Relationship Between Coffee and Environmental Conservation in the Serra da Mantiqueira, Minas Gerais, Brazil

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SUMMARY

This work was addressed to analyze the relationship between coffee and environmental preservation in the Serra da Mantiqueira, Minas Gerais, Brazil, using geotechnologies. The physiographic structure of the study area was characterized aiming at analyzing and crossing biotic and abiotic variables that act on the local landscape configuration and to access how coffee plantation are distribute in this landscape. The results showed the study area is rich in natural resources, with high drainage density, high variation in height and geomorphological features quite different. The human impacts changed the local landscape structure over time, and limited the ecosystems ability to perform their ecological functions. Coffee plantation contributed to modify the landscape structure and affect natural resources in the study area. However, pasture was the human activity of greater negative environmental impact, due to the inadequate management of some areas. The change of land-uses for agroforestry systems, based on sustainable development, can represent an alternative to the compatibility of agricultural production and conservation of local natural resources.

INTRODUCTION

The Brazilian Atlantic Forest is considered one of the richest ecosystems on the planet. This forest has been converted into man-dominated areas, largely for agricultural production. The consequences of this conversion are the habitat loss and fragmentation, which endanger biodiversity maintenance.

In order to seek the proper use of natural resources, balancing the conservation of ecological systems and the economic interests of modern society, environmental planning is an important tool to guide decision makers. To this end, information on the physical characteristics and the land use dynamics of are important information to be used in the characterization of a landscape.

The southern region of Minas Gerais is considered as the largest coffee producing region of Brazil. The microregion of the Serra da Mantiqueira is a major coffee producing regions of the state and the country, and is characterized by mountainous terrain, and internationally known for the production of specialty coffees.

The city of Carmo de Minas has physical characteristics that represent the microregion of the Serra da Mantiqueira and therefore was used as a pilot area for this work.

In this context, this paper analysed the relationship between coffee plantations and environmental conservation in the Mountain range, Minas Gerais, Brazil.

MATERIALS AND METHODS

Study site

The study area comprises the municipality of Carmo de Minas, located at 22 ° 07'21 "S and 45 º 07'45" W, in the microregion of the Serra da Mantiqueira, South state of Minas Gerais. This municipality has 32,332 ha, minimum altitude and maximum altitude of 856 and 1645 meters, respectively. The mean annual temperature is 19.1 º C and average annual precipitation is 1,568 mm. The climate is Cwb, subtropical high, according to the Köppen system. The municipality is within the Atlantic Forest biome according to the Brazilian classification.

Image processing and data analysis

Hydrography and roads were extracted from IBGE planialtimétic charts. We obtained the total drainage density (DDT = Σh / A) and total roads density (DET = Σe / A), based on the hydrography and roads quantification, using the total length of watercourses/roads and the total area.

We conducted a field campaign for recognition of the study area, and the survey of secondary information. We used biophysical maps and IBGE 1:50,000 scale planialtimetric charts (SF23VDVI4 - Conceição do Rio Verde; SF23YBIII1 - Cristina; SF23YBIII2 – São Lourenço). This information was adjusted and inserted in a geographic database in the softwares SPRING 5.1.5 and ArcGIS 9.3.1 ®.

We used maps from NASA SRTM (90m resolution, quadrants: sf-23-vd and SF-23-yb on 1:250,000 scale). The SRTM data were interpolated to 30 m. Later we generate the Digital Elevation Model - DEM to obtain the maps of elevation and slope. The altitude was divided into nine classes in units of 100 meters between 856 and 1645 m. The first and last class contained values below 900 m above 1600 m (<900m, 900-1000m, 1000-1100m, 1100-1200m 1200-1300m, 1300-1400m, 1400-1500m, 1500-1600m,> 1600m). The relief classes were divided in five classes: plane (0-3% slope), softly wavy (3-8%), moderately wavy (8-13%), wavy (13-20%), strongly wavy (20-45%); mountain (45-100%), steep (> 100%).

We use a HCR SPOT5 image, with 2.5 m spatial resolution from 2008 to conduct a visual interpretation using SPRING 5.1.5. We mapped eight land use classes: (i) natural vegetation: old growth secondary forest remnants, (ii) coffee: coffee plantations, (iii) annual agriculture: corn and pasture crops, (iv) pasture: livestock areas, (v) secondary forest: early growth secondary forest patches on abandoned cropland and pasture, (vi) watercourse: ponds and rivers, (vii) silviculture: eucalyptus plantations; and (viii) other uses: urban areas and agricultural buildings. Field survey was carried out in order to guarantee high map accuracy with Kappa index of 0.92.

All these biophysical information were used to a final analysis to explore the relationships between coffee plantations and environmental conservation in the study area.

RESULTS AND DISCUSSION

The municipality of Carmo de Minas belongs to the Rio Verde basin, which belongs to the of the Rio Grande basin. Carmo de Minas is rich in springs and streams possibly due to its mountainous terrain. Hydrography was estimated at 740.66 km, including 10 m average width water courses and a part of the Rio Verde, which has an average width greater than 20 m.

Drainage density was estimated to 22.97 m/ha, and was considered high according to the DENAEE classification. So, we can infer that the volume of water drained is compatible to the extent of water courses, reducing vulnerability to flooding. Besides this, a high drainage density is closely related to the presence of riparian corridors, which act as structural connectors in the landscapes. The riparian corridors in agricultural matrices may facilitate biological fluxes and prevent the extinction of species in fragmented habitats. According to the Brazilian Environmental legislation (Brazil, 1965) riparian corridors are known as Permanent Protected Areas - PPAs. The PPAs vary in length according to the average width of the water bodies and should be preserved.

We also accounted the roads, which totalized 397.21 km. The density of roads was estimated at 12.28 m / ha, which is considered high. A high density of roads can be considered positive in terms of greater accessibility to rural human communities. But, it is considered negative in terms of biodiversity conservation, because it increases the probability of being run over wildlife, promotes access to natural areas (facilitating the plants and animals collection) and the entrance of impurities and pollutants, and erosion processes along the roads.

The study area had a high altitudinal range (789 m). The highest percentage of the study area (80%), found in altitudes lower than 1,100 m. Class 900 to 1000 m occupies almost 50% of the municipal territory. The altitude along with hydrography determines the existence of most of the remaining natural vegetation in the area of study. The difficulties to implement agricultural activities at high altitudes represent the most important factor for the maintenance of forest areas.

We also calculate the percentage area of natural vegetation in each altitude range and compared with the area of Carmo de Minas in each altitude range. There was an increase in the area at higher altitudes when comparing the values of natural vegetation to the values of the municipal area.

the amount of natural vegetation has doubled in almost all ranges of altitude above 1,100 m, compared to the total area of the municipality. The vegetation amount at altitudes below 1,100 m was kept because these altitudinal ranges occupy larger areas.

This information highlights that some vegetation types found at lower altitudes were lost, leaving only those adapted to higher altitudes. This was due to the development model the region where the study area is located. In this model, agricultural activities are widely associated with the slope, and altitude. There are large areas with softly wavy slope, wavy and moderately wavy (80%) that allow the development of agricultural activities, such as pastures and annual crops. However, areas with steep slopes more related to coffee require proper management to prevent erosion, since this activity is well developed and relevant to the region's economy.

The terrain is very irregular, varying from plane to mountainous. Most of the area (62.13%) can be used for agricultural activities, using practices for controlling erosion. The other areas (37.87%) show strong or severe susceptibility to erosion. These areas are not suitable for farming practices, because erosion control may be costly or even uneconomic. We observed in the field, that most coffee crops were associated with high slope, but they were well structured from a soil conservation perspective.

We evaluated the compatibility of land use, especially coffee plantations, with the conservation of Atlantic Forest in the study area and verified the natural vegetation remnants

are dispersed in a matrix of agricultural activities, consisting mainly of pasture. Pasture occupied about 45% of the total area. We observed that most pastures were poorly managed and highly compacted, with bare ground and no protection against the erosive action of rain and winds. Natural vegetation is extremely fragmented. There remain few remaining and most of them are very small.

Coffee plantations occupied about 15% of the landscape. In comparison with the areas occupied by pasture, the negative environmental impact of coffee production, especially in soil conservation, can be considered moderate to low. Furthermore, according to the cultivation of organic coffee positively affects the biomass, population density and species diversity of soil organisms (earthworms, in this case), contributing to soil conservation.

We found a geographical proximity between the natural vegetation and coffee plantations, due to the relationship of these two classes with altitude.

There is strong evidence that altitude and latitude directly influence the quality of coffee beverage. The study by legitimized fluctuations in scores of cafes, which varied with height as a function of latitude. The results showed that the higher the altitude, the greater the sensory quality of the coffee beverage.

Pasture is the human activity of greater negative environmental impact, due to inadequate management. Coffee plantations are well structured, but could be optimized from the point of view of conservation, changing from traditionally productive character to agroforestry systems, based on sustainable development. This change is an alternative to the compatibility of agricultural production and biodiversity conservation and local water resources.

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