

ENVIRONMENTAL PROTECTION AREAS: THE CASE OF THE BEBEDOURO STREAM WATERSHED

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Introduction

The implementation of environmentally protected areas in Brazil began in the 1930s, when the industrialization and urbanization processes were intensified. In this context, the legal provisions that would support the implementation of protected areas have been established due to influences by world actions directed to natural protection and by the need to reorganize the forest extractions (MEDEIROS, 2006).

In the first Brazilian Forest Code (law on forest preservation), the forest already had been characterized as a natural resource protector, a public interest area and a national territory protector (BRASIL, 1934). The inapplicability and obsolescence of this law led to the reissuing of the 1965 Forest Code. The forest suppression was already a problem from the political and administrative perspective in the 1960s. However, the concern was remitted to the raw material reserve, aiming to meet the wood production for trading (CUNHA; MELLO-THERY, 2010). The Forest Code did not offer real restrictions to the farmers at that time, because there was a large pristine ecosystem territory (FIGUEIREDO; LEUZINGER, 2001).

Since the 1970s, the agribusiness potentiated the agricultural expansion mainly through the savannas, leading the agricultural production to the boundaries imposed by law (FIGUEIREDO; LEUZINGER, 2001). However, the Brazilian Constitution of 1988 reassured the need for environmental protection in face of the increase in environmental movements.

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The protection areas defined by the Forest Code (BRASIL, 1965), Permanent Preservation Area (APP) and Legal Reserve (RL), were received by article # 225 of the Brazilian Constitution, designating the government to define “territorial spaces” to be protected. Consequently, the New Forest Code defines the protection areas that were already part of the previous code, but hadn’t been included in the National System of Conservation Unit (BRASIL, 2000).

The APP definition is closely related to geomorphologic characteristics and /or transition areas between aquatic and terrestrial systems, occupying territories of high fragility and / or environmental importance, having a strong usage restriction, both in urban and rural areas. RL is specific to rural property and can be economically exploited by the approval of a sustainable management plan.

Several alterations were approved in the Forest Code to attend the rural interests since the 1990s (CUNHA; MELLO-THERY, 2010). These actions culminated in a proposition of the new law in a less restrictive version regarding forms of recuperating the preservation areas, excluding previously protected areas with the promulgation of the New Forest Code. According to Marques (2013), *“Brazil gave a dangerous step against of the History of socio-environmental law, being the first democratic country to promote the legislative regression in the regulation of the right to an ecologically balanced environment”* (p.2).

In the New Forest Code, the legal enforcement of APP and RL reassert the social function of private property, giving differentiated treatment to the APP recovery and RL sustainable use in proprietaries with up to four fiscal modules. According to Ellovitch; Valera (2013, p. 5), the utilization of fiscal modules as a parameter will promote juridical insecurity, because *“the Brazilian environmental policy will be conditioned to a normative infra-legislative act of the President of the National Institute of Colonization and Agrarian Reform (INCRA)”*, since the dispositions about situations of change in size of the fiscal modules or dismemberment of rural proprietaries are not explicit. In this case, the New Forest Code would be more assertive if it restricted the flexibility of the law for family farming.

The 2006 census registered family farming as responsible for ensuring most of the country’s food security. Consequently, the food production has an indispensable social function in itself. The family farming produces 84.4% of food supplied to the internal market and occupies only 24.3% of all areas of Brazilian agricultural establishment (IBGE, 2006).

Considering the needs of family farming, adding to the growth of production without the enlargement of cultivated areas, agricultural policies must be adequate to give support to increase of efficiency per cultivated area, including: technification of small farms; price policy; infra-structure for flow and storage of agricultural products (SBPC; ABC, 2011).

It is necessary to emphasize that APP and RL are also productive areas, because their ecosystem functions are important to the farmer, as discussed in the case study below. The ecosystem functions of forest areas guarantee long-period production, providing the conservation of the water and soil resources, which are crucial to family farming.

On the other hand, the protected areas mean “barriers to production” to the landowner, who concentrates a large part of the environmental liabilities (SAUER; FRANÇA, 2012) and gets the profit with the land concentration and exploitation of labor wages. Configuring the capitalist exploitation in the field, this is performed

through land speculation and previous acquisition of the income in the field (GIRARDI, 2007). In the latifundium the ecosystem functions are underestimated and replaced by agricultural inputs, whereas the environmental impact is overcome by acquisition or lease of new land.

The arguments that support the increase of agricultural production areas to ensure the food security are fomented by landowners, with the assumption that the protected areas configure restrictions to food production and losses to family farming. However, the food crisis is a consequence of the neoliberal policies applied to agriculture and to world food trade, with speculation of commodities (OLIVEIRA, 2009), the three main ones in expansion in Brazil being: corn, soy and sugar cane (SAUER; LEITE, 2012).

Considering the territory reorganization, having been established by cattle breeders in the past and more recently directed by the sugar and alcohol industry, the objective of this study was to characterize changes in the use of land between 2002 and 2011, verify the application of these provisions on the Bebedouro Stream Watershed (Frutal, Minas Gerais, Brazil) and analyze the implications of the Forest Code alterations. Such characterization also intends to indicate a management proposal for the utilization of the Bebedouro Stream as a future source to supply the Frutal population.

Methodology

This study is descriptive (according to Volpato, 2013) and adopted the systemic approach as a theoretical basis, seeking the vision of the regional total space presented by Ab'Saber (2005) that stated the need:

“to perform a trajectory among the physical world, the geological world and the regional biotic, reaching the appreciations of the delicate and complex problems of the cumulative anthropic actions that answer for conjuncture and dynamics of the so called total regional space” (p.98).

For the system characterization and understanding of its operation, the data were obtained as follows:

- 1) Documental search with sampling data at the property register office of the Municipality of Frutal for the identification of the RLs recorded in the Bebedouro Stream Watershed and information provided by the State Forest Institute. Agricultural data for the Municipality of Frutal were obtained from the website of the Brazilian Institute of Geography and Statistics (IBGE, 2014).
- 2) Work performance in five field samplings; between August and December 2011, aiming the characterization of the following descriptive data: types of natural and cultivated vegetation; geomorphology; impacts produced by anthropic activities at the streams and localization of the RLs and APPs. The geographic localization of landscape components was made with the GPS- Garmin Model GPSMAP 76CSX.

- 3) Mapping of the land use was carried out on a cartographic basis on the scale of 1:10.000, including hydrography, contour level, roads and boundaries (basis provided by BMP Infogeo Company). Satellite images of 2011 were used for the photointerpretation with images obtained from Google Earth®, because of the absence of available images in better spectral resolution and the ease of data acquisition. The field check was made to avoid possible map errors relative to the Land Use in 2011. The satellite image was placed in the software AutoCAD®, followed by photointerpretation, according to the precepts of Koffler et al. (1993), using the analyses of the texture patterns, density and colors tonality for the identification of the landscape components in 2002. Afterwards, each kind of land use was estimated for the temporal comparison. The length of watercourses, the Bebedouro Stream Watershed area and the APP area composed by the riparian vegetation also were estimated from the maps.

The presentation of result and discussion in the form of a case study, aims the understanding of the changes in the locality of the study, between 2002 and 2011, as a result of the territorial reorganization in view of the agricultural activity. In this context, we discussed the law enforcement and the Forest Code reformulation. Finally, measures were indicated for the adequacy of the land use in the Bebedouro Stream Watershed

Case study

The Municipality of Frutal has 57.269 inhabitants in an area of 2.426,966 km² (IBGE, 2014) located in the region known as Triângulo Mineiro/Alto Paranaíba.

Historically, the municipality has cattle farming as its main economic activity (IBGE, 1959), but currently this territory delimited and constructed by cattle farming is being dominated by power relations directed to the interests of the sugar-alcohol agro-industry. Consequently, both family farming and urban areas suffer alterations for access to natural resources.

Since the 1980's, the sugar and ethanol plants began to be established in the Triângulo Mineiro, two of which are in the Municipality of Frutal: Usina Frutal operating since 2007 and Usina Cerradão since 2009. These stimulated the evolution of the sugar cane production in the municipality (Table 1). Farming is still important for the municipal economy. The last livestock census in 2006 shows 65.334 hectares occupied by pastures (IBGE, 2014), this area represents a little more than a quarter of the municipality land. However, the reduction of the production is evidenced by decrease in the number of cattle between 2004 and 2011 (Table 1).

Other types of land use maintained or reduced the occupied area between 2004 and 2011, with exception of mango and pineapple cultures. The former began to occupy a small production area previously nonexistent, and the latter had little expansion of occupied area (IBGE, 2014).

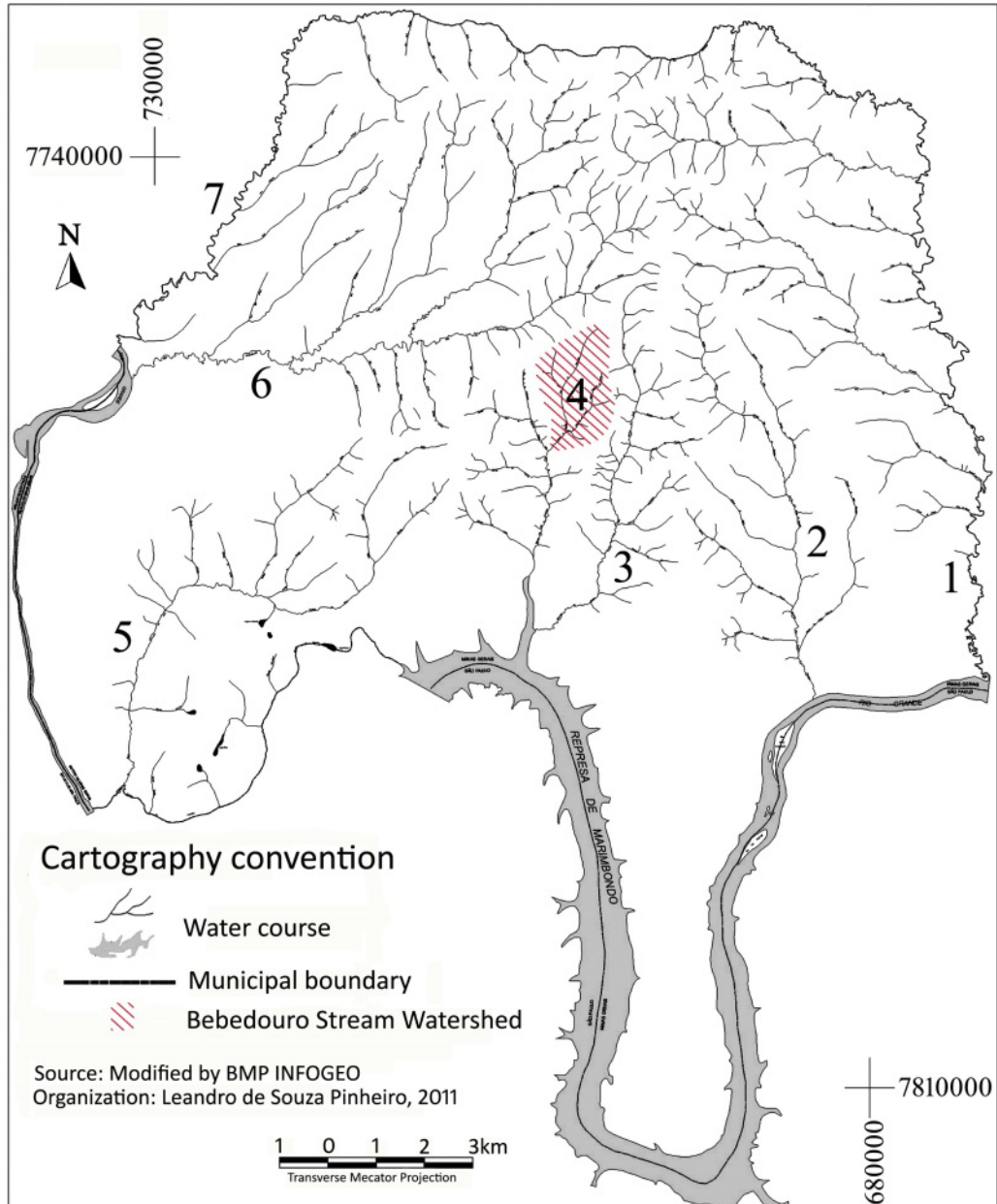
Table 1: Livestock and agricultural evolution in the Municipality of Frutal (MG)

<u>Livestock</u>	2004	2011
Cattle (unit)	187.067	145.825
Milked cows (unit)	51.009	53.150
Produced milk (thousand liters)	53.968	51.300
<u>Temporary crops</u>		
Cultivation of sugar cane (hectares)	7.028	30.689
Produced amount (tons)	562.240	2.455.120
Cultivation of pineapple (hectares)	1.500	1.900
Produced amount (thousand fruits)	45.000	57.000
Cultivation of soy (hectares)	28.000	8.100
Produced amount (tons)	78.400	25.920
Cultivation of sorghum (hectares)	4.800	450
Produced amount (tons)	7.200	945
Cultivation of corn (hectares)	2.000	4.000
Produced amount (tons)	12.000	23.550
<u>Permanent crops</u>		
Cultivation of orange (hectares)	8.500	6.500
Produced amount (tons)	153.000	195.000
Cultivation of mango (hectares)	0	200
Produced amount (tons)	0	8.000
Cultivation of rubber trees (hectares)	728	728
Produced amount (tons)	1.456	2.215

Source: IBGE Cidades (Available at: <http://www.ibge.gov.br/cidadesat/xtras/temas.php>)

All activities above use the water resource of the low watershed of the Rio Grande, including the main tributary streams located in the municipality - these are presented in Figure 1. Considering the increase in demand for the public water supply, the Municipal Director Plan of Frutal (2006) appoints the Bebedouro Stream as an Area of Special Environmental Interest, classified as Area of Environmental Preservation (APA).

Figure 1. Hydrography of the Municipality of Frutal, with main tributaries of the low Rio Grande: 1) São Francisco River, 2) São Bento da Ressaca River, 3) Frutal Stream, 4) São José do Bebedouro (highlighting the Bebedouro Stream basin), 5) Cisco Stream, 6) Marimbondo Stream, 7) São Mateus Stream.



The specific characterization of the Bebedouro Stream Watershed is presented followed by comments about its uses and conservation. We hope that the information presented can be used as a tool for management decisions to be implemented in the basin.

The Bebedouro Stream Watershed, with an area of about 28 km², lies northwest of the urban area and is surrounded by highways: from the south by MG 255, from the southwest to the northeast by BR 153, from the southeast to the northeast by BR 364, with BR 153 and BR 364 intersecting near the main source of this stream. The water course, along with its main tributary Cabeceira do Lucas Stream, has about 20 km of extension. The Bebedouro Stream is a fourth-order river, according to classification by Strahler (1952), situated in the transition between the plain and plateau of Rio Grande. The area of the basin is characterized by Rhodic Ferrasol arranged in broad hills, with low slope relief, but with some local geological conditions of greater slopes, highlighting the existence of ferruginous concretions observed in the field.

According to IPT (2008), in the study region there is the predominance of Rhodic Ferrasol, followed by Dark Red Ferrasol, this one occupying principally the source region of the Bebedouro Stream Watershed. Nevertheless, soil with a characteristic Rhodic Ferrasol color was not registered in field observations, but variations of Red Ferrasol to Red-yellow Ferrasol. The low slope relief arranged in broad hills, observed in the field, corroborates the kind of relief described by Rocha et al (2001) as the characteristic of the Triângulo Mineiro region. The occurrence of ferruginous concretion outcrops at the right margin of the middle-high watershed of the Bebedouro Stream promotes differentiated resistance to erosive processes (Penteao-Orellana, 1976), which characterizes the highest slopes in this place. This area is covered by natural vegetation, probably, because the soil aggregation makes it difficult to apply pasture.

Since the watercourse studied is of low order, surrounded by vegetation over most of its extension and situated in a region with a lower natural erosive process, probably there are natural conditions to use its water for human supply. However, recovery measures to contain erosion processes already existent in the basin and the leaching of agricultural inputs are needed to maintain good water quality.

The Bebedouro Stream Watershed had the same tendency of the municipality, with increase of agriculture to the detriment of livestock activity between 2002 and 2011. The pastures were reduced from 1560 ha to 790 ha and the sugar cane production increased from 150 ha to 950 ha (Figures 2 and 3). Rubber tree cultivation had a more discreet increase (from 240 to 370 ha) and mango cultivation, formerly inexistent, had occupied 175 ha and pineapple cultivation that occupied 140 ha ceased to exist.

The rubber and mango cultivations can present ecological and economic benefits, because permanent crops have the tendency to minimize problems related to erosion. The rubber tree cultivation analyzed had a plantation of palms in the sub-forest and some cattle grazing though the trees. The diversified crop decreases the negative impacts on land use, mainly when the conservation area is respected.

Figure 2. Land use map of the Bebedouro Stream Watershed, 2002, located in between latitudes 7793357; 778338 S and longitudes 7105010; 710472 E (UTM SAD 69; Zone 22).

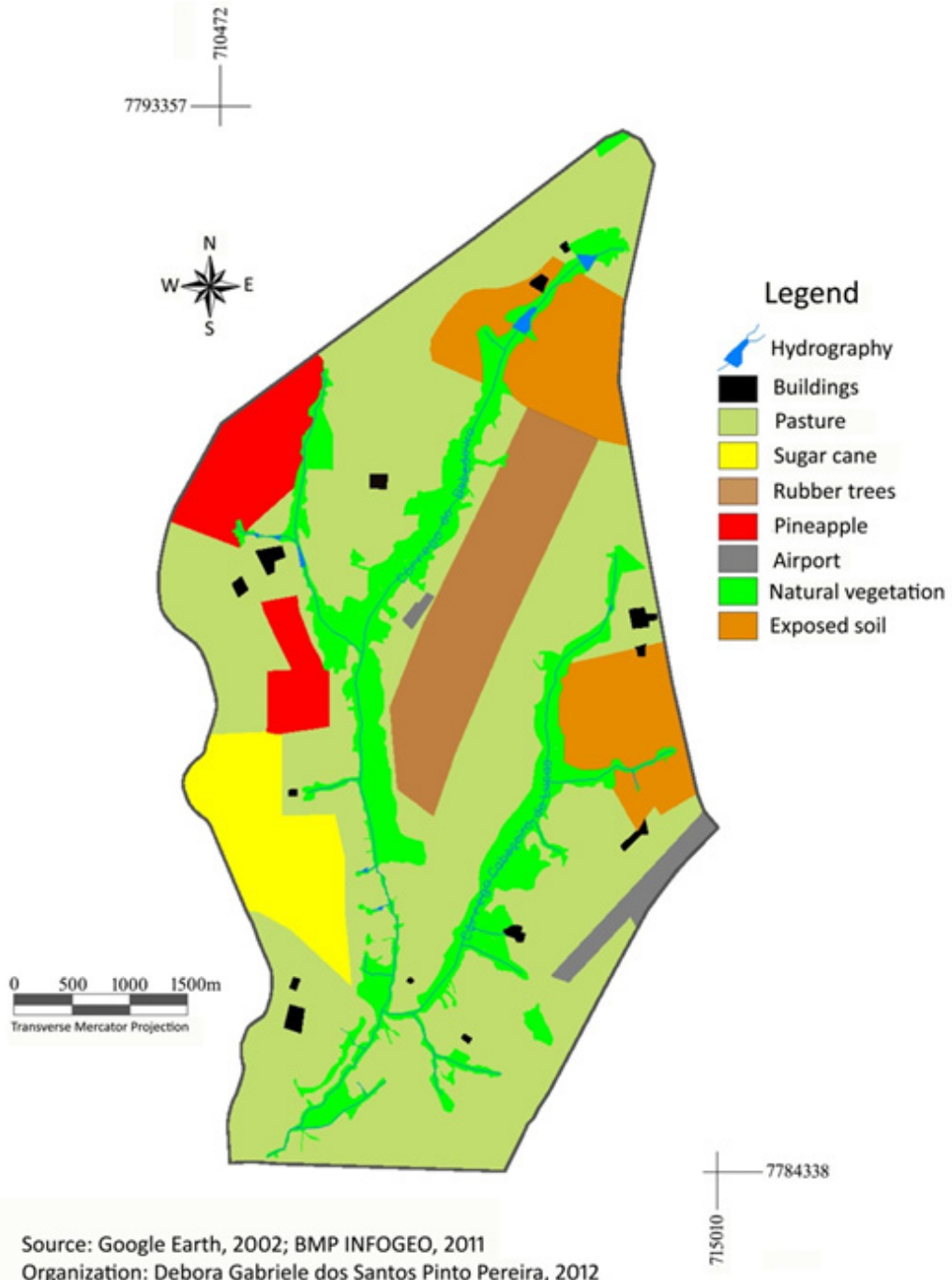
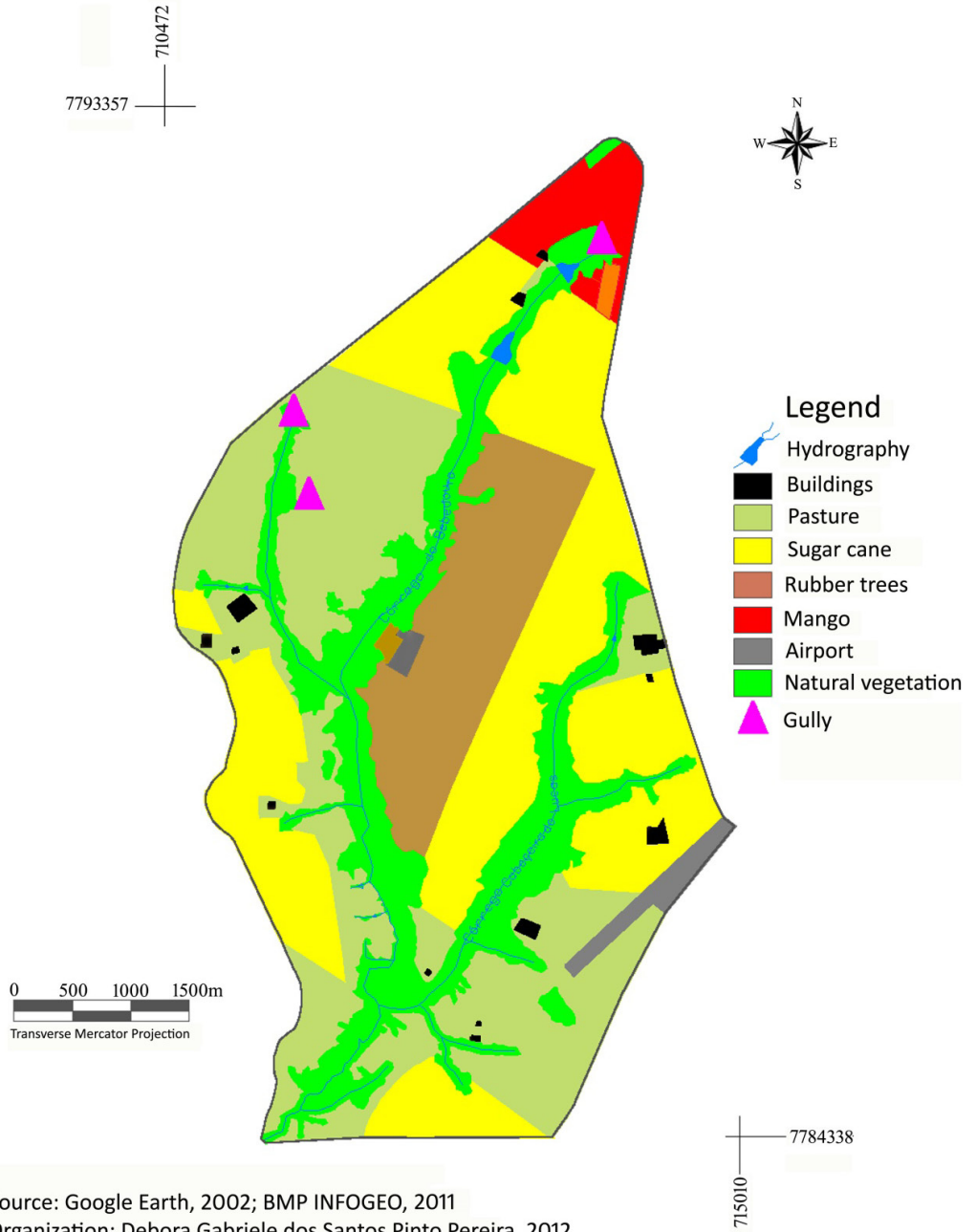


Figure 3. Land use map of the Bebedouro Stream Watershed, 2011, located in between latitudes 7793357; 778338 S and longitudes 7105010; 710472 E (UTM SAD 69; Zone 22).



According to the data obtained at the register office, 7% of the watershed area is classified as having smaller portions of land (up to 1 fiscal module); 36% as small rural propriety (1 to 4 fiscal modules); and 57% as medium property (5 to 15 fiscal modules). There is no record of latifundium (according to INCRA, 1980, the fiscal module in Frutal is 30 ha). Nevertheless, some landowners have more than one property in other basins with different registers. If land structure analysis had considered all registers for each landowner, there would probably be different conclusions on the distribution of land. The subdivisions of properties by different registrations expose a somewhat masked reality – several properties belonging to only one landowner. Thus, landowners can be benefited with the reduction of APP and RL recovery, in view of the property size, besides resulting in fragmented RLs, which make them less effective as natural resource conservation areas.

Considering the proposal of the New Forest Code, the establishment of the Rural Environmental Registry (CAR) would be able to reduce such distortions, because the registration will be done with the identification of owners (BRASIL, 2012). On the other hand, the Environmental Regularization Program (PRA), will:

“stimulate the regularization of the rural properties with illicit interventions in protected areas, enable the consolidation of illicit acts and permit continuity of agrosilvopastoral activities, ecotourism and rural tourism, in areas once protected by laws... In addition, it will be an instrument for amnesty of fines and crimes committed up to July 22, 2008” (p. 6).

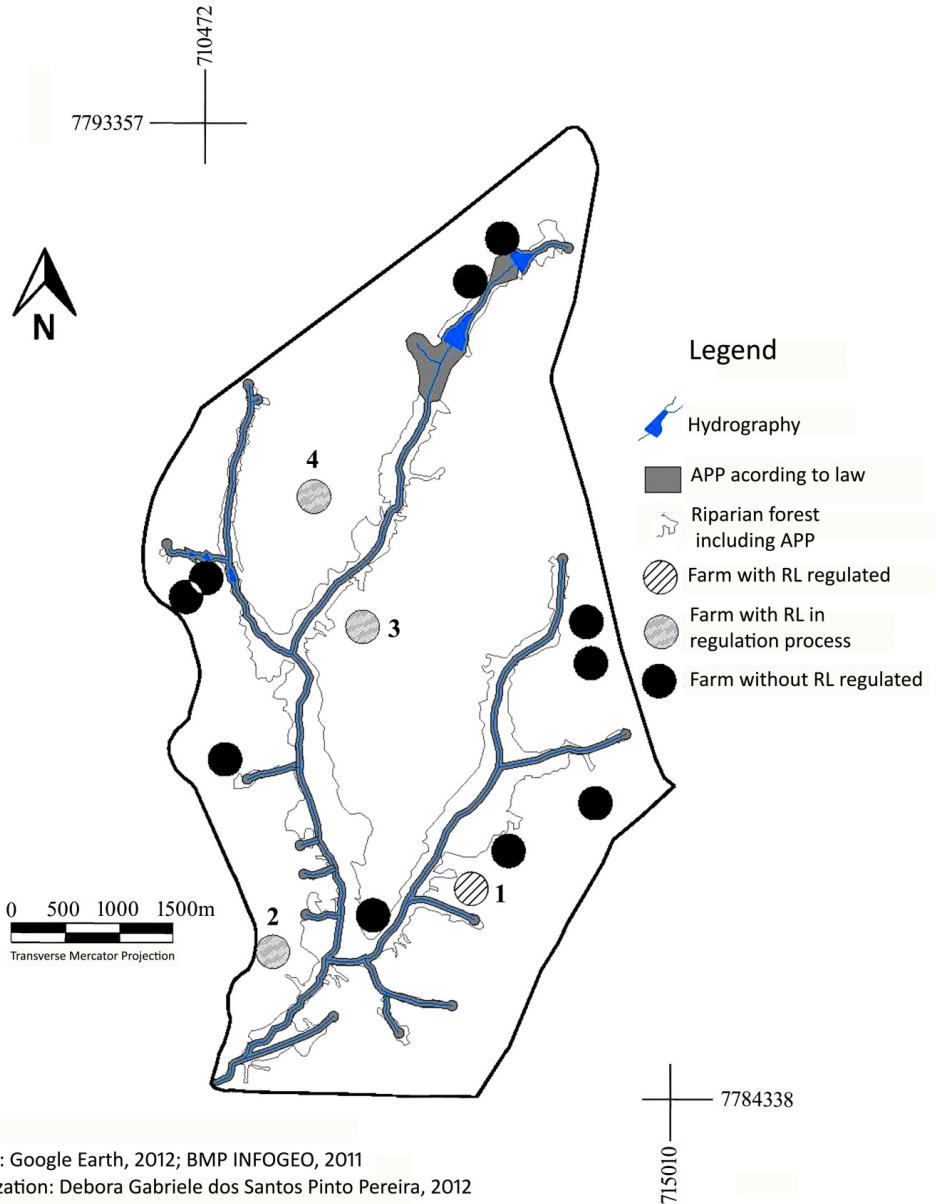
The obtained data (Figure 4), about RL registration in the Bebedouro Stream Watershed, illustrates the possible effect of the Forest Code application before the recent reformulation. Only one property with RL was registered (location: 713082 E, 7786038 S - UTM SAD 69; Zone 22), but three other properties have ongoing registration processes in the State Forestry Institute, placed at the following coordinates: 711171 E, 7785417 S; 712005 E, 7788523 S and 711535 E, 7789766 S (UTM SAD 69; Zone 22).

In the field work, two fragments of *Cerrado* vegetation (Brazilian savannas) were observed, pointing at the possible places reserved for future RL, the location of which are the following: 0712921 E; 7792574 S and 0713446 E; 7793452 S (UTM SAD 69; Zone 22).

Analyses of the land use map from 2002 to 2011 (Figure 2 and 3), also illustrate the regulation effect of the APPs. In 2002, there were approximately 400 ha of riparian vegetation, increasing to 515 ha in 2011. Almost all the extension of water courses in the watershed have the minimum margin established according to current law. However, the insufficient presence of RLs shows an inadequate area of vegetation, because half of the required area is not registered yet or is in process of regulation; there should be 700 ha of forest for full compliance to law requirements.

The RLs of the analyzed properties have not ceased to be under obligation to preserve 20% of its total area for forest, except for those allowed to recover degraded RL in properties with up to four fiscal modules, which represent 14% of the watershed area studied. The four RLs regulated and in registration process add 255 ha of natural vegetation

Figure 4. Map of the APPs, RLs and farmhouses in the Bebedouro Stream Watershed. Site1: 713082E, 7786038S; Site 2: 711171E, 7785417S; Site3: 712005E, 7788523S; Site 4: 711535E, 7789766S (UTM SAD 69; Zone 22).



with 79 ha registered outside the basin. One RL of the study area is in regulation process by acquisition of non-contiguous land in the Rio Grande Watershed, being instituted in a Private Reserve of the Natural Patrimony, located in the *Serra da Canastra*. In this case, the RL is a possibility for preservation of some vegetation with high biotic and functional value, while providing area for economic activity (SBPC; ABC, 2012).

The natural vegetation found in the watershed, according to field observations, corresponds to the phytogeographical domain of the *Cerrado*, being identified with the following phytophysionomy: *campo sujo*, *campo cerrado*, *cerrado sensu stricto*, *cerradão*, *veredas* and *matas galerias*. The nomenclature used for phytophysionomic classification follows Batalha (2011), with addition of *veredas* (wetland with regional palms) that occur in the region and are treated in a specific form by the New Forest Code. The several kinds of vegetation present in the *Cerrado* reveal the importance of RL existence and not only APPs.

Due to the large diversity of species adapted to the water deficit in the *Cerrado*, the sole preservation of APPs would bring losses to xeromorphic species found outside the area covered by riparian forests. On the other hand, the RLs in the Bebedouro Stream Watershed are connected to APPs, permitting the establishment of animals that need larger territories for their reproduction, reducing the extinction risk.

Despite not being obligatorily close to the rivers, the RLs also have an important role in the water infiltration in soil, supporting the aquifers recharge. "*Radicular system, litter and densified vegetation of forests together are able to take 70% of precipitation volume on average, regulating the river flux, which contributes to the improvement in water quality*" (SBPC, ABC, 2012, p.63). Considering the ecosystem function of forested areas for maintenance of water resources, the infiltration of water made by the vegetation-covered areas in the Serra da Canastra will favor the recharge of the Rio Grande, while the sub-basins of the Municipality of Frutal would be favored directly by larger vegetation areas in the "Serrinha" region, plateau lying north of the municipality that works as a boundary between the rivers Grande and Paranaíba.

Some functions of different types of APP and RL overlap, but it is important to highlight that RLs aim to ensure the differentiated role in the distinct Brazilian biomes, while APPs have larger importance in the prevention of anthropic negative impacts on the water resources and erosive dynamic. In this way, the importance of riparian forest structures needs to be characterized to better understand its functions. The riparian APPs are places of expressive variation of soil kind, topographic diversity, water regime, kind of perturbations; besides adding to shade, abundant water and "omnipresent ecotone (or edge) effects" and intensive use as corridors and refuges of the regional fauna (BROWN JR., 2009). Consequently, in this environment, a large richness of small animals that contribute to agrobiodiversity "constituted by a group of organisms and ecosystems that show strong relation with the human people" is installed (NODARI; GUERRA, 2015). These organisms act as pollinating agents, seed dispersers and natural enemies of pests and they are responsible for native species' reproduction. According to SBPC; ABC (2012):

"the maintenance of the native vegetation remaining in the properties and in the landscape transcends a purely ecological and environ-

mentalist discussion, picturing, beyond its economic potential, the sustainability of agricultural activity” (p. 78).

The formation of marginal dikes by deposition action of the sediments brought by the river overflow, with the progressive densification of vegetation enriched with the material brought by the river in the time of floods, along millennia (AB’SABER, 2009), performs a complex environment. This region represents an increasingly effective barrier to sediment retention, avoiding the flux concentration with transport of the sediment and prevents the soil loss, benefiting the water infiltration in riverine soil too.

In the Bebedouro Stream Watershed there are some typical *veredas* sited in hydro-morphic soils and colonized by *buritis* (*Mauritia* spp.). These places should be protected with the presence of APP conforming to the New Forest Code. Nevertheless, the *veredas* sited in the study area are unprotected against the silting and input of agrochemicals. The *veredas*, even if intermittent as other wetlands, have their importance neglected by a large part of the population, because they are identified as a swampy area where there are bad smells and several insects. However, these areas are places of stock and decomposition of organic matter and they filter the water before the organic matter reaches the rivers of higher order.

Wetlands have similar functions to the riparian forest, though the process occurs in distinct physical and chemical conditions, favoring another kind of biological community and other metabolic ways to degrade organic matter and other substances that come into the aquatic system. The siltation, characteristic of deposition in riverbeds and *veredas*, promotes the depth reduction and colmatage of the water table outcrop (BARRELA et al. 2009). The silted water bodies have a tendency to become shallower and wider, favoring the increase of water evaporation, which may decrease local water availability in surface bodies.

When it comes to an agricultural area, sometimes the utilization of agrochemicals is more intensive than in pastures. The riparian forest forms a mosaic of vegetation that retains high nitrogen and phosphorus concentration, allowing fast biochemical cycling and minimizing the transport to aquatic systems. The driving of those nutrients to rivers can lead to the acceleration of the eutrophication process of aquatic ecosystems (RODRIGUES FILHO et al, 2015). The increase of organic matter promoted from primary productivity growth results in high rates of decomposition, in some cases promoting anoxic conditions, with the escalation of fish and invertebrate mortality. Moreover, excess of nutrients may benefit the development of opportunistic and potentially toxic cyanobacteria species.

In the Bebedouro Stream there are some small dams, an environment that favors the eutrophication because of the increase in the water residence time and accumulation of material by sedimentation, leading to negative impacts in the physical, chemical and biological conditions of the aquatic system and degrading the water quality for more restrictive uses.

Before the New Forest Code, the 15-meter band was required around reservoirs with up to 20 ha in the rural zone (BRASIL, 2002), but now “the establishment of the Permanent Preservation Area surrounding natural and artificial water accumulation with an area

of less than 1 (one) hectare is excused” (BRASIL, 2012, p.8). The sediment deposition is one of predominant processes in reservoirs, the increase of material deposition interferes in the loss of storage water capacity, because the sediment can be one of the main water pollution vehicles, as a large transporter and catalyzer of pesticides, organic residues, nutrients and pathogenic organisms (BUFON, et al 2009).

Two reservoirs in the main course of Bebedouro Stream illustrate the negative impacts mentioned above. In one of them, the water presented a greenish color characterizing probable eutrophication and the other one was very shallow, with little storage capacity. The releasing of APP existence in these places may promote impairment to the farmer, who will need to invest financial resources for the management of the reservoir or new damming.

The damming of the water flux can be used as a way to retain erosive processes, producing improvements to the rural property. In the region of one Bebedouro source, a grounded reservoir was registered which apparently stabilized and reversed an erosive process of an old gully. Gullies are characterized by an advanced erosive process stage, in which superficial horizons of soil are degraded reaching the water table. In the watershed studied, some gullies were stabilized by the development of arbor vegetation along the water course. These formations assume characteristics of first order rivers surrounded by riparian forest, being differentiated from them because the water course is embedded between approximately vertical walls with a height of more than 2 meters.

An aggravating factor recorded in the Bebedouro head was the disposal of solid waste inside a gully located in a pasture, increasing the water contamination risk. Besides, several sites of silting were registered. In some properties, the riparian vegetation is surrounded to prevent the passage of livestock and watering in the watercourse. The deepened path created by cattle trampling between the pasture and the stream favor the formation of erosive features, facilitating the arrival of the sediment to the bed of the river.

The existence of gullies and other erosive features near the Bebedouro head is of concern (Figure 3), considering the large expansion of sugarcane cultivation, since there is data indicating the possibility of greater soil degradation with sugarcane, when compared to the well managed pasture (BERTONI; LOMBARDI NETO, 2007). In a study performed in São Bento da Ressaca Stream Watershed, also situated in the Municipality of Frutal, with physical characteristics and similar uses to the basin studied, Santos; Oliveira (2013) characterized the region as little susceptible to natural erosion, but they verified that the expansion of sugarcane cultivation potentiated an acceleration of erosive processes.

Among the inserted questions on expansion of sugarcane cultivation, with the discourse of the production of “renewable” and “cleaner” energy, there is a serious latent problem which encompasses both human health and aquatic system balance. The seriousness of the introduction of toxic substances into these systems has been underestimated not only by agribusiness. Even more worrisome, environmental agencies linked to the management of water resources have neglected the water body contamination, because ecotoxicological monitoring is still incipient (BUSS et al., 2008).

In the concessions for reforestation of the new law, the small reservoirs and intermittent sources (“eye of water”) are exempted from APPs. This, added to change of measurement reference to determine the width of the APP along of the river, reduces the

ecologic service efficiency of the riparian vegetation, among other factors. The increasing of APP area reduces the degradation capacity of agricultural inputs made by the abundant microorganisms on the riparian forest moist soil. It is important to highlight that in the previous code the measurement of the APP had being accounted from the highest level of the river, whereas in the current law it passed to the regular level, resulting in wide stretches of unprotected areas, principally in flood plain regions.

Another large land extension, now unprotected, is the hilltop vegetation, covering important areas of the Triângulo Mineiro. The new law *“doubled the minimum height of what was considered a hill and ignored the existence of the ridgeline and elevation groups. Thus, extensive areas in plateaus are without protection”* (ELLOVITCH; VALERA, 2013, p. 8). The hilltops that have become unprotected are essential to recharge the basin, even being about eight kilometers distant from the Bebedouro Stream Watershed, influencing directly the recharge of rivers and water sources available in the region.

The proposed changes by the New Forest Code can potentiate part of the problems related to quality and quantity reduction of water resources. However, in the Municipality of Frutal there are possibilities of actions, already previewed in the current Municipal Director Plan, which can be improved and applied in order to make the utilization of the Bebedouro Stream waters viable for public supply.

Final considerations

The recent restrictions to the water resources the in Municipality of Frutal, similar to several regions of the country, are due to inefficient enforcement of the public policies aimed at the use and conservation of natural resources. Also, the lack of articulation between the water and forest resource management is emphasized, mainly, in the scenario of the approval of a more permissive Forest Code, favoring agribusiness with the water availability in quantity and quality over other uses.

The use of agrochemicals represents a serious problem, still underestimated when water use is considered. Despite the water quality not being characterized in this study, the reduction of about 50% of pasture area and the more than six fold increase of the sugarcane area cultivated indicate a possible increase in the use of agrochemicals in the basin analyzed during the study period. Several studies have already been published on the important role of the forest in the retention and degradation of fertilizers and agrochemicals. On the other hand, data characterizing the real situation of the protected area by law and proposing practical applications for the improvement of water resources are scarce for the micro region of Frutal.

The increase of 29% in the APP areas observed in the Bebedouro Watershed can be highlighted, between 2002 and 2011, as a positive enforcement of the environmental law. The watershed has APPs within the required size according to the current Forest Code in almost all its extension. Nevertheless, there are losses for the APP area in relation to the previous code which considered the larger riverbed as reference for the APP width. The two veredas present in the watershed are an exception to the enforcement of the current law and must be recovered according to the new law.

The Bebedouro Watershed reservoirs should have their margins forested, even not having any more legal requirement, aiming the deceleration of the eutrophication and silting. This measure favors the future water resource use for the urban supply of Frutal and, in the long run, would avoid the need for investments in water treatment and the building of new reservoirs to attend the rural property.

Most of the rural properties do not attend the law related to RLs. Thus, according to the present possibilities in the new law, the landowners that do not have RL will not be punished for irregularities, if they assume the Regularization Compromise Term after the PRA regularization.

Considering the possibility of the RL compensation outside the property, it is necessary to give priority to compensation inside the watershed. Thus, the expansion of the future APA for the “Serrinha” and its surroundings, together with the support of managers for the realization of the RL compensation in this area could favor the aquifer recharges that supply the regional watercourses. In this way, the new Municipal Director Plan should consider establishing the APA and the managers should, as soon as possible, act for its effectiveness, prioritizing the recovery of the RLs in a favorable area to supply recharge of the Bebedouro Watershed aquifer.

According to the geomorphological data and APP area presented in this study, the Bebedouro Stream has adequate natural conditions to provide water for human supply, mainly because it is a low order river and has kept large part of its extension with riparian vegetation and with low natural vulnerability for erosive processes. However, according to registers of partial replacement of pastures by sugarcane, actions for conservation of water quality are needed, with the establishment of the policy to control the use of agricultural inputs and technical qualification of owners and rural workers.

The existence of effective cattle barriers to prevent the access to riparian areas of APP is important to avoid one of the principal factors that accelerate the erosive dynamics of the basin, because in several sites we registered silting in the Bebedouro Stream as a result of intense erosion processes, observed mainly in pasture area.

Due to the current situation of water availability, the new infrastructure for water captation is urgent, aiming at the adequate maintenance of the municipality supply. If the option is not groundwater utilization, generally with high costs, then a reservoir for water extraction of the Bebedouro Stream could be the most indicated measure. In this case, in addition to the above recommendations, such a reservoir should be installed upstream of the MG 255 highway and the flux of dangerous truck loads should be removed from the junction between the BR 153 and BR 364 highways. It would be a preventive measure to avoid accidents that can contaminate the future water resource.

It is important to note that the Municipality of Frutal suffered the first episode of water rationing in October 2014 and, according to publicity of regional media, it is among the municipalities in imminent situation of public water supply collapse in the Triângulo Mineiro. Consequently, actions to expand the possibility of water catchment become essential, together with the restoration of protected areas, guaranteeing the ecosystem functions to maintain the water quality and the amplification of the aquifer recharge that supplies the municipality water sources.

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ENVIRONMENTAL PROTECTION AREAS: THE CASE OF THE BEBEDOURO STREAM WATERSHED

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Abstract: Environmental Protection Areas are legal provisions aiming at the preservation of natural resources through the maintenance of the ecosystem functions. This study aimed to characterize the changes on the land-use between 2002 and 2011, verify the implementation of these legal provisions on the Bebedouro Stream Watershed (Frutal, Minas Gerais), analyze the implications of changes in environmental laws and indicate management options for water resource conservation. For this work the following procedures were performed: land-use mapping of the watershed; investigation on the occupation of the Frutal region; survey of records about the rural properties and Environmental Protection Areas registered. The comparative study of the Bebedouro Stream watershed showed the replacement of large pasture areas by sugarcane plantation; insufficient area of legal provision for biodiversity conservation and increase in the riparian forest during the period studied. Concluding remarks suggest management options for the water uses of the analyzed watershed.

Keywords: Environmental Protection Area, water availability, Bebedouro Stream Watershed.

Resumo: Áreas de Preservação Permanente e Reserva Legal são dispositivos legais que visam a conservação dos recursos naturais pela manutenção das funções ecossistêmicas. O presente estudo teve como objetivo caracterizar alterações no uso da terra, entre os anos de 2002 e 2011, verificar a aplicação desses dispositivos na bacia hidrográfica do Córrego Bebedouro (Frutal, Minas Gerais), analisar as implicações decorrentes da alteração do Código Florestal, e propor sugestões para a conservação dos recursos hídricos. Para este trabalho, foram realizados os seguintes procedimentos: mapeamento do uso da terra na bacia hidrográfica; investigação sobre a ocupação da região; levantamento dos registros das propriedades rurais e Reserva Legal. O estudo comparativo da bacia apresentou a substituição de uma área considerável de pastagem por canavial, uma área insuficiente de Reserva Legal, e o

aumento na área de vegetação ribeirinha no período estudado. As considerações finais sugerem opções de manejo para o aproveitamento dos recursos hídricos na bacia analisada.

Palavras-chave: Área de Proteção Permanente, Reserva Legal, disponibilidade de recursos hídricos, Bacia do Córrego Bebedouro.

Resumen: Las Áreas Protegidas son dispositivos legales que tienen como objetivo la conservación de las funciones ecosistémicas. El estudio tuvo como objetivo caracterizar el uso de la tierra entre 2002 y 2011, verificar la aplicación de estos dispositivos en la cuenca del Arroyo Bebedouro (Frutal, Minas Gerais), analizar las consecuencias de los cambios en la legislación ambiental y proponer sugerencias acerca de la conservación. Para esto se realizaron los siguientes procedimientos: mapeo de uso de la tierra; investigación sobre la ocupación regional; levantamiento de los registros de las propiedades rurales. El estudio, comparativo de la cuenca presentó cambio de considerable área de pastajes por caña de azúcar, un aumento en el área de vegetación ribereña durante el período de estudio, sin embargo son insuficientes las áreas para la protección de la biodiversidad. Las consideraciones finales se plantean opciones de manejo para el aprovechamiento de los recursos hídricos de la cuenca analizada.

Palabras-clave: Área de Protección Permanente, Reserva Legal, disponibilidad de recursos hídricos, cuenca del Arroyo Bebedouro.
