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Valuation of a Green Belt in the Cerrado Biome

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Abstract — *The complex relationship between economy and the environment results in the aggravation of environmental problems while categorizing the urgency of thinking about connections between economy and nature. Nowadays it is a challenge to master techniques of valuation of natural resources to curb their predatory exploitation, enabling sustainable paths for development. In this context, the objective research is to carry out the valuation of an area called the green belt of a fuel storage terminal located in Cerrado biome. For this valuation, was used the replacement cost method associated to the values of the environmental regulation services. The main results were that the total cost of replacement of the area and respective value of annual and total environmental services, in which it can be check that the environmental services exceeded the investment made. It was also possible to verify the local forest densification and the list of flora and fauna species that include individuals protected by current legislation. It was concluded, therefore, on the applicability of the proposed method as well as on the study importance as an initiative for the Cerrado's environmental resources valuation.*

***Keywords* — environmental compensation; environmental valuation; valuation of the Cerrado.**

I. INTRODUCTION

Occupying approximately 24% of the national territory, Cerrado is the second largest Brazilian biome in extension with about 204 million hectares. Most of it is in the Brazilian Central Plateau comprehending high altitude regions in the central portion of the country. This feature guarantees a fundamental role of the biome in the distribution of water resources throughout the country, constituting the origin of great Brazilian hydrographic regions and the South American continent (Lima & Silva, 2018).

Besides being the cradle of the waters, Cerrado is one of the world's hotspots and its conditions guarantee the richest Savannas' flora of the world with a high level of endemism. The richness of birds, fish, reptiles, amphibians and insect species is equally large, although the richness of mammals is relatively small (Klink & Machado, 2005).

Environmental resources, the source of human life over the time, are used by man for his subsistence according to his evolutionary state. Predatory exploitation of these resources, including in Cerrado, has been the cause of flora and fauna extinction, water, soil and air pollution. This motivates the formulation of environmental preservation, conservation, management and control measures. According to Maia (2002), at most part, environmental resources are considered public, freely accessible and without a defined price in the market, so people consider themselves the right to use it in an abusive, unconscious and uncontrolled way.

In this context, the economic valuation of environmental resources theme is the proposal to value the environmental asset, collaborating with the sustainable use of these resources. Delfes *et al*. (2016) recognizes the need, through an economic valuation study, to diagnose how much the population (directly and indirectly) values the referent environmental asset, enabling a better use regarding the sustainability of the region.

Menuzzi & Silva (2015) highlight the complexity of the relationship between economy, environmental and its complexity results in the aggravation of environmental problems, while categorizing the urgency in the revision of many economic concepts, seeking a new way of thinking about the connections between economy and environment nature. Pasqualeto & Silva (2014) also point out that techniques of economic valuation of environmental resources have been questioned by economists due to the demand for more elaborate techniques that avoid incorrect analysis. This reinforces the demand for cautious exercise of such valuation, which is possible considering this paper.

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The economic valuation of environmental resources demonstrates great importance in the face of environmental licensing processes and environmental management of various projects, as well as the assessment of damages under legal proceedings. It occurs as a result of environmental compensation procedures, damage assessment for the application of infractions and fines, project feasibility analysis, among other processes, an assertive calculation base must be provided to not underestimate the value of environmental resources involved an enterprise context.

That said, this research aimed to perform the valuation of a green area called green belt of a fuel storage terminal located in Cerrado biome through replacement cost method associated with the valuation of regulatory services by Constanza *et al*. (1997).

II. MATERIAL AND METHODS

The research was conducted between September/2018 and June/2019 when the economic valuation of a green area called the green belt of a fuel storage terminal, located in the city of Senador Canedo, in the state of Goiás, Brasil, was carried out.

2.1. Enterprise Characterization

The project characterization was based on the description of the fuel storage terminal, that is the operational nature of the company studied, including its green belt. Such characterization also involved environmental, economic, social and legal aspects, that represent an essential data for environmental valuation. The aspects were obtained from technical in site visits, from environmental studies provided by the company and from the available literature.

Finally, this characterization was complemented by an evolution survey of the area through the georeferenced system Google Earth, which had records from 2002 to 2019.

2.2. Valuation method definition

From a previous analysis of references that relate various environmental valuation methods and considering the objective of the valuation, the possible hypotheses, the data availability and the knowledge of the ecological dynamics of the valued object, the replacement cost method was defined (MCR) as the one that most applies to the green belt valuation of the fuel storage terminal.

The replacement cost considers the estimated benefits generated from the replacement or repair environmental resource after it has been damaged, for example in the case of reforestation in a deforested area. The estimates use market prices as base to replace or repair the damaged good or service, assuming that the environmental resource can be properly substituted, knowing, however, that not all the complex properties of environmental service will be replaced by a simple resource substitution (MAIA *et al*., 2004).

It is also possible to question the possibility of adopting the avoided cost method for the case since the forest fragment studied has the function of minimizing the risk of fire. However, such a conception would underestimate the other possible values of the environmental service that the resource offered, it is to enterprise or to the population that benefits from the environmental services in question.

MCR was also associated with the valuation of regulatory services performed for world biomes by Constanza *et al.* (1997). The method of Constanza *et al*. (1997), from an international research, relates world biomes to approximate values of ecosystem services in an area such as gas regulation, water regulation, erosion control, soil formation, waste treatment, pollination, biological control, production food, recreation, among others. With this, it is possible to obtain a monetary value from this area. This association was also performed by Romacheli & Spinola (2011) in the economic valuation for the typical Cerrado physiognomy, thus allowing an update of the value previously raised eight years ago.

2.3. Modeling, data listing, calculations and critical analysis

Once knowing the valuation objective, the assumptions made, the availability of data and the ecological dynamics of the evaluated object, it is possible to adopt a method for environmental valuation (MOTTA, 2011).

For the green belt economic valuation of a fuel storage terminal located in the Cerrado biome, was used the replacement cost method associated with the valuation of regulatory services by Constanza *et al*. (1997).

To calculate the replacement cost, the replacement actions applicable to the study area were listed and pointed out by Vicente (2008), Romacheli & Spinola (2011) and Moreira *et al*. (2019) which were: soil collection; physicochemical analysis of soils; mechanized mowing or plowing; ant controlling; harrowing, subsoiling or furrowing; location and opening of the pits; fertilizer distribution, limestone and soil correction; chemical crowning in the pits; distribution of seedlings and plantings; tutoring; controlling of leaf-cutting ants; manual or mechanized mowing; chemical crowning of seedlings; replanting. For pest and competitor vegetation control actions after planting, a five-year horizon was considered.

Once the actions were related, a survey of values and budgets practiced in 2019 by Moreira *et al*. (2019) was made in companies located in the capital (Goiânia) in the region of the enterprise since the fuel storage terminal did not easily have the implementation values of the project that took place over 20 years ago. So the budgeted values were then averaged.

Finally, the value in reais per hectare (R$/ha) of the green belt was obtained, as well as the value of environmental services provided, and the return time of the replacement investment made. From then on, a critical analysis of the material and methods used for such research was performed, as well as the value obtained. With such value, it was possible to know the importance of associating the preservation and environmental conservation of green areas with risk areas, industrial, commercial and relevant economic areas. In addition to collaborating with professionals who demand knowledge for the economic valuation of green areas with risk areas, industrial, commercial and relevant economic areas and sensitize entrepreneurs, public agencies and the general community for the preservation and environmental conservation from the valuation of preserved areas associated with economic activities.

III. RESULTS AND DISCUSSION

3.1. Green Belt Characterization: A Fragment of the Cerrado Biome in Evolution

Senador Canedo's fuel storage terminal has a total area of 798,215 m² (79.82 ha), of which 4,490 m² (0.459 ha) of built area, and a nominal fuel storage capacity such as diesel, gasoline and gas liquefied petroleum gas of 138,346 m³. The terminal is located at GO-536 Highway No. 01, Central Brazil Industrial District, Senador Canedo-GO, at latitude 16°42'25" South and longitude 49°06'34" West. The highway delimits the terminal to the east. To the north, the terminal is bounded by GO-019 State Highway. To the south and west the boundaries are rural properties.

Senador Canedo's terminal is one of the poliduct's units. Noteworthy for its high level of automation, the pipeline operates since 1996, maintaining the title of the longest pipeline in Brazil, with 964 km of trunk line, plus approximately 45 km of extensions, crossing 40 municipalities of three States (São Paulo, Minas Gerais and Goiás), as well as the Federal District.

When the company arrived in Senador Canedo, the region was characterized as a rural area and land use was intended for grazing. The terminal was installed and surrounded by a green belt, planted by the company. According to Transpetro (2006) the green belt has 545,900 m² (54.59 ha), discounting the orchard, the passage of the poliduct and access and transit areas, there is an area of 523,300 m² (52.33 ha). The implementation of this native forest was accompanied by a project whose supervision counted on trained and qualified professionals. For this reason, the area has a high diversity of species of native Cerrado flora, some of them even protected, as determined by the Secretariat of State of Goiás for Environment and Sustainable Development (SEMAD) through Memorandum nº. 34 (SEMAD, 2012), which is the case of Aroeira (*Myracrodruon urundeuva*), Ipê (*Tabebuia sp.*), Gonçalo Alves (*Astronium fraxinifolium*), Pequi (*Caryocar brasiliensi*) and Baru (*Dipteryx alata*). Due to the urban expansion of the municipality of Senador Canedo, the area is no longer rural and is today called the Central Brazil Industrial District.

In the management of the green belt by the company is considered the subdivision of the area in 3 parts, with different levels of conservation. Fig. 1 shows such areas. The area 1, with 107,000 m² (10.70 ha) in green color, represents an area that has been primarily recovered and received a new planting campaign in 2008, thus consisting of the most densely populated area. The area 2, with 206,600 m² (20.66 ha) in red, has a smaller density and area 3, with 209,700 m² (20.97) in pink, did not include revegetation, because it is an area of expansion of the terminal.

Fig. 1: Sub-areas of Senador Canedo's terminal green belt.

The area 1 includes an ecological trail called "Mico-Estrela Trail" implemented between 2008 and 2009 which aims to encourage conservation, protection, landscape beauty and the defense of scientific sources of the Cerrado through environmental awareness and the rational use of natural resources in Senator Canedo. The project also

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enables the strengthening of relationships with the local community, such as residents, teachers and students of the Senador Canedo municipal network, and employees of the unit, reaffirming the company's commitment to social and environmental responsibility (MAGALHÃES *et al*., 2009).

According to dimensions of the green belt arranged by Magalhães *et al*. (2009) was considered as focus of this work the area of 31.336 ha (313,360 m²), which comprises the areas 1 and 2 of the belt, which underwent recovery and contains significant samples of local biodiversity.

A list of flora and fauna species identified in the area was prepared by Transpetro (2006) and (2018) and maintained during the performance of this work based on monitoring and technical visits in the area. Such listings are used by Appendices A and B.

On the west side of the terminal is the Laginha stream, which has riparian forest and floodplain areas along its banks. In this stream the non-contamination rainwater effluents of the terminal are disposed.

Since the implementation of the green belt in 1996, there has been a thickening of vegetation, as can be seen in Figures 2, 3, 4 e 5, the result of a survey conducted with the Google Earth system, which had images since 2002.

Fig. 2: Green belt registration in 2019 (Google Earth, 2019, adaptad by authors)

Fig. 3: Green belt registration in 2015 (Google Earth, 2019, adapted by authors).

Fig. 4: Green belt registration in 2009 (Google Earth, 2019, adapted by authors).

Fig. 5: Green belt registration in 2002 (Google Earth, 2019, adapted by authors).

3.2. Economic Value and Critical Analysis Calculation

To obtain the updated replacement cost, considering the recovery actions applicable to the area of the green belt studied in the light of that carried out by Vicente (2008), Romacheli & Spinola (2011) and Moreira *et al*. (2019), a survey of values and budgets was practiced in 2019 by Moreira *et al*. (2019) and companies located in Goiânia-GO. The budgeted values were then averaged and presented in Table 1. These budgets were necessary, becouse the company did not have the project implementation values that occurred more than 20 years ago. For actions to plague control and competing vegetation after planting, a five-year horizon was considered.

Table. 1: Average value of budgets in 2019 for actions to recover the green belt.

Operations	R$/ha
Previous activities and interventions	
Soil sample	R$ 58.00
Physical-chemical analysis of soils	R$ 150.00
Subtotal	**R$ 208.00**
Land clearance, pest control and competing vegetation	
Mechanized mowing or plowing	R$ 3,200.00
Ant control	R$ 658.00
Subtotal	**R$ 3,858.00**
Soil preparation	
Railing, subsoiling or furrowing	R$ 2,452.00
Pit leasing and opening	R$ 4,356.00
Soil correction	R$ 1,946.16
Chemical crowning in the pits	R$ 1,410.48
Subtotal	**R$ 10,163.14**
Planting activities	
Distribution of seedlings and plantings	R$ 4,604.72
Tutoring	R$ 4,749.14
Subtotal	**R$ 9,353.86**
Pest control and competing vegetation after planting	
Combat leaf-cutting ants	R$ 1,477.00
Manual or mechanized mowing	R$ 3,200.00
Chemical crowning of seedlings	R$ 1,533.40
Subtotal	**R$ 6,210.40**
Replant	
Replant	R$ 2,010.04
Subtotal	**R$ 2,010.04**
Total	**R$ 31,803.44**

Given these values, there is an average total cost of R$ 31,803.44 to recovery/restoration of one hectare of Cerrado in the city of Senador Canedo. In the budget, the values consider costs of materials, tools, inputs and services. It is noteworthy that the use of chemical mowing was not considered, since ecologically harmonic principles were taken as basis.

Next to the recovered area, the main environmental services are listed: erosion and flood control, availability of cerrado fruits and herbal medicines for sustainable exploration, preservation of flora, fauna and their local habitat, temperature regulation, control of gas emissions greenhouse effect (CO_2), increased recharge and water availability in the hydrographic basin (the Paranaíba River basin and the Meia Ponte River sub-basin), an environment conducive to environmental education activities, among other preservation and conservation researches of Cerrado, protection of the operational area against fire, among others.

Constanza *et al*. (1997) present, among the studied biomes, the Savanna. Romacheli & Spinola (2011) state that Savanna can be considered a biome similar to Cerrado, since in general, they have ecological and physiognomic relationships with other savannas in tropical America and on continents such as Africa and Australia and that is why they were used the values of regulatory services listed in Table 2 in their economic valuation of a typical Cerrado fragment.

Updating the total value of regulation services by Constanza *et al*. (1997) in relation to the accumulated American inflation between 1994 and the date of this survey, March/2019, has a value of US$ 232.00 ha/year corrected to US$ 404.50 ha/year. Considering the dollar value on April 28, 2019 of R$ 3.92, we have the updated value in reais to R$ 1,585.64 ha/year. Adding then, all the values calculated in this research (replacement cost of Table 1 and adjustment service of Table 2), it is understood that the estimated value of the studied area is R$ 33,389.08 per hectare.

Table. 2: Regulation services provided by the Cerrado biome based on the values of Constanza et al. calculated in 1994 (1997).

Regulation services	**Estimated benefit value (US$/ha/year)**
Gas regulation	7
Water regulation	3
Erosion control	29
Soil formation	1
Waste treatment	87
Pollination	25
Biological control	23
Food production	67
Recreation	2
Total	**232**

Therefore, it is estimated, in view of the proposed method, that the area already recovered 23 years ago (31,336 ha) provided an annual amount of R$ 49,725.67 for environmental services, making a total of R$ 1,143,690.42 for this period environmental costs for a total replacement cost in 2019 of R$ 997,355.88, a cost that would be reverted to environmental benefits in a 20-year payback time, in addition to adding value to fixed assets, which, according to the company, is estimated at R$ 250,000.000.00. Consider that the project was implemented in 1996. Replacement values may vary according to the specificities of the area and region, so it is worth considering the possibility of updating it for each case.

It is important to consider that, in addition to areas 1 and 2 comprising the 31,336 ha studied, the company also has area 3 (20.97 ha), considered as an expansion area, which is kept clean with fire breaks, thus allowing a advance of native vegetation planted in the last 23 years, as can be seen in the sequence of Figures 2 to 5. So, it is possible to consider an increase in environmental services of R$ 33,250.87 per year, without a robust specific replacement cost investment in this area. This allows us to consider the relevance of plantations in these areas, extrapolating the environmental services provided by the studied area next to the region bordering it.

Constanza *et al.* (1997) shows limitations in his method that, since it is a valuation of 16 world biomes, such values may be underestimated and under the guidance of the authors, the particularities of each case must be deepened.

It is observed that the recreation services, for the specific case of the fuel storage terminal studied, could be revised since the area was incorporated with an ecological trail, according to Magalhães *et al*. (2009), such a project even allows the fulfillment of specific condition of environmental license of the polyduct that supplies the terminal. Another environmental regulation service value proposed by Constanza *et al.* (1997) and liable to increase would be water regulation. This is because, according to Bastos and Ferreira (2010), the drainage network in the area of Cerrado biome domain is mostly perennial, guaranteeing the supply of water to several regions of Brazil, including the main hydrographic basins being: Platina, Amazon, São Francisco and Araguaia-Tocantins, which justifies the popular saying that "Cerrado is the cradle of Brazilian waters".

However, it is worthwhile remember that the valuation of environmental services by the MCR tends to underestimate the environmental services provided by nature, since there is a whole complex of ecosystemic services that demands time to the recovery until it approaches of the original conditions. But it is worth highlighting the company's initiative to recover an area where it had not degraded, since when the area was acquired it was composed of pasture and today it is made up of a Cerrado's fragment.

The results of this research, in addition to demonstrate the environmental gains from the regulation services provided and calculated by the Cerrado biome, provide the company with a basis for environmental compensation evidence from licensing agencies, guaranteeing credits and benefits, among others, in support of its environmental licensing processes. Such results and methods also allow guiding environmental and professional in the segment in carrying out calculations of compensation and environmental valuation, in addition to guiding the compensation practices recognition carried out by projects located in Cerrado biome. And, finally, to enable society and the academic community to recognize such practices and the possible gains with the conservation and preservation of urban forest fragments.

IV. CONCLUSION

The work carried out made it possible to know the environmental services provided by the green belt of the fuel storage terminal located in Senador Canedo - GO, using the economic replacement cost valuation method associated with the regulation services valuation method. An estimated value was obtained from the studied area of R$ 33,389.08 per hectare. It was possible to estimate that the area already recovered 23 years ago (31,336 ha) provided an annual amount of R$ 49,725.67 in environmental services, making a total of R$ 1,143,690.42 in environmental services for a replacement cost total of R$ 997,355.88 in 2019, this cost reverted to environmental benefits in a return time of 20 years, that is, in environmental services the investment cost has already been exceeded. Replacement values may vary according to the specificities of the area and region, so it is valid to consider the possibility of updating it for each case.

It is also recommended to carry out studies that allow the creation of specific indexes, as done by Constanza *et al.* (1997), for Cerrado biome and that consider its wealth and diverse formations and that in sequence can consider particularities of the environmental regulation services of each region and of the biome.

It was also possible to know the forest density of the studied area in the period between 2002 to 2019, making a horizon of 17 years. In view of this density monitoring, it was possible to obtain a list of 146 fauna specimens and another 28 fauna specimens that include individuals protected by current legislation, in addition to concluding by the expansion of environmental services to the areas adjacent to the recovered area, which in turn were kept surrounded and with firebreak, so they are potential areas for recovery and conservation.

As a result, it is possible to consider the essential role of companies in adopting measures for compensation, recovery and environmental preservation, adding value to their enterprises through the provision of environmental services in their preserved and/or conserved areas. The results and methods presented here and proposed respectively, allow to guide environmental and professional in the segment to carrying out calculations of compensation and environmental valuation, in addition to guiding the recognition of compensation practices carried out by enterprises located in Cerrado biome. And, finally, to enable society and the academic community to recognize such practices and the possible gains with the conservation and preservation of urban forest fragments.

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Appendix

Appendix A – List of Registered Flora Species

Table. 3: List of Registered Flora Species

	Specie
1	*Acosmium brachystachyum* (Benth.) Yakovl.
2	*Acosmium dasycarpum (Vogel) Yakovlev.*
3	*Albizia niopoides (Bent.) Burkart var. niopoides*
4	*Albizia polycephala* (Benth.) Kilip ex Record
5	*Anacardium occidentale*
6	*Anacardium othonianum* Rizzini
7	*Anadenanthera falcata* (Benth.) Speg.
8	*Andira humilis* Mart. Ex Benth.
9	*Anemopaegma arvense* (Vell.) Stellfeld ex de Souza
10	*Annona coriacea* Mart.
11	*Annona crassiflora* Mart.
12	*Annona* sp1.
13	*Annona* sp2.
14	*Annona* sp3.
15	*Apeiba tibourbou Aubl.*
16	*Apis mellifera scutellata*
17	*Arrabidae brachypoda Burg.*
18	*Aspidosperma macrocarpon* Mart.
19	*Aspidosperma polyneuron* M. Arg.
20	*Aspidosperma* sp.
21	*Aspidosperma tomentosum*
22	*Aspidosperma tomentosum* Mart.
23	Asteraceae1
24	*Astronium fraxinifolium* Schott.
25	*Banisteriopsis* sp1.
26	*Banisteriopsis* sp2.
27	*Bauhinia* sp1.
28	*Bauhinia* sp2.
29	*Bauhinia* sp3.
30	*Brosimum gaudichaudii* Tréc.
31	*Buchenavia tomentosa* Eichler
32	*Byrsonima coccolobifolia* Kunth.
33	*Byrsonima crassa* Nied.
34	*Byrsonima* sp.
35	*Caesalpinia echinata* Lam.
36	*Callisthene mino* (Spreng) Mart.
37	*Campomanesia pubescens* (DC.) O. Berg.
38	*Caryocar brasiliense* Camb.
39	*Casearia sylvestris* Swartz
40	*Cecropia pachystachia* Tréc.
41	*Cedrela fissilis* Vell.
42	*Chorisia speciosa* A. St.-Hill
43	*Clitoria* sp.
44	*Cochlospermum regium* (Mart. ex Schrank.) Pilger
45	*Connarus suberosus* Planch.
46	*Copaifera langsdorffi* Desf.
47	*Crotalaria* sp.
48	*Croton glandulosus* L. Muell Arg.
49	*Croton urucurana Baill.*
50	*Curatella americana* L.
51	*Cybistax antisyphilitica (Mart.) Mart*
52	*Davilla elliptica* A. St. Hil.
53	*Dilodendron bipinnatum* Radlk
54	*Dimorphandra mollis* Benth.
55	*Diospyros burchellii* DC.
56	*Diospyros burchellii Hiern.*
57	*Diospyros* sp.
58	*Diplusodon* sp.
59	*Dipteryx alata* Vog.
60	*Enterolobium ellipticum* Benth.

61	*Eriotheca gracilipes* (K. Schum.) A. Robyns
62	*Eriotheca pubescens* (Mart. & Zucc.) Schott & Endl.
63	*Erythroxylum deciduum* A. St. Hil.
64	*Erythroxylum suberosum* A. St. Hil.
65	*Erythroxylum* sp1
66	*Erythroxylum* sp2
67	*Eugenia calycina* Camb.
68	*Eugenia dysenterica* Mart. ex DC.
69	*Eugenia* sp.
70	*Genipa americana* L.
71	*Guapira noxia* (Netto) Lundell
72	*Guazuma ulmifolia* Lamb.
73	*Hancornia speciosa* Gomez
74	*Himatanthus obovatus* R. E. Woodson
75	*Hymenaea courbaril* L.
76	*Hymenaea courbaril var. stilbocarpa* (Hayne) Y.T.L.
77	*Hymenaea stigonocarpa* Mart. ex Hayne
78	*Inga alba* (Sw.) Willd.
79	*Jacaranda brasiliana* (Lam.) Pers.
80	*Jacaranda mimosifolia*
81	*Kielmeyera coriacea* (Spreng.) Mart.
82	*Leguminosae – caesalpiniodeae*
83	*Leguminosae* 2
84	*Leguminosae* 3
85	*Leucaena leucocephala* (Lam.) de Wit
86	*Luehea grandiflora* Mart. & Zucc.
87	*Machaerium acutifolium*
88	*Machaerium hirtum* (Vell.) Stellfeld.
89	*Machaerium opacum* Vogel
90	*Memora nodosa* (Silva Manso) Miers
91	*Miconia* sp.
92	*Mimosa debilis* Humb. & Bonpl. Ex Willd.
93	*Moraceae* sp1.
94	*Moraceae* sp2.
95	*Myracrodruon urundeuva*
96	*Myracrodruon urundeuva* (Engler) Fr. Allem.
97	*Myrcia linearifolia* Cambess.
98	*Myrciaria cauliflora*
99	*Myrcine guianensis* (Aubl.) Kuntze
100	*Neea theifera* Oerst.
101	*Ouratea hexasperma* (A.St.-hill) Baill.
102	*Oxalis densifolia* Turcz.
103	*Palicourea* sp.
104	*Parkia pendula* (Willd.) Benth. ex Walp.
105	*Peixotoa* sp.
106	*Peltaea* sp.
107	*Phytolacca* sp.
108	*Piptadenia gonoacantha* (Mart.) J.F. Macbr.
109	*Piptocarpha rotundifolia* (Less.) Baker
110	*Platipodium elegans* Vogel
111	*Plenckia populnea* Reissek
112	*Pouteria ramiflora* (Mart.) Radlk
113	*Pouteria torta* (Mart.) Radlk
114	*Pseudobombax tomentosum* (Mart. & Zucc.) A. Robyns
115	*Psidium guajava* L.
116	*Psidium* sp1.
117	*Psidium* sp1.
118	*Qualea grandiflora* Mart.
119	*Qualea parviflora* Mart.
120	*Roupala montana* Aubl.
121	*Rourea induta* Planch.
122	*Sabicea brasiliensis* Wernhm
123	*Salacia crassifolia* (Mart.) Peyr.
124	*Salacia elliptica*
125	*Salacia* sp.
126	*Salvertia convallariaeodora*
127	*Serjania* sp.
128	*Smilax goyazana* A. DC.
129	*Solanum lycocarpum* St. Hil.
130	*Sterculia chicha* A. St. – Hil. Ex Turpin
131	*Strychnos pseudoquina* A. St. Hil.
132	*Stryphnodendron adstringens* (Mart.) Coville
133	*Stylosanthes guianensis* Sw.
134	*Styrax ferrugineus* Nees & Mart.

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135	*Syagrus romanzoffiana* (Cham.) Glassman
136	*Tabebuia aurea* (Manso) Benth. & Hook
137	*Tabebuia caraiba* (Mart.) Bur.
138	*Tabebuia chrysotricha* (Mart. ex A.DC) Standl
139	*Tillandsia* sp.
140	*Tocoyena formosa* (Cham. & Schltdl.) K. Schum
141	*Vernonia* sp1.
142	*Vernonia* sp2.
143	*Vochysia haenkeana* Mart.
144	*Vochysia tucanorum* Mart.
145	*Xylopia aromatica* (Lam.) Mart.
146	*Zeyheria digitalis* (Vell.) Hoehne

Appendix B – List of Registered Fauna Species

Table. 4: List of Registered Fauna Species

	Specie
1	*Ara ararauna*
2	*Amphisbaena alba*
3	*Aratinga Leucophthalma*
4	*Atta* sp.
5	*Boa constrictor*
6	*Bothrops jararaca*
7	*Buteo magnirostris*
8	*Callithrix penicillata*
9	*Camponatus sp.*
10	*Chironius bicarinatus*
11	*Coedou* sp.
12	*Coragyps atratus*
13	*Crotalus durissus*
14	*Crotophaga ani*
15	*Erythrolamprus aesculapii*
16	*Euphractus sexcinctus*
17	*Gnorimopsar chopi*
18	*Guira guira*
19	*Myrmecophaga tridactyla*
20	*Lycalopex vetulus*
21	*Ozotoceros bezoarticus*
22	*Pitangus sulphuratus*
23	*Polybia occidentalis*
24	*Polybia sericea*
25	*Sicalis flaveola*
26	*Synoeca syanea*
27	*Theristicus caudatus*
28	*Trigona spinipes*
29	*Turdus fumigatus*