Analysis of Land Cover Distribution and Spatial Pattern of Landscape Fragmentation and Connectivity in the Taperoá and High Paraíba River Basins, Brazil

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Introduction

The semiarid region of Northeastern Brazil had, throughout history, several sizes and different denominations. These aspects have always been linked public development policies for the region. One of the first juridical delimitations is present in a norm of the Brazilian Constitution of 1988, that in its Article 159, instituted the Constitutional Fund of the Northeast - FNE. The FNE was established by Law No. 7,827, of December 27, 1989, and defined the Brazilian semiarid region as the area of operation of the Northeast Development Superintendence - SUDENE, created in 1959, with equal rainfall annual 800mm or less. Using these criteria the semiarid had, at that time, 1,031 municipalities. In 2017 it was held the last official delimitation of the semiarid region, which now has a total of 1,262 municipalities. The semiarid region now occupies an area of approximately 900,000 km2, about 10% of the total area of Brazil, covering part of Maranhão, the other states of the Northeast, North of Minas Gerais (IBGE, 2015). Presents climate BSh 'of Koppen, with two seasons, wet and dry, with average annual rainfall of about 300 to 800mm. Most of the rainfall is concentrated in three to four months into the rainy season, causing a negative water balance in most months of the year and high level of aridity. In much of the semiarid region are the dry forests, represented by a mosaic of vegetation landscapes called Caatinga, which in their bio-climatic conditions, and the diversity and endemism of the flora and fauna, it is a unique biome. French authors and Anglo-Saxons as Trochain (1957), Cole (1986), Hueck (1978), Schnell (1979) and Riou (1995), and Brazilian authors like Andrade Lima (1981), Rizinni (1997), Ab'Saber (2003), Fernandes; Bezerra (1990) and Martius (1996) performed studies in Caatinga and its physiognomic aspects xerophytic forest, composed of thorny trees and shrubs, with succulent plants, cactáceas, bromeliáceas and herbaceous plants. Some researchers like Kuhlmann (1974), Cain; Castro (1959), defined the Caatinga as "savannah-steppe". This definition for authors like Cámara; Lima (2013), Martinez (2002) and Lima (2012), shouldn’t be applied beyond the physiognomic features, as for bio-climatic and geochemical conditions that operate in the edaphic processes, there are major

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differences between steppes and savannas. In this sense, may have Caatinga vegetal formations that are characterized as a arboreal or shrub Savannah, with formations of the type tropical deciduous forests with geoecodinamic regime tropophile, xerophilous, with deciduous shrub formations, with or without cactaceous. However, for bioclimatic conditions and surface formations associated with the Caatinga, it can't be compared to a Steppe. Much of the structure of the vegetation present today in the Caatinga is due to the process of use and occupation of the semiarid, which has undergone significant transformations in the landscape, especially during the last decades of the 20th century and beginning of the 21st century, with a strong desertification process. In periods of drought degradation becomes more severe, since the agricultural yields tend to decrease. The lack of economic alternatives in the dry period leads to the intensification of the vegetal extraction for the use of firewood in industries and bakeries and the production of coal. thereby developing an analysis of the use and soil cover is essential for environmental studies, it depicts the pressures and impacts on natural elements present in the landscape.

Objective

Thus, this study was aimed at analyzing the distribution of the use and coverage in the soil, the spatial pattern of fragmentation and connectivity of caatingas landscapes in the basins of Taperoá and High Paraíba in the state of Paraíba, Brazil. The basins of the Upper Paraíba and Taperoá are part of the basin of the Paraiba River, which is fully inserted in the State of Paraíba with approximately 20,000 km2. The basin of the Paraíba River drains wholly or partially the territories of 85 municipalities that are home to a population of about 1.9 million inhabitants, which represents 53% of the entire population of the state of Paraíba (IBGE, 2010).

Methodology

The identification of the remaining savanna vegetation was obtained from supervised classification based on objects (GEOBIA), using images from MSI sensor (multispectral Instrument), carried by the Sentinel 2 satellite. These images were generated on August 4, 2010 and then made available on the website of ESA (European Space Agency). The choice of mapping methodology for rating GEOBIA justified the possibility of greater intervention by the interpreter in the use process of classification and land cover, which is a very important factor in dynamic and complex environments such as the Caatinga. The classification of the types of plant formation by geoecodynamic regime was based on the methodological approach of Cámara (2004). The method of Geoecodynamic schemes has based on the water balance, the bioclimatic balance and textural characteristics of the soils. The water balance (BH) is based on the proposal of Thornthwaite-Matter (López Cadenas, 1986) and the bioclimatic balance (BB) in the Montero de Burgos & González de Rebollar (1974) methods, as increase of the ecological valence of plant formations and edaphic (Field Capacity). After generalization and fusion classes, forest fragments were extracted from the maps of land use and cover, and after being converted to raster format (10x10m) were imported and manipulated in GUIDOS® software (Graphical User Interface for the Description of image Objects and Their Shapes), which is a free software, designed for spatial analysis of forest fragments (VOGT, 2012). The fragments were manipulated from the MSPA (Morphological Spatial Pattern Analysis) module, given as the value fragments edge distance of 100 meters (10 pixels).

Results

Through the calculation area on the map to use and ground cover, comparing data from the geoecodynamic scheme, it is observed that the predominance in the area is of Sub-mesophytic Caatinga, considered Dense Caatinga (42%), located in higher areas, followed located in higher areas, followed the cleared areas (28%) and semiarid Caatinga Tropófila, considered the bearing bush Caatinga (26.5%), located on the flatter areas. Subtropical Tropophyll caatinga, considered arboreal shrub, small crops and mesquite, occur in just over 2% of the area, and the other uses, take up little less than 1% of the basins As for the distribution of uses, we can see from reading the map of use and soil cover a higher concentration of areas with Caatinga vegetation mainly busiest relief surfaces, medium and high slopes of inselbergs. These These locations when the associated subhumid mesophyll geoeconidic regime or similar humid conditions, can be considered refuges (Ab'Saber, 2003), among a deciduous seasonal vegetation of Caatinga. According to Prado (2003) and Rodal et al. (2002), these environments originated in the late Quaternary period between 200.000 and 10.000 years BP, a time when Earth's climate was determined by severe glaciations. The vegetation Caatinga is degraded in areas with flat and slightly corrugated surfaces in the central portion of the basins, where economic activities such as farming and cattle and goats are developed, and where there are urban areas. Also note that the areas in better conservation status are located in Taperoá Basin, and that in the two basins, the western portion is in better condition than the eastern portion. The results generated by analysis of distribution pattern and connectivity of fragments of the caatinga vegetation through the MSPA module of the GUIDOS software helped us to better understand the distribution of vegetation remnants in the basins under analysis, indicating areas in which the connectivity of these fragments is larger, as in the south and northwest of the high Paraíba basin, and in the southeast of the Taperoá basin. These areas are located in lands of great altimetric amplitude, with a more active relief, usually wavy or strongly undulated. The quantitative analysis performed with the results of the feature map generated from GUIDOS pointed to the presence of more than 234.153 hectares of core areas within the Taperoá and high Paraíba basins, which represents more than 19% of the area. This is a very significant number, and would be more encouraging if it did’t contrast with the more than 57% of the matrix area, which alternate between deforested areas and pasture areas, which may be in the process of desertification.

Conclusion

In these more degraded areas it is important to develop a proposal for recovery and propose ideas similar to what Scheid (1993) describes as a quality landscape for rural development in Andalusia. "We understand by landscape quality the aesthetic-visual values that reside in the formal or physiognomic manifestation of the territory, without losing sight of the other values (ecological, cultural, etc.) that are usually attributed to the landscape concept" (Scheid 1993: 43). It is concluded that there is presence of the largest number of caatinga fragments in the branches and edges of the studied area. In the core areas, on undulating and strongly undulating relief surfaces the caatinga vegetation is denser. Deforested areas occur on flat and slightly undulating surfaces in the central portion of the basins, where vegetation is more fragmented. It is also noted that the high Paraíba-Caatinga basin is in a better state of conservation than the Taperoá basin, and that in both cases the western portion of the basins is in a better state of conservation than the eastern portion.

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