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LAND USE AND COVER CHANGE CAUSED BY MINING IN THE MUNICIPALITY OF IPIXUNA-PA

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ABSTRACT

Mining is a high impact activity environmental and socially speaking. The mineral district of Capim river in the State of Pará has the largest reserve of kaolin in the Brazilian territory. The aim of this study is to identify changes in land use and cover caused by the modifications in the way of ore prospecting in the municipality of Ipixuna-PA from 2004 to 2014 and to analyze potential impacts on natural resources due to these changes in land and the lack of compliance by the company. Data from the TerraClass Project and the United States Geological Survey were used. In 2004 the mining area was 439.70 ha (0.08%) and in 2014 was 1131.19 ha (0.22%), an increase of 157.26%. Regarding the values of the production of unprocessed and processed kaolin in the state of Pará, it was verified that from 2004 to 2014 there was an increase of 28.24% in the gross production of kaolin in the area that is the focus of this study. The company Imerys Rio CapimCaulim's lack of compliance with the Brazilian environmental laws has compelled the regulatory organization to act in a way which only the company has had benefits despite environmental and social aspects, typical of the current discussion of modernity.

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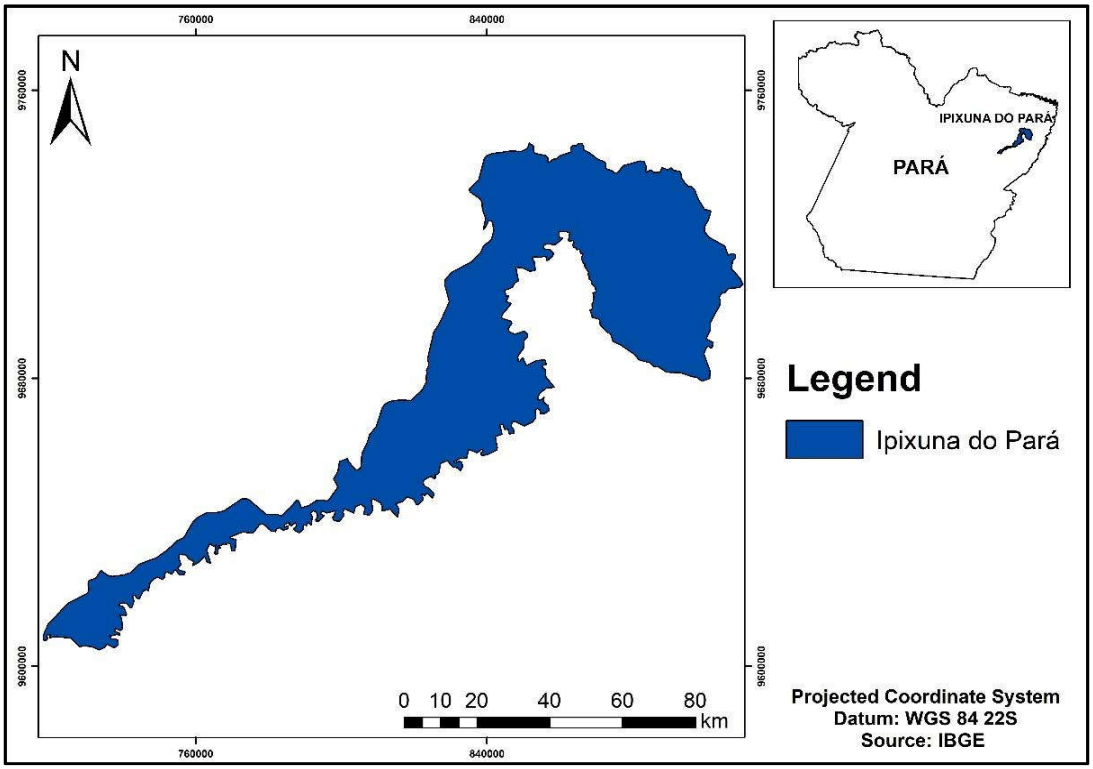
INTRODUCTION

Mining is a high impact activity environmental and socially, and it is a sector managed mainly by multinational companies or by their national partnership corporations. Operations, whether in a small or large scale, is inherently environmentally damaging, producing huge amounts of waste that can have harmful impacts for decades (Kitula, 2006, Morrison *et al*, 2016). One of the impacts of mining is the change in land use and land cover, which according to Oliveira *et al*. (2016), is the way of how humans use the land, its practices, and management; some examples of use are urban areas, agriculture, pasture, and mining. The change in land use is a direct consequence of ore prospecting which impacts are not often analyzed by tools such as remote sensing. Multitemporal analysis performed on a local scale helps to understand the current complex events of greening and environmental degradation (Sonter *et al* 2014; Nutini *et al*., 2013). Amazon is an attractive region for mineral resources. That is because of the exploration that has been done there, which is a form of domination, a way of colonial authority that controls this territory, the same one established in Latin America (Quijano, 2000, Mignolo, 2012). This exploration is due to the increase in consumption, resulting in the accelerated depletion of the different types of raw materials, which increases the need to seek resources in new areas and in increasing spaces and distances. The kaolin has global dimension both from the point of view of the extraction and impacts as well (Lapčík *et al*., 2017; Mensah *et al*., 2015; Bunker, 2003). One of the raw materials included in this plot is kaolin, according to Paiva *et al*. (2014) is basically formed by kaolinite (aluminum hydrated silicate) and is white in color because of its low iron content. It is a non-toxic, white clayey mineral with low thermal and electrical conductivity and no chemical reactivity. Kaolin has been intensively used as an industrial mineral, mainly in the paper industry, as a cladding or cellulose fiber stuffing material (Santos *et al*., 2012). These different ways of kaolin production range from the big business to small business. The mineral district of the Capimriver in the State of Pará has the largest and best reserves of kaolin in the Brazilian territory. Although kaolin reserves were discovered in the region just in 1970, their recognition only began in 1990 (Monteiro, 2011),



Source: author

Figure 1. Location of the municipality of Ipixuna in the State of Pará

and one of the most important mining companies in this region is ParáPigmentos S/A (PPSA), located in the Capim river basin, in the county of Ipixuna do Pará, northeastern Pará state (Costa *et al*., 2009; Murray, 2007; Mussel *et al*., 2008). In 2010, Vale sold 86.2% of the ParáPigmentos SA (PPSA)'s capital to the Imerys Group and the mining rights of kaolin in Ipixuna do Pará. Beyond increasing its mineral reserves of kaolin in the paper market - 64% of the Brazilian market for kaolin paper production - Imerys Rio CapimCaulim took control of the processing plant and logistics infrastructure, with the pipeline and the pier owned by ParáPigmentos SA (PPSA) (Monteiro, 2011). This mining company has exceeded the environmental standards on kaolin prospecting. The waste resulted from Kaolin extraction contains, in addition to other contaminants, a concentration of metals such as Iron (Fe), Aluminum (Al), Zinc (Zn) and Cadmium (Cd), more than allowed by the law. The consequences of this contamination often exceed the boundaries of the work areas, reaching also the topography, flora, fauna and the water and morphophysiological system of the land, etc. (Aumond&Balistieri, 1997). Imerys Rio CapimCaulim's lack of compliance with the Brazilian environmental laws has compelled the regulatory organization to act in a way which only the company has had benefits despite environmental and social aspects. Kaolin mining process also causes a lot of disturbance, due to its excessive production of particulate matter and the production of effluent that when dried, become dust and, due to the wind, spreads through the streets and avenues, polluting the air and compromising the visual aspect of the place where the company operates (Fernandes, Pessoa, 2011). In this way, the impact on land use and land cover are deeply linked to all these events. The aim of this study is to identify changes in land use and cover caused by the modifications in the way of ore prospecting in the county of Ipixuna-PA from 2004 to 2014 and to analyze potential impacts on natural resources due to these changes in land and the lack of compliance by the company.

MATERIALS AND METHODS

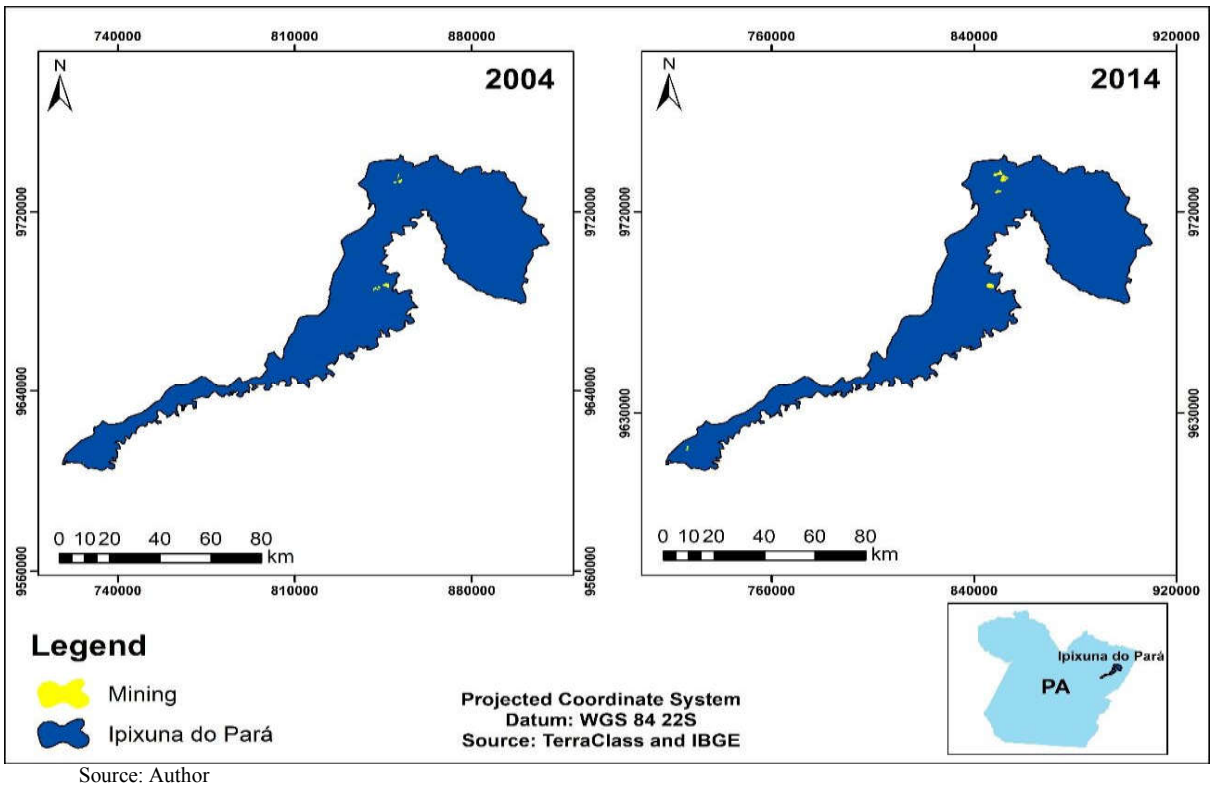
Study area: The county of Ipixuna is located in northeast of Pará State (Figure 1). The climate type is the Am according to the Köppen classification, characterized by temperature, air relative humidity and the annual average rainfall of 26 ºC, 82.5% and 2,250 mm, respectively, with a more rainy period (January to June) and another less rainy (July to December). The predominant soils are of the dystrophic yellow Latosol type (Lima *et al*., 2017). This municipality is notable for concentrating infrastructure actions aimed at local economic development, among which are mining activities of kaolin and industrial projects (Dias *et al*., 2018). Kaolin is inserted in the context of the Ipixuna Formation, in the region of the municipality of Ipixuna do Pará, where it is possible to distinguish two main units (Lower Unit and Upper Unit) separated from each other by a discordant erosive surface. The lower unit is formed mainly of kaolin, the ore from quarry. In the apparent base of this unit, the kaolin is a mainly of a soft type with high whiteness, at the top, the kaolin is flint or semi-flint type (Carneiro *et al*., 2003). Currently, the kaolin of the region is being industrialized by the company ParáPigmentos S/A (PPSA) and Imerys - Rio CapimCaulim S.A (IRCC).

Characterization of use and cover area: To characterize the mining in the municipality of Ipixuna, data from the TerraClass Project (INPE, 2017) were used from 2004 to 2014, with a mapping scale of 1: 100,000. TerraClass data are available in orbit spots, based on the Landsat 5 satellite (TM sensor) in the Lat/Long Projection System and SAD 69 Geodetic Reference System (Nascimento, Fernandes, 2017). In the study, only the mining class thematic was used, which corresponds to the areas of mineral extraction in open areas involving deforestation. Cartographic bases containing the municipal boundaries of the Brazilian Institute of Geography and Statistics (IBGE) were also used. The vector data from the TerraClass project were systematized and redesigned for the

Table 1. Areas of land cover use in the municipality of Ipixuna do Pará

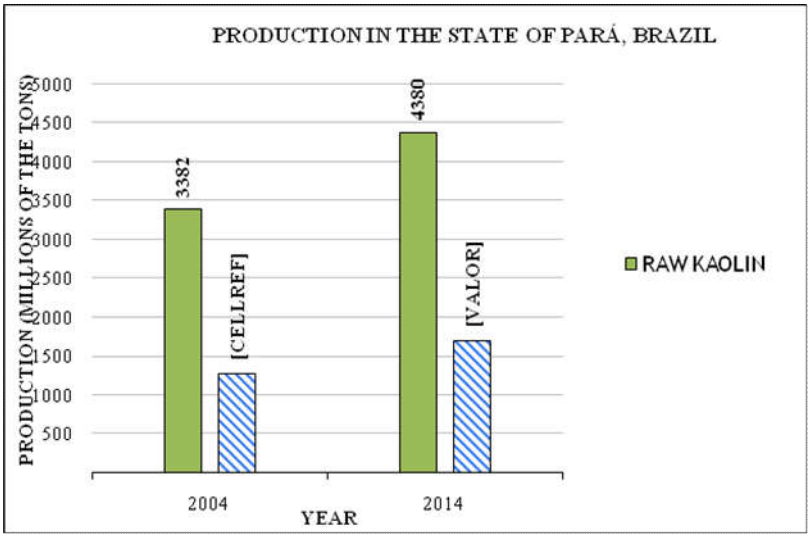
Type of process	2004		2014	
	Ha	%	Ha	%
Mining	439,70	0,08%	1.131,19	0,22%
Total	521.700	100%	521.700	100%

Source: Author



Source: Author

Figure 2. Land Use and Cover from Mining in the municipality of Ipixuna in the State of Pará



Graph 1. Production of Kaolin in the state of Pará

Mercator Transverse Universal Cartographic Projection System - UTM WGS 84 Zone 22S, for the study area.

Identification of Caulim production in the city of Ipixunado Pará: The data were extracted from government documents that are directly linked to the Brazilian mineral sector, the Brazilian Mineral Yearbook, the State Mineral Yearbook, both prepared by the National Mining Agency and the Mineral Report prepared by the Mining Union of the State of Pará, and the United States Geological Survey as well.

RESULTS

Table 1 and Figure 2 show that the area of mineral extraction of kaolin in the municipality of Ipixuna do Pará has grown over the years. In 2004, 439.70 ha (0.08%) of the total area and in 2014 the occupied area reached 1131.19 ha (0.22%), which represented an increase of 157.26% in relation to 2004. Graph 1 for the years 2004 to 2014 highlights the values of the production of raw and processed kaolin in the state of Pará and shows an advance in the production of kaolin. It is verified that

from 2004 to 2014 there was an increase of 28.24% in the production of kaolin at the mine located in the city of Ipixuna do Pará.

DISCUSSION

The eastern Amazon has gained prominence as it has one of the world's largest reserves of kaolin in the country, which is located in the Capim River region of the state of Pará (Sabedot *et al*., 2014). In 2000, IRCC sold 313,500 tons of kaolin. In 2002, the process of expanding the installed capacity to 600 thousand tons of kaolin was concluded, in which year the company sold 337 thousand tons (Monteiro, 2011). Thus, of the other kaolin producers located in the eastern Brazilian Amazon, Imerys is highly represented in the exploitation of kaolin and aims to expand its production to one million tons annually (Monteiro, 2011). Since the installation of the kaolin mining industrial facilities in the municipality of Ipixuna, constant adaptations in the logistics and in the production process has been adopted by the mining companies operating in this region. Graph 1 shows this increase in kaolin production in the period from 2004 to 2014, and this trend has been maintained over the years, according to updated data on the commercial balance of mineral production. Brazil in 2017 was the sixth largest producer of kaolin, with approximately 2,100 million tons, about 5.68% of world production, which was 37 million tons (USGS, 2018).

The ore deposit, formed mainly by kaolinite in the Capim River region, is classified as a large-scale mine with production value between 100 million and 1 billion tons in 2016 (MME, 2017). Corroborating with the above, the present study also identified an increase in the mined area of 157.56%, which corresponds to 691.49 ha in the ten year period (2004 to 2014). Thus, the mining area expanded and there was an increase in the state's production of crude kaolin over the years, which justifies the growth of 998 million tons of raw kaolin and 423 million kaolin benefited between the years 2004 and 2014, only in the state of Pará where the companies is responsible for 63.2% of the production of this ore in Brazil (PPSA and RCCSA) and responsible for 1.9% of the mining sector in the state of Pará (MME, 2017). As all major enterprise operations, mining is followed by impacts in different spheres (economic, social and environmental) (Sánchez, 2013). Extraction activities, unavoidably, impact the land as the land surface is removed during the process itself and the construction of necessary facilities (storage piles, disposal areas, ponds, buildings, access roads, etc.) causing disturbances in natural habitats, fauna, and flora (Marnika *et al*., 2015). Thus land use and land cover of areas in the vicinity of mining sites are significantly affected by corresponding mining activities and consequently change faster than other areas. The surface changes include erosion, acid-mine drainage, and sediment load increase (Raval e Shamsoddini, 2014).

In environmental terms, mining projects stand out because of their significant interaction with surface and underground water resources, either because of their use in production processes or because they are located in regions of springs and water recharge (CNI, 2017). The use of water is not limited to the mining process, but also extends to mining operations and transportation, as well as mine closure (CNI, 2017). It is important to point out that the IRCC does not present compliance in the country's regulatory framework since it does not use preventive measures for damages caused by its operation. At a time when new patterns of development are being sought that adjust environmental protection, social justice, and economic efficiency (Becker, 2010), it is important for large commodity corporations to seek better technologies and productivity levels, with a lower impact on natural resources and, mainly, a reduction in the forest degradation. This same concern should guide the agenda of the companies that work in the study area, coordinating actions in order to minimize social and environmental impacts.

Conclusion

The state of Pará, located in the Brazilian Amazon, is the federation unit with the highest kaolin mineral production at the national level. This activity generates good economic results for the large corporations that operate here. For local society, the inferior mentality implanted in the region over decades, allows regressions to occur to the detriment of these gains, in particular, by the accelerated environmental degradation, fruit of the capitalist desire to obtain the maximum profit in the shortest possible time. As can be seen in table 1, in 2004 deforestation in the area destined to the mineral exploration of kaolin in the Rio Capim was of 439,70 ha. Since that time with the entry of another actor, Imerys S.A, the gross production of kaolin has increased significantly in 10 years. Figure 3 shows the graphic of a beneficiary and crude production of kaolin, such that there was a 29% and 32% increase, respectively, in kaolin production in the period from 2004 to 2014. During the same period, the deforested area in the Capimriver was also bigger, in the region that concerns the mining of kaolin. The increase was more significant than that of production and in 2014, 1131.19 ha of deforested land was reached, an increase of 157% over the area suppressed in 2004. Finally, it is inferred that the increase in kaolin production had a direct relationship with the increase of deforested area in this region of the grassy river. However, due to the limitations of access to the region and the mine site, it was not possible to answer two important questions. The first is how increased deforestation was influenced by the operability of the mine area? And the second is what are those processes been used that are causing so much damage environmentally?

Compliance has not been a concern of corporations, such as the IRCC, which operates in the industry. Using the terminology of Environmental Responsibility, Sustainability and Social Responsibility, the Mineral Sector corporations present a poor performance related to compliance with the national and international rules related to the social and environmental area, where land cover and land use evidence the impacts of this mining in the Capim river basin. Corporations, when located in developing countries, seek to use regulatory failures as mechanisms of competitiveness in the coordination of their global activities and non-compliance with environmental rules and transparency as a principle of sustainability are a colonial form of behavior of these companies. Mignolo (2000) emphasizes that postcoloniality is the counter-modern discourse that emerges from the colonies. The discourse disseminated by the mining companies that operate in the exploitation of kaolin in the Capimriver's region is based on this "modernity" that aims to progressively destroy the environment and generate great profits. Thus, we are preparing a speech to provide a scientific intervention that has aimed to collect information that can subsidize effectual action by the government so that it can articulate a way that will stop the advance of this "rampant" deforestation.

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