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Spring protection and watercourse and its relationship with environmental quality in family property, in the Caparaó region of Espírito Santo, Brazil

Proteção de nascente e o curso d'água e sua relação com a qualidade ambiental em propriedade familiar, na região do Caparaó capixaba

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ABSTRACT

Inappropriate use and management of land has generated processes of environmental degradation, in which the increasing removal of forest coverage has impaired the hydrological cycle, water and soil quality. The objective of this work is to know the effects of the protection of the spring, and the initial part of its watercourse, on the environmental conditions in a family property. The study was carried out on the property located in the Rainha da Paz Community, in Alegre-ES, using indicators used for environmental monitoring, at the beginning in September 2013 and after one year (September 2014) of the Water Planters Project. The quality indicators used in the evaluation clearly show that the initial situation in the spring APP, and APP around the main watercourse was inadequate, in several indicators mainly due to the occupation of the area with agricultural use, specifically pasture, occurring cattle trampling within a radius of 50 meters of the spring's permanent preservation area, causing soil compaction and silting, showing a high degree of degradation, reflecting the lack of environmental adequacy, thus not complying with current environmental legislation. The project promoted improvements in the environmental conditions of the family property, through the natural regeneration of native species, bringing gains to the floristic composition, in addition to improvements in the soil conditions.

Palavras-chave:
Escassez Hídrica
Manejo e Conservação de Solo e Água
Desenvolvimento Rural
Educação Ambiental

RESUMO

O uso e manejo da terra de forma inadequada têm gerado processos de degradação ambiental, no qual a crescente retirada da cobertura florestal tem prejudicado o ciclo hidrológico, qualidade da água e dos solos. O objetivo deste trabalho é conhecer os efeitos da proteção da nascente, e parte inicial do seu curso d'água, sobre as condições ambientais em uma propriedade familiar. O estudo foi realizado na propriedade localizada na Comunidade Rainha da Paz, em Alegre-ES, por meio de indicadores utilizados para o monitoramento ambiental, no início em setembro de 2013 e após um ano (setembro de 2014) de projeto Plantadores de Água. Os indicadores de qualidade utilizados na avaliação mostram claramente que a situação inicial na Aréa de Preservação Permanente da nascente, e em torno do curso d'água principal era inadequada, em diversos indicadores principalmente devido a ocupação da área ser com o uso agrícola, especificamente pastagem, ocorrendo pisoteio de gado no raio de 50 metros da área de preservação permanente da nascente, causando compactação do solo e assoreamento, apresentando elevada condição de degradação, reflexo da falta de adequação ambiental, não atendendo assim a legislação ambiental vigente. O projeto promoveu melhorias nas condições ambientais da propriedade familiar, através da regeneração natural de espécies nativas trazendo ganhos a composição florística, além das melhorias nas condições do solo.

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INTRODUCTION

Water is one of the most important elements for life on Earth, being used by humans for different purposes such as human supply, agriculture, electricity generation, navigation, industrial supply, among others (BONFIM et al., 2019). Water scarcity has become a chronic problem worldwide, being justified by the way in which water has been used, threatening the socioeconomic growing situation coupled with environmental protection (RIBEIRO; ROLIM, 2017; CRISPIM et al., 2020).

Inadequate exploitation of natural resources in an unbridled way, through deforestation activities, inadequate agricultural practices, aggressive extractive activities, the indiscriminate construction of dams, the industrial and domestic discharge of sewage into rivers and lakes, promote numerous environmental problems, especially in riparian forests and spring areas (VALENTE; GOMES, 2011).

Water springs are extremely important for other waterbody and, are strategic places for water supply aimed at meeting human needs, however, proper protection is necessary to provide water in satisfactory amount and quality (OLIVEIRA, 2018). Conceptually, “spring” is the term that defines an environmental system in which groundwater outflow occurs naturally in a temporary or perennial way, integrating the drainage network. This process is responsible, partiatly, for the energy entry into the system and dependent on the interception of the water table by local topography (FELIPPE, 2009). The spring water forms a small stream that contributes to an increase in the water voulme in other watercourses (SILVA JÚNIOR, 2015), and the conservation of these springs is vitally dependent on the maintenance of vegetation coverage in its surroundings.

Actions aimed at the conservation and preservation of water resources are rare, and despite its great importance, it has been observed that this valuable resource has been threatened due to improper actions of man. Despite this reality, the “Water Planters” project, implemented in the rural area of Alegre/ES municipality has been changing the perception of the need to take better care of water resources, where they themselves can seek new knowledge and actions able of providing solution for its problems (SENNA et al., 2013).

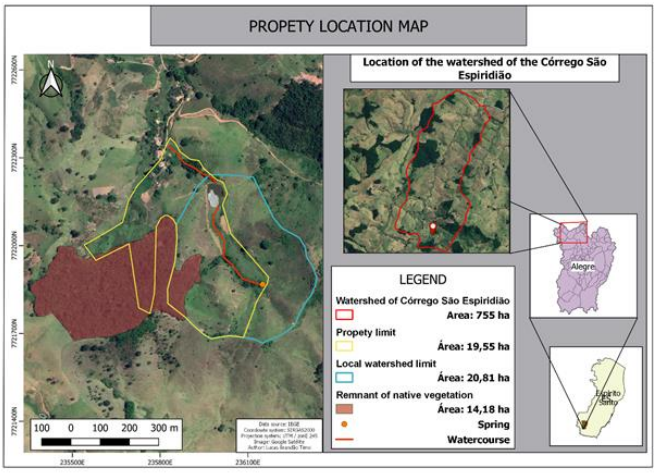
Some actions have been developed to recover and preservate water resources with family farming producers promoting sustainable rural development such as: protection and isolation of Permanent Preservation Areas (APP) from springs, capture and storage of rainwater using dry boxes, full boxes, containment terraces and installation of septic tanks. In 2012, the “New” Forest Code was sanctioned, establishing general rules for APPs and Legal Reserve (RL) areas, in order to inspect products of forest origin and protection of forests, using economic devices in order to achieve its purposes (BRASIL, 2012a). Thus, the legislation requires that owner/holder of the rural property, carry out a Rural Environmental Register (CAR), making a more effective and efficient evaluation system in the registration process using georeferencing, in addition to carrying out a parallel between calculation used in the new and old Forest Code (VANZETTO et al., 2017).

In this context, the environmental adequacy of rural properties can be associated to the Agroecology perspective, aiming to optimize the management of natural resources. According to Caporal and Costabeber (2002), agroecology is understood as a knowledge field of a multidisciplinary nature that intends to contribute in the construction of ecological farming styles and elaboration of rural development strategies, having the ideals of sustainability as reference in a long term multidimensional perspective. Therefore, this study aims to know the effects of the springs protection, and initial part of its watercourse, on the environmental conditions in a family property, in a rural area of Alegre/ES municipality.

MATERIAL AND METHODS

The present study was carried out in a family rural property, which is located in the watershed of Córrego São Esperidião, Rural community Rainha da Paz, in the district of Araraí from Alegre – ES municipality, located at Caparaó region of Espírito Santo (Figure 1). The Universal Transverse Mercator (UTM) coordinates reference number are (UTM) 0235834E, 7722268N at 381 m height.

Figure 1. Location map of the family rural property in the Córrego São Esperidião watershed, rural community Rainha da Paz, in Alegre municipality, Espírito Santo.



Source: Authors, 2020.

The Atlantic Forest is the main biome in the region, with an extensive hydrographic network in its territory. Subsistence agriculture, pastures and coffee planting predominate in whole municipality. The South region of Espírito Santo state is characterized by a very rugged relief, interspersed with reduced flat areas. The climate of the region is characterized as C_{wa} according to the Köppen classification (1948), hot tropical humid, cold and dry winter, average annual temperature of 23.1ºC and average annual total precipitation of 1341 mm (LIMA et al., 2008).

Araraí district presents slope lower than 8% and is formed in crystalline rocks. The district presents a wide oscillation of temperature, from hot to mild, and natural zones of transition between drought and rain due to differences in altitude. It is usually rainy from October to April, partly dry in May and dry from June to September, with maximum averages temperatures of 27.8 ° C to 30.7 °C in the hottest month and 9.4 °C to 11.8 °C in the colder ones (INCAPER, 2011). The field has approximately 19.55 hectares, which corresponds to less than one fiscal module, in Alegre municipality, which is equivalent to 24 hectares (INCAPER, 2011). The main productive activity of the families is dairy and beef cattle. Grasslands of

Brachiaria sp. take large part of the property area and the local watershed.

The rural property has a main spring, which before "Water Planters" project was unprotected, being accessed by cattle around spring and also along the entire length of watercourse. Figure 2 shows that the spring is located close to the property's limits and its recharge area is outside property. It is worth noting the existence of a remnant native vegetation close to the rural property. This forest fragment has secondary vegetation in a medium stage of natural regeneration.

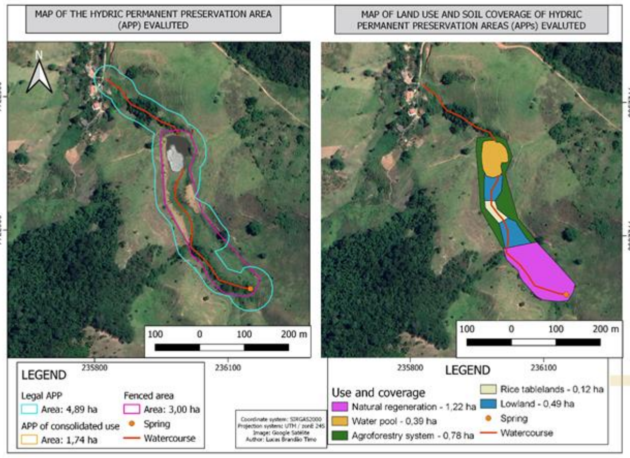
Figure 2. Location of the main spring from Córrego Novo, on a family farm of Córrego São Sebastião watershed, rural community Rainha da Paz, in Alegre municipality, Espirito Santo.

Source: Authors, 2020.

The proposed actions were divided into five main axes: a) Isolation of Permanent Preservation Areas (APP's) of springs and watercourses; b) Implantation of agroforestry systems to recompose APPs of watercourses; c) Implementation of dry boxes and containment terraces; d) watercourse decontamination by implemeting septic tanks in the houses, following the NBR 7,229/1993 norms; e) Environmental education.

Three hectares of spring APP and part of the APP watercourse from the rural property were surrounded, and in its interior, restoration of riparian forest occurred through an agroforestry system implantation in 0.78 hectares and conduction of natural regeneration in 1.22 hectares, in addition to other land uses as can be seen in Figure 3.

Figure 3. Map of APP, land map use and coverage of the APPs under study, in Córrego Novo, on a family farm of Córrego São Esperidião watershed, rural community Rainha da Paz, in Alegre municipality, Espirito Santo.



Source: Authors, 2020.

Environmental condition indicators were created to assess the environmental characteristics of the property (Table 1). Indicators were created through conversations among farm family, researchers and the technical team of "Water Planters" project, in addition to international and national scientific articles that relate the theme of springs and their protection. Visits were carried out on September 7 and 8, 2013 for initial assessment of the environmental indicators and after 12 months, on September 24 and 24, 2014, for reapplication of the indicators. In addition, photographic records of the area under study were used to assist the evaluation.

Table 1. Characteristics and quality indicators used in the evaluation of environmental conditions

Indicators	Scored notes¹	Characteristics
Occupation of the area	1-3	Areas in agricultural use (Pastures and crops)
	4-7	Unused areas - in regeneration - scrub
	8-10	Areas occupied with forest (natural formations or planted forests)
Floristic composition of occupation of the area	1-3	Greater presence of exotic species (Brachiaria, Banana, Coffee, Bamboo, among others).
	4-7	Average presence of exotic species + some native species.
	8-10	Low presence of exotic species. Greater presence of regenerative vegetation species.
State of development of natural regeneration	1-3	Absence of natural regeneration (2 to 11 months from beggining of recovery).
	4-7	Low to medium expression of natural regeneration with low floristic diversity (12 to 23 months from the beginning of recovery).
	8-10	High expression of natural regeneration with high floristic diversity (24 months onwards).
Soil conditions of the soil	1-3	Uncovered soil/without vegetation
	4-7	Soil with scarce vegetation coverage/few species
	8-10	Soil with abundant vegetation coverage/more amount of species
Degradation conditions	1-3	High. Intense erosive processes: trampling of animals, (Cattle and Horses). Crop management in the area of protection. High silting process.

	4-7	Median. Average erosive processes: trampling of animals, (Cattle and Horses). Crop management in the area of protection. Presence of low silting points.
	8-10	Nonexistent. Absence of erosive processes: absence of animal trampling, (Cattle and Horses). Absence of crops in the area of protection. Absence of silting.
Topography	1-3	[2] Mountainous to steep - Very strong erosion, great loss of soil, mass movement (from 45 to over 75% declivity).
	4-7	[2] Wavy to strongly wavy - Mass movement, very strong linear erosion, great loss of soil (from 8 to 45% declivity).
	8-10	[2] Flat to slightly wavy - Beginning of diffuse and laminar flow (from 0 to 8% declivity).
Adequacy to environmental legislation	1-3	It does not meet the law nº 12651 of the new forest code for the management of APP's or meets up to 33%.
	4-7	Meets between 33% to 66% the current legislation for the APP's management.
	8-10	Meets 66% with the law nº 12651 of the new forest code for the APP's management.

Source: Developed by authors. [1]The scores obtained for each environmental indicator used in this study was the adapted Delphi method, according to Carmo et al. (2016). [2]The relief classification according to Benavides & Machado (2014).

These quality indicators are useful as tools to evaluate certain phenomena, of scientific nature, presenting their trends and progress that change over time (PROGÊNIO et al., 2019). According to Akpoti et al. (2019), the use of environmental indicators is an absolute environmental measurement tool that, based on a comparison between the present and the future or sustainable situation, shows the extent to which sustainability objectives are met.

The scores obtained for each environmental indicator used was the adapted Delphi method. According to Carmo et al. (2016), this methodology is based on scores attribution according to the knowledge about the phenomenon or theme to be investigated. Banknotes that ranged from 1 to 10, where those closest to "1" are low sustainable, while those closest to "10" attribute greater sustainability. To define the declivity, a field survey was carried out with growers. The floristic composition was recomposed taking into account the plant species that characterized the successional stage.

RESULTS AND DISCUSSION

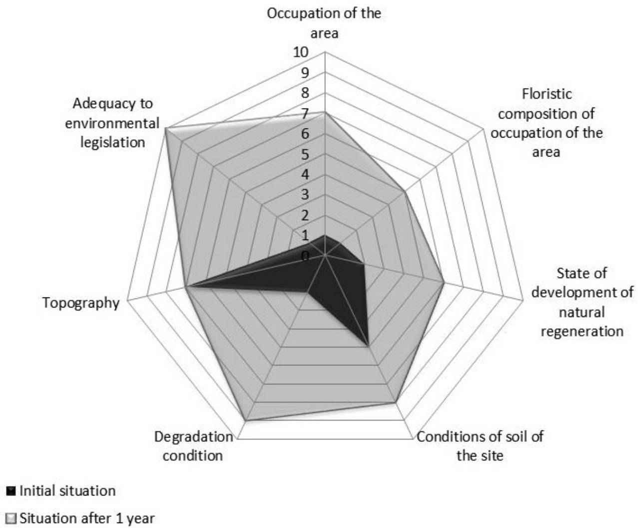
Analysis of environmental quality indicators

The quality indicators clearly show that the initial situation was unsustainable in the APP of the main spring of Córrego Novo. Before the project, the use of area for agriculture, specifically pasture, cattle trampling within 50 m radius from the spring's APP, causing soil compaction, silting and high degradation condition.

Pollo et al. (2019) evaluated disturbance factors in an environmental protection area and concluded that changes in vegetation coverage caused by agricultural activities became the region susceptible to environmental degradation processes, generating fragile water resources, such as irregular land occupation in areas of environmental preservation and silting of water bodies.

Occupation of the area with intense cattle trampling contributed to the fact that the other indicators also had low values, excepting the topography as seen in Figure 4, which does not change regardless occupation, compromising the APP quality.

Figure 4. APP quality indicators of the main spring from Participatory Experimentation Unit in Water Planting Córrego Novo, before and after one year of the Water Planters project.



Presence of exotic species, such as Brachiaria (*Brachiaria* sp.) and Bananeiras (*Musa* spp.) in its floristic composition, were observed in the area, with absent state of natural regeneration and low density of native species, leading to low state of natural regeneration. This low value of native species indicates a process of vegetation loss, caused by anthropic actions. The main activity of the property is livestock, it exposed the soil to frequent rain and wind erosion, for example, in the APP the greatest use of the soil is for pastures.

According to Brancalion et al. (2016) the vegetation, mainly the native, protects the local fauna and its genetic diversity, helps the natural control of pests, ensures the soil structure, decreases the erosive processes, acts on the adjustment of the local temperature, improves soils fertility through nutrient cycling (TAMBOSI et al., 2015).

The lightly undulating topography (Table 1), defined according to a field survey and corroborated by Incaper (2011), which states that the district studied has a slope lower than 8%, slightly mitigates the degradation process, causing partial exposure. However, in the spring surroundings there are steep slopes (Figure 2), that suffer more impacts during rainy periods, being more susceptible to erosion and silting, which together with cattle trampling cause soil compaction, making difficult infiltration and percolation of water in soil.

The vegetation that borders the springs is essential to maintain environmental services. To ensure the presence of coverage vegetation around springs is of great importance, as it contributes to reduce the water contamination risks, since it helps soil hydrology, reducing surface runoff and intensifying the subsurface runoff, which minimizes the soil erosion process (TAMBOSI et al., 2015; SOUZA et al., 2019).

In this way, deforestation around springs, coupled with cattle trampling, increase erosion probability and landslides (CARMO et al., 2016), and this process removes particles when they reach the soil and transports through runoff, where they are deposited in lowlands and wetlands, causing the beds silting of water courses (BIERHALS et al., 2020). Evaluations of the indicators characteristics suggest that the compromise of APP quality, observed before the project, was result of environmental adequacy lack, thus not complying the current environmental legislation (Figure 4).

Changes in the Córrego Novo property are notorious regarding indicators one year after project conducting (Figure 4). Before project, the spring APP was not complying with law regulations and 12 months after project execution, the APP was surrounded, meeting the area of consolidated rural use, which is 15 meters around spring (Figure 3). It can be observed that despite significant improvement in the environmental quality of the spring APP, the isolation carried out did not meet the APP of 50 m radius in the surroundings and also the whole spring recharge area continues with extensive grazing.

The occupation of the area is another indicator that had positive evolution, since after spring fencing, the land soil use changed and became a protected area with conduction of natural regeneration and control of invasive exotic species. The natural regeneration showed low expression, suggesting that the area was surrounded during a short time and then the vegetation started the regeneration process, being in the initial regeneration stage of the secondary vegetation, according to the Resolution nº 29 (CONAMA, 1994). In addition, areas of native vegetation remnants (RNV) are close to these areas that were surrounded and protected (Figure 3), which helps in the regeneration process, consequently changing another index, which is the development state of natural regeneration.

Another indicator that suffered changes was soil conditions, as well as floristic composition of the occupation area, which currently has greater vegetation coverage, with greater amount of regenerating species (Table 2).

Table 2. Species used in the Agroforestry System in the APPs under study in Córrego Novo, on a family farm of Córrego São Esperidião watershed, rural community Rainha da Paz, in Alegre municipality, Espirito Santo

Common name	Scientific name	Ori.	Spec. use	Amount
Cashew	*Anacardium occidentale L.*	N	F./Med.	10
Red Angico	Anadenanthera colubrina (Vell.) Brenan	N	Mad./Orn.	10
Soursop	*Annonamuricata L.*	Ex	F.	10
Pupunha	*Bactris gasipaes Kunth*	N	F./Orn.	50
Trumpetwood	Cecropia hololeuca Miq.	N	W./Medic.	10
Coconut tree	*Cocos nucifera L.*	Ex	F./Orn.	10
Jacarandá caviúna	Dalbergia nigra (Vell.) Allemão ex Benth.	N	W.	10
Acai	*Euterpe oleracea Mart.*	N	F./Orn.	100
Juçara	*Euterpe edulis Mart.*	N	F./Orn.	100
Genip tree	*Genipa americana L.*	N	F.	10
Yellow Ipe	Handroanthus chrysotrichus (Mart. ex DC.) Mattos	N	W./Orn.	10
Jatobá	Hymenaea courbaril L.	N	W./F.	10
Ingá de metro	Inga edulis Mart.	N	F.	10
Acerola	*Malpighia emarginata Sessé & Moc. Ex DC.*	Ex	F.	10
Mango tree	Mangifera indica L.	Ex	F.	10
Banana	*Musa paradisiaca L.*	Ex	F.	300
Avocado	*Persea americana Mill.*	Ex	F.	10
Araça	*Psidium rufum Mart. ex DC.*	N	F./Orn.	10
Aroeirinha	Schinus terebinthifolia Raddi	N	F./W./Medic.	20
Guapuruvu	Schizolobium parahyba (Vell.) Blake	N	W./Orn.	10
Ipé 5 leaves	Sparattosperma leucanthum (Vell.) K. Schum	N	W./Medic.	10
Mombin fruit	*Spondia macrocarpa Engl.*	N	F.	10
Jerivá	Syagrus romanzoffiana (Cham.) Glassman	N	F./Orn.	50
Grandiúva	Trema micrantha (L.) Blume	N	W./Orn.	10
Total				800

In which: Ori.= Origin: N = Native; Ex = Exotic; Spec. use = Specific use; F = Food; W = Wood; Med = Medicinal; Orn = Ornamental; Am. = Amount.

In view of all these factors, in absence of grazing and animals trampling (cattle) within APP area, progress is being observed of improving the environmental quality of this spring, since it has a topography with low slope, decreases even more degradation and, consequently, the silting process, improving water quality and complying the environmental legislation (Figure 5).

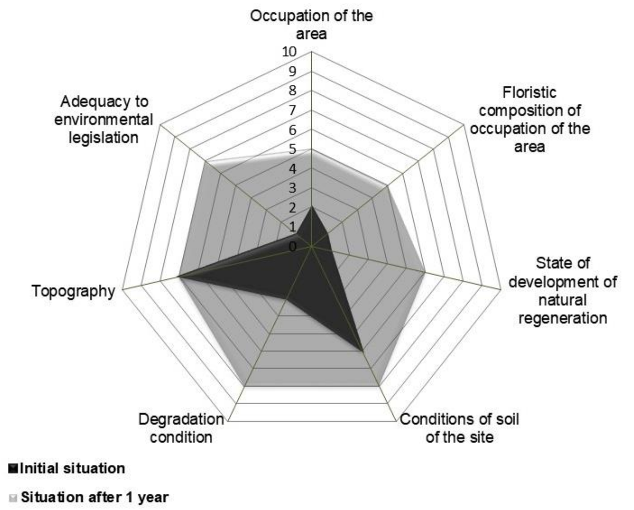
Therefore, higher vegetation density improves soil protection against erosion processes, also contributing to its fertility due to greater presence of organic materials, leaves and fruits (VERDUM et al., 2016). In addition to this soil protection, it also helps to reduce water erosion, favoring infiltration by reducing the runoff speed (PROGÊNIO et al., 2020), where all these factors also point to an improvement in the rate of degradation conditions.

Figure 5. Species cultivated in the APPs under study in Córrego Novo, on a family farm of Córrego São Esperidião watershed, rural community Rainha da Paz, in Alegre municipality, Espirito Santo.

Source: Authors, 2020.

Analysing the environmental conditions of APP around the main formation watercourse of Córrego Novo (Figure 6), it was observed that, as well as in the spring, the environmental quality of this area was also inadequate in several indicators. As in the spring, the watercourse was occupied by pasture with direct cattle trampling, its floristic composition was absent of native species, composed mainly of Brachiaria sp, and therefore, there is no natural regeneration.

Figure 6. Quality indicators of the watercourse present in the Participatory Experimentation Unit in Córrego Novo Water Planting, before and after one year of the Water Planters project.



The topography of the watercourse is flat, with some slopes. The soil around this site was covered, with a sloping stretch surrounded by forest coverage, and even with animals trampling and without riparian forest in a large part of the watercourse, the degradation process is lower compared to that of spring, and even then, silting was observed in the area (Figure 6). According to Silva et al. (2018), silting of water bodies may increase with APP lack, as it acts as an aggravating factor for the runoff appearance, reducing infiltration and increasing the erosion risk in these areas.

Maintenance of riparian forest that borders the water body is fundamental to preservate the surrounding river and soil, as well as to improve the infiltration capacity, in addition to exercising transpiration, contributing to evapotranspiration and, consequently, to the maintenance of the water cycle (GOMES & VIEIRA, 2018). Analyzing these data, it can be noted that the area also did not comply the environmental legislation (Figure 6).

After one year of project conduction, the conditions of watercourse APP (Figure 6), and main spring, are better. It is due to the practices adopted for fencing 2 hectares around the APP area and implementing the Agroforestry System (SAFs) (Table 2). As a strategy for implementing or maintaining ecological restoration, SAFs use temporarily the space between native seedlings with economic crops, which can assist in the control of competing species, decreasing restoration costs (MARTINS et al., 2019).

Regeneration potential and survival of species implanted in degraded areas, especially for livestock, decreases due to the high competition with pasture, in addition to the competition caused by emergence of weed species, generated due to isolation of the area combined to the delay in the establishment of tree and shrub species during the early years of recovery (MARTINKOSKI et al., 2013).

The occupation, with isolation and animals removal, already represents an area`s change, from agricultural use to a regeneration in process, with appearance of spontaneous species such as angico (*Anandenanthera* sp.), assa-peixe (*Vernonia* sp.), embaúba (*Cecropia* sp.), papagaio (*Erytrina falcata*), alecrim (*Pectis* sp.), cafezinho do mato (*Casearia decandra*), some Palmaceae family species, several grasses species, among others that are indicators of environmental regeneration.

Consequently, the indicator of the development state of natural regeneration increased, from absent to low-medium regeneration, with low floristic diversity, which is still at the beginning of the recovery process. According to Fávero et al. (2008) the recovery of degraded areas through agroforestry systems, in the agroecological perspective, presupposes the potentiation of natural regeneration and the species succession, promoting improvements in soil conditions through positive interactions that occur between its components.

In the floristic composition, there were also advances in the indicators of environmental conditions, because in addition to the natural regeneration conduction, with native species emergence, there was SAFs implementation with diversified planting of fruit seedlings as shown in Table 2, in the area around Córrego Novo, as allowed by Normative Instruction n° 4 (BRASIL, 2009).

Thereby, it is possible to verify the increase on vegetal coverage throught the number and quantity of species in soil, decreasing considerably the degradation factors and erosive processes caused, mainly, by animal trampling. However, there is crops in the marginal strip of the watercourse, consolidated as APP (Figure 3), which in this rural property is 5 m, as it has a total area smaller than a fiscal module, as stated in the article 61-A of the law nº 12,727, of 2012, where is cited in the first paragraph (BRASIL, 2012b):

> § 1 For rural properties with an area of up to 1 (one) fiscal module that have consolidated areas in Areas of Permanent Preservation along natural watercourses, it will be mandatory to recompose the respective marginal strips in 5 (five) meters, counted from the regular bed gutter edge, regardless width of the watercourse.

In this area, crop management is still carried out within protection area and still causing silting of part of the watercourse. The cultivated site is located in a small portion of the watercourse, in a lowland area, where a seasonal rice crop with low environmental impact was implanted, with manual riverbank construction and no-tillage system, which is a technology that does not require soil turning and prevents erosion from direct sowing, and without agrochemicals use. Using simple and low-cost measures, springs preservation improves the quantity and quality of water; and restores the ecosystem, thus fieldwork aimed at protecting, recovering i.e, preserving springs is so necessary to avoid problems of future availability (MARCIANO et al., 2016).

At the main spring of Córrego Novo, as well as in adjacent areas to the watercourse, there was also a significant environmental advance after 12-month of the Water Planters Project, demonstrating its contribution to the local environmental transformation, also in the actions of the family farmers involved, which demonstrates their relevance and efficiency. The families actions can be multiplied in several other family farms.

CONCLUSION

The indicators show that actions taken to protect the spring and the initial part of the watercourse of Córrego Novo, promote better environmental conditions at the family property, through natural regeneration of native species, improving floristic composition, in addition to improvements in soil conditions.

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REFERENCES

AKPOTI, K.; KABO-BAH, A. T.; ZWART, S. J. Agricultural land suitability analysis: State-of-the-art and outlooks for integration of climate change analysis. Agricultural Systems, v. 173, p.172–208, 2019. 10.1016/j.agsy.2019.02.013.

ABNT, ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR-7229: projeto,construção e operação de sistemas de tanques sépticos. Rio de Janeiro, 1993.

BENAVIDES SILVA, V. C.; MACHADO, P. S. SIG na Análise Ambiental: Susceptibilidade Erosiva da Bacia Hidrográfica do Córrego Mutuca, Nova Lima – Minas Gerais. Revista de Geografia (UFPE), v. 31, n.2, p.66-87, 2014.

BONFIM, A. A. C.; SANTOS, A. V.; LANDA, G. G.; NERIS, R. A. Diagnóstico e análise de nascentes localizadas na parte alta do município de Nanuque – MG. Acta Biologica Brasiliensia, v.2, n.1, 2019.

BOMFIM, E. O.; GADELHA, C. L. M.; FILGUEIRA, H. J. A.; AMORIM, J. F.; AMORIM, D. S. Sustentabilidade hidroambiental de nascentes na bacia hidrográfica do rio Gramame no Estado da Paraíba, Brasil. Revista Sociedade & Natureza, v. 27, n.3, p.453-468, 2015. 10.1590/1982-451320150307.

BRANCALION, P. H. S.; GARCIA, L. C.; LOYOLA, R.; RODRIGUES, R. R.; PILLAR, V. D.; LEWINSOHN, T. M. Análise crítica da lei de proteção da vegetação nativa (2012), que substituiu o antigo Código Florestal: atualizações e ações em curso. Natureza e Conservação, v. 14, p. 1-15, 2016. 10.1016/j.ncon.2016.03.004.

BRASIL. Instrução Normativa Nº 4, de 8 de setembro de 2009. Dispõe sobre procedimentos técnicos para a utilização da vegetação da Reserva Legal sob regime de manejo florestal sustentável, e dá outras providências. Diário Oficial da União, Brasília, DF, 08 de setembro, 2009.

BRASIL. Lei n. 12.651, de 25 de maio de 2012a. Dispõe sobre a proteção da vegetação nativa. Diário Oficial da União, Brasília, DF, 28 maio, 2012a. Disponível em: <http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm.> Acesso em: 10 out. 2020.

BRASIL. Lei n. 12.727, de 17 de outubro de 2012b. Altera a Lei nº 12.651, de 25 de maio de 2012. Diário Oficial da União, Brasília, DF, 18 out., 2012b. Disponível em: <http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/L12727.htm.> Acesso em: 10 out. 2020.

CARMO, A. M. D. O. M; SOUTO, V. S; DUARTE, C. R; LOPES, P. S; SABADIA, J. A. B. Avaliação de suscetibilidade à movimentos de massa, utilizando as variáveis morfométricas, para as serras da porção sul do maciço central do Ceará. Revista Brasileira de Cartografia, v.9, n.68, p.1787-1804, 2016.

CAPORAL, F. R.; COSTABEBER, J. A. Análise Multidimensional da Sustentabilidade Uma proposta metodológica a partir da Agroecologia. Revista Agroecologia e Desenvolvimento Rural Sustentável, v.3, n.3, 2002.

CONAMA - Conselho Nacional do Meio Ambiente. Resolução nº 29, de 7 de dezembro de 1994. Disponível em <http://www.mma.gov.br/port/conama/res/res94/res2994.html>. Acesso em 10 out. 2020.

CRISPIM, D. L.; MACHADO, E. C. M.; FERNANDES, L. L.; ARAÚJO, L. M.; PROGÊNIO, M. F. Análise da sustentabilidade hídrica de comunidades rurais do município de Pombal – PB. Geografia Ensino & Pesquisa, v.24, 2020. 10.5902/2236499439213.

FÁVERO, C.; LOVO, I. C.; MENDONCA, E. S. Recuperação de área degradada com sistema agroflorestal no Vale do Rio Doce, Minas Gerais. Revista Árvore, v.32, n.5, p. 861-868, 2008.

FELIPPE, M. F. Caracterização e tipologia de nascentes em Unidades de Conservação de Belo Horizonte-MG com base em variáveis geomorfológicas, hidrológicas e ambientais. Minas Gerais, 2009. Tese (Mestrado). Universidade Federal de Minas Gerais.

GOMES, A. S.; VIEIRA, T. A. Percepção e uso de mata ciliar em um projeto de assentamento, Santarém (PA). Revista Ibero-Americana de Ciências Ambientais, v.9, n.6, p.307-320, 2018. 10.6008/CBPC2179-6858.2018.006.0029.

INCAPER. Programa de assistência técnica e extensão rural PROATER 2011 – 2013/ Alegre: Planejamento e programação de ações – (2011). Disponível em: <http://www.incaper.es.gov.br/proater/municipios/Caparao/Alegre.pdf> Acesso em: 04 out de 2020.

LIMA, J. S. de S.; SILVA, S. de A.; OLIVEIRA, R. B. de; CECÍLIO, R. A.; XAVIER, A. C.Variabilidade temporal da precipitação mensal em Alegre–ES. Revista Ciência Agronômica, Fortaleza, v. 39, n. 02, p. 327-332, 2008.

MARCIANO, A. G.; SILVA, L. F.; SILVA, A. P. M. Diagnóstico das nascentes da bacia hidrográfica do córrego do Vargedo. Revista Brasileira de Energias Renováveis, v. 5, n. 3, p. 330–342, 2016. 10.5380/rber.v5i3.48128.

MARTINKOSKI, L.; VOGEL, G. F.; MARTINS, P. J. Sistemas agroflorestais na recuperação de matas ciliares. Revista Científica ANAP Brasil, v. 6, n. 7, p. 195-212, 2013.

MARTINS, E. M.; SILVA, E. R.; CAMPELLO, E. F. C.; LIMA, S. S.; NOBRE, C. P.; CORREIA, M. E. F.; RESENDE, A. S. O uso de sistemas agroflorestais diversificados na restauração florestal na Mata Atlântica. Ciência Florestal, v. 29, n. 2, p. 632-648, 2019. 10.5902/1980509829050.

CONAMA -Resolução nº 29, de 7 de dezembro de 1994. Define vegetação primária e secundária nos estágios inicial, médio e avançado de regeneração da Mata Atlântica, considerando a necessidade de definir o corte, a exploração e a supressão da vegetação secundária no estágio inicial de regeneração no estado do Espírito Santo. Publicada no DOU nº 248, de 30 de dezembro de 1994.

OLIVEIRA, L. R. Caracterização das nascentes da sub-bacia hidrográfica do rio Gaviãozinho-Bahia. Dissertação, Universidade Federal Rural do Rio de Janeiro, Seropédica, 2018,139p.

POLLO, R. A.; SILVA, C. O. F.; CARDOSO, L. G.; LESSA, L. G. F. Fatores de perturbação identificados em área de proteção ambiental Corumbataí-Botucatu-Tejupá, perímetro Botucatu, estado de São Paulo. Revista Raega, v.46, p. 204 - 214, 2019.

PROGÊNIO, M. F.; COSTA FILHO, F. A. M.; SOUZA, M. J. R.; PESSOA, F. C. L. Análise do potencial de impacto ambiental para implantação de pequenas centrais hidroelétricas nas unidades hidrográficas do estado do Pará. Revista Aidis de Ingeniería y Ciencias Ambientales: Investigación, desarrollo y práctica, v. 12, n.3, p.399–412, 2019. 10.22201/iingen.0718378xe.2019.12.3.62469.

RIBEIRO, L. G. G.; ROLIM, N. D. Planeta água de quem e para quem: uma análise da água doce como direito fundamental e sua valoração mercadológica. Revista Direito Ambiental e sociedade, v. 7, n. 1, 2017.

SENNA, D. S.; KOBI, H. B.; SANTOS, R. A. B.; SOUZA, D. S.; MARTINS, K. G. G.; MEIRA, A. C. H. “Plantadores de Água”: uma experiência de construção coletiva de saberes agroecológicos. In: VIII Congresso Brasileiro de Agroecologia, p.5, Resumos. São Paulo: Cadernos de Agroecologia, 2013.

SILVA JÚNIOR, L. G. Ação antrópica em torno das nascentes da Microbacia do Rio Bitury, Município de Belo Jardim (Região Agreste de Pernambuco). Revista Brasileira de Gestão Ambiental e Sustentabilidade, v.2, n. 3, p. 105-119,2015.

SILVA, T. G. N., COSTA GAMA, R., TEIXEIRA, L. G., SANTOS, G. R., SOUSA, R. M., SOUZA, P. B. Diagnóstico ambiental de uma área de proteção permanente (app), formoso do Araguaia–To. Revista da Universidade Vale do Rio Verde, v.16, n. 2, 2018.

SOUZA, K. I. S.; CHAFFE, P. L. B.; PINTO, C. R. S. C.; NOGUEIRA, T. M. P. Proteção ambiental de nascentes e afloramentos de água subterrânea no Brasil: histórico e lacunas técnicas atuais. Revista Águas Subterrâneas, v. 33, n.1, p. 76-86, 2019. 10.14295/ras.v33i1.29254.

TAMBOSI, L. R.; VIDAL, M. M.; FERRAZ, S. F. B.; METZGER, J. P. Funções eco-hidrológicas das florestas nativas e o Código Florestal. Estudos Avançados, v. 29, n. 84, p. 151-162, 2015. 10.1590/S0103-40142015000200010.

VALENTE, O. F; GOMES, M. A. Conservação de Nascentes: produção de água em pequenas bacias hidrográficas. 2. ed. Viçosa: Aprenda Fácil, 2011.

VANZETTO, G. V.; QUADROS, F. R.; ROVANI, I. L.; DECIAN, V. S. Cadastro ambiental rural e avaliação comparativa entre o antigo e atual Código Florestal federal em um imóvel. Ciência e Natura, Santa Maria, v. 39, n. 2, p. 259-271, 2017. 10.5902/2179460X22711.

VERDUM, R.; VIEIRA, C. L.; CANEPPELE, J. C. G. Métodos e técnicas para o controle da erosão e conservação do solo. Porto Alegre: IGEO/UFRGS, 2016.