the level of vegetable desolation with a decrease of 1.21 km<sup>2</sup>, that is, 11.01% of the anthropized area when compared to the period of 2011-2014. However, heat spots registered the largest amount of registration with 40 spots, being, 19 in 2017 and 17 in 2018 (Figure 5).

Figure 5. Variation of vegetation and heat spots in the Porto Seguro SDP Settlement area for the period 2015 to 2018.



Source: Authors (2020).

The increase in the records of heat spots in the period from 2015 to 2018 can be explained by Asher (2018) and Ribeiro et al. (2018), who emphasize the action of *El Niño* associated with oceanic cycles caused the reduction of humidity and extended the period of extreme drought. In addition, smoke from fires and fires potentialize the extension of drought periods and vegetation vulnerability to fire (CARRERO; ALVES, 2016).

## 5 CONCLUSION

Therefore, in the 16-year period (2003-2018) about 84 heat spots, an average of anthropized area and vegetation, respectively of 1.52 km<sup>2</sup> and 9.52 km<sup>2</sup>, were computed. Which means that in that period the settlement region underwent constant changes in its landscape. Furthermore, you can see that the critical period of change in the landscape due to anthropic action it took place between the years 2007 to 2010, with the increase of the degraded perimeter. However, the period from 2011 to 2018, there was a significant reduction in the degradation perimeter, which represents the effectiveness of the SAF system in family farming. Despite this, there was an evolution in the record of heat spots, which highlights the intrinsic climate interaction and the need for the use of geotechnologies to detect these points that pose a risk to the conservation of the settlement's forest environment.

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