Chapter 122

Environmental Diagnosis of Permanent Preservation Area in Rondônia

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ABSTRACT
The Amazon forest plays an essential role in maintaining ecosystem services, in addition to collaborating with the planet's climate balance. However, the levels of degradation in the region have increased considerably, through anthropic activities, mainly due to the intense change in the use and occupation of the soil. This work aimed to carry out an environmental diagnosis at the source that belongs to the Manicoré River basin in the municipality of Rolim de Moura - RO, as well as to elaborate a Recovery Plan for Degraded Areas for the region. To this end, a technical visit was made to the site, in which water samples were collected for laboratory analysis, used as parameters for diagnosing the level of degradation of the spring catchment area. To facilitate the assessment, the Degraded Permanent Preservation Area was divided into three sectors: APPD1 - beginning of the source; APPD2 - medium portion; and, APPD3 - end of spring. At the time, twelve types of degradation were considered and after the evaluation, a sum was made to classify the level of degradation of the area. After classification, indications for recovery of environments were proposed, by sector. Two parameters of the physical-chemical evaluation of water quality showed results superior to the reference values established by CONAMA, conductivity and thermotolerants. Finally, a high degree of degradation was observed in all sectors, with mitigation measures being indicated for each of them. As mitigating measures for the recovery of the three sectors, bioengineering, consolidation and nucleation, planting of fast-growing forest species and conventional planting with low spacing were recommended. The purpose of the measures is to promote edaphic and vegetation characteristics suitable for good local development.

Keywords: Degraded area recovery, Amazon, water quality.

1 INTRODUCTION

The Amazon rainforest is the largest tropical forest in the world, stands out as an important center of world biodiversity, besides working with the climate balance, with the process of evaporation and transpiration of trees. Furthermore, this biome plays dispensable role in the maintenance of ecosystem services, including acting as a *carbon pool* (SAATCHI *et al.* , 2007; BARROSO; MELLO, 2020). It is noteworthy that the region is home to about 20% of the world's availability of fresh water (CORREIA *et al.* , 2007).

However, even representing an important source of ecosystem goods and services essential for global well-being, the forestry degradation in the Amazon region has increased considerably over the years, especially due to the emergence of new areas of logging, expansion of deforestation and an increase in burned areas in the region (MATRICARDI et al, 2020). In this sense, Rondônia had a significant participation in this scenario, because from the 1970s, due to incentives by the government, large-scale colonization projects, granting of credits and investments made (BECKER, 1997; PEDLOWSKI *et al*., 1999). The colonization of the Amazon in the territory of Rondônia occurred quickly, not considering the fragility of the areas of natural ecosystems, including encouraging producers to deforestation, ensuring their establishment and hope of gaining new lots (TRONCO, ROCHA, 2022).

Rondônia has 52 municipalities, with an area of 237,765,347km² (IBGE, 2021), containing seven hydrographic basins: Guaporé, Mamoré, Abunã, Madeira, Jamari, Machado and Roosevelt, and 42 more sub-basins (ZUFFO; ABREU, 2010). The municipality of Rolim de Moura has an area of 1,457,811 km², and an estimated population of 55,748 inhabitants (IBGE, 2021). Its area is drained by 2 sub-basins: Muqui River and Rolim de Moura River, belonging to the Machado river basin (SEDAM, 2002). In the sub-basin of the Muqui River, if and against the Igarapé D'Alincourt and the Manicoré Stream responsible for the supply of the municipality (VENDRUSCOLO *et al.* , 2019).

According to data from the PRODES system of the National Institute of Space Research (INPE, 2022), in 2021, 90.6% of the area of this municipality was deforested, leaving only 9% of forest cover. It is emphasized that this forest cover plays a vital protective role in river basins, reducing soil erosion, silting of rivers and nutrient loss. Thus, the presence of the forest acts as a natural barrier that protects the rivers, increasing the quality and quantity of water of these (RIEGER *et al.* , 2014).

Permanent Preservation Areas (APP's) according to Article 3 of the Federal Forestry Legislation, Law No. 12,651/2012, is defined as: protected area, covered or not by native vegetation, with the environmental function of preserving water resources, landscape, geological stability and biodiversity, facilitating the gene flow of fauna and flora, protecting the soil and ensuring the well-being of human populations (BRASIL, 2012).

Aiming at the protection and recovery of APPs, due to all the above-mentioned benefits, environmental diagnosis is a valuable tool. Therefore, through the evaluation of ambiental impacts, such as water and soil quality, measurement of these and subsequent interpretation, it is possible to minimally interfere in the site and enhance the success of the recovery of this site.

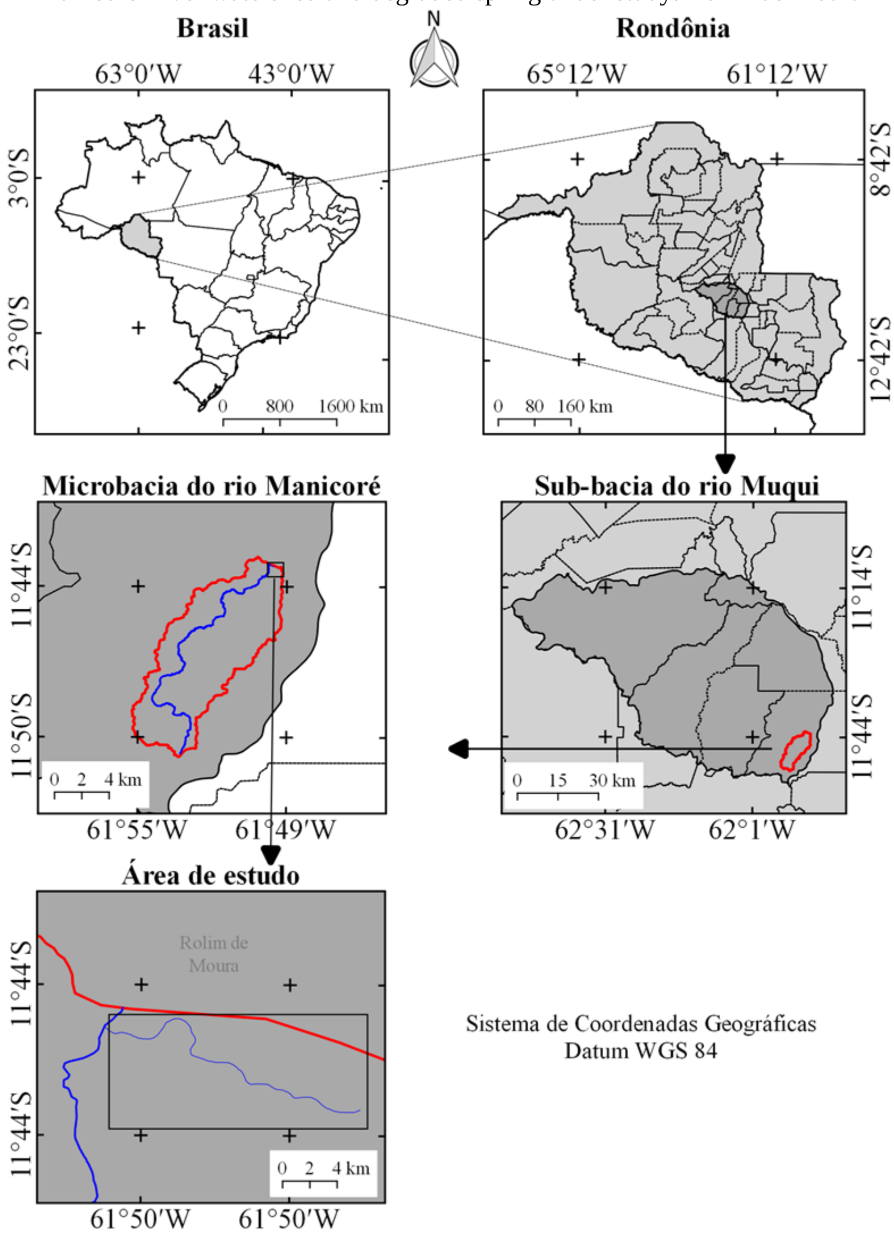
Several parameters can be used to determine water quality , in which it is possible to quantify or estimate contamination of biological sources, such as those from feces, by chemicals, originate in accidents or irregular disposal. The representative collection of water samples allows these variables to be quantified and can be extrapolated to the system of origin (BRASIL, 2022).

In view of the above, the objective of this work was to carry out an environmental diagnosis in the spring belonging to the Manicoré River basin in the municipality of Rolim de Moura - RO, measuring the impacts in different stretches and pointing out potential methodologies for the study site.

2 MATERIAL AND METHODS

The study was carried out in a spring located on a private property, at km 6 north of line 25 of highway RO-010 in the rural area of the municipality of Rolim de Moura-RO. The property in question was domestic and industrial waste deposit, affecting the quantity and quality of spring water. The source belongs to the Manicoré River basin (Figure 1) which, together with the D'Alincourt River, supplies the city of Rolim de Moura.

Figure 1 - Manicoré River watershed and degraded spring under study. Rolim de Moura-RO, 2019.



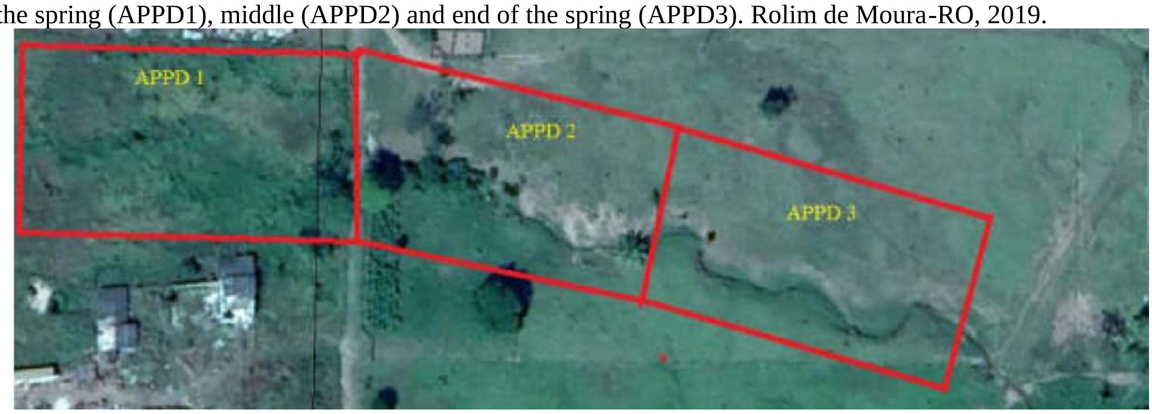
In September 2019, *on-site visits were made to measure quantitative parameters of groundwater* quality, as well as the characterization and quantification of the degradation of the area of capture of the spring. For the analysis of groundwater quality, the methodology of collection and analysis of parameters was performed according to the standards established by APHA (2012) and ABNT - NBR 12,620 (1992). Four water samples were collected from a piezometric well located 200 meters from the spring in sterile polyethylene containers.

The parameters selected to be evaluated outside m: temperature, pH, hardness, conductivity, dissolved oxygen (O.D) and microbiological assays for Thermotolerant and *Escherichia coli*. Except temperature and O.D., which were measured at the time of sampling with digital portable meter (Lutron/DO-5519), the others were determined in the Laboratory of Ecosystem Recovery and Forest Production - REProFlor of the Federal University of Rondônia, by title metric methods with analytical equipment of the institution itself: Spectrophotometer (Libra- Biochrom), colorimeter (AquaColor, DQC), pHmetro (MS TECNOPON, mPA – 210), turbidimeter (MS TECNOPON, TB 1000 p), conduit meter (SANXIN, DDS – 11 C Cond Meter) and flame photometer (Benfer/BFC-300).

The microbiological analysis was determined by MEANS OF KIT Colitag, which complies with the instructions of the Ministry of Health Ordinance No. 2,914/2011 (BRASIL, 2011), to the reagent 100 ml of water sample is added and, after mild homogenization, it is incubated at 35 ºC for 24 hours. For this purpose, the mean of the four samples was used, and the results of the water quality found were compared between the periods evaluated and the parameters established by the Resolution of the National Council of the Environment (CONAMA) no. 357, of March 17, 2005, taking into account the framing classes of watercourses. These were also compared with CONAMA Resolution No. 430 of June 13, 2011.

In relation to the environmental diagnosis, in order to quantify the level of degradation of the nascent catchment area, the rainfall area was divided into three sectors of degraded Permanent Preservation Area: APPD1 - beginning of the spring; APPD2 - average, and, APPD3 - end of the spring (Figure 2).

Figure 2 – Delimitation of the degraded Permanent Preservation Area, belonging to the Manicoré River basin, sectorized at the beginning of the spring (APPD1), middle (APPD2) and end of the spring (APPD3). Rolim de Moura-RO, 2019.



Along the length of the spring, 12 different types of degradation actions were listed, following borges' adapted methodology (2005). For each type of degradation and in each sector evaluated, the presence (number 1) or absence (number 0) of these were marked: 1. Water interruption (when fragmentation in the water flow was observed); Two of them. Signs of burning; 3. Exposed soil; 4. Presence of bovine (viewing within 10 meters for each side of the watercourse); 5. Waste (deposition of some type of waste, industrial or domestic, within a radius of 10 meters to each side of the watercourse); 6. Isolation (presence of app fence); 7. Silting in the watercourse; 8. Tree cover (presence of forest vegetation, regardless of the height of the trees); 9. Gullies; 10. Presence of grasses; 11. Livestock waste and trampling; 12. Oilsoil tank ing.

At the end, the sum of the items recorded was made and each sector was classified as to the number of items recorded: Up to 4 items registered, the area was considered of medium degradation; from 4 to 8 items registered, high degradation; above 8 items, very high degradation. After the diagnosis of the degree of degradation, the indication of recovery by sector was made (APPD1, APPD2 and APPD3).

For each level of quantified degradation, and consequently, resilience level, recovery methodologies were suggested.

3 FINDINGS

Regarding the analysis of groundwater quality, two parameters were above the reference value, according to CONAMA Resolution (Table 1) and one of these exceeded the limit allowed by the legislation in accordance with the Parameters for Analysis of Groundwater Collection Points referring to State Decree No. 10,114, of September 20, 2002, regulation of Complementary Law No. 255 of January 25, 2002.

Table 1 - Physical-chemical evaluation of water quality in piezometric spring well in the Manicoré river basin. Rolim de Moura/RO, 2019.

Parameters	Values found	Reference Values Conama Resolution 357/2005
Temperature	27.8°C	-
ph	8,65	6.0 to 9.0
Hardness	75.6 mg/L	75 to 150 mg $^{L-1}$
Conductivity	122.4 µS/cm	10 to 100 µS/cm
Dissolved oxygen	6.2 mg/L	5 to 8 mg/L
Thermotolerant	NPM (2000)	Maximum 1000 NPM
Escherichia coli	70th NPM	-

The measurement of the degree of degradation of each sector (APPD1, APPD2 and APPD3) showed that, despite the different types of degradation recorded in them, in all sectors the degree of degradation was high (Table 2). At the beginning of the spring (APPD1), the most evident types of degradation were soil contamination with oils and the presence of many residues in general and of different sizes. There were no grazing animals in this sector, but the spring was fully discovered and with the presence of grasses (*Brachiaria* spp.) in the surroundings.

Table 2. Classification of the degree ofdegradation and source of the Manicoré River basin, according to the methodology proposed by Borges (2005), Rolim de Moura/RO, 2019

Types of degradation	Registered items		
	Appd1	**Appd2**	**Appd3**
1.Water interruption	0	0	1
2.Signs of burning	1	0	1
3.Exposed soil	1	1	1
4.Presence of bovine	0	1	1
5.Garbage	1	0	0
6.Isolation	0	0	0
7.Siltation in the watercourse	1	1	1
8.Tree cover	0	0	0
9.Gulbys	1	1	1
10.Presence of grasses	1	1	1
11.Cattle stumping and trampling	0	1	1
12.Soil contamination with oil	1	0	0
Total	**7**	**6**	**8**

in which: APPD1 - Degraded Permanent Preservation Area of sector 1, beginning of the spring; APPD2 - Degraded Permanent Preservation Area of sector 2, middle part of the spring; and, APPD3 - Degraded Permanent Preservation Area of sector 3, end of the spring.

There was no isolation in any of the sectors studied and there was erosion, to different degrees, but in the entire length of the watercourse. Although each sector has intrinsic characteristics, all three were classified as highly degraded. Thus, the methodology adopted for the recovery of this area is similar and in two stages, in order to isolate the processes that cause degradation and implement forest species throughout the course of thearea, but with different indications of how to perform them. Moreover, when accounting for the radius of 50 meters around the spring, as established in the current legislation, it was noticed that, within this radius, there is a warehouse (shed) and a dwelling house. In addition, the entire surroundings have exposed soil, containing large gullies.

4 DISCUSSION

It is important to emphasize that the studied source is located near the water catchment of the Manicoré River for supply to the municipality of Rolim de Moura. Thus, the slightest change in any water variable, or measurement of environmental impacts on its surroundings, is highly dangerous to the health of residents. It is emphasized that the division into three distinct sectors took place in a methodological way for better discussion. However, the results should be fully interpreted for this watercourse.

The result of measured water quality is mainly a reflection of the contamination of water bodies caused by inadequate deposition of waste from various categories such as construction waste, household waste and disposal of mechanical workshops. This is because the site has served as an irregular waste dump for this type of material for many years, besides the fact that the spring is totally unprotected from vegetation, which results in the reduction of water quality and degradation of the river and spring bed.

The temperature detected remained within the range found by Cunha *et al*. (2020), which also analyzed water from wells in the Rolimde Moura do Guaporé-RO area, whose values remained between 27.2 and 31.7ºC, in a region where the elevation varied between 150 and 235 meters. Water temperature has a direct influence on the metabolism of aquatic organisms and the concentration of dissolved gases (MEDEIROS, 2022), besides affecting conductivity, pH and other values. Thus, the determination of this parameter has great importance in the analysis of other properties that are crucial to consider quality water or not. In this study, the value obtained within the range of bibliographic data serves as a basis for supporting the analyses of the other chemical and physical components studied, because there is no discrepancy in the temperature found, compared to similar studies, any change in the other parameters that also depend on temperature, it is due to non-intrinsic agents and not to temperature.

The pH level of well water (8.65) remained under basic conditions and at the maximum limit suggested by Resolution CONAMA 357/2005 of the Ministry of Health, whose established pH range is from 6.0 to 9.0 and outside the range of 5.5 to 8.5 (ANDRADE JUNIOR *et al*., 2018). These changes in the levels of this variable can be caused by organic agents, such as the presence of residues originating of vegetation decomposition that result in acid values, behavior observed in some watercourses in the Amazon plain (QUEIROZ; ANDRADE *et al*., 2009). The pH of a solution, for example, refers to the activity of hydrogen cations (H^+) or their concentration, in those contexts where concentration and activity are approximated. Water has an ionic balance that forms this ion, as well as hydroxyls (OH^-), this balance can be altered by any acid or base that reacts with the water (KOTZ, 2015), leading to changes in pH values, down under acid effect and upwards, when the reaction occurs with a base.

The pH values may come from the dissolution of rocks and photosynthesis or, also, by anthropogenic factors such as domestic and industrial evictions (PARRON *et al*., 2011). However, among other aspects, in a degraded environment the rains can easily reach the wells and the pH value tends to rise, surpassing neutrality due to a higher concentration of dissolved compounds. As the site presents such characteristics, resulting from several anthropic activities around the spring question, mainly coming from construction and junk waste, the pH values higher than those indicated by Andrade Junior (2018) and at the limit allowed in CONAMA Resolution No. 357, of March 17, 2005, indicate that loc degradation al may be affecting the quality of the water table, making the local water unfit for consumption (CARVALHO *et al*., 2000; IEPEC, 2008) and can pollute downstream, due to the on-site spring.

The hardness found in the analyzed samples is in agreement with values described in bibliography for groundwater in the state of Rondônia (CUNHA *et al*., 2020) and water used for human consumption and work with animals in the region of Rolim de Moura (SOFFA *et al*., 2020), whose values are appropriate to the intervention mild to moderate hardness. The variable water hardness is of paramount importance in certain contexts, characterized by the concentration of the rambling cations of calcium and magnesium metals (USGS, 2018), commonly expressed as milligrams of calcium carbonate per liter of solution (mg $caco_3$/mL), this way of expressing hardness allows the classification of water into mild (for hardness less than 60 mg $CaCO_3$/mL), (up to 120 mg $CaCO_3$/mL), hard (not more than 180 mg $CaCO_3$/mL), very hard (with values above 180 mg $CaCO_3$/mL) (USGS, 2018).

Also in relation to hardness, it is worth mentioning the influence that degraded sites have on the worsening of water quality of these regions, although no such influence was evidenced in the collected samples and result may be linked to heterogeneity in the well water, associated with the difficulty of collecting samples from a specific point within the water. Thus, in view of the current legislation, this hardness value alone does not characterize a water source at odds, even though labeling the water of a region as drinkable requires the analysis of a set of variables..

The conductivity value was above the maximum limit established by CONAMA Resolution 357/2005 (122.4 µS/cm). This normal variable is measured in µS/cm, refers to the ability of the solution to conduct electrical current (APHA; AWWA; WEF, 2012). As water is an electrical insulator, the conduction observed in its solutions is primarily due to the concentration of salts from it. Despite being an unselective parameter, conductivity provides global information about the presence of solution salts, without discriminating their nature.

The change in conductivity values may be associated with the lack of plant protection of the soil and the accumulation of residues in degraded areas, which in rainy periods can be easily leached into wells and rivers (CASTRO; CARVALHO, 2009), a scenario corresponding to the site of the well and river, which would explain the change in this parameter. Natural water must have conductivity levels in the range of 10 to 100 µS/cm, however in environments polluted by domestic sewage or industrial waste, the values can reach 1000 µS/cm. These aspects are also related to the use of incorrect soil, which can also modify the composition of water, reflecting in high electrical conductivity (ESTEVES, 2011; BRASIL, 2014).

The concentration of Dissolved Oxygen (O.D) in the well water reached values of 6.2 mg/L, which is in conformity and with that established by CONAMA Resolution 357/2005 (from 5 to 8 mgL-1). The biochemical oxygen demand refers to the amount of oxygen that aerobic microorganisms consume through their metabolic processes (VALENTE; P; SILVA, 1997), with lower values indicate smaller amounts of microorganisms, being an important parameter in the analysis of water quality (BRASIL, 2022), and closely related to the amount of dissolved oxygen, which refers to the oxygen existing in a solution and available for breathing (VALENTE; P; SILVA, 1997). The value measured in this is an adequate oxygen concentration, indicating that at the time of collection, the water source did not suffer appreciable influence of factors that modify this parameter, which may vary according to climatic and environmental conditions, with atmospheric pressure and salinity of water (SILVA *et al.*, 2008), besides eutrophication and the amount of dissolved organic matter, which may affect the number of aerobic microorganisms in solution, resulting in the decrease of dissolved oxygen (GARCIA; BATTERO, 2010).

In microbiological terms, the presence of thermotolerant coliforms above the limit allowed by CONAMA Resolution 357/2005 was identified, weighing the high value of these bacteria, which do not directly imply contamination by feces, because part of the species that make up this group may occur in the environment in a non-anthropic way. Bacteriological determinations are also part of the routine set of analyses related to water quality (FUNASA, 2005), where the coliform group gain prominence, especially thermotolerant coliforms, due to *escherichia coli* bacteria (SIQUEIRA, 1995). These bacteria are characterized by being Gram-negative, that is, they present reddish color when dyed with gram coloration, by fermenting lactose with gaseous production at temperatures around 35 °C, or 45 °C for those called thermotolerant, *group of E. coli* (SOUZA, 1983).

E. coli is the representative of thermotolerant bacteria that live exclusively in the intestines of animals such as cows, pigs and humans, and its presence in the samples is caused by contamination by feces, possibly of the animals present at the site. It becomes evident that surface material, such as animal droppings, penetrate sun protected soil and reach groundwater, which should occur with surface water as well. In a study carried out by Stachiw et al. (2015), in the region of Rolim de Moura, the values found for both *thermotolerant and E. coli* were even higher , above 1000 NPM for both parameters, since these samples were collected in the urban area, where there is a large number of septic tanks.

The higher the stability and conservation of the riparian forest, the higher the quality and quantity of water. Regarding the benefits of its presence, we mention the filter effect of this vegetation, which has the ability to retain pollutants and sediments that would be transported to the pit, directly affecting the quantity and quality of water, especially the pH, turbidity and hardness parameters (TRONCO et al., 2021).

The well had, in its surroundings, many contaminant residues such as reservoirs of combustible oils, old batteries, expansive foams and construction residues. This is worrisome, especially in the rainy season, from November to April, when the spring will receive a high load of water due to the very large surface runoff with the presence of these contaminants.

5 ANALYSIS OF THE RAINFALL AREA OF THE SPRING AND ITS COURSE

The catchment area consists predominantly of pasture, with marked slope and presence of grazing animals in the middle and final sections of the course of the spring and many gullies. The burning activity of shrubby vegetation was evident in the area, causing soil exposure, oxidation of organic matter, disaggregation of particles and sealing of soil cover, further increasing the surface runoff rainwater due to the difficulty of infiltration in this soil.

The practice of fire is a cultural issue, used for the cleaning of areas, pasture renewal, opening of agricultural areas and control of pests and diseases in vegetable crops (REDIN *et al*., 2011). However, this practice causes enormous damage, especially to the soil and environment. Permanently or not, in the soil, fire alters several physical, chemical and biological properties, such as pH, nutrient and carbono content, micro biodiversity, meso and macrofauna, temperature, porosity and density, exposure of soil profiles to weather conditions and, consequently, decrease of moisture and onset of water and wind erosion (POTES *et al*., 2010; REDIN *et al*., 2011; CAPECHE, 2012).

In the APPD1 sector, at the beginning of the spring, the water flow was low, but the color was crystal clear. For the recovery of this area, the containment of erosive processes is indicated. For this, an efficient and inexpensive measure is bioengineering, using the bagged soil technique, with bags of abomia containing soil and sand. Then, these bags are arranged circularly around the spring, and the objective is to avoid the supply of the soil together with rainwater and increase the infiltration of water, even in this place that the mechanical oil residues were observed in the soil. After containment of erosion, it is possible to plant forest species.

In bioengineering there is the use of living inert materials concomitant with inert materials with the objetive of stabilizing the soil and allowing the growth and development of vegetation cover and the process of ecological succession (GOMES, 2005). This technique is a great ally in the recovery of degraded Permanent Preservation Areas, as an object of this stucco, due to its great effectiveness, low financial cost and low execution complexity (NAKATA *et al*., 2016). In this sense, the use of bags containing soil and sand promotes the improvement of microclimatic conditions, moisture conservation in the surface layer of the soil and therefore facilitate the growth and development of plant species (HOLANDA *et al*, 2010).

In the APPD2 sector, which is located after an old road (disabled precisely because it collapsed on the watercourse, it became more evident the presence of grazing cattle, with the existence of animal waste near the watercourse and trampling on the course, and the flow decreases dramatically at the end of this stretch. This is due to the fact that the watercourse is exposed with silting points and grasses in the surroundings. It is worth noting that, as much as in APPD 2, tree cover was not recorded, at the beginning of this sector there were some trees, containing around one meter of margin, and that precisely in this lime there was no gullet. However, this vegetation was punctual, that is, there was no continuity of vegetation throughout the APPD2 sector, not being representative for all of this.

It was also evident that the color of the water was changing along the course, because in the spring, the color of the water was crystal line, but from the middle stretch the turbidity was accentuated. Moreover, at the end of this sector, when water began to become scarce in the course and highlighted turbidity, there were points of great exposure of the soil.

As an indication of recovery of the APPD2 sector, it is suggested two moments of vegetation recovery, aiming at reducing costs: at the first moment, the practice of densification and nucleation is carried out. Then, the planting of fast-growing forestry species (from the pioneer successional group) is planted throughout the sector and in large spacing, interspersed with diversity nuclei, containing seeds of soil-conditioning legumes, such as pork beans (*Canavalia ensiformis* DC) and guandu (*Cajanus cajan* L.), together with forest seeds of beginning of succession and rapid germination. At the second moment, enrichment is carried out in the area. Thus, after germination and growth of the installed seedlings, seedlings of slower-growing forest species and dependent on more favorable edaphoclimatic conditions (secondary successional group and climax) are introduced.

The planting of pioneer species is indispensable, because in addition to the high capacity of regeneration and survival in anthropic environments, they create favorable conditions for the establishment of secondary species and climax. Nucleation is a model used for the recovery of degraded areas that consists of the preservation of islands or nuclei of remaining vegetation, which facilitates and accelerates the succession process of woody species (ASIGBAASE et al., 2019).

In the APPD3 sector, the spring water no longer flowed as a course, since the catchment area is fully exposed and with the presence of cattle. Moreover, the high turbidity of the water was clear, before this abruptly ceased. In this location, as the degradation is higher, indicated by the higher score of degradation factors performed in the diagnosis, conventional planting and low spacing between seedlings is recommended. There, as the area does not offer good conditions for seedling growth, it is necessary to prepare the soil to increase the probability of successful planting.

In addition to higher cost, this sector will also require greater care and time for recovery. This is because the more degraded the area, the lower the resilience and the more difficult the recovery of soil and vegetation. Resilience is the permanence capacity of a forest under altered environmental conditions, even if the initial conditions are changed (ALBRICH et al., 2020). It is important to emphasize that the lower the resilience, the higher the cost of recovery of this area. Conventional planting is the methodology used in places of low resilience, consequently, of higher cost, because it needs to interfere with high intensity in this location.

It is noteworthy that isolation is a primordial and vital factor in the whole recovery process of degraded areas. The fence prevents the entry of large animals, such as cattle, which tramplant growing seedlings, natural regeneration, causes the onset of erosion and soil exposure (TRONCO et al., 2021). Therefore, in the three sectors studied, isolation should be performed prior to the indicated recovery practices.

The watercourse receives a large load of contaminants, affecting the quality of the water,oeding from the surroundings of the spring and throughout its course, besides the diagnosis pointing out that it is in high degradation in its entirety. In addition, this water course is 465 m away from the Manicoré River and from the catchment point of water supply the municipality of Rolim de Moura. Thus, the need for recovery of this watercourse in order to preserve this ecosystem and the health of the community is urgently needed.

6 CONCLUSION

In the three sections of the spring under study, it was considered highly degraded (7 items of degradation of 12; 6 items of 12 and 8 items of 12), requiring different methodologies for each stretch, from bioengineering, in the first stretch, nucleation in the second stretch and conventional planting in the third section.

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