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Environmental Degradation and Risk of Desertification in Alto Sertão Region, Alagoas State, Brazil

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ABSTRACT

In this research, the authors evaluated the degree of degradation of the Caatinga biome in Sertão do São Francisco Microregion, Alagoas State, Brazil, by the association of these results with the aridity. We obtained a panorama of the desertification propensity in this area. From the aridity index (IA), the region was classified as having a semi-arid condition ($0.2 \leq IA < 0.5$). It was observed values of IA less than 0.50, characterizing an environment with high propensity to establish the state of desertification. From the collected data, we realized the state of degradation of the municipalities in study, all with percentage of anthropic areas greater than 60%. The municipality of Piranhas deserves highlight by the analysis of temporal evolution of the anthropized Caatinga area, with an increase of 44, 661 km² between 2002 and 2009, corresponding to an increase of 17.8% in only seven years. It leads to a scenario where 74.21% of the original Caatinga is in an anthropized state. The critical values of the aridity index, associated to high degree of anthropization may lead to the establishment of desertification process in the study area.

Keywords: Caatinga, Aridity index, Use and occupation of the soil

Introduction

Caatinga is inserted in its greater part in the Northeast region of Brazil, extending through the states of Alagoas, Bahia, Ceará, Maranhão, Pernambuco, Paraíba, Rio Grande do Norte, Piauí, Sergipe and north of Minas Gerais. It occupies a total area of about 844,453 square kilometers, equivalent to 11% of the national territory. The population living in the biome is about 27 million people, and most of them dependent on the biome's resources to survive. (BRAZIL, 2017). It is the only biome exclusively from Brazil, holder of a great and diversified biological patrimony, with the occurrence of endemic species and an invaluable wealth of plant species and animals (MEDEIROS, 2013). Despite the mentioned attributes, the development of several anthropic activities bring serious threats to its conservation (SIQUEIRA FILHO, 2012). The process of use and occupation of the Brazilian semiarid, in a predatory and fast way, has been contributing to the gradual reduction of forest remnants (1998). Factors that lead the Caatinga to be one of the Brazilian ecosystems most threatened by desertification, because of climatic factors and human activities (COSTA et al., 2009).

The various practices used for agricultural production, such as deforestation, burning and overgrazing, culminate in the depletion of natural resources, changing the characteristics of soil, air and water, as well as in the loss of biological diversity of its fauna and flora. Leading to the impoverishment of the ecosystem, especially in regions with lower rainfall rates, which has a conducive environment for the formation of degraded and decertified areas (AQUINO; ALMEIDA, 2012).

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The loss of the productive potential observed in degraded areas represent a real risk to the population of the regions located in the Arid, semi-arid and dry sub-humid areas of the planet. These processes are already observed in about 33% of the Earth's surface, where about 2.6 billion people live (LIMA et al., 2016).

Desertification has the potential to reach a large part of the Brazilian territory. However, the vast majority of the land susceptible to this process is located in Semi-arid and dry sub-humid areas of the Northeast of Brazil. The occurrence of extreme droughts with anthropogenic pressures, lead to a worsening of this problem in the region (GALINDO et al., 2008).

The objective of this study was to identify the degree of degradation of the Caatinga biome in São Francisco Sertão Microregion, Alagoas State, Brazil, associating these results with the aridity index for the municipalities of the micro-region. The research aims at providing an overview of the sustainability and desertification in this area.

Material and Methods

The Alagoas Micro-region of "Sertão do São Francisco" consists in the municipalities of Olho D'Água do Casado (9 ° 31 'S and 37 ° 51' W, altitude: 209 m), Delmiro Gouveia (9 ° 23 'S and 37 ° 59' W, altitude: 256 m) and Piranhas (9 ° 37 'S and 37 ° 46' W; altitude: 110 m) (DCA, 2017). Occupying an area of 1,339 km² and a population of 82.086 habitants (IBGE, 2010). The area is located in the driest region of Alagoas State, presenting a tropical semiarid climate (BSh), according to the classification of Köppen (LIMA, 1977).

Several soil classes predominate in the region, with extensive areas of Neosols and Planosols, besides Red-Yellow Latosols and Luvisols in lesser occurrence (EMBRAPA, 2002). The predominant vegetation is Caatinga Hyperxerophilic with stretches of deciduous forest (CPRM, 2005), with the presence of species such as cacti, juazeiro (Ziziphus joazeiro Mart.), Pereiro (Aspidosperma pyrifolium Mart.), Angico (Parapiptadenia zehntneri (Harms) MP LimaAnd HC Lima) (ANDRADE et al., 2006).

In order to carry this research out, data of precipitation and evapotranspiration from Gois et al. (2005) were analyzed. For the calculation of the aridity index (IA), the formula proposed by the United Nations Environment Program (UNEP, 1992), which has been used to classify land susceptibility desertification, was used. Its mathematical equation is described below:

IA = Pr / ETP

In which:

Pr: annual mean precipitation (mm / year)

ETP: annual mean potential evapotranspiration (mm / year)

For the data collection of anthropization of Caatinga in the region of study, we used information from the Brazilian Institute Environment and Renewable Natural Resources (IBAMA) in the period from 2002 to 2009.

Results and Discussion

From the values of precipitation and evapotranspiration, it is possible to verify the extreme disparity between the volume of rainfall and the potentially volume of lost water, leading to a water deficit most of the time in the region. Factor that generates some problems, in particular because it jeopardizes agricultural activities, disturbances of social and economic orders, such as the rural exodus (GOMES, 2017). This irregularity of conditions that affect the agricultural activities, leads to greater exploitation of the Caatinga's timber resources, since this is one of the few options for the Northeastern backwoodsmen.

The determination of the aridity index is of paramount importance in the study of desertification process, since the susceptibility to this process is intrinsically associated with the degree of aridity of the area (FREITAS, 2005). By the values obtained in this study (Table 1), the Sertão do São Francisco Microregion of Alagoas States, Brazil was classified as a semi-arid region (0.2 ≤ IA <0.5), considering the UNEP climate classification (1992).

Table 1: Average values of precipitation (Pr), potential evapotranspiration (ETP) and aridity index (IA) for the municipalities of Sertão do São Francisco Microregion of Alagoas States, Brazil.

Municipality	Pr	ETP	IA
Delmiro Gouveia	541,8	1702,4	0,318
Olho D'Água do Casado	551,9	1721	0,321
Piranhas	515,2	2046,5	0,252

In this study, values of IA lower than 0.50 were observed, which mean that the study region has a high propensity to establish the state of desertification (Table 2). Similar values to these found in this research were also observed by Jesus and Mattos (2013) in the desertification nucleus of Seridó city, Rio Grande do Norte State, Brazil. The semi-arid Northeast is the main region of Brazil with environmental problems of desertification, with a total area of approximately 1,340,000 km2 susceptible to this process, which can directly affect 30 million people. Currently, at about 180,000 km2, equivalent to approximately 13% of the territory of the Northeast, is already in serious or very serious desertification (MMA, 2007; RIBEIRO, et al, 2016a).

Table 2: Desertification class standards according to IA.

Aridity index	Degree of risk to the process of Desertification
0,05 to 0,20	Very Hight
0,21 to 0,50	Hight
0,51 to 0,65	Moderate

Source: Matallo Junior (2001).

Critical IA values are reported in several locals in the northeastern semi-arid region (JESUS, MATTOS,

2013, ALMEIDA, et al., 2014, FRANCISCO et al., 2015), largely due to the climatic characteristics of the region, with low rates of precipitation and high evapotranspiration. Scenario that tends to get worse, due to the climate change. There is a tendency for the climate to be drier, with reduced precipitation levels, and water deficit of these regions (LOPES, LEAL, 2015, RIBEIRO et al., 2016b).

The desertification process consists of land degradation in arid zones, Semi-arid and sub-humid areas. Its establishment is given to several factors, which ranging from climatic variations to anthropic actions. The loss of the environment equilibrium leads to desertification from the impoverishment of the soil and the others natural resources. The withdrawal of native vegetation and its replacement by agricultural exhaustive soil, leads the soil to lose its fertility and organic components, leading it to its impoverishment and, subsequent, installation of the erosion process (ALMEIDA, et al., 2014).

From the data collected, we can observe the state of degradation of the municipalities in the study area (Table 3). Being all with percentages of anthropized areas more than 60%. In the region, the unbridled exploitation of natural resources, with the occurrence of practices such as withdrawal of vegetation to new areas of cultivation and for the production of firewood and charcoal. Researches show that about 94% of the firewood and coal used in the semi-arid region come from deforestation of the Caatinga (RIEGELHAUPT et al., 2010).

This biome is responsible for 90% of the demand for forest products in the semi-arid region, accounts for 70% of the energy used by families and participates with 15% of the total income of rural producers. Firewood and coal account for about 25% of the primary energy used by industry and are, respectively, the first and second place in the energy matrix of the region (SILVA, 2013).

In the analyzed municipalities, the land structure is based on small and medium-sized properties. Since one of the pillars of the economy is agriculture and livestock, the exploration of these areas is accentuated. Factor that leads to the exhaustion of the land and its impoverishment, without any practice aimed at restoring the initial fertility of the soil, it may lead to erosion, acidity and salinization (SILVA et al., 2015). This intensive use of natural resources is mainly due to the extreme level of poverty and lack of information that these rural populations are subjected to (LEMOS, 2001).

In this context, without the presence of a fertile soil, the farmer is unable to planting and to maintaining the natural feeding of the herds. Consequently, he loses its main source of income (SANTOS, PACHECO, 2017). The pursuit of other activities, such as timber production, reduce the remaining areas of Caatinga on its property. The maintenance of biodiversity and soil protection depends directly on the existence of vegetation. Plants work on nutrient cycling and organic matter that their leaves intercept by the rain water droplets, reducing the direct incidence on the soil and avoiding its disintegration and, subsequent, erosion (NEVES; SOUZA, 2014).

The municipality of Piranhas deserves special attention due to temporal evolution of the anthropized Caatinga area, with an increase of 44, 661 km² between 2002 and 2009, which corresponds to an increase of 17.8% in just seven years. It leads to a scenario where 74.21% of the original Caatinga is in an anthropic state. Added to this, there is the predominance of shallow soils, with low water storage capacity (EMBRAPA, 2002). In addition to the agricultural practices adopted, such as grazing soil compaction and erosion, they contribute to the desertification of the region (CAMPOS et al., 2015, COSTA et al., 2016).

The three municipalities of the micro-region have in common a high level of anthropization of its original vegetation, which leads to the formation of areas of bare soil without coverage, leaving it unprotected and exposed to wind and water erosion (SOUSA et al., 2016). The main cause of the desertification process is the absence of vegetal cover. In addition, soil impoverishment is a factor that hampers regeneration of plant species (FREIRE; PACHECO, 2011).

Table 3: Overview of anthropogenic Caatinga areas in the Alagoana Microregion of Sertão do São Francisco)

Municipality	Area of the municipality in Caatinga (km²)	Caatinga anthropized until 2002 (km²)	Caatinga anthropized between 2002-2008 (km²)	Caatinga anthropized between 2008-2009 (km²)	Caatinga anthropized until 2009 (km²)
Delmiro Gouveia	606,11	366,46	12,466	0,89	379,816
Olho D'Água do Casado	322,84	223,837	5,124	0,29	229,251
Piranhas	406,52	255,035	45,361	1,3	301,696

Source: Monitoring Report of the Caatinga Biome (IBAMA, 2010, IBAMA, 2011) (Adapted).

Conclusions

Critical values of the aridity index, associated to the high degree of anthropization, may culminate in the establishment of the desertification process of Sertão do São Francisco Microregion, Alagoas State, Brazil. Scenario that inspires care to the maintenance of the economic activities and the environment.

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