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RECOVERY PLAN FOR A DEGRADED AREA (PRAD): EXECUTION COST FOR A PERMANENT PRESERVATION AREA (APP)

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Abstract: The Ribeirão Mestre d'Armas is important for the water supply of the Federal District and its riparian forests, indispensable for water quality, are degraded. Thus, the objective of this study is to estimate and analyze the cost of executing a Degraded Area Recovery Plan (PRAD) for a Permanent Preservation Area (APP) of Ribeirão Mestre d'Armas. All PRAD activities, divided into implementation, maintenance and monitoring stages, were planned to take place over a period of four years. The total present cost of the PRAD was R$ 57,885.50 to recover an area of 0.53 hectares, which is close to R$ 72 thousand/ha. The highest costs of the project were concentrated in the implementation phase, highlighting the costs of acquiring seedlings and technical supervision.
Keywords: Environmental management; environmental impact assessment; environmental recovery.

INTRODUCTION

Anthropogenic activities are responsible, over the years, for the modification of Brazilian biomes. The Cerrado biome is responsible for the maintenance of water, an essential factor for all species (FELFILI et al., 2000). This biome is the second richest in biodiversity in Brazil and also the birthplace of many endemic plant and animal species (DURIGAN et al., 2011). Today it is among the most threatened ecosystems, about 50% of its original cover has already been lost.

Despite the recognition of its biological importance, the Cerrado is the biome that has the lowest percentage of areas under full protection. The biome has 8.21% of its territory legally protected by conservation units; of this total, 2.85% are fully protected conservation units and 5.36% are sustainable use conservation units, including Private Natural Heritage Reserve (RPPN) (0.07%) (MMA, 2019).

The riparian forests have the function of protecting the banks of the rivers, having a great importance for the preservation of the flora and fauna. It works as a kind of filter and prevents contamination of water by polluting products, such as those used in agriculture, and allows the absorption of nutrients such as nitrogen, phosphorus, calcium and magnesium. This function is often not prioritized, with agricultural and urban advances occurring in their areas due to the ineffectiveness of the legislation and supervision that protect them.

With the disorderly growth of the urban population, undue occupations in permanent protection areas have been occurring, causing the withdrawal of riparian environments, affecting water quality, among other aspects. As an example we can highlight an area located in the administrative region of Planaltina - DF, approximately 30 km from Brasília. It is a riparian forest of the Ribeirão Mestre d'Armas that has its source in Lagoa Bonita, which is located in the Águas Emendadas Ecological Station (ESECAE). The Ribeirão Mestre d`Armas is one of the tributaries of the São Bartolomeu River, the largest in the Federal District, and is of great importance for the water supply of the cities of Planaltina and Sobradinho in the Federal District.

The legal instrument for adjusting conduct regarding the recovery of degraded areas within the environmental licensing is the Plan for the Recovery of a Degraded Area (PRAD). The PRAD had its origin in article 225, of the Federal Constitution of 1988, and in Decree-Law n. 97.632/89, which regulated Law n. 6,938/81, requiring the recovery of the degraded area as part of the Environmental Impact Study and Environmental Impact Report (EIA/RIMA) (ALMEIDA, 2016).

In this context, this work aims to estimate and analyze the cost of carrying out a PRAD for the Permanent Preservation Area (APP) of

Ribeirão Mestre d'Armas.

METHODOLOGICAL PROCEDURES

RECOVERY PROJECT AREA

The project area is located in the administrative region of Planaltina – DF, under the coordinates 15°36'21.02"S / 47°41'32.52"W. The predominant soil is the Red-Yellow Latosol, highlighting the presence of Hydromorphic soil in smaller portions (Figure 1).

The climate in the project area is tropical, with more rainfall in summer than in winter. According to Köppen and Geiger, the climate is classified as Aw , reaching an average temperature of 23.2 °C and an average annual rainfall of 1091 mm (CLIMATE DATA, 2019).

PRESENT COST OF THE PROJECT

The project for the recovery of the Ribeirão Mestre d'Armas APP was based on bibliographic research and analysis of the degree of degradation of the area after *on-site visits* .

After defining the recovery project, the costs for its realization were raised, being distributed in a quarterly cash flow for subsequent decapitalization and calculation of the total Present Cost of the project (Equation 1).

$$CP = \sum_{t=1}^{n} \frac{C_t}{(1+i)^t} \text{(Equation 1)}$$

so that:

CP = Present Cost

Ct = Cost of each activity

t = period (quarters)

i = interest rate

The Interest rate considered was the Long-Term Rate (TLP) of BNDES, whose average value is around 6.26% per year. Transforming the annual rate of 6.26% to an equivalent rate in a compound regime, the value is 1.5% per quarter. The choice of this interest rate is justified by the existence of BNDES credit lines for carrying out projects of this nature (BNDES, 2019).

RESULTS AND DISCUSSIONS

DEGRADED AREA RECOVERY PROJECT

For the recovery of the degraded area, the planting of native species of the Cerrado biome is planned. Therefore, it is necessary to close the site with a fence, preventing the access of animals and people.

Based on CONAMA Resolution nº 429/2011 (BRASIL, 2011) , the recovery of degraded Permanent Preservation Areas must be carried out by the methods of: conducting the natural regeneration of native species; planting of native species; or planting of native species combined with the conduction of natural regeneration of native species. In view of the degree of human activity in the project area, the method of conducting natural regeneration, applied in isolation, is not appropriate. For this reason, the methodology used is the planting of native species. According to Durigan et al. (2011, p. 10):

In situations where the impact was a little more intense or persisted for a longer time, it is common to find regenerating cerrado plants, but with low density or the presence of a very restricted number of species. In these cases, enrichment planting is recommended to accelerate the coverage of the land and increase diversity.

Enrichment was the planned system for areas in an intermediate stage of degradation, which still maintain some of the typical characteristics of the original vegetation. Generally, these areas are composed of capoeiras and species from the early stages of succession. In these areas, it is foreseen the introduction of species from the final stages of succession under the canopy of the pioneer

trees that are present in the area (RODRIGUES & GANDOLFI, 1996).

The areas bordering the watercourses are, in general, fragile environments, due to the irregular relief, the uneven topography, the water table regime, among others. Thus, it is necessary to avoid causing major alterations in the soil to avoid erosion (MARTINS, 2009).

Soil preparation depends on the disturbance condition to which the forest was subjected. It is important to characterize and delimit the area to be recovered, considering the humidity gradients and the types of soil found. These conditions vary from the grassland to the edge of the stream or river (FELFILI et al., 2000).

The choice of species was based on their natural occurrence on the banks of rivers in the region and, in the case of using other species, observed their adaptation with the presence of shallow or shallow water table.

The planting is planned to be done in rows, to facilitate mechanized planting or maintenance operations, with a spacing between the seedlings of 2 x 3 m. The project foresees the planting of 850 seedlings for 0.53 ha. The density of seedlings at planting must be equal to that of the original vegetation that was eliminated and must be carried out at the beginning of the rainy season, normally in the months of October and November. The holes will have dimensions of 40 cm for width, length and depth, they will be prepared with organic fertilizer and 70 grams of Super Simple fertilizer in each hole.

The planned monitoring period is three years, as this is the period with the highest growth rate of seedlings, being the most important phase in the development cycle; where they should receive fertilization and cultural treatments that allow a good adaptability.

Table 1 highlighted all the activities to be carried out in the stages of implementation, maintenance and monitoring of the PRAD.

PRESENT COST OF THE PROJECT

The PRAD costs are shown in Table 2 and were collected in August 2019 in the companies: Landscape Nativa, Casa do Adubo, Nativa Agricultura, Hortibraz and Loja do Fazendeiro . To simplify the calculations, the project costs were considered stable over time. From the total quarterly costs, the project's cash flow was elaborated.

The total present cost for the recovery of 0.53 hectares in the Ribeirão Mestre d'Armas APP was R$ 57,885.50 . The implementation phase corresponded to more than 50% of the total costs. The higher cost in the implementation phase is explained because it is in this phase that the expenses with seedlings, fencing the area, soil preparation and most of the cost with technical supervision are.

In the quarters corresponding to the months of June and December, there is an increase in the costs of technical supervision, the reason being that in these months the control reports are carried out, normally required by the competent environmental agency. Also in the months of December, an increase in costs is expected, as it is during this period that replanting takes place to replace any dead seedlings. All food and transport costs are included in daily and labor costs.

Table 3 shows values for the recovery of degraded areas in areas on the limits of the Cerrado Biome and close to the study site of this work. For comparison purposes, the values were corrected for the period of May 2019 by the Price Generation Index - Internal Availability (IGP - DI).

Figure 1. Location and delimitation of the Project area

Source: Google Earth (2019)

IMPLANTATION	
fencing	Isolate the area with stakes and flat wire.
Area signage	Making and placing a notice board in the recovery area.
pest management	Control of ants and termites through handling and granulated baits.
soil preparation	Opening of cradles for planting the seedlings in rows, 2 meters apart.
planting seedlings	Planting should preferably be carried out in the rainy season, thus avoiding the use of irrigation, which makes planting more expensive.
Crowning and trimming	Mechanized mowing of existing vegetation (predominantly grasses). Crowning (manual), about 50 cm in diameter for each pit.
tutors	Fixation of tutors to support the seedlings that will also serve for their location.
Fertilizing	Organic fertilization and the use of Simple Superphosphate fertilizer.
fencing	Isolate the area with stakes and flat wire.
MAINTENANCE	
replanting seedlings	Evaluation of seedling survival and replacement of dead seedlings and replanting in the rainy season.
Silvicultural Treatments	Crowning at the end of the rainy season, mowing according to the evaluation of the area and pest control.
fire prevention measures	Fire control by building firebreaks during the dry season.
MONITORING	
reports	According to the decision of the control body, seven reports must be delivered, one on planting, five on monitoring and a final report.
technical supervision	Follow-up and supervision of implementation, maintenance and monitoring activities by a qualified and technical professional.

Table 1. Project stages and activities

IMPLANTATION	Cost R$)	QUARTER 6	Cost (BRL)
area fencing	3,022.50	Pest Monitoring	270.00
Signaling	110.00	Silvicultural Treatments	420.00
pest management	328.00	Fire Prevention	280.00
Fire Prevention	280.00	Technical Supervision	1,990.00
Inputs, preparations and planting	11,458.00	**Total Quarter 6**	**2,960.00**
technical supervision	13,750.00	**QUARTER 7**	**Cost (BRL)**
Total Deployment	**28,948.50**	Pest Monitoring	270.00
QUARTER 1	**Cost (BRL)**	Silvicultural Treatments	420.00
Pest Monitoring	270.00	Fire Prevention	280.00
Silvicultural Treatments	420.00	Technical Supervision	1,440.00
Fire Prevention	280.00	**Total Quarter 7**	**2,410.00**
Technical Supervision	1,440.00	**QUARTER 8**	
Total Quarter 1	**2,410.00**	2nd Replanting	1,611.00 _
QUARTER 2	**Cost R$)**	pest management	328.00
Pest Monitoring	270.00	Technical Supervision	1,990.00
Silvicultural Treatments	420.00	**Total Quarter 8**	**3,929.00**
Fire Prevention	280.00	**QUARTER 9**	**Cost (BRL)**
technical supervision	1,990.00	Pest Monitoring	270.00
Total Quarter 2	**2,960.00**	Silvicultural Treatments	420.00
QUARTER 3	**Cost(R$)**	Technical Supervision	1,440.00
Pest Monitoring	270.00	**Total Quarter 9**	**2,130.00**
Silvicultural Treatments	420.00	**QUARTER 10**	**Cost (BRL)**
Fire Prevention	280.00	Pest Monitoring	270.00
Technical Supervision	1,440.00	Silvicultural Treatments	420.00
Total Quarter 3	**2,410.00**	Technical Supervision	1,990.00
QUARTER 4	**Cost (BRL)**	**Total Quarter 10**	**2,680.00**
replanting	2,465.00 _	**QUARTER 11**	**Cost (BRL)**
pest management	328.00	Fire Prevention	280.00
Technical Supervision	1,990.00	Technical Supervision	1,410.00
Total Quarter 4	**4,783.00**	**Total Quarter 11**	**1,960.00**
QUARTER 5	**Cost(R$)**	**QUARTER 12**	**Cost (BRL)**
Pest Monitoring	270.00	Technical Supervision with Final Report	1,990.00
Silvicultural Treatments	420.00		
Technical Supervision	1,440.00		
Total Quarter 5	**2,130.00**	**Total Quarter 12**	**1,990.00**

Table 2. Costs of all activities throughout the project

Author	Cost/ha for 05/31/2019 by the IGP-DI (R$)
Value found	**71,708.73**
Almeida et al. (2017)	54,546.29
Borges *et al* (2011)	47,856.72
Embragea (2016)	24,849.41
Oliveira (2012)	22,005.49
Almada et al. (2016)	10,865.00

Table 1. Comparison of cost/ha between projects for the recovery of degraded areas.

Almeida et al. (2017) presented a PRAD for an old garbage dump area, currently a gravel pit, located in Planaltina - DF, several treatments were planned for the soil, which was diagnosed as in an extremely degraded state, which increased the recovery costs of the soil. area.

On the other hand, there are factors in the project by Almeida et al. (2017) which made it cheaper than this study. The project by Almeida et al. (2017) has fewer monitoring and maintenance actions, there are only nine visits in the six-year duration of the project, in the case of the Ribeirão Mestre d'Armas APP, twelve visits are planned in three years; this amount of visits is justified because it is in a permanent preservation area and requires different recovery techniques. Another determining factor is the amount of reports charged by the environmental agency to carry out the PRAD, reports that are not foreseen in the work by Almeida et al. (2017), since it was not a recovery project to meet the legal requirements of a PRAD.

The cost for the implementation phase of this PRAD was R$ 28,948.50, which is close to the same value foreseen in the MMA cost worksheet (2011), the difference that exists is due to the lower cost with labor in the MMA worksheet (2011).

The difference between the costs found in comparison to the work by Almada et al. (2016), who estimated the costs to recover 3.38 ha of APP in Anápolis. What explains the big difference is that in the budget proposed by Almada et al. (2016) there were no expenses with reports, qualified professionals, fencing and signage in the area, essential items for carrying out a PRAD.

The difference between the recovery costs of the various projects mentioned in Table 1 can be explained by several factors, such as: study region, type of environment, stage of development and seedling species, technique chosen for recovery, degree of degradation of the environment, value of local labor, among other factors.

CONCLUSION

The cost for the recovery of the Ribeirão Mestre d'Armas APP was approximately R$ 72 thousand per hectare, noting that a large part of this amount is composed of the cost of technical supervision and quarterly follow-ups, required in the form of PRAD follow-up reports by the environmental agency. As it is a place with invasive vegetation that requires rapid revegetation, care such as the size of the seedlings are essential and these also made the project more expensive.

However, as the area has an environmental importance of public interest, it is possible to carry out partnerships with environmental research institutes, as well as other public bodies, which can reduce costs such as technical supervision and acquisition of seedlings.

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