



RESEARCH ARTICLE

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EVALUATION OF THE IMPACTS OF DISORDERLY EXPANSION OF URBAN AREAS: A STUDY ON THE ADOLPHO DUCKE FOREST RESERVE

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ABSTRACT

During the months of August and September 2019, a study was conducted to evaluate the environmental impacts resulting from the disorderly expansion of the City of Godneighborhood, in the city of Manaus - AM. This study used satellite images of the PRODES project, IBGE data and environmental impact assessment method check-list. In addition, field analyses were carried out around the AdolphoDucke Forest Reserve/Amazon Museum - MUSA to identify solid waste dumped in the forest fragment area. Thus, it was observed that the area surrounding the MUSA is located, the precariousness of solid waste management and the lack of environmental education of the residents of the neighborhood.

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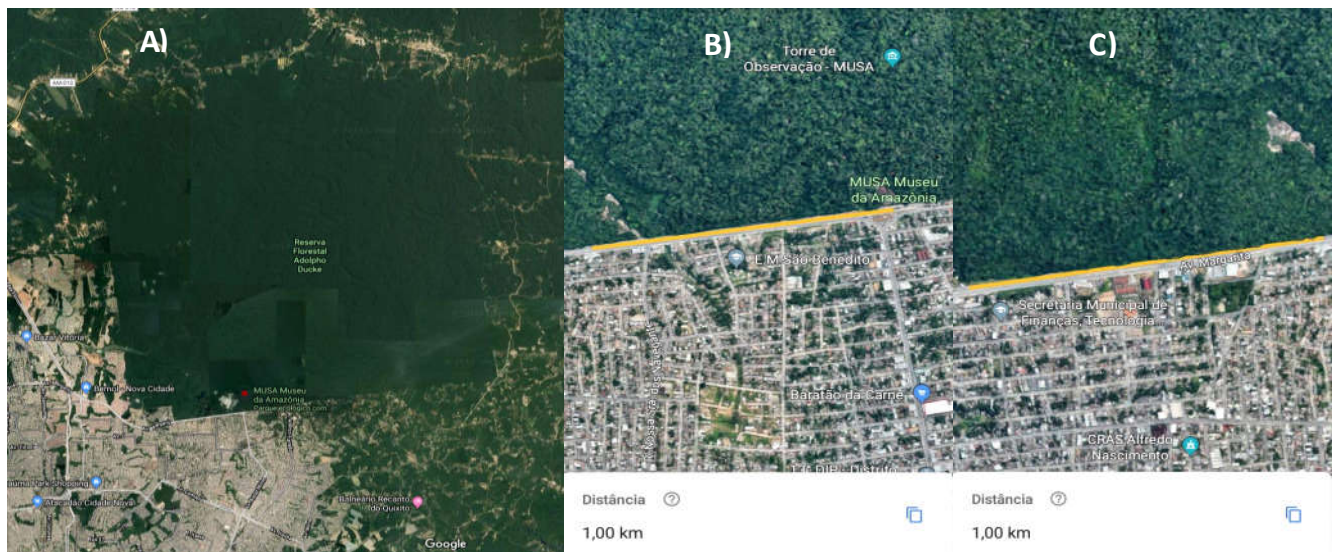
INTRODUCTION

The accelerated growth of cities combined with the lack of urban planning, causes numerous negative impacts on the environment and man (SANSON, 2007). This growth reflects in deforestation, appropriation of areas that should be preserved, changes in soil dynamics, soil pollution through irregular disposal of solid waste, impact on surface and underground water and among others (SOARES *et al.*, 2006). However, urban growth is accompanied by increased environmental pollution, as with the development of cities generate more and more garbage. Mainly, waste that takes a long time to decompose in the environment, when deposited incorrectly affecting so; unprotected soils, in addition to fauna and flora (VIANNA, 2015). The socio-environmental problems caused by irregular occupations can affect not only physical space but also public health, because they involve factors such as: disasters caused by erosion, floods, landslides; indiscriminate destruction of forests and protected areas, contamination of the water table or water supply dams, among

others (GROSTEIN, 2001). The expansion of the northern zone of Manaus is worrisome due to the proximity of the AdolphoDucke Forest Reserve. The city is an example of an urban area developed in the middle of the forest, which has been suffering in recent years with its process of demographic expansion, and this expansion has reached the perimeter of the Ducke Reserve. With regard to the impacts derived from this urbanization, the reserve is a path to dialogue that brings the population closer to environmental issues, collaborating with biodiversity conservation and the promotion of socio-environmental sustainability. Also, on the expansion of the northern area of Manaus, Barroso (2012) showed that the Reserve has already suffered great pressures due to irregular occupations close to it. Even through the irregular disposal of waste that is made through the resident population close to it. This can compromise the water course that passes through the reserve, so that this waste can travel through the park area during the rainy periods (NOGUEIRA *et al.*, 2007). These residues can change soil dynamics, causing a plating and harming the watercourse in the same way. This can occur due to urban superficial defuvium, which has all pollutants that are

deposited on the soil surface. In the occurrence of rains, the materials are dragged by rainwater to surface watercourses, constituting a source of pollution (PHILIPPI and PELICIONI, 2014). Gaining knowledge about the causes of disorderly urbanization and its possible impacts is extremely important to try to reverse the picture or minimize it in a certain way. The irregular disposal of solid waste is one of the aggravating problems of this urbanization, especially when they have in fragmented forest areas, causing pollution and changes in soil, vegetation, water resources and the like (SÁNCHEZ, 2008). Therefore, it is intended to analyze the environmental impact of the expansion of the City of God neighborhood in the AdolphoDucke Forest Reserve. Identifying the pollution points being formed because of the incorrect dumping of solid waste. Check if there was growth of the population surrounding the AdolphoDucke Forest Reserve and generate mitigation procedures for these anthropic actions.

At first, the study area was delimited using the Google Earth tool, thus it was possible to know the points most directly affected by the irregular disposal of solid waste by residents of the neighborhood surrounding the reserve. Delimited the area, a survey of information on the increase of the neighborhood was carried out through the data provided by IBGE, as well as the generation of maps to identify deforestation through images of LANDSAT satellites, through data from the Project of Estimated Amazon Crude Deforestation (PRODES) with updates from 2008, 2013 and 2017. For this, we used the Environmental Impact Assessment (AIA) process seeking the identification and prediction of potential impacts on the environment from anthropic actions. The control or checklist method (SILVA, 2001) was then used. The method is based on developing a list of environmental factors and impacts, and its application is an environmental diagnosis until the comparison of alternatives.



Source: Google Earth (2019)

Figure 1. a) Total image of the reservation; b) Location of Point A; c) Location of Point B

Table 1. Classification of the degree of importance analyzed

CLASSIFICATION OF THE DEGREE OF ANALYZED IMPORTANCE	
Grade 1 – minor impacts, those that were temporary or those that do not fit the items of Grade 2;	Grade 2 – impacts of greater importance, which relate to biodiversity, water resources and the like.

MATERIAL AND METHODS

The study area refers to the two designated points of point A and point B, located in MUSA – Museum of the Amazon, in the segment corresponding to a 2 km stretch of Av. Margarida, in the C neighborhood. Satellite images of the Google Earth platform were used on April 29, 2019, with the aim of delimiting the study area. In addition, LANDSAT images from the PRODES project were used. In operation since 1988, the PRODES project aims to carry out satellite monitoring of shallow-cut deforestation in the legal Amazon. The images were used from LANDSAT8, OLI - Terra Imager Operational sensor, obtained in Geotiff format, with colorful composition of RGB bands, with spatial resolution of 30x30. The scene obtained for the study area was orbit/point 231/62. To complete the study information, photographic records were still made. The on-site visits aimed to visually obtain an overview of the current situation of the preservation area, through photographic records.

Among the advantages of the check-list method, we can highlight the memorization of all factors, in addition, presents a good performance and qualitative evaluation of the most relevant impacts. The listing of the consequences, i.e. environmental impacts from the positive and negative perspective of known causes. Environmental impacts were classified according to their importance, as shown in Table 1.

RESULTS

In this section, the results of the environmental impact analysis caused by the urbanization of the City of God neighborhood, around the Adolfo Ducke Reserve, will be shown. Population growth has been primarily responsible for environmental degradation. Studies show that the AdolphoDucke Reserve is under immense pressure due to the increasingly intense emergence of irregular occupations around the forest fragment. This finding was also exposed in Nogueira *et al.*, (2007), when the authors showed the environmental impacts generated in the city of Manaus.

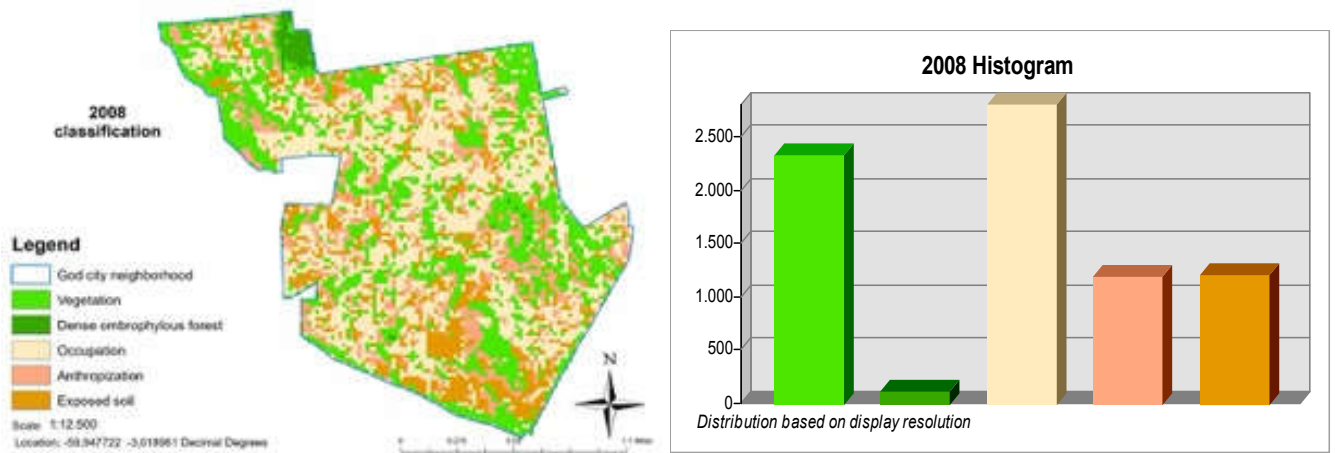


Figure 2. Ranking map and histogram of the neighborhood City of God in 2008

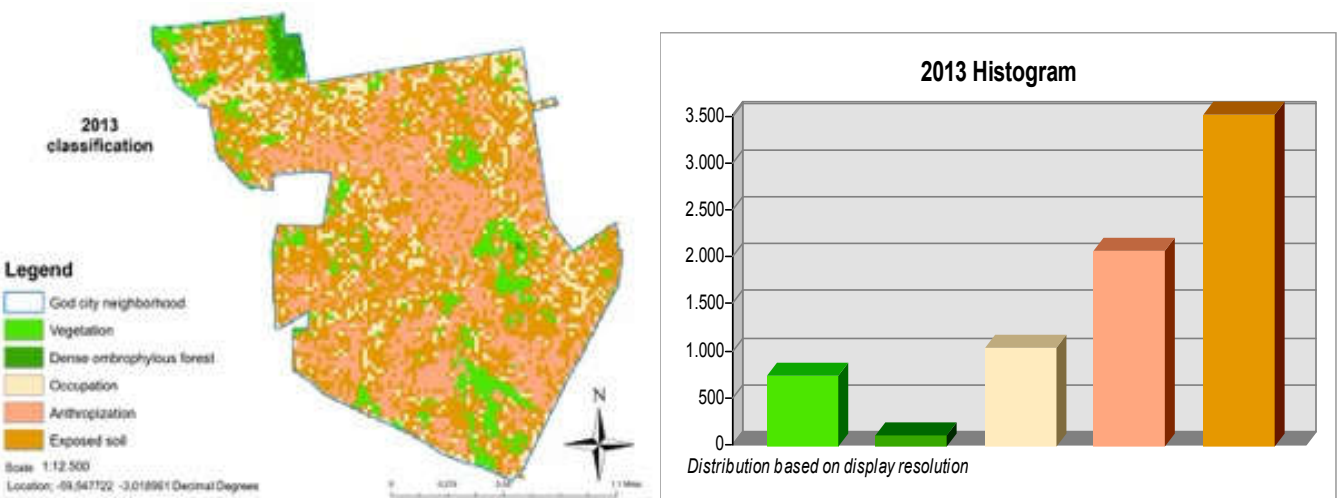


Figure 3. Map and ranking histogram of the Neighborhood City of God in 2013

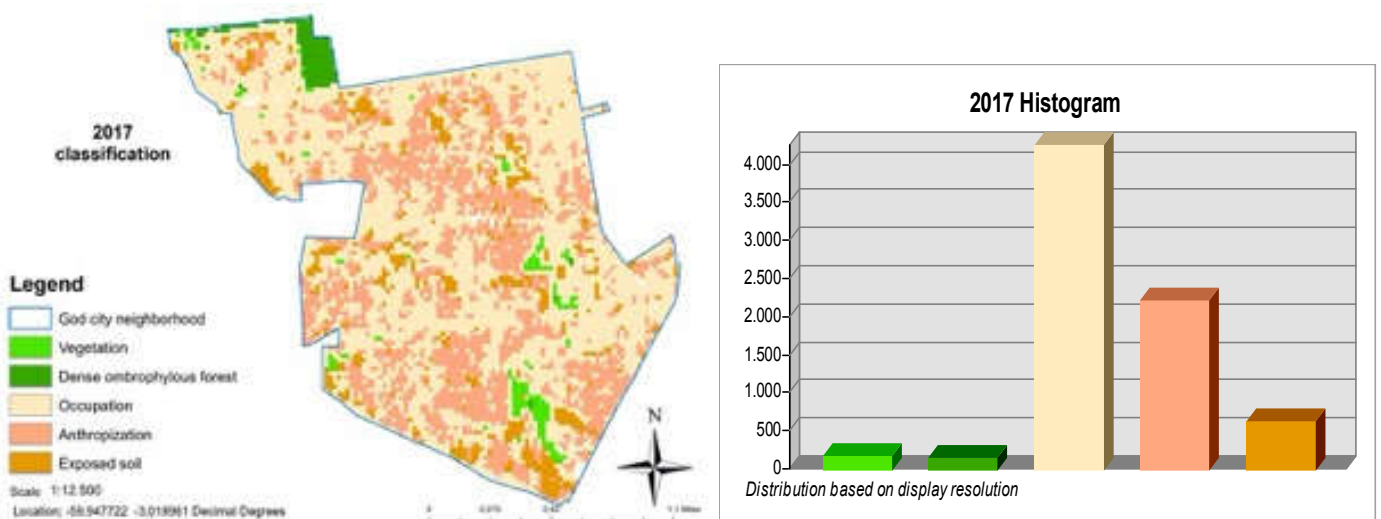


Figure 4. Map and ranking histogram of the City of God Neighborhood in 2017

This urbanization thus causes noticeable impacts, as shown in Figure 2. As it is possible to observe in Figure 2, in 2008 the neighborhood City of God had a vast vegetation and few urban/and irregular occupations and exposed soil. It was at this time to notice some changes already noticeable due to irregular occupations and urbanization of the neighborhood, however this process of urbanization of the neighborhood was growing. Also, around 2009 the neighborhood had a population of

approximately 70,142 inhabitants (IBGE,2009) and with this, environmental degradation also grew and accumulates over the years and over the years. What agrees with the results of Soares, *et al.*, (2006), who showed that the effects of urbanization lead to the deterioration of the environment. In 2013, as shown in the map and histogram, exposed soil and irregular occupation increased significantly compared to 2008, which indicated in the classification map of Figure 2.

Vegetation and forest decreased, thus causing environmental losses to the AdolphoDucke Forest Reserve. It is noticeable that the devastation of the site first occurred, that is, deforestation which led to the loss of forest characteristics, so the result of the exposed soil is so significant. The first cause can thus be cited as a result of deforestation the increase in the population, which occurred in the neighborhood City of God. In a study in the city of Tucuruí in the state of Pará, Vasconcelos and Novo (2004) showed that deforestation occurs intensively due to urbanization, through mapping these and coverage of the land, thus agreeing with the results presented. According to the most recent information of PRODES, in 2017 it had a great loss of vegetation and forest fragment characteristics, due to the increase in irregular occupations showing almost 100% of the area. Compared to the classification map set out in Figure 3, where the devastation had been great, the year 2017 the neighborhood City of God was all occupied, with minimal vegetation and presentation of significant modifications and irreversible character to the environment, because of the occupation of the entire neighborhood of the City of God. However, it was found that the neighborhood has a high degree of disordered occupation, preeminently residences, shops and etc. However, in the around the Ducke Reserve are in evidence the residences, and with this ends up receiving a load of the solid waste dumped, improperly. In accordance with these results, Machado *et al.*, (2017) presents an analysis on the use and occupation of environmental preservation areas (APP) in the city of Humaitá. The authors evidenced the impacts that are generated due to disorderly occupations. With the growth of irregular urban areas, environmental impacts are noticeable to the point where not only change the environmental scenario but also bring negative impacts to the environment. The main negative impact can be represented by the significant amount of garbage being dumped daily in the study area of the project.



Figure 5. Dumpster located around the MUSA

The dynamic and historical processes of the use and occupation of urban soil have strong social and environmental implications, thus imply directly to situations of risks and social and environmental vulnerability (SALLES *et al.*, 2013). Since the soil is polluted, these pollutants undergo constant downward migration, although sometimes they are not noticeable to the naked eye, degradation is occurring and can reach groundwater, altering and harming the quality of this water resource. As shown in Figure 5, the dumpster being the result of the boundary contact between the neighborhood population and the AdolphoDucke Forest Reserve.

Despite population growth, the city of Manaus did not have proportionally a follow-up to what concerns the city's infrastructure and basic sanitation, showing a deficiency of the government in receiving this population demand. In a study in the city of Ibimirim, Pernambuco, Araújo *et al.*, (2011) showed the importance of basic sanitation and insufficient infrastructure and public policies regarding the management of environmental resources, agreeing with the results presented.

In general, the places where we find low-income residents are subject to precarious basic sanitation assistance. In addition, the garbage produced in the neighborhood is not collected in its entirety, generating the famous addicted dumpsters, which can be shown in this research through Figure 6.



Figure 6. Waste discarded incorrectly by the very population of the neighborhood City of God. Among these is home origin

Soil quality has a lot of influence on the health and productivity of an ecosystem, if it has a good state of quality, the entire ecosystem is also expressed. However, unlike air or water, the soil has no quality standards, definition and quantification are difficult to access. What can be presented is that a healthy ecosystem is characterized by its integrity and other cycles that compose it (SILVEIRA and FREITAS, 2007). What does not demonstrate in Figure 6, because the around the SMA is experiencing changes in its ecosystem. According to Taveira (2011), Amazonian forests and their

waterways are being progressively attacked by the intense and growing deforestation that destroys the natural environment, alters soil and water quality.



Figure 7. Appliance dumped and water resource contaminated due to waste dumped incorrectly

Figure 7 can identify the exacerbating negative impacts, which demonstrates the capacity of activities such as irregular deposition of waste due to urbanization near the forest fragment in order to interfere with the environment. It is also noticed the loss of local vegetation due to the dumping of solid waste, which leads to the erosion of water resources that is already present outside quality standards. It is noteworthy that, because of the rain the residues that are dumped, end up percolating to the water resource, changing their physicochemical pattern. The water course in the Ducke Reserve is at constant risk in this way. We highlight the problem of our society related to household waste, as shown in Figure 7 a refrigerator disposed improperly. The obsolescence of this object is inevitable, but reverse logistic is of paramount importance so that situations like this are not customary in our day.

Table 2. Identification and description of impactactivities

Soil:	- Soil exposure; Increased susceptibility to erosive processes (grooves and the like); Worsening soil structure due to worse distribution of plant roots and worse microbiota development.
Water:	- Contamination of water resources; Deregularization of flow; Floods; Assoareamentos.
Flora:	- Decrease in plant species; Loss of forest fragment characteristics
Fauna:	- Possibility of reduction of terrestrial faunistic populations due to contamination; Decreased ecosystem sustainability.
Halfanthropic:	- Change in land use; Visual impact; Possibility of loss of the natural environment for leisure; Public health problem due to depreciation of the chemical quality of water resources; Worsening local urban quality of life due to negative effects.

To further facilitate understanding, environmental impacts could be identified based on the check-list method and as a result, the following flowchart was mounted, adopting as a departure the impactful processes and the others as resulting from the first Action.

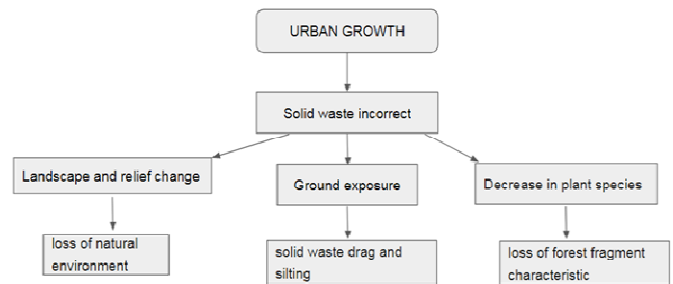


Figure 8. Impact flowchart with check-list method

Mitigating or potentiating measures

Table 3. Definition and characterization of environmental measures for the impacts of irregular dumping of solid waste

ENVIRONMENTAL IMPACT/ENVIRONMENTAL MEASURES	
Irregular disposal of R.S	- Environmental education in the neighborhood; fines.
Soilexposure	- Urban planning; R.S. gathering; recovery of vegetation cover.
Contaminationwaterresource	- Creation of a barrier to protection for the surroundings of the MUSA; creating barrier in the watercourse itself.
Visual impact	- Application of educational boards; implementation of recycle bins.

Table 3 can be observed, the environmental measures for each environmental impact that was found in this work, in order to minimize the impacts that result. It is important that a clear and objective view on the eviction of the waste they see, as well as the improvement of the selective collection service provided in the neighborhood City of God, is passed on to the neighborhood. After the work of environmental education, it is expected that there will be awareness of the surrounding, and that it is possible to recover the vegetation cover where the solid residues were once. Planting seedlings and seeking the recovery of space, approaching as much as possible to what was before. Also seeking to protect the course of water, making it necessary a containment barrier to prevent sediments and repair of riparian forest for constant preservation of this water resource.

Final Considerations

This article allowed to verify and complete the impacts caused by the disordered expansion in particular to the Forest

fragment AdolphoDucke Forest Reserve. The assessment of environmental impacts is an arduous task, but with a framework of qualified and diverse professionals in training, can reveal the identification in more detail. Finally, the conduct of this environmental impact study, has brought benefits because it reports the problematic disordered expansion and the current picture in which the forest fragment is located due to the high improper disposal of solid waste, as well as a contribution personal and knowledge to the scientific community, providing the reference study for future research in the field of environmental engineering and similar area, in addition bringing more knowledge about the AdolphoDucke Forest Reserve.

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