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Abstract

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ABSTRACT

The Tarumã district over the years has grown demographically in accelerated mode. In the neighborhood area, there is currently an environmental conflict due to the increase deforestation. These causes have been a major concern in this area. The study of this work relates this accelerated growth to the deforestation in the neighborhood, which is the object of study area. Images and shapes downloaded from the PRODES system were used in the site analysis, which were processed in the Arcgis 10. The results pointed out a very significant growth of deforestation at Tarumã area.

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INTRODUCTION

During the last few years the labor market in the city of Manaus has been heated by the Industrial Pole of Manaus (PIM), and with the opening of new jobs hundreds of families have migrated from the south / southeast / northeast regions (ANDRADE, 2012). In this way, the city has experienced a rapid growth of the urban areas and consequently the removal of the forest cover of the place (COSTA et al., 2012). In addition, because the city has been built around the river the only alternative to supply the demand is the expansion of the urban areas towards the forest. At the same time, much of this expansion takes place through intrusions and irregular constructions. Cunha et al. (2012) have shown that the large concentration of irregular housing is mainly a consequence of the disorderly growth of large urban centers. At the same time, Assad (2006) showed that some districts of the city of Manaus in the West, East and North zones developed from the deforestation of adjacent areas and also from irregular occupations in areas lacking basic infrastructure, such as the banks of the streams.

At the same time, the IBGE demographic census (2010) showed that more than 80% of the Brazilian population resides in urban areas. The lack of administrative, that is, government and supervisory planning of the competent bodies does not prevent the population of lower income from dealing with areas that are close to urban areas, clandestinely.

These irregular occupations have become one of the most worrying issues for society, due to the problems that have arisen in relation to the environment. The environmental conditions of cities create a hostile nature, as the imbalance between the elements that compose the urban system compromises the quality of life of its inhabitants (CARRARA, et al., 1991), where many of these occupations take place in areas known nationally as Areas of Permanent Preservation (APP's), protected by Federal law. In the face of this, these irregular invasions also bring social problems through risky situations caused by riverbank / igarapés constructions and elevations in the terrain (ravines), where they often reach natural disasters such as landslides and floods (PLATE, et al., 2002). These events are commonplace because the invaded sites do not offer infrastructure or housing conditions. In this way, unorganized and unplanned growth is directly linked to the withdrawal of part of the vegetation cover of large cities.

In addition, the occupation process causes the native vegetation to be removed, altering the soil permeability and causing a decrease in the infiltration capacity and the increase of the surface runoff, accelerating the silting process, besides increasing the flow of the rivers in times of (KOBIYAMA, et al., 2006; TOMINAGA, et al., 2009). Forest and soil are of great importance in the conservation and preservation of biodiversity, acting as protection against erosion, sedimentation or contamination. However, these areas that should be preserved have not been able to play their part for some time, due to urbanization and the great increase in human actions.

Invasions of protected areas tend to compromise the water resources of the region, especially the river basins around the invaded areas. The conservation and maintenance of watersheds plays a key role in the natural abstraction of water, which through rainfall converges part of the rainwater that has not infiltrated the soil by surface and underground flow to a single point of exit, the rivers of the region (TUCCI, 1997). In recent years, these basins have not been fulfilling this role, because several factors such as the human environmental degradation and changes basically strong impacts and changes in the basin area.

These actions do with natural modifications in the functions of the river basins, indispensable for the maintenance of the forest and human life. Among the actions and damages caused to the basins we can highlight pollution as one of the most aggravating. This shows us that the population without any structure and without planning directly harms the natural means.

This population growth has a great relation with the significant changes in the forest areas. One of the problems generated by the increase of the population in the Amazon region is deforestation through burning practices, cutting of trees to obtain land for housing and pasture for livestock (SANTOS, 2010). In this context there is a need to seek guidelines that fit into social, economic and environmental planning. After a few decades of the worst period of suppression of green areas, it was possible to analyze and discuss the problems that this accelerated development (COPQUE et al., 2011). Thus, today we have computational tools that allow us to better analyze the decrease of the vegetative cover of a region.

The use of these techniques and tools are known respectively as remote sensing and Geographic Information System (GIS) (ASRAR, 1992) conceptualizes remote sensing as the acquisition of information or state of a target by a sensor, without being in physical contact. In this technique, the objective is to analyze and provide, through satellite images, a better evaluation and analysis of the deforestation situation in the studied areas. Where this information is obtained through the use of Geographic Information System. A Geographic Information System can be described as a computational technology, developed to capture, store, manipulate and visualize georeferenced data (Burrough and McDonnell, 1998). Therefore, this type of study helps us as a reference for the generation of information, which aims to estimate the deforested area of an irregular occupation in the urban area of Manaus. With a view to the calculation of vegetation cover and the monitoring of land use and coverage through studies and analysis of spatial information.

The mapping of these urban areas was necessary due to the increase in urban expansion around the district of Tarumã. Monitoring through spatial images makes it easier to detect deforested areas. The development of these techniques is necessary because it allows to identify the dynamics of space and time of an area. The use of these images becomes necessary for these studies of deforestation of areas, even for technical decision making. This technical study based on spatial studies becomes interesting because it enables the extraction of more detailed information about the objects and classes concerned. Antonyms et al., 2001). In addition, it is possible to take the elements of recognition of classical photointerpretation, such as hue, shape, pattern, density, texture, shadow, geographic position and context.

2. DATA AND METHODOLOGY

The study was conducted in the neighborhood of Tarumã at coordinates 3 ° 0 '17.50 "S and 60 ° 5' 53.13" W. The neighborhood is located to the west of the urban area of Manaus, capital of the State of Amazonas. The city is situated on the left bank of the Negro River, 18 km upstream from its confluence with the river (Bühring, et al., 2006). Its territory is 11,401,092 km² and an estimated population of 2,057,711 inhabitants (IBGE, 2015), as can be seen from figure 1.

The State of Amazonas is bathed by a multitude of interconnected rivers, forming an integrated hydrographic network. Among them the rivers Purus, Juruá, Içа, Negro, Madeira and Solimões stand out.

The state hydrography is of extreme importance in waterway transport, economic, fishing activity among others (IBGE - Brazilian Institute of Geography and Statistics).

At the same time, the vegetation of the Manaus area is composed by Dense Ombrophylous Forest (Tropical Rain Forest), Open Ombrophylous Forest (Savanna, Cerrado, Campinarana), Pioneer formations of fluvial influence (alluvial vegetation) Ecological, according to the classification of IBGE (2012).

According to the classification of Köppen, the climate of the municipality of Manaus is characterized as tropical rainy and average temperature of 27.4 ° C (Am). Featuring an annual average rainfall of 2145 mm and relative humidity of 80% and a short dry and not very effective season (IBGE, 2012).

The predominant soils of the region in the plains areas are the eutrophic Alluvial Soils and the eutrophic and allelic Gleissolos. In the area of dissection in tabular interflutions elaborated on the cretaceous sediments is the Alico Yellow Latosol, whereas in the section corresponding to those dissected in plio-pleistocene sediments, the Plicosol is found in the tabular tops and the Alic Red-Yellow Podzolic in the convex tops (RADAMBRASIL Project).

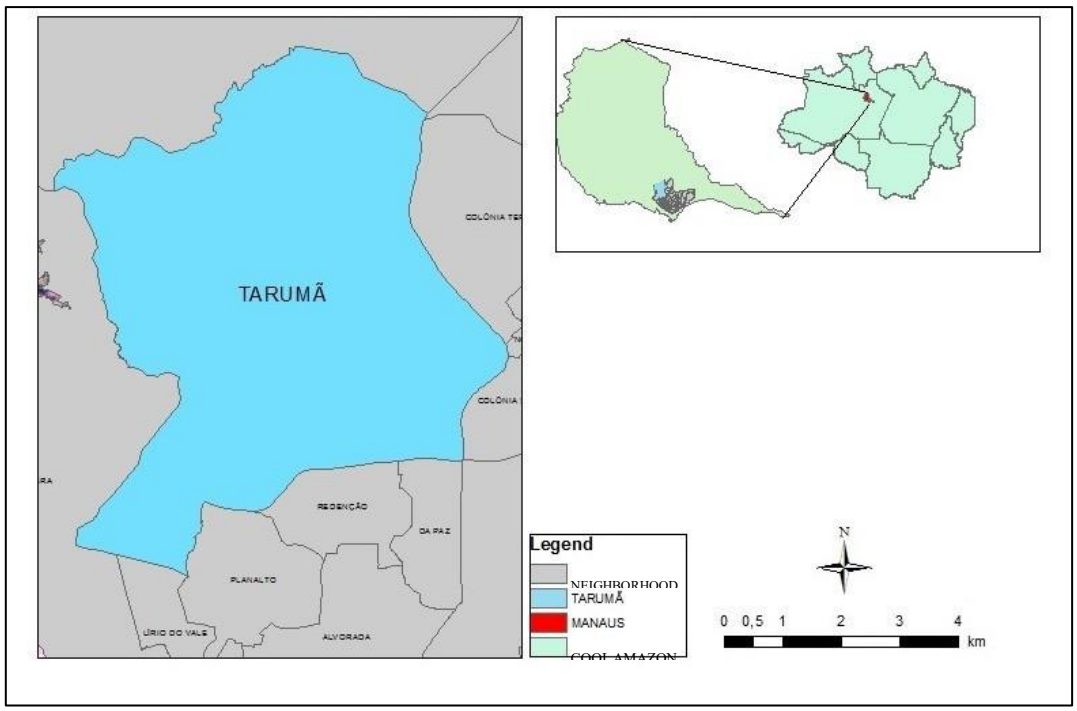

Figura 1: Location of study area

2.1 Image used

For the accomplishment of this work and the mapping of the study area, images from the Landsat series 5 and 8 of the orbit 231, point 62 were used. These images were collected from the database of the BRAZILIAN AMAZON FORESTRY MONITORING BY SATELLITE-PRODES project. PRODES uses this set of Landsat satellite images to estimate and map annual deforestation. However, to improve the study of rates year by year, the PRODES system maps shallow-cut deforestation. The methodology applied by the system takes into account the Landsat satellite scenes by visual interpretation. Landsat images were

projects developed by the American Space Agency (NASA) to survey studies for the assessment and observation of terrestrial natural resources.

The Landsat 5 satellite had a TM sensor (Thematic Mapper) and operated with 7 bands on the visible (3), near infrared (2), medium (1) and thermal (1) with spatial resolution of 30 m, thus offering subsidies for thematic mapping. The TM sensor has become important because it allows the development of methodologies in broad areas of scientific knowledge.

O Landsat 8 começou a ser disponibilizado no ano de 2013, operando com dois sensores: O OLI (Operation Lander Imager) e o TIRS (Thermal Infrared Sensor). A operação do sensor OLI é desenvolvida a partir de bandas denominadas pancromáticas (1, 2, 3, 4, 5,6, 7 e 9) e uma banda 8 (pancromática), respectivamente com 30 e 15 metros de resolução. O sensor TIRS tem uma operação com duas bandas espectrais (10 e 11) com resolução espacial de 100 m.

2.2 Shapefile used

The data in shapefile format were downloaded by PRODES to analyze deforestation in the area according to the classification provided by the system. Through the information contained in the shapes of polygons can identify the main land use classes. The polygon extracted from the PRODES database facilitated the evaluation of the standards and aspects that were necessary for the study.

The use of shapefile with images allowed the delimitation and extraction of detailed information of the study area. This identification is determined from the Landsat images through the delimitation of the new polygons considering supposedly what has forest cover (INPE, 2012). The polygons are edited by means of an interpretation of the forest cover taking into account the type of deforestation, that is, the clear cut and the following patterns: tonality, texture and context. The shapes of the IBGE databases were made necessary for the location and boundaries of the study area.

Data processing

In the process of the images the Arcgis software was used to analyze the data. This computational resource facilitated the visual interpretation and extraction of the information for a more complete study of the area. The use of the computational techniques developed facilitated the creation and manipulation of the extracted data.

The data provided that are worked by INPE and downloaded in the PRODES system were worked on in Arcgis. The geographic information system was used in this work for a visual analysis and for decision making in the study. Through this software it was possible to obtain the necessary results for the calculation of deforestation. These processes were done through images and polygon maps of the deforestation generated in the INPE project. The data were worked in the Arcgis and the annual results of the deforestation were obtained, through the software studies the time series was used for the deforestation rates in the Tarumã neighborhood.

The images obtained, compacted and in format .tif, in geographic coordinates projected to the North. In order to adapt images to the data set of the study area and the area calculations, all were redesigned to the South in the Universal Transverse Mercator (UTM) projection, Datum WGS84. This procedure is

performed to avoid errors in further processing when integrating data from other sources. For this process we used the tools of ArcToolbox / Data Management Tools / Projections and Transformations / Raster / Project Raster.

RESULTS

The analysis of the deforestation of the Tarumã neighborhood in the city of Manaus / AM using the MODIS image processing software in Arcgis during the years of 2005, 2010 and 2015 generated class maps, obtained from PRODES data and methodology, through analysis and interpretation of images and Shapes. (Figure 2).

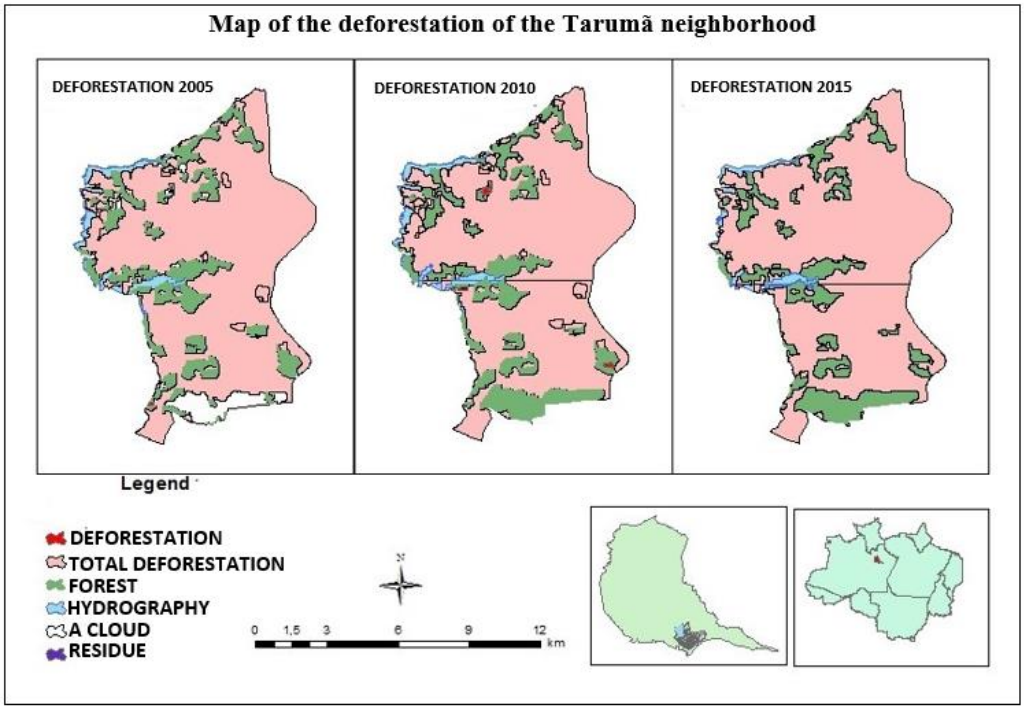

Figure 2: Map of the deforestation of the Tarumã neighborhood in the years 2005, 2010 and 2015.

For the calculation of the areas, the shapes of the neighborhood of Tarumã obtained through the PRODES system and processed by Arcgis were used, using the data referring to the period of 2005, 2010 and 2015. From the shapes it was possible to obtain the information contained in the referring to classes: total deforestation (previous years), deforestation, forest, hydrography, within the limits of the studied neighborhood. By means of class measures tools contained in ArcMap10 software.

Through ArcMap10, the values obtained for the study and the percentage of each class that presented the area values in hectares (ha) during the monitored years are shown, in table 1 and in figure 3.

Table 1. Calculation of the classes

Classes	2005	%	2010	%	2015	%
Deforestation	3,86	0,045	16,17	0,19		0
Total deforestat					849,76	79,16
Forest					301,774	18,51
Hydrography					01,8728	2,33
A cloud						0
Residue						0
Total					653,41	100

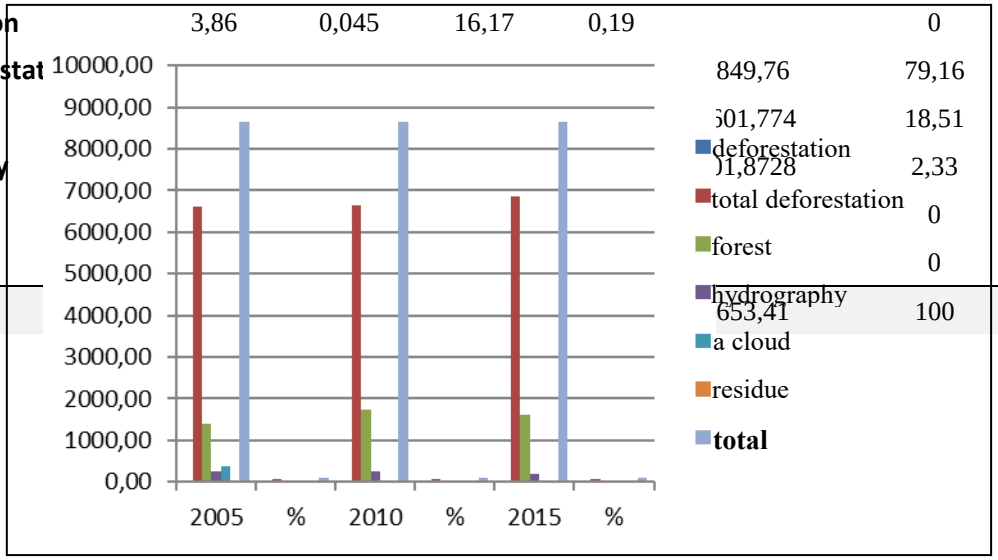

Figure 3: Classes generated during the years of 2005, 2010 and 2015.

The results of the PRODES methodology show the land use and coverage in the studied area, observing that due to the expansion of the district of Tarumã area presented a high degree of anthropization.

Thus, the results of the classes analyzed for the calculation of deforestation rates in the neighborhood were 8,653.41 hectares, taking into account total deforestation and forest. Table 1 shows the analyzes of deforestation during the study years. In the year 2005, which was the initial year in this study, the anthropic area was 76.525% of the total area analyzed, equivalent to 6,622 hectares. Comparing the year 2005 with 2010, it can be observed that in the latter the anthropized area is 76.78% which corresponds to 6643.85 hectares, thus showing an accumulation of 0.255% in the area of deforestation, being considered significant in relation to the which was deforested in 2005 (initial year). In the images for the year 2015, the area of forest cover had an increase of 2.38% deforested, totaling 79.16% which corresponds to 6,849.76 hectares. The forest cover area corresponds to 18.51% of the total area, showing that the removal of the forest from urban area is not intense. "In the state of Amazonas deforestation rates are not as intense as in other states in the region" (Higuchi et al., 1998).

Analyzing the differences in the years studied, considering from the year 2005 initial year. It can be observed that in 2010 there was an increase of 0.255% of deforested area in relation to the year 2005. The results showed that there was a small percentage of deforested area when compared to the same period of five, but in relation to 2010 and 2015 , which showed a more significant increase of deforested area. This increase is of the order of 2.38% of deforested areas over the five subsequent years (2010-2015). Although deforestation occurred in the period from 2005 to 2010 result in a few anthropized areas, the results presented in previous years, period from 2010 to 2015, is worrisome due to the percentage of deforestation double in relation to the accumulated of 2010. The rapid advance of urbanization in the direction of the western zone of the city of Manaus, with several settlements and invasion history, is the main vector of deforestation in the Tarumã neighborhood. "What has been observed is that as the urban

boundary of the city of Manaus is expanded, the forest is removed and the water resources, previously used mainly as places of leisure and recreation, become inappropriate for these ends "(Bridges Barros1).

In relation to the hydrography that was analyzed in the study years represented by the Tarumã basin and the Tarumazinho basin on the scale allowed by the Landsat image. In the year 2005 (initial year), compared to 2010 the water part did not change in its area corresponding to these two decades 3.03% of the total area. It was observed that this occurred due to the little withdrawal of the forest cover. Already in the decade of 2015 due to the double increase of the forest cover removal, the water part of this area should decrease by 2.33% of the total area analyzed. "Although the degradation of these streams is easily perceived, several studies have been done to evaluate the degree of impaction suffered by them" (Cerdeira et al., 2004).

Removal of forest cover near water bodies as a result of improper use of the soil can cause erosion, sedimentation, contamination and reduction of organic matter in the watershed area. The Coordinating Research on Climate and Water Resources (CPCR) of the National Institute of Amazonian Research (INPA) has been investigating the transformation water relations, rainfall flow, transport of suspended material, nutrient cycling and etc to consolidate an appropriate reference for the control and monitoring of the modifications imposed to the natural system in the future, and to other hydrological systems of the urban area of Manaus.

Deforestation in hydrographic areas has intensified over the years, caused by population increase in both urban and rural areas. "In the Amazon, occupation in areas of terra firme forests removes the well-organized biotic structure, implying the rapid loss of nutrients by leaching under conditions of high temperatures and intense rains, causing in many places the degradation of both the soil and the environment (Pontes Barros).

Urban sprawl in these areas compromises the key role of rivers and lakes in the region due to human degradation and modification of natural resources. "In the case of Manaus, in addition to the harmful consequences caused by the simple removal of vegetation, there was a great aggravation, due to the fact that there is a population density in the banks of the igarapés" (Pontes Barros). These anthropic actions occurring along rivers are often accomplished by failing to enforce protected area laws and regulations (PPAs).

Human interference with the environment is aggravated every year by inadequate use of natural resources. The present study shows that mainly the water resource has been decreasing due to the withdrawal of the forest cover. The impassional practice in the soil in the areas of irregular occupations for constructions of houses compromises the balance of rivers and streams near these areas. In an area of vegetated soil, accounting for inputs and outputs of soil water the water balance of a region tends to remain without major natural changes, but with increasing population and the indiscriminate use of water, anthropic actions may end up interfering in the hydrological cycle, through precipitation rates, soil infiltration, evapotranspiration and surface and deep runoff (Pontes Barros).

We can also emphasize with the removal of the forest cover, consequently the water decrease in these irregular areas is a bad factor for the social sector. According to the FAO (2005), one in five

developing countries will be suffering from water shortages by the year 2030, thereby compromising world food production. As a consequence, there may be social conflicts.

The inadequate use of the soil requires changes in the sense of its better conservation, being the first step to avoid the fires, adopted by the practices in the occupation of irregular areas near basins. The reach of an organizational level by society mainly by the residents. This organization can be done in what says towards the management of the basin thus allowing changes that would improve the quality of the water. Within the planning the legislation proposes the constitution of river basin committees (Drafting given by Law 9.984, of 2000). The creation of this committee is fundamental for a better study of the degraded areas together with the political organization and the society to establish specific criteria and tools for the monitoring of deforestation in the basins.

Therefore, for the best form of intervention in the area of irregular occupations is necessary to the interaction between economic, environmental and cultural aspects, since they will interfere in the degree of organization of residents and technological tools for study interaction of these deforested areas and government subsidies.

CONCLUSION

Geoprocessing is an indispensable tool in the management of environmental problems. Thematic maps help characterize the surface in different ways. The generation of the urban land use capacity map helps us in the issue of environmental studies and the monitoring of invaded areas.

The use of remote sensing together with the geoprocessing techniques used in the study proved to be an efficient tool for the mapping of the research area in the analyzed periods. The satellite images, after being worked, offered a lot of information for the actions carried out in the research.

For the analysis of the evolution of land use and natural vegetation cover of the district of Tarumã, the methodology used proved to be appropriate for this type of mapping. It can be concluded that the study district, which even though its vegetation area is suppressed by urban expansion, does not present high rates of deforestation. For the anthropic area studied using the PRODES methodology and processed in Arcgis 10.0 did not present nor 3% of deforested area during the ten years analyzed.

Therefore, the study contributed to a perspective of government planning in relation to urbanized areas and the impacts of urban sprawl on cities. Providing a general evaluation for the realization of new projects and urban development.

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