Adaptation of Leopold Matrix for Assessment of Environmental Impacts Caused by the Flower Avenue Project in Manaus City - Amazonas

Diana Barbosa de Castro

diana_castro.b@hotmail.com

FAMETRO University Center – Brazil

Fabiana Rocha Pinto

fabiana.floresta@gmail.com

Engineering Coordination at FAMETRO University Center – Brazil

David Barbosa de Alencar

david002870@hotmail.com

Galileo Institute of Technology and Education of the Amazon – ITEGAM

Ricardo Silva Parente

ricardosilvaparente@gmail.com

Galileo Institute of Technology and Education of the Amazon – ITEGAM

Abstract

This study aims to describe the effects generated by the construction of Avenida das Flores, has the objective of evaluating the effects caused by an urban mobility project, located in Manaus-AM, and the use of some neighborhoods of the city is prohibited. . Through this process of urban expansion, it is necessary to search for alternatives to urban problems, in addition to seeking solutions for the traffic disorder, a lack of urban mobility due to the difficulty of movement of people living in the more remote neighborhoods of central Manaus. . In this context, formulate the Matrix method of use based and adapted in the Leopold Interaction, which par excellence is dedicated to making relationships, noting the most relevant impacts. The survey allowed to obtain results that could indicate the negative effects caused by the environment in compartments such as: alteration (soil quality, area and microclimate), biotic reduction (reduction of endemic species and forest areas) and social (increase of vehicle circulation, attraction of new constructions and services, serving as a source of decision making, allowing to identify the most relevant effects for the use of instrument in decision making.

Keywords: Urban Expansion, Urban Mobility, EIA.

1. Introduction

With the installation of the automobile industry in Brazil, in 1956 there was an increase in the number of vehicles in cities caused by urban expansion and changes in travel patterns and traffic. Given this, there

was a need for public managers to implement urban expansion projects, through the construction of new streets, roads, avenues, etc., seeking measures to prevent or minimize the negative impacts caused by buildings regardless of type, purpose or size [1].

The construction of avenues, roads, highways, roads is one of the alternatives found to reduce the problems of urbanism, which in turn causes impacts on the environment, where it can often be irreversible. Such expansions and / or constructions should be made by planning so that environmental degradation does not occur in the construction space. From this arise many discussions about the environmental impacts caused by anthropic activities, which are of fundamental importance to the population. Thus, the environmental issue has complexity that encompasses social, economic and natural aspects [2].

The significant increase in urban sprawl causes high levels of socioenvironmental vulnerability, in which several social problems arise, such as: irregular allotments and slums in risk areas, and even in areas protected by environmental legislation. One of the consequences of the constructions is the environmental impacts generated in green areas, which give space to these access roads, besides the other constructions that help the population. The preservation of green areas is related to the quality of the environment, as well as having a direct influence on the spheres: aesthetic, environmental and psychological [3].

Environmental impact according to art. 1 [4], cites as "any change in the physical, chemical and biological properties of the environment, which, directly or indirectly, may interfere with the health, welfare of the population, social and economic activities, as well as environmental resources. . These must be evaluated, controlled, and reduced with a focus on minimizing numerous social, economic and ecological problems that can be remedied by numerous processes such as environmental management.

From the urban problems of the municipality, one of the alternatives for administrations that seek solutions to these problems is the Master Plan, a basic instrument of urban development and expansion policy, and important legal support. Complementary Law No. 2 [5], which provides for the Urban and Environmental Director Plan of the Municipality of Manaus, which is noted in Chapter II, art. 6th, that the strategy of environmental qualification should value the municipality's natural heritage, prioritizing the maintenance of protected spaces, remedy conflicts, in addition to mitigating environmental degradation processes and sanitation deficiencies.

The Avenida das Flores project generated a lot of environmental controversy, since the avenue passes through a part of the State Conservation Unit (Sumaúma State Park), according to the Manaus / AM Master Plan. In addition, it can affect the habitat of an endemic species - Saguinus bicolor, which is endangered [6], causing social and environmental impacts, such as the emergence of irregular occupations of the environment on fauna and flora.

Manaus, not unlike other major cities, has been growing uncontrollably, thus bringing a series of problems, such as traffic congestion, exhaust gas emissions, especially by public transport, being one of the main causes of environmental problems.

The relevance of this study is shown given the environmental impacts that occurred in the extension of Avenida das Torres, involving endangered animals, forest fragments, conservation unit, irregular occupations, congestion and the emergence of new buildings.

The Federal Constitution of 1988 states that all cities with more than 20,000 inhabitants are required to draw up the Master Plan, which is an integral part of the municipal planning process [7].

According to [8], in its Art. 17, by the evaluated follow-up the Avenida das Torres corridor, analyzed based on chapter II, in the area of the northern segment, encourages residential use and commerce and service activities.

Due to the repercussions of environmental degradation, it is necessary to propose measures capable of analyzing the environmental impacts resulting from anthropic activities [9].

Thus, the interaction matrix relates the indicators of environmental impacts, based on the listing of human actions in certain phases of the project, which is important for communication, for an environmental assessment, having qualitative and quantitative data, allowing easy understanding of the population about social factors [10].

However, it is necessary to evaluate the social and environmental impacts caused by the avenue of flowers project, analyzing the existence of mitigation and compensation measures, as well as considering the environmental impacts from the matrix [11], describing the magnitude of the importance of each one. impact generated by the project.

2. Materials and Method

2.1 Study area

The focus of the study is located at Avenida das Flores, in the city of Manaus / AM (Figure 01), a road built to give greater accessibility to different areas of the city.

Figure 01 - Location of Avenida das Flores, Manaus-AM
Source: Thiago Barbosa Fernandes, 2019.

According to data from IBGE (2010) [12], the capital of Manaus had an estimated population of 2,182,763 people, a demographic density of 158.06 inhab / km², and because it is an urban mobility project, it presents a little half of 718 people. thousand vehicles - DENATRAM (2018) (Table 1).

Table 1 - Vehicle Fleet, by type in Manaus City

Type	Nº of Vehicles
Car	372.803
Truck	16.421
Micro bus	2.998
Motorcycle	172.173
Motor scooter	17.192
Bus	7.831
Others	72

Source: National Traffic Department, 2018

The Avenida das Flores project, extending Avenida das Torres, is approximately 11.1 km long, starting at Avenida Timbiras, in the Cidade Nova neighborhood, North Zone, ending at the beginning of AM-010, the road that connects the capital to the municipality. from Itacoatiara / AM, covering the following neighborhoods: Cidade Nova, Monte das Oliveiras, Joao Paulo Complex, Santa Etelvina, Col. Terra Nova and Lago Azul.

The housing complexes present in the area, causes the growth of Peri - urban areas and the emergence of irregular occupations, which in turn implies the absence of infrastructure, such as basic sanitation, sewage system, and consequent increase in sanitation. pollution of streams, soil, air, and besides caused deforestation, even focusing and changing permanent preservation areas (APP).

2.2 Data collect

The methodology used was exploratory research, through case study, using bibliographic research, on-site visit and data collection.

The method applied in the environmental impact assessment process was developed through the characterization of the collected, adapted and corrected data for interaction matrix [11]. The most relevant impacts on the physical environment, biotic environment and anthropic characteristics were described. In the project.

2.3 Impact Matrix Characterization

The interaction matrix developed by [11] used in this study was adapted given some characteristics, since the matrix has 88 environmental characteristics (factors) in the table rows and 100 projects actions in the column, being satisfactory for use in most projects (MMA, 1995). Considering this matrix, 8,800 interactions between them are possible, so the Leopold matrix has been and continues to be widely adapted, giving rise to a number of other matrices.

After the preparation of the document, the theoretical explanation of the factors addressed in the project was described. From this, the data were crossed to evaluate the impacts generated by the project.

The last step is the sum of the values obtained by crossing the impacts and the subgroup components resulting in the value of importance, obtaining the result with the possibility of identifying the most representative impacts to the environment, adapted from the physical environment, environment. biotic and

anthropic characteristics.

3. Results and Discussion

The socio-environmental issue has taken great proportions in recent years, where the theme has sought to deepen knowledge in the areas of social, environmental and health sciences, as well as to consolidate public policies [13]. Also, according to [13] environmental problems spread in the larger territories, bringing medium and long term consequences. Thus, it is noted the involvement of the distribution of the population causing the attraction, expulsion or retention of people and as a consequence change in the transport system and the pattern of urban mobility.

With the urban mobility project (extension of Avenida das Torres) there was a reduction in traffic jams and the impact assessment results were positive for the social environment, but negative for the environment.

With the characterization of the impact matrix, the consequences of the identified and quantified environmental impacts after the project implementation were determined.

The existing aspects were distributed into three (3) subgroups, given the place where the action took place. Where the conditions attached to the groups were described, described in the Impact Matrix (Table 3). The columns of the matrix correspond to the interactions between components and the impacts generated, then the results were valued from 0 to 5, where in the end added the importance.

The number 0 (zero) corresponds to the lowest (minimum significance of the action on the environmental component considered) and the number 5 (five) corresponds to the values of highest significance for the attributes (Table 2).

Table 2: Rank on the importance of impact.

0	No Impact
1	Very Low
2	Bass
3	Intermediate
4	High
5	Very High

The total achieved corresponds to the sum of the score, as to the degree of importance of each impact evaluated. At the end, summing all the interactions between the rows and columns elaborated and described in the spreadsheet, one can visualize the impacts, when aggregated the highest scores (Table 3).

Table 3 - Impact / Interaction Matrix

Components	Physical Medium				Biotic Medium		Anthropic Characteristics			IMPORTANCE (TOTAL)
Impacts	Air	Water	Climate	Soil	Flora	Fauna	Developments	Tax Generation	Devaluation Real Estate	
Soil compaction	0	4	0	5	4	4	5	0	0	22
Deforestation	5	5	5	5	5	4	5	0	1	35
Leaching	0	5	3	5	5	3	2	2	2	27
Loss of Diversity	2	2	2	4	4	5	1	1	1	22
Pollutants	4	5	4	5	5	5	4	3	2	37
Asphalt	4	0	4	5	4	3	0	3	0	23
Visual Impact	0	0	0	0	4	5	3	0	2	14
Soil Removal	0	4	0	5	5	4	2	0	3	23
Wildlife Habitat	0	0	0	0	3	5	4	0	2	14
Tree felling	5	0	4	5	5	5	4	0	0	28
Noise	0	0	0	0	3	5	4	0	0	12
Forest Fragment	5	1	5	5	5	5	3	0	3	32
Waste generation	4	5	3	4	2	5	4	3	1	31
Vehicle Traffic	5	3	5	5	4	4	0	4	0	30
TOTAL	**122**				**105**		**62**			**289**
Legend	0 - No Impact	1 - Very Low		2 - Low		3 - Intermediate	4 - High		5 - Very High	

Source: Prepared by the authors, 2019

3.1 In the physical environment

the quality of air, water, microclimate and soil was evaluated. From the implementation phase to the operation phase, the visual impact caused by the removal of part of the native vegetation and buildings (housing developments, new developments) in the region is observed. Therefore, the process of urban expansion is one of the most relevant transforming agents of landscape and the environment, which can lead to important losses, such as historical, natural, affective and defining loss of an area [14].

The consequence of soil impacts was given by the loss of nutrients and microorganisms, which are essential for land productivity, thus harmed the environment given some suppressed soil ecological characteristics, leaving it unprotected and vulnerable to wind, which carries microparticles, to distant areas.

The soil has the function of generating natural resources, in addition to reserving nutrients and minerals important for renewal and support of living beings, microorganisms and vegetation, being extremely important for the life cycle [15]. The soil compaction caused by the generating actions (deforestation,

movement of machines) favored the superficial runoff and the emergence of erosive processes.

During the implementation phase there was a change in air quality by moving heavy machinery, altering the microclimate of the region. Then there was an increase in the emission of vehicle pollutants, due to the pace of vehicles on Avenida. Given the relationship between pollutant gases and the atmosphere, there was interference in air quality, where we have: that the higher the concentration of pollutants in the atmosphere, the worse the effects under the atmosphere, also helping to decrease the quality of the air. air.

According to [16] the dispersion of pollutants depends on the built environment, larger roads with high vehicle flow present higher levels of concentration of pollutant emissions.

3.2 In the biotic environment

with the removal of native forest, there was a reduction of preserved forest, including sometimes suppression of ciliary forest, in which there was visual impact, loss of fauna species, decreased microclimate, changes in the macro and soil microbiota. , besides promoting other losses, while the species that, due to the scaring process, could not adapt to the new habitat, mainly in the project implementation phase, which through noise of the machines and many equipments operating, many ecological niches were affected. , causing species extinction in the local condition.

For [17] the first phase for conservation and rational use of an enterprise, is the survey of species that make up the flora and fauna.

Animal migration is triggered by some factors such as temperature, lighting, feeding. However, animals excluded from the affected areas cause problems in the territories where they take refuge, as they are occupied by other animals, and the arrival of "intruders" unbalances the environment, given the competition for numerous survival conditions. Moreover, food may not be sufficient for everyone, increasing competition and mortality rates of different species in search of new habitats [14].

Sauim-de-coleira, as an endemic species in the region, has been suffering more and more individual losses due to the occupation of areas. Thus, with the disappearance of forests, the impact becomes increasingly potentially harmful to the species.

For [18] there is a huge possibility of attracting the species of collar sauins, which can be explained by the cultivation of fruit trees of the resident population near the forest fragments, corroborating this study, since the foods mark the habitat of the species in productive backyards.

3.3 Anthropic characteristics

There was the generation of noise from the horns, caused by vehicles, in addition to the flow of cars and people, which has been increasing; maximizing waste generation given the addition of the community; constant emergence of new buildings, such as housing developments, trades and others.

With positive impact, there was hiring labor during the construction phase, thus contributing to the reduction of unemployment that affects the country, in addition to the appreciation of real estate, with the increasing demand for new properties, given the ease of access.

According to [15], the anthropic actions in fact, is the flagship for land use changes and urban sprawl, causing numerous problems, increasing the process of degradation.

3.4 Mitigation measures

Mitigation measures can easily reverse, minimize or compensate for environmental impacts. Therefore, the following mitigation measures are suggested:

3.5 For the physical environment

Promote techniques for managing native species, so that the environment continues to maintain species with characteristics of the region and the Amazon rainforest in the central region; soil recompositing by means of drainage system implantation; development and implementation of hydrological and meteorological monitoring in the area to assess changes in standards.

3.6 For biotic environment

Preserve the remaining forest areas, especially in permanent preservation areas; recovery of affected areas through the cultivation of native species, avoiding erosive processes; evaluation of the establishment of new protected areas, considering the diversity of the present ecosystems; avoid opening new access routes, prioritizing those already consolidated.

3.7 For anthropogenic characteristics

Guide nearby communities on the conservation of trees that attract sauins and other animals of the local fauna, and on the prohibition of hunting; have information signs on the Avenue to alert vehicle drivers of the risk of animals being run over; and implement a fauna and flora monitoring program; beyond the monitoring control for use of areas, for purposes of open dumps, or simply new areas of invasion.

4. Conclusions

Given the study, it is noted that Avenida das Flores was an important alternative to reduce vehicle congestion and interconnection between various neighborhoods of the city, given the conditions of urban mobility of the city of Manaus, but that enhanced the environmental impacts.

In the implementation phase, one of the major impacts was on the physical environment, such as visual impact, change in air quality, process associated with the removal of vegetation, the intense use of vehicles, machinery and equipment, the impact on local soil, deconfiguration of the local landscape, transforming the area.

The project implies in the increase of the emission of gases and particulates to the atmosphere, through the circulation of vehicles, consequently, the variation of the air quality.

5. References

[1] REZENDE, E.N; COELHO, H. A. Impactos Ambientais Decorrentes da Construção de Estradas e Suas Consequências na Responsabilidade Civil. 2015

[2] MEDEIROS, L. M.; DURANTE, L. C.; CALLEJAS, I, J. A. Contribuição para a avaliação de ciclo de vida na quantificação de impactos ambientais de sistemas construtivos. Ambiente Construído, Porto Alegre, v. 18, n. 2, p. 365-385, abr./jun. 2018.

[3] BORGES, R. H. J. Políticas e Tensões na Preservação do Parque Vale Encanto - Salvador/BA. 2014.

[4] CONAMA - Conselho Nacional do Meio Ambiente. Resolução CONAMA nº 001 de 23 de janeiro de 1986. Dispõe sobre os critérios básicos e as diretrizes gerais para uso e Implementação da Avaliação de Impacto Ambiental. Brasília, 1986. Disponível em: <http://www.mma.gov.br>. Acesso em: 27 fev. 2019.

[5] Leis Municipais. Lei Complementar Nº 2, de 16 de janeiro de 2014. Dispõe sobre o Código de Obras e Edificações do município de Manaus e dá outras providências. Disponível em: <www.leismunicipais.com.br>. Acesso em: 18 set. 2019.

[6] ICMBio/MMA. Livro Vermelho da Fauna Brasileira Ameaçada de Extinção. Ministério do Meio Ambiente. 1. ed. Brasília-DF, 2018.v.1.p.88.

[7] BRASIL. Constituição da República Federativa do Brasil: D.O. 5 de outubro de 1988. Disponível em: www.mec.gov.br/legis/default.shtm. Acesso em: 20 out. 2019.

[8] PMM. PREFEITURA DE MANAUS. Sugestões Recolhidas nas Audiências Públicas da Revisão do Plano Diretor. Manaus: Prefeitura de Manaus. Acesso em: 23 set. 2019

[9] PINTO, L. M. P.; RODRIGUES, T. S. N. Análise dos Impactos Ambientais Decorrentes do Projeto de Expansão da Super quadra 500 do Setor Habitacional Sudeste, Distrito Federal (DF). 2016

[10] CREMONEZ, F. E.; CREMONEZ, P. E.; FEROLDI, M.; CAMARGO, M. P.; KLAJN, F. F.; FEIDEN, A. Avaliação de impacto ambiental: metodologias aplicadas no Brasil. 2014.

[11] LEOPOLD, L. B. A procedure for evaluating environmental impact. Geological Survey Circular, Washington, n. 645, p. 1-16, 1971.

[12] IGBE. Censo Demográfico. Disponível em: <https://cidades.ibge.gov.br /brasil/am/panorama>. Acesso em: 13 ago. 2019

[13] MARANDOLA JR., E. Mobilidade e vulnerabilidade nos espaços de vida de Campinas. Anais. 2016.

[14] BARBIERI, Edison; CAVALHEIRO, Felisberto. Impactos nos Microclimas da Ilha Comprida Decorrentes da Retirada de Vegetação. 2017.

[15] BARSANO, P. R..; BARBOSA, R. P. Meio Ambiente - Guia prático e didático. 1 ed. São Paulo: Érica, 2012.

[16] FERREIRA, C. C. M.; OLIVEIRA, D. E. Estimativa da poluição veicular e qualidade do ar nas principais vias do sistema viário da região central da Cidade de Juiz de Fora – MG. 2016.

[16] PAZETTI, C. F.; SANTOS, C. G.; DALAZEN, M. L.; FREITAS, V. A. L. Avaliação dos impactos ambientais nas fases de implantação e Operação do Parque Ambiental Vitório Piassa no município de Pato Branco – PR. 2018

[17] SANTOS, L. S.; PEREIRA, H. S.; GORDO, M. Interações entre população humana e sauim-de-coleira (Saguinus bicolor) em fragmentos florestais urbanos de Manaus, Amazonas – Brasil. 2017