Journal of Management and Sustainability; Vol. 12, No. 2; 2022
ISSN 1925-4725 E-ISSN 1925-4733
Published by Canadian Center of Science and Education

Geoenvironmental Mapping for the Delimitation of Regulated Areas for Use and Occupation

José Falcão Sobrinho[1], Francisca Edineide Lima Barbosa[2], Bruna Lima Carvalho[2], Vanessa Campos Ales[2], Nayane Barros Sousa Fernandes[2] & Pedro Henrique Eleoterio de Assis[2]

[1] Professor Doctor. Leader of semiarid search and extension networ/RPES. Vale do Acaraú State University/UVA, Ceará, Brazil

[2] Researchers at semiarid search and extension networ/RPES. UVA, Ceará, Brazil

Correspondence: José Falcão Sobrinho, Professor Doctor. Leader of semiarid search and extension networ/RPES. Vale do Acaraú State University/UVA, Ceará, Brazil.

Received: August 3, 2022 Accepted: September 18, 2022 Online Published: September 27, 2022

doi:10.5539/jms.v12n2p58 URL: https://doi.org/10.5539/jms.v12n2p58

Abstract

The pressure constantly increases for the use and occupation of unexplored areas, concomitantly degrading natural resources. On the other hand, national, state, and municipal laws have arisen to regulate and preserve sites for environmental sustainability, such as Areas of Permanent Preservation (APP) and Legal Reserves. Nevertheless, the significant territorial extension and the multiple legislation make it difficult to define these areas. A relevant instrument to solve this issue is the geoenvironmental mapping of the territory. This work sought to delimit effectively regulated areas for use and occupation based on the geoenvironmental mapping of a section of the municipality of Ubajara, Ceará. Therefore, it was necessary to analyze the hypsometry, slope, water resource, and soil and delimit the APP and Conservation Units. The mapping revealed 15.67% of APP and 37.44% of use and occupation areas, being 46.88% effectively regulated for the use and occupation of the soil with diverse economic activities – such as agricultural, forestry, and pastoral-contemplated in the Ubajara master plan.

Keywords: Areas of Permanent Preservation (APP), environmental impacts, environmental licensing, zoning

1. Introduction

Population growth, globalization, and capitalism have contributed to land degradation and increased environmental impacts. Also, it has intensified the pressure for the occupation of areas and greater exploitation of natural resources (Dantas, 2021; Rodrigues et al., 2019).

The awakening to the environmental problems related to the unbridled exploitation of natural resources began around the 1970s and had as important milestones the Stockholm Conference and Agenda 21, which gave visibility to the concept of sustainability (Baste & Watson, 2022).

In Brazil, actions to reduce environmental impacts began with the creation of Federal Law No. 6.938 on August 31, 1981, which provides for the National Environmental Policy. The law established the Sistema Nacional do Meio Ambiente (National Environmental System, SISNAMA) and defined competencies for the Conselho Nacional do Meio Ambiente (National Environmental Council, CONAMA). It also created environmental licensing, which has regulated the territory for economic activities (BRASIL, 1981).

Other laws of great importance were Federal Law No. 9,605 of February 1998 (Environmental Crimes Law) (BRASIL, 1998), which provides for criminal and administrative penalties derived from conducts and activities harmful to the environment, and Law No. 12,651 of May 25, 2012 (new Brazilian Forest Code) (BRASIL, 2012).

The Forest Code protects native vegetation and establishes general rules for APP and Legal Reserve Areas (RL).

> The Areas of Permanent Preservation is a protected area, covered or not by native vegetation, with the environmental function of preserving water resources, landscape, geological stability, and biodiversity, facilitating the genetic flow of fauna and flora, protecting soil, and providing human well-being. The Legal Reserve is an area located within a property or rural possession, delimited, with the function of ensuring the

> sustainable economic use of the natural resources of the rural property, assisting the conservation and rehabilitation of ecological processes, and promoting biodiversity, as well as the shelter and protection of wild fauna and native flora (BRASIL, 2012).

Besides being in the Forest Code, at the municipal level, the occupation and use of soil are in the municipal master plans through ecological-economic zoning, which are instruments that guide it within the territory (BRASIL, 2001).

Although municipal zoning defines urban, low-occupation residential, and rural zones to regulate the use and occupation of the soil, such data are usually on scales hard to interpret and access. Besides, the territorial extension and multiple laws hamper the definition of areas regulated for the use and occupation by entrepreneurs who seek to develop economic activities—agricultural, forestry, and pastoral—and those that contemplate the exploitation of natural resources, which contributes to non-compliance with laws and the occurrence of environmental impacts.

In this context, and considering the need to enforce environmental legislation at the federal, state, and municipal levels, the geoenvironmental mapping of the territory becomes a relevant tool because it enables the integration of information on the physical environment (Silva & Dantas, 2022). It favors the framing of mapped territories according to guidelines in environmental legislation, which provides compliance with the law and proper use and occupation of soils.

Therefore, the work presents the geoenvironmental mapping of an area in Ubajara, Ceará, delimiting zones of use and occupation. In addition, it promotes knowledge about Brazilian environmental legislation.

2. Material and Method

The study area is in Ubajara, northwestern Ceará, on the border with the Piauí, in a region known as Ibiapaba Plateau or Ibiapaba Mountains. The municipality is the seat of a Conservation Unit (CU), a denomination under Law No. 9985 of July 18, 2000, given by the Sistema Nacional de Unidades de Conservação da Natureza (National System for Nature Conservation, SNUC) to natural areas subject to the protection that have unique characteristics. It includes zones with biodiversity and ecological representativeness in specific territories (SNUC, 2000).

The considered CU is Parque Nacional de Ubajara (Ubajara National Park, PARNA), whose protector is the Chico Mendes Institute for Biodiversity Conservation (ICMBio). It covers 13,968.5 km² in northwestern Ceará (61.06%) and northeastern Piauí (38.94%) (BRASIL, 2002).

The delimitation of the study area took place in a perimeter with a radius of 3 km, starting from the PARNA cave, one of the main tourist attractions of the park located at coordinates 3°49'42.13" lat. S and 40°54'22.50" long. W (Figure 1).

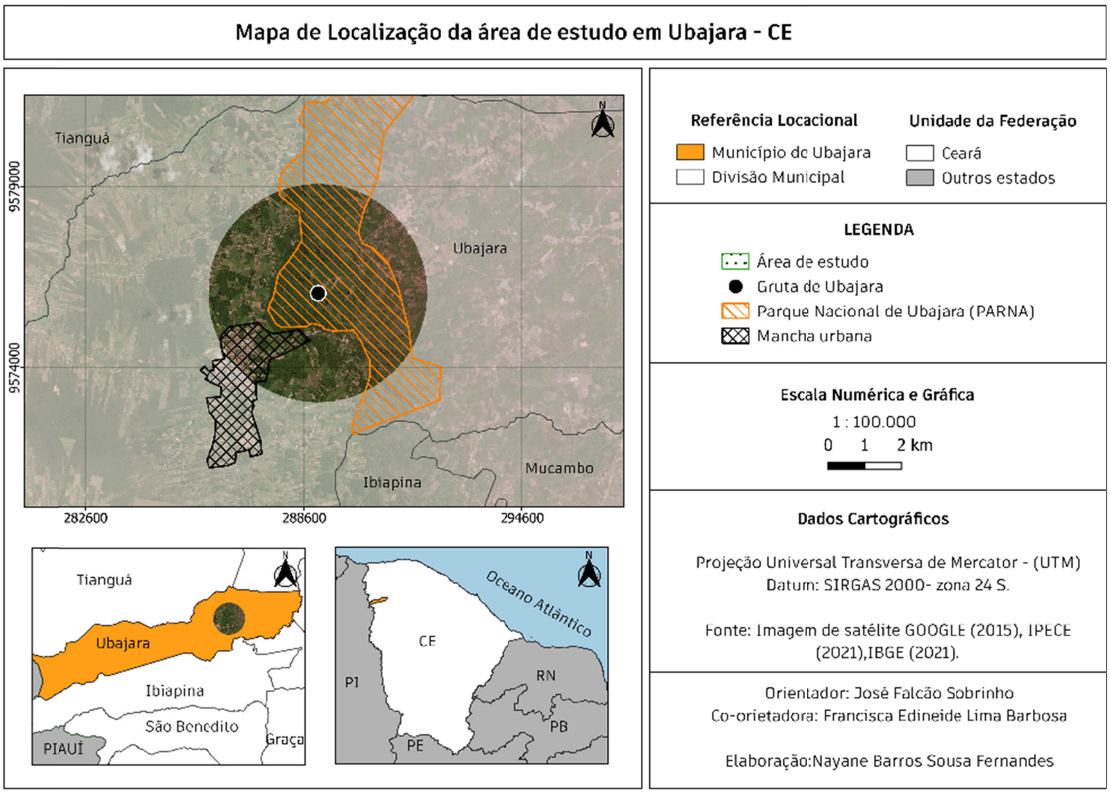

Figure 1. Location map of the study area

Source: Made by the authors, 2022.

The definition of the delimiter polygon happened through an automatic delimitation technique, making it necessary to cut a mosaic with a radius of 3 km from Google and Bing satellite images available in Qgis through the QuickMapService plugin.

After the area delimitation, the data collection began for the thematic maps created from the free software Qgis in versions 2.18 and 3.22. The Alos Palsar satellite provided data concerning hypsometry, slope, and water resources, which was valuable in map production. It used a 12.5-meters resolution, raster reclassification, UTM projection, and a 1:60,000 scale mosaic suitable for the research area.

Raster classification of the hypsometry and slope maps provided categories defined according to the research objective. Eight classes, in meters, served the altitude map, and seven others, in degrees, served the slope map.

The Companhia de Gestão de Recursos Hídricos (Water Resources Management Company, COGERH, 2015) provided water resource data validated through satellite images. Concerning the soil map, the data were from the Empresa Brasileira de Pesquisa Agropecuária (Brazilian Soil Classification System, Embrapa, 2018).

In possession of the data cited above, the next step was the APP delimitation based on Law 12.651/2012 (New Forest Code) and CONAMA Resolution 303/2002. The APP types and criteria used for their delimitations were:

> I – the marginal strips of any natural perennial and intermittent watercourse, excluding the ephemeral ones, from the edge of the regular bed, with a minimum width of:
>
> (a) 30 (thirty) meters for watercourses less than 10 (ten) meters wide;
>
> IV – the areas around springs and perennial waterways, whatever their topographical situation, in a minimum radius of fifty (50) meters;
>
> V – slopes or their part upper than 45°, equivalent to 100% (one hundred percent) on the line of greatest declivity;
>
> IX – on hilltops, hills, mountains, and mountain ranges, with a minimum height of 100 (one hundred) meters and an average inclination upper than 25°, the areas delimited by the contour line corresponding to 2/3 (two-thirds) of the minimum height of the elevation always concerning the base, this defined by the

horizontal plane determined by the plain or adjacent water mirror or, on undulating reliefs, by the quota of the saddle point closest to the elevation.

The APP mapping used automated methods applied to Digital Elevation Models (DEM) from Alos Palsar, with a spatial resolution of 12.5 m, which underwent pre-treatment and filling of the raster depressions.

The springs delimitation happened from the drainage layer using the adherence tools to mark a point in all the initial areas of the drainage network, which resulted in the APP of springs.

The APP of the watercourses had bases on the drainage layers using a vector tool that generated a buffer following the Forestry Code parameters mentioned above. It used a 30-meters distance buffer because the study area has waterways up to 10 meters wide. After the buffer creation, it dissolved the file and created a shapefile layer named APP of watercourses.

The DEM assisted the acquisition of the APP of hilltops. Thus, it was necessary to remove the dark depression named Hydrologically Consistency of Elevation Digital Model (HCDEM) using the Fill Sinks tool from Saga, an extension within Qgis. The creation of an inverse DEM helped to define elevation domains and generate dividers by demarcating the flow lines that, in the non-inverted relief, represent the saddle points.

Subsequently, it turned the file from raster to vector. Naming the layer as the base boundary, it assigned slopes above 45° and amplitude above 100 meters. The saddle points, zonal statistics, and field calculator tools provided the creation of a column with the value of the upper third, and, after that, the file became a raster again. To check the hilltop APP, the (DN = 1) formula applied in the field calculator provided the hilltop features.

For the definitions of the slope APP, the use of the previous process described above only considered values greater than 45°.

3. Result and Discussion

The study area has 2,824.53 hectares—42.55% of it (1,201.83 ha) is in the Conservation Unit of the National Park of Ubajara. The Conservation Units around the country maintain natural spaces and conservation of local biodiversity (Hassler, 2005).

The hypsometry, slope, and soil maps are in Figure 2. The altitude evaluation (Figure 2A) shows variations between 230 m and 900 m, with significant representativeness between 750 m and 900 m, which occupy about 54.4% of the area and are distributed mainly in the plateau area. Lower altitudes (between 230 m and 620 m) are usual in the escape area, which follows in the direction of the hinterland surface, with the most significant among these, the altitudes in the 230 m and 360 m range, which represent about 18.02 % of the total area (Figure 2A).

The high altitudes are due to the local geological nature, characterized as a plateau resulting from high crystalline and sedimentary residual reliefs (Araujo & Martins, 1999; Sampaio, 1995).

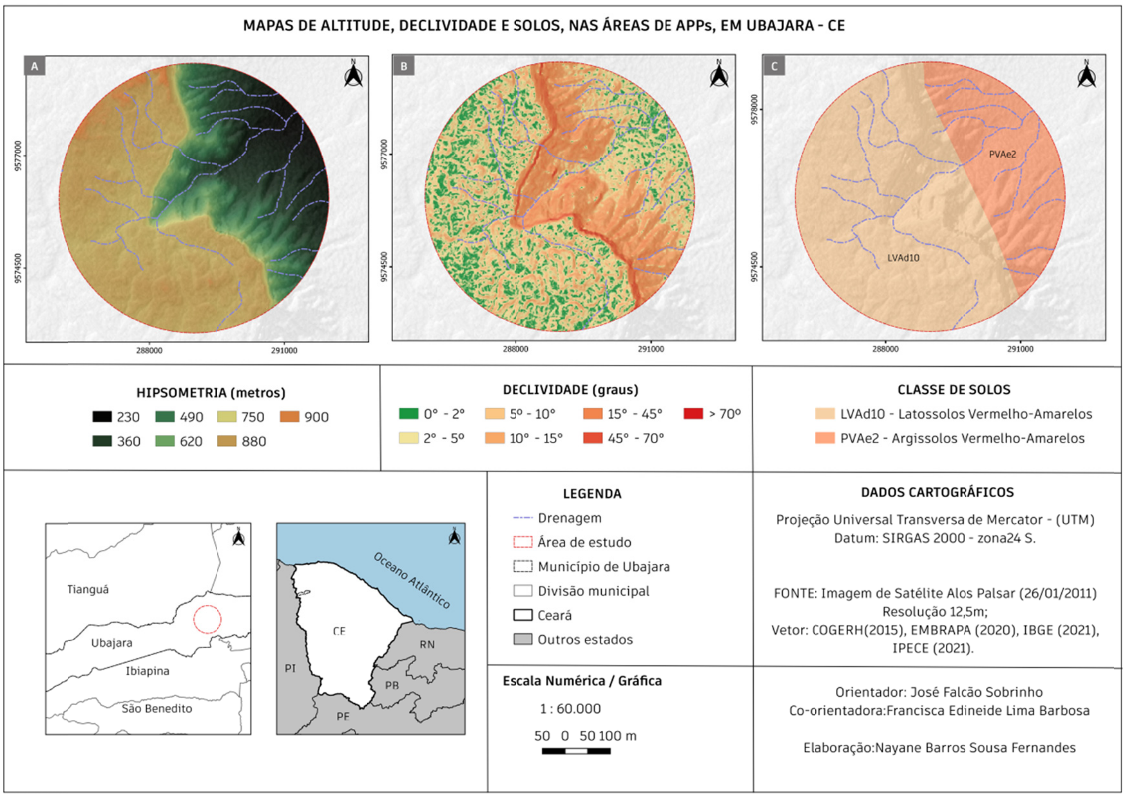

Figure 2. Maps of altitude (A), slope (B), and soils (C) of the study area.

Source: Made by the authors (2022).

In the slope map (Figure 2B), variations from 0º to values higher than 70º were evidenced, with the most quantitatively significant areas with slopes between 5º and 10º. The sum of these represented a total of about 33.11% of the total area studied. Slope ranges between 2º–5º and 15º–45º were also significant, representing 23.58 and 23.87% of the study area, respectively.

Regarding soils (Figure 2C), Red-Yellow Latosol predominates in about 69.52% of the area, distributed mainly in areas with altitudes, while Red-Yellow Acrisol occurs in escarpments. The occurrence of the mentioned soil classes is consistent with what the literature reports about the soil-landscape relationship (Silva, Hayakawa, & Martins, 2021; Lepsch, 2017), being the Latosol formed in conditions of higher precipitation and lower slopes and the Acrisol in higher slopes (Roman Dobarco et al., 2021; Embrapa, 2018).

From the environmental point of view, Acrisol is more susceptible to degradation as the slope of the land increases because it has the B textural horizon (Bt) with higher clay content and a surface layer with sandier texture, which increases the erodibility (Embrapa, 2018).

Considering the objective proposed in this work and the current absence of legislation that limits the use and occupation of the territory based on the classes of soil occurrence, it is noteworthy that the knowledge about the soils of the study area does not lead to significant impacts on the regulation of use and occupation.

However, it requires detailed soil surveys to create more specific legislation, especially at the municipal level, to consider the relationship among the soil classes and their use capacity to define the most appropriate economic activities to be included in environmental zoning and master plans. Thus, contributing to reducing the degradation of natural resources and environmental impacts.

Still analyzing Figure 2, it is possible to verify the delimitation of the hydric network of the Ubajara River, whose sources flow into the PARNA. The selection of the water network of the study area supported the delimitation of the Areas of Permanent Preservation waterways and springs, as shown in Figure 3.

From the environmental point of view, riparian forests have a fundamental ecological and environmental role since they serve as a barrier to contain sediments eroded from adjacent areas, contribute to the reduction of siltation of water bodies and support local biodiversity, among other essential functions (Correia et al. 2019;

Castro et al., 2013). For these and other characteristics, the Forest Code determines the preservation of the APP, whose use and occupation are forbidden, with some exceptions (BRASIL, 2012).

The legislation also defines APP, slopes, parts of slopes upper than 45°, hilltops, hills, and mountains with a minimum height of 100 (one hundred) meters and an average slope upper than 25° (Figure 2).

Figure 3A below shows the delimitation of the APP identified in the study area. These areas totalize 442.64 hectares, about 15.67% of the study area. Of this total, 219.93 ha are APP of water courses, 14.92 ha are APP of springs, 81.6 ha are APPs of slopes, and 126.19 ha are APPs of hilltops.

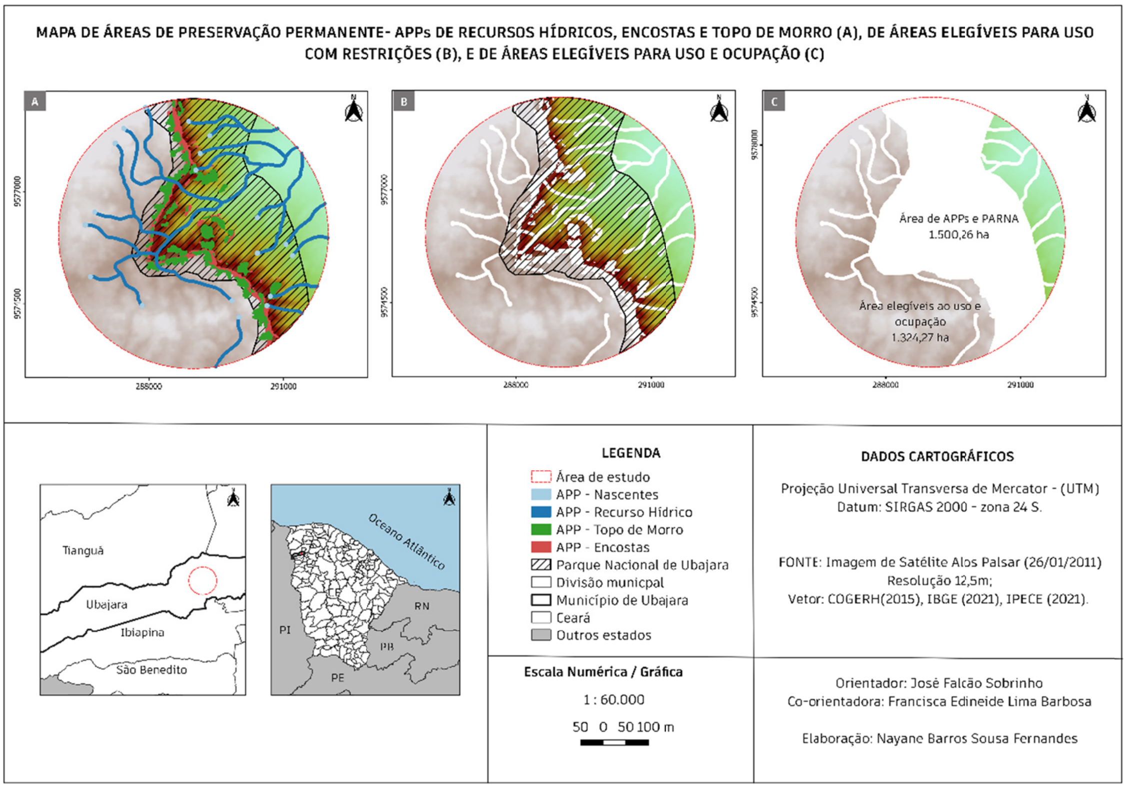

Figure 3. Map of APP of watercourses, springs, slopes, and hilltops (A), areas with restrictions (B), and areas for use and occupation (C)

Source: Made by the authors, 2022.

According to the Forest Code, interventions in APP can occur in a limited manner and depend on authorization from competent environmental agencies. Activities with permission to partially use the APP must be of public utility and necessary for national security and need to access water resources (BRASIL, 2012; CONAMA, 2006). In these cases, the area of intervention must undergo recovery after the cessation of the activity, or the measure of the intervention area must serve as a reference for the restoration of another zone to compensate for the environmental damage done (BRASIL, 2012).

In cases of undue occupation, which occurred after July 22, 2008, the Forest Code provides for the immediate halt of activities and recovery of the affected area. Concerning such issues, the delimited APP from the study area will not count in the total for use and occupation.

Constructed reservoirs, such as dams with an area greater than one hectare, must have their APP delimited (BRASIL, 2012; CONAMA, 2002). Thus, the area regulated for use presented in this study is not suitable as a reference in the preparation of projects for use and occupation of the clipping in question since the scale of the data used is quite large, which can not record all APP.

The APP with a slope between 25º and 45º is also subject to exceptions to the regulation of agroforestry activities and infrastructure maintenance, with some of the requirements being the use of sustainable management, public utility, and social interest (BRASIL, 2012).

The summary of the regulated areas is in Figures 3B and 3C. Figure 3B shows areas with partial regulation for use and occupation, such as agriculture, forestry, pasture, tourism, and scientific and environmental education activities, totalizing 2,381.9 ha or 84.33% of the study area. The areas include the Ubajara National Park, which is under ICMbio jurisdiction.

As for the nature of use and occupation, the areas in the Ubajara National Park (1,057.63 ha or 37.44%) are for touristic, scientific, and environmental purposes since the PARNA belongs to a protective group. The preservation goal does not allow the use of its resources but only actions that do not involve consumption, collection, or damage (BRASIL, 2000). In these areas, the development of any of the activities mentioned depends on the ICMbio authorization and other competent environmental licensing agencies.

Figure 3C contemplates the areas eligible for use and occupation that are not in the Ubajara National Park. Therefore, the regulation is due to various economic activities, including agriculture, forestry, and cattle ranching, and is subject to environmental licensing by competent licensing agencies. These represent a total of 46.88% of the total area assessed, or 1,324.27 ha.

4. Conclusions

The mapping revealed that 46.88% out of the 2,824.53 ha of the study area has regulations for use and occupation, including agricultural, forestry, and pastoral activities. In addition, 37.44% are only to research, tourism, and environmental education activities with authorization from ICMbio. The remaining zones—forbidden for use and occupation—are APP for watercourses, springs, slopes, and hilltops.

Geosystemic knowledge obtained through the integrated analysis of the geographic elements in geoenvironmental maps of this study enables the classification and selection of regulated areas for use and occupation. Besides, it supports the elaboration of legislation and municipal ecological-economic zoning, which contributes to sustainable occupancy.

The importance of geoenvironmental mapping is significant for small areas. Therefore, and due to the wide scale, this study is not appropriate to be a single reference when elaborating projects for use and occupation in the area of the clipping in question.

Acknowledgment

This research is thankful to the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Coordination for the Improvement of Higher Education Personnel, CAPES), to the Conselho Nacional de Desenvolvimento Científico e Tecnológico (National Council for Scientific and Technological Development, CNPq), and the Fundação Cearense de Apoio ao Desenvolvimento Científico e Tecnológico (Ceará Foundation for the Support of Scientific and Technological Development, FUNCAP) for their continuous help and financial support, as well as to the Universidade Estadual Vale do Acaraú (Acaraú Valley State University, UVA) for the technical, scientific, and structural support.

Reference

Araujo, F. S. D., & Martins, F. R. (1999). Fisionomia e organização da vegetação do carrasco no Planalto da Ibiapaba, Estado do Ceará. *Acta Hol. Hras*, *1*(9), 1−13. https://doi.org/10.1590/S0102-33061999000100002

Baste, I. A., & Watson, R. T. (2022). Tackling the climate, biodiversity and pollution emergencies by making peace with nature 50 years after the Stockholm Conference. *Global Environmental Change*, *5*(73), 2−8, https://doi.org/10.1016/j.gloenvcha.2022.102466

BRASIL. Decreto S/N, de 13 de dezembro de 2002. (2022). Amplia os limites do Parque Nacional de Ubajara, no município de Ubajara, no Estado do Ceará. Diário Oficial da União, Brasília, DF, 16 dez. 2002. Disponível em Acesso em 16 de junho de 2022.

BRASIL. Lei Federal nº 6.938, em 31 de agosto de 1981. (2022). *Dispõe sobre a Política Nacional do Meio Ambiente, seus fins e mecanismos de formulação e aplicação, e dá outras providências*. Disponível em http://www.planalto.gov.br/ccivil_03/leis/l6938.htm#:~:text=LEI%20N%C2%BA%206.938%2C%20DE%2031%20DE%20AGOSTO%20DE%201981&text=Disp%C3%B5e%20sobre%20a%20Pol%C3%ADtica%20Nacional,aplica%C3%A7%C3%A3o%2C%20e%20d%C3%A1%20outras%20provid%C3%AAncias

BRASIL. Lei Federal nº 9.605, de fevereiro de 1998. (2022). *Dispõe sobre as sanções penais e administrativas derivadas de condutas e atividades lesivas ao meio ambiente, e dá outras providências*. Disponível em http://www.planalto.gov.br/ccivil_03/leis/l9605.htm#:~:text=LEI%20N%C2%BA%209.605%2C%20DE%

2012%20DE%20FEVEREIRO%20DE%201998.&text=Disp%C3%B5e%20sobre%20as%20san%C3%A7%C3%B5es%20penais,ambiente%2C%20e%20d%C3%A1%20outras%20provid%C3%AAncias

BRASIL. LEI Nº 9.985, DE 18 DE JULHO DE 2000. (2022). *Regulamenta o art. 225, § 1o, incisos I, II, III e VII da Constituição Federal, institui o Sistema Nacional de Unidades de Conservação da Natureza e dá outras providências*. Disponível em http://www.planalto.gov.br/ccivil_03/leis/l9985.htm

BRASIL. LEI Nº 10.257, DE 10 DE JULHO DE 2001. (2022). *Regulamenta os arts. 182 e 183 da Constituição Federal, estabelece diretrizes gerais da política urbana e dá outras providências*. Disponível em http://www.planalto.gov.br/ccivil_03/leis/leis_2001/l10257.htm#:~:text=O%20plano%20diretor%20%C3%A9%20obrigat%C3%B3rio,%C2%A7%204o%20do%20art

BRASIL. LEI Nº 12.651, DE 25 DE MAIO DE 2012. (2022). *Novo Código Florestal. Dispõe sobre a proteção da vegetação nativa; altera as Leis nos 6.938, de 31 de agosto de 1981, 9.393, de 19 de dezembro de 1996, e 11.428, de 22 de dezembro de 2006; revoga as Leis nos 4.771, de 15 de setembro de 1965, e 7.754, de 14 de abril de 1989, e a Medida Provisória no 2.166-67, de 24 de agosto de 2001; e dá outras providências*. Disponível em http://www.planalto.gov.br/ccivil_03/_ato2011-2014/2012/lei/l12651.htm

Castro, M. N., Castro, R, N., & Souza, P. C. (2013). An importância da mata ciliar no contexto da conservação do solo. *Revista eletrônica de educação da faculdade Araguaia*, *4*(4), 230–241.

COGERH – Companhia de Gestão de Recursos Hídricos. (2022). *Rede de Drenagem* (2015). Disponível em http://i3geo.cogerh.com.br/i3geo/ogc/download.php#

CONAMA. CONSELHO NACIONAL DO MEIO AMBIENTE. Resolução nº 303 de 20 de março de 2002. (2022). *Dispõe sobre parâmetros, definições e limites de Áreas de Preservação Permanente*. Disponível em http://www.mma.gov.br

CONAMA. CONSELHO NACIONAL DO MEIO AMBIENTE. Resolução nº 369, de 28 de março de 2006. (2022). *Diário Oficial da União, Edição Número 61, de 29/03/2006*. Disponível em https://www.pmf.sc.gov.br/arquivos/arquivos/pdf/20_12_2013_15.00.37.7bd8d431d55dcfcfee40314c9c495266.pdf

Correia, I. M. G., Souza, B. H., Moura, D. C., & Souza, Y. G. (2019). Mata ciliar, conservação e sustentabilidade. Fundamentos de sua importância para o Semiárido paraibano: Estudo de caso no alto curso do Rio Paraíba. *REGNE*, *5*(2), 41–60. https://doi.org/10.21680/2447-3359.2019v5n2ID17233

Dantas, G. R. S. (2021). *DESENVOLVIMENTO ECONÔMICO, QUESTÃO AMBIENTAL E "QUESTÃO SOCIAL" NO RIO GRANDE DO NORTE*. Monografia (Graduação em Serviço Social) - Universidade Federal do Rio Grande do Norte, Centro de Ciências Sociais Aplicadas, Departamento de Serviço Social. Natal, RN, 2021. Orientador: Prof. Dr. Marcelo Braz Moraes dos Reis.71 páginas.

EMBRAPA. (2021). *Empresa Brasileira de Pesquisa Agropecuária, 2018; Sistema Brasileiro de Classificação de Solos/ Humberto Gonçalves dos Santos et al. 5ª ed., rev. e ampl. Brasília, DF. 365 p.: il. color.; 16 cm x 23 cm*. Disponível em https://ainfo.cnptia.embrapa.br/digital/bitstream/item/199517/1/SiBCS-2018-ISBN-9788570358004.pdf

Hassler, M. L. (2005). A Importância da Unidades de Conservação do Brasil. *Sociedade E Natureza*, *17*(33), 79–89.

Lepsch, I. F. (2017). Pedometria, mapas digitais e convencionais de solos e os modelos conceituais solo-paisagem. *Boletim Informativo da SBCS*, *43*(3), 16–17.

Rodrigues, S. C. M., Dias, L. A. L., Carvalho, A. C., Fenz, N., Lopes, L. O., & Do, C. (2019). Os recursos naturais no processo de desenvolvimento econômico capitalista: uma breve reflexão. *Semioses: Inovação, Desenvolvimento e Sustentabilidade*, *13*, 50–68. https://doi.org/10.15202/1981996x.2019v13n4p50.

Roman Dobarco, M., Mcbratney, A., Minasny, B., & Malone, B. (2021). A modelling framework for pedogenon mapping. *Geoderma*, *393*, 1–16. https://doi.org/10.1016/j.geoderma.2021.115012

Sampaio, E. Y. S. B. (1995). Overview ofthe Brazilian caatinga. ln S. H. Bullock, H. A. Mooney & E. Medina (Eds.), *Seasonally dry tropical forests* (pp. 35–63). University Press. Cambridge. https://doi.org/10.1017/CBO9780511753398.003

Silva, B. A. D. A., Hayakawa, E. H., & Martins, V. M. (2021). Espacialização das classes solos a partir da utilização de atributos geomorfométricos na Bacia do Paraná, Brasil. *Revista Brasileira de Geografia Física*, *14*(7), 4126–4147. https://doi.org/10.26848/rbgf.v14.7.p4126-4147

Silva, C. R. D., & Dantas, M. E. (2022). *Mapas Geoambientais*. Disponível em https://rigeo.cprm.gov.br/xmlui/bitstream/handle/doc/17873/mapas_geoambientais_sbcgg.pdf?sequence=1&isAllowed=y#:~:text=Trata%2Dse%20de%20um%20diagn%C3%B3stico,abrangendo%20todo%20o%20territ%C3%B3rio%20brasileiro

SNUC. (2022). *Sistema Nacional de Unidades de Conservação da Natureza* (5th ed., p. 56). Brasília: MMA/SBF, 2004. Disponível em https://www2.camara.leg.br/legin/fed/lei/2012/lei-12651-25-maio-2012-613076-normaatualizada-pl.pdf