DEGRADATION PROCESSES IN THE SEMI-ARID REGION: A SOCIO-ENVIRONMENTAL ANALYSIS

PROCESSOS DE DEGRADAÇÃO NO SEMIÁRIDO: UMA ANÁLISE SOCIOAMBIENTAL

PROCESOS DE DEGRADACIÓN EN LA REGIÓN SEMIÁRIDA: UN ANÁLISIS SOCIOAMBIENTAL

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ABSTRACT

The depletion of natural resources, due to the increasing demand for agricultural and forestry products, combined with land use that disregards its potential and limitations, has led to the degradation of vegetation, soil, and water. The study of the vulnerability to which populations are exposed, as well as knowledge of land use capacity an important factor for proper soil management constitute essential elements for assessing the impacts on these areas. This study seeks information regarding socioeconomic, environmental, and drought-related vulnerabilities, as well as land use capacity in the northeastern semi-arid region. Furthermore, it highlights the need for planning and sustainable management guided by technical criteria and local realities, as indispensable strategies to mitigate degradation and promote the resilience of semi-arid populations. However, the adoption of appropriate land-use practices, combined with effective public policies, can contribute to the conservation of natural resources and to a more balanced and sustainable development of the region.

Keywords: Anthropogenic Impacts. Socioecological Resilience. Soil Conservation.

RESUMO

O esgotamento dos recursos naturais, devido à crescente demanda de produtos agrícolas e florestais, aliados à utilização das terras sem considerar suas potencialidades e limitações, tem levado à degradação da vegetação, do solo e da água. O estudo da vulnerabilidade a que as populações estão expostas, assim como conhecimento da capacidade de uso das terras, importante para o manejo adequado do solo, constituem elementos essenciais para a avaliação dos impactos sobre essas áreas. O estudo busca informações a respeito das vulnerabilidades socioeconômicas, ambientais e das secas, bem como capacidade de uso da terra no semiárido nordestino. Contudo, este estudo reforça a necessidade de planejamento e manejo sustentável, orientados por critérios técnicos e pela realidade local, como estratégias indispensáveis para mitigar a degradação e promover a resiliência das populações do semiárido. No entanto, a adoção de práticas adequadas de uso da terra,

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associada a políticas públicas eficazes, pode contribuir para a conservação dos recursos naturais e para o desenvolvimento mais equilibrado e sustentável da região.

Palavras-chave: Impactos Antrópicos. Resiliência Socioecológica. Conservação do Solo.

RESUMEN
El agotamiento de los recursos naturales, impulsado por la creciente demanda de productos agrícolas y forestales, junto con el uso de la tierra sin considerar sus potencialidades y limitaciones, ha llevado a la degradación de la vegetación, el suelo y el agua. El estudio de la vulnerabilidad a la que están expuestas las poblaciones, así como el conocimiento de la capacidad de uso de la tierra —importante para el manejo adecuado del suelo—, constituyen elementos esenciales para la evaluación de los impactos en estas áreas. Este estudio busca información sobre las vulnerabilidades socioeconómicas, ambientales y relacionadas con las sequías, así como la capacidad de uso de la tierra en el semiárido del nordeste. Asimismo, refuerza la necesidad de planificación y manejo sostenible, orientados por criterios técnicos y por la realidad local, como estrategias indispensables para mitigar la degradación y promover la resiliencia de las poblaciones del semiárido. La adopción de prácticas adecuadas de uso de la tierra, junto con políticas públicas eficaces, puede contribuir a la conservación de los recursos naturales y a un desarrollo regional más equilibrado y sostenible.

Palabras clave: Impactos Antrópicos. Resiliencia Socioecológica. Conservación del Suelo.

1 INTRODUCTION

In Brazil, environmental degradation began in the colonial period, with the exploitation of brazilwood, which marked the beginning of large-scale deforestation. This process has intensified over time and persists to the present day, being aggravated by the continuous expansion of industrialization and urbanization (Mesquita, 2026).

Environmenta degradation, both worldwide and in the semi-arid region, has increased drastically due to the growing demand for agricultural, forestry and livestock products, combined with the inadequate use of natural resources, resulting in the degradation of vegetation, soil and water.

The main cause of degradation of natural resources is the predatory use by man, who acts in this environment, due to his low level of conservation awareness and lack of information about the use of natural resources in relation to their potentialities and limitations (Oliveira et al., 2007).

The beginning of environmental degradation begins with the removal of native tree vegetation and after the inadequate management of the natural resources of the area, leaving the soil without protection, it is subject to various types of erosion, negatively altering the attributes of the soil (Pereira, 2011).

Erosive processes are one of the main consequences of inadequate land use, which has been exploited and degraded intensively, causing a decrease in productivity and income of farmers. Soil conservation is undoubtedly one of the most important aspects today (Mota et al., 2008).

A soil conservation plan consists of the use of land related to its capacity and the application of conservation practices to allow its best use without suffering degradation (Giboshi et al., 2006).

The diagnosis of land use, which indicates the capacity to use it, is of great importance for territorial planning, in which it shows the way in which the use of the area is being used, with the classification of the capacity to use the land it is easy to identify the limiting factors and the potential of the soils in an area (Costa, 2009). However, inadequate land use planning causes impoverishment and low production, which results in a decrease in the socioeconomic and technological level of the rural population (Rampim et al., 2012).

In the semi-arid region of the Brazilian Northeast, the lack of planning for land use, together with prolonged droughts and the absence of adequate infrastructure to live with the semi-arid climate, has become one of the main sources of risks for the population of this region and, consequently, contributes to the increase in social, economic and environmental vulnerabilities.

It is verified that the concept of vulnerability refers to certain environmental issues, problems or impacts such as climate change, erosion, among others, in addition to being linked to other factors, such as exposure to pressures, sensitivity of the ecological system and adaptive capacity of society (Figueiredo et al., 2010).

Populations are constantly vulnerable, both economically and socially, and public policies are needed to minimize the needs and deprivations of families. These existing realities lead to the need for studies in these locations, which provide an assessment of the vulnerability index, informing the needs that reduce growth and development (Cruz et al., 2013).

Therefore, the land use capacity provides important information about the limitations and potentials of an area, while the vulnerability study indicates the carrying capacity of the area in relation to environmental aspects and its interactions with the population. These studies help to implement, according to the limitations or potentials of each region, adequate land use management and public policies for sustainable development.

2 SEMI-ARID REGION AND ENVIRONMENTAL DEGRADATION

In Brazil, environmental degradation is expressed in a differentiated way in different environments. In the Northeast region, especially due to the predominance of the semi-arid climate, which imposes limitations on the physical base, a strong relationship between human actions and environmental degradation processes is observed. This dynamic has its origins in the period of colonial occupation and persists to the present day, configuring a scenario marked by precarious working conditions and intense pressure on natural resources, resulting from livestock and family-based agriculture (Lemos, 2001).

In the semi-arid Northeast is the Caatinga biome, characterized by the semi-arid tropical climate, which forms an extensive area of land in the interior of the Northeast region, including the states of Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, Bahia and the north of Minas Gerais (Brasileiro, 2009).

The semi-arid region has an area of 980,133 km2, with approximately 22.5 million inhabitants. With rainfall of 800 mm on average, in the period from January to May, but distributed irregularly in time and space, making it a challenge for communities and the productive sector. These difficulties are accentuated by the occurrence of prolonged droughts that make life and production conditions in the semi-arid region even more difficult (Teixeira and Machado, 2015).

A determining aspect for the formation of semi-arid regions is drought, which is marked by a marked deficiency of rainfall, where the Caatinga biome is inserted with a

diversity of animal and plant species adapted to low water availability (Serafini Júnior, 2014). Originally, the Caatinga biome is formed by arboreal vegetation, being one of the richest in species among the regions with a dry climate in the world (Souza, 2011). The semi-aridity of the Northeast is a natural event that has been accentuated due to human activities and prolonged droughts, which cause a more accentuated use of natural resources by rural families with lower income and thus more vulnerable (Sousa et al., 2008).

The Brazilian semiarid region has a natural disposition for soil degradation due to irregular climate, prolonged droughts, high evapotranspiration, shallow soils, low water retention capacity and soil salinity, reflecting on productivity. In these environments, production systems have reduced or no sustainability, as a result of the use of technologies that degrade the soil, thus compromising its quality (Nunes et al., 2005).

In semi-arid areas, physical degradation is directly due to erosion, a consequence of the lack of vegetation cover that contributes to the surface runoff of water and the disaggregation of soil particles. Chemical degradation is related to the accumulation of salts in the soil profile, due to saline material, low rainfall, high evaporation of water on the soil surface, and the use of low quality water for irrigation. And biological degradation originates from the low content of organic matter in the soil, due to the characteristics of the vegetation and the accentuated deficit of moisture that contributes to reducing the activity and diversity of soil fauna (Melo Filho and Souza, 2006).

In these semi-arid regions, the vegetation is open, causing the soil to be uncovered and susceptible to erosion, but this was not always the case, the degree of cover has been suffering a process of degradation due to the removal of firewood, fires and deforestation for land use, agriculture and livestock, causing the extinction of several species and reducing the rich biodiversity of this ecosystem (Araújo, 2011).

The main anthropic impact caused in the caatinga is the formation of pastures, which begins with the removal of native vegetation for the production of firewood and charcoal, followed by the implementation of extensive pasture, which associated with the water deficit of the semi-arid region, causes the degradation of the soil and the local environment (Serafini Júnior, 2014). The change in the spatial configuration of the semi-arid region is linked to the impacts of land use by small, medium and large properties, but the most vulnerable populations, who practice family-based agriculture, are the most fragile to this whole process (Brasileiro, 2009).

Agricultural exploitation, with inadequate use of irrigation that contributes to soil salinization, extensive and semi-extensive cattle raising, and mining, expose the soil to erosion, and the lack of conservation practices, which have been causing changes in the

landscape of the semi-arid Northeast, aggravating the natural processes of degradation or desertification, in several regions, especially in the area of the drought polygon (Alves et al., 2009; Medeiros et al., 2012).

In this context, Travassos and Souza (2011), studying soils and desertification in the Paraíba hinterland, concluded that through the data it is possible to prove that frequent deforestation in caatinga soils, previously fertile, leads to a decline in their natural fertility, causing impacts on flora, and changes in chemical attributes and consequently in soil fertility. Showing that this management practice favors desertification.

The complexity and heterogeneity of the characteristics of the semi-arid region with regard to climate, soil and vegetation for agricultural activities become a challenge in the use and management of soil and water (Melo Filho and Souza, 2006). Research carried out by the Ministry of the Environment on the occurrence of desertification observed that 60.47% of the region of the Drought Polygon in the Northeast is in the process of desertification (Nóbrega et al., 2003).

3 SOCIOECONOMIC, ENVIRONMENTAL AND DROUGHT VULNERABILITY

The study of vulnerability has been highlighted with regard to the human being, in works of population groups, helping to understand human-environment interactions. It is used to assess and analyze the risk, danger, impacts and damages to which populations are exposed, in addition to the degree of susceptibility and adaptation to the disturbance to this exposure (Correia, 2010).

To know and identify the term vulnerability in different scientific areas, it is necessary to observe together with the concept of risk, in which in research on risk, vulnerability is initially found in the environmental dimension and only later in the socioeconomic dimension. Risk or vulnerability should not be treated in isolation, as risk comes from the danger-vulnerability relationship, in which each of them originates from various factors that involve sectors linked to the creation, coping and consequence of the phenomenon (Marandola Jr. and Hogan, 2005).

The terms danger and risk applied to the context of the semi-arid region, it can be said that Danger is represented by drought (natural danger) and desertification (environmental danger) driven by anthropic action. Risk is the probability of greater or lesser occurrence of hazards, such as droughts, atmospheric factors, desertification, human activities in the environment and the form of conservation management practices, etc. (Melo, 2010).

A given natural phenomenon only becomes a disaster if the area is vulnerable, socially, economically or environmentally, so it is of fundamental importance to understand the meaning of vulnerabilities (Melo et al., 2009).

In this scenario, according to Cardona (2001), vulnerabilities have their beginning in causes linked to economic, demographic and political processes, which can interfere in the distribution of power and thus in the destination and distribution of resources among the different population levels. Also according to the same author, the social processes developed in the communities are related to vulnerability, due to the difficulty of recovering from actions to which they are exposed. This vulnerability has increased in countries due to disorderly urban growth and environmental degradation, which has consequences for impacts on quality of life and natural resources.

Vulnerability is linked to the resilience of a certain area in relation to the impacts to which they are likely to occur, so understanding these factors that cause these environmental impacts helps to direct public investments to various regions (Figueirêdo et al., 2007).

At this juncture, Cruz et al. (2013) observed that the value of 80% of economic vulnerability (very high) is a consequence of the low working conditions of rural people conditioned by the lack of credit, technical assistance and the low level of education. Feitosa et al. (2010) found high social vulnerability in the municipalities of Mirandela, Portugal (37%), Serra Branca (42%) and Coxixola (42%), Brazil, reflecting the low level of education, housing and size of rural properties, which are small, causing families to lack sustainability.

The purpose of the Environmental Diagnosis is to know the direct impacts of the environment, through questionnaires with the population belonging to the Hydrographic Basin, to generate the curve of the line of environmental deterioration (Alves et al., 2011). The information obtained through these diagnoses is capable of identifying facts and techniques that favor the current level of the quality and use of water, soil and vegetation in these areas analyzed (Pereira and Barbosa, 2009).

The low capacity to resist droughts generates vulnerabilities that evolve with economic and social crises, caused by the form of population and productive occupation of the semi-arid region of Paraíba, which causes great impacts on the environment and natural resources that are already limited (Sousa et al., 2008). Socioeconomic and environmental diagnoses are considered to be of great relevance because they show the socioeconomic, technological and environmental situation of an area. These diagnoses seek answers to solve problems related to people's quality of life, while the environmental diagnosis is related to environmental impacts (Franco et al., 2005).

4 VULNERABILITIES AND THE SEMI-ARID

The vulnerabilities of families and the process of desertification of the lands are linked, impacting the environment and the quality of life of the population. This is due to the scarcity of natural resources in these desertified areas, which cause severe social, economic and environmental vulnerabilities, which are intensified with droughts and the lack of policies to coexist with them (Sousa et al., 2008).

Sensitivity to droughts directly affects social, technological, and economic vulnerabilities, making it the most impactful on the quality of life of the population of the semi-arid Northeast, such as the cariri of Paraíba. In these locations, public policies are needed to control the risks and their effects on the population (Feitosa et al., 2010).

Over five centuries of exploitation of the semi-arid region, there has been a risk of desertification, considering the form of colonization that sought only profitability without due care for the natural resources and the quality of life of this population, thus deconstructing the deterministic view of a punishing region and giving more emphasis to the understanding of the social action of vulnerabilities (Melo, 2010).

Considering this scenario , Alves and Alves (2012), studying some communities located in the Microregions of Cariri and Sertão of the State of Paraíba, observed that these communities are vulnerable to the adverse conditions of the semi-arid region because they have presented a high degree of socioeconomic deterioration.

In addition to the lack of water, the semi-arid region has soil limitations for agriculture and pest attacks. However, the climate is not the limiting factor according to farmers, but the lack of investment in production due to the scarcity of financial resources (Andrade et al., 2013). The high values of vulnerability obtained demonstrate the fragility of the population to social, economic, technological and environmental aspects, and the lack of public policies that reduce the impacts of droughts, which initiate the others (Alencar, 2008).

Vulnerability is understood as the decrease in the availability, access and management of assets that generate opportunities, leading to social inequalities such as marginality and exclusion. Reducing vulnerability provides increased sustainability, so teaching populations to respond to situations of social and environmental risks to which they are exposed, will produce their social inclusion and better quality of life (Marandola Jr. and Hogan, 2005).

In view of this, Andrade et al. (2013) mentions that the continuation of studies of the characteristics of the vulnerabilities of agriculture, related to communities, are important to seek solutions that contemplate the real needs and potentialities of these communities. Campos (2009) says that a deficiency was found in rural extension, with regard to the

absence of investments for the qualification of human resources, the number of technicians and infrastructure. In addition to technical training in agricultural schools and a technical assistance policy.

5 LAND CAPACITY AND USE

The use and occupation of land is the way in which the area is used by man, making it necessary to survey it, while the inadequate form of use leads to environmental degradation, allowing the identification of the current use of the area according to its suitability (Dortzbach et al., 2013).

In agri-environmental planning, information related to the physical diagnosis is sought, which involves aspects of soils, climate, relief, vegetation, water resources, among others. By means of methods to evaluate the areas, it is possible to indicate different forms of agricultural activities, providing soil production and conservation (Mendonça et al., 2006).

The land use capacity changes according to the characteristics of the soil (effective depth, internal drainage of the profile, slope and surface erosion) and environment, interfering with the classification at the group and class level. This classification makes it possible to indicate better practices in land use and management (Santos et al., 2012).

The survey of land use capacity is not the set according to economic use or its purchase cost. However, these classes indicate a decreasing ordering of the feasibility of more intense use of the land, without danger of soil degradation, providing the owner with better autonomy in the possibility of use (Niemann, 2012).

When carrying out agricultural or sustainable land use planning, it is necessary to follow a plan, despite having methods used in each phase, and it is necessary to evaluate, know and characterize. Starting with the diagnosis and environmental identification for the analyses and evaluations and thus being implemented according to the reality of the area (Alves et al., 2003).

The use of the Minimum Mandatory Formula to define classes of land use capacity brought together a set of knowledge of great importance regarding environmental physical-conservationist practices, for the planning and execution, by the component agencies, of a preservation zoning in the area of the Patativa do Assaré Settlement (Melo and Guerra, 2013).

The basis of agronomic planning is formed by the evaluation of the capacity to use the land together with the socioeconomic conditions. This assessment of land use capacity is related to various agricultural activities and not to specific crops. Grouping the plots into

hierarchically ordered categories or classes, based on the characteristics of the soil and the area (Alves et al., 2003).

The planning of the natural resources of a municipality requires the mapping of suitability for use, current use and permanent preservation areas, which makes it possible to define the areas with conflicts of use, making it possible with this data to improve the use of the areas in an economic and sustainable way (Pedron et al., 2006).

To obtain a conservationist purpose, it is necessary to raise awareness among rural producers, linked to technical assistance and financial resources. Understanding the dynamics of sustainability, the correct use of natural resources, including soil (Mota et al., 2008).

6 FINAL CONSIDERATIONS

The inadequate use of vegetation and soil in the semi-arid region has been causing environmental degradation, which leads to problems in agricultural activity, with a decrease in soil fertility and organic matter and, consequently, productivity, in addition to the reduction of flora and fauna, with social and economic impacts for the populations of the region.

The study of the vulnerabilities to which populations are susceptible is necessary for the implementation of public policies. Another important point is the conservation planning of the land, with identifications of its physical-environmental aspects, which demonstrate its capacity for use.

In the semi-arid Northeast, the conservationist use of natural resources is essential to reduce environmental degradation and ensure productive sustainability. Conservationist practices such as Environmental education and technical assistance, Proper management of the Caatinga, Crop-livestock integration, among others. These strategies contribute to the conservation of natural resources, increased productivity, and greater resilience of production systems in the face of recurrent droughts in the semi-arid region.

REFERENCES

Alencar, M. L. S. (2008). Os sistemas hídricos, o bioma caatinga e o social na bacia do rio Sucuru: riscos e vulnerabilidades (Tese de doutorado). Universidade Federal de Campina Grande.

Alves, A. R., & Alves. (2012). Riscos e vulnerabilidades em assentamentos rurais no estado da Paraíba. Revista Geonorte, 2(5), 1120–1132.

Alves, H. M. R., Alvarenga, M. I. N., Lacerda, M. P. C., & Vieira, T. G. C. (2003). Avaliação de terras e sua importância para o planejamento racional do uso. Informe Agropecuário, 24(220), 82–93.

Alves, J. J. A., Souza, E. N., & Nascimento, S. S. (2009). Núcleos de desertificação no estado da Paraíba. RA'E GA, (17), 139–152.

Alves, T. L. B., Araújo, A. R., Alves, A. N., Ferreira, A. C., & Nóbrega, J. E. (2011). Diagnóstico ambiental da microbacia hidrográfica do Rio do Saco. Revista Brasileira de Geografia Física, 4(2), 396–412.

Andrade, A. J. P., Souza, C. R., & Silva, N. M. (2013). Vulnerabilidade e resiliência da agricultura familiar. Campo-Território, 8(15), 1–30.

Araújo, S. M. S. (2011). A região semiárida do Nordeste do Brasil. Revista Rios Eletrônica, (5), 89–98.

Brasileiro, R. S. (2009). Alternativas de desenvolvimento sustentável no semiárido nordestino. Scientia Plena, 5(5), 1–12.

Campos, H. L. (2009). O processo de desertificação. Revista de Geografia, 26(3), 79–93.

Cardona, O. D. A. (2001). La necessidade de repensar los conceptos de vulnerabilidad y riesgo. International Work Conference on Vulnerability in Disaster Theory and Practice.

Correia, K. G. (2010). Biota do solo e atividade microbiana (Tese de doutorado). Universidade Federal de Campina Grande.

Costa, A. S. (2009). Levantamento da capacidade de uso da terra (Monografia). Universidade Federal de Campina Grande.

Cruz, F. R. S., Sousa, F. Q., Oliveira, C. J., Alves, C. A. B., Souto, J. S., & Nunes, E. N. (2013). Vulnerabilidade socioeconômica em comunidades rurais. Scientia Plena, 9(5).

Dortzbach, D., Oliveira, C. A. F., Bini, G. M. P., Ristow, S. F. P., Machado, L. N., Bacic, I. L. Z., & Silva, E. B. (2013). Conflito de uso do solo da microbacia Mato Escuro. In Simpósio Brasileiro de Sensoriamento Remoto (pp. 207–214).

Feitosa, P. H. C., Andrade, K. S., Barbosa, M. P., & Ribeiro, G. N. (2010). Estudo comparativo das vulnerabilidades. Revista Verde, 5(3), 1–9.

Figueiredo, M. C. B., Teixeira, A. S., Araújo, L. F. P., Rosa, M. F., Paulino, W. D., Mota, S., & Araújo, J. C. (2007). Avaliação da vulnerabilidade ambiental. Engenharia Sanitária e Ambiental, 12(4), 399–409.

Figueiredo, M. C. B., Vieira, V. P. P. B., Mota, S., Rosa, M. F., & Miranda, S. (2010). Análise da vulnerabilidade ambiental. Embrapa.

Franco, E. S., Lira, V. M., Pordeus, R. V., Lima, V. L. A., Neto, J. D., & Azevedo, C. A. V. (2005). Diagnóstico socioeconômico e ambiental. Revista Engenharia Ambiental, 2(1), 100–114.

Giboshi, M. L., Rodrigues, L. H. A., & Lombardi Neto, F. (2006). Sistema de suporte à decisão. Revista Brasileira de Engenharia Agrícola e Ambiental, 10(4), 861–866.

Lemos, J. J. S. (2001). Níveis de degradação no Nordeste brasileiro. Revista Econômica do Nordeste, 32(3), 406–429.

Marandola Júnior, E., & Hogan, D. J. (2005). Vulnerabilidades e riscos. Revista Brasileira de Estudos Populacionais, 22(1), 29–53.

Medeiros, L. R. A., Ismael, L. L., Brasiliano, L. N., & Schmidt Filho, R. (2012). Desertificação na Paraíba. Revista Verde, 7(1), 239–248.

Melo, A. C., & Guerra, H. O. C. (2013). Análise da capacidade do uso da terra. Acta Geográfica, 7(14), 55–75.

Melo Filho, J. F., & Souza, A. L. V. (2006). Manejo e conservação do solo. Bahia Agrícola, 7(3), 50–60.

Melo, J. A. B. (2010). Diagnóstico físico-conservacionista (Tese de doutorado). Universidade Federal de Campina Grande.

Melo, J. A. B., Pereira, R. A., & Dantas Neto, J. (2009). Atuação do estado brasileiro no combate à seca. Qualit@s Revista Eletrônica, 8(2), 1–13.

Mendonça, I. F. C., Lombardi Neto, F., & Viégas, R. A. (2006). Classificação da capacidade de uso das terras. Revista Brasileira de Engenharia Agrícola e Ambiental, 10(4), 888–895.

Mesquita, L. (2026). Meio ambiente. Disponível em: https://www.preparaenem.com/geografia/meio-ambiente.htm

Mota, A. R. P., Cardoso, M. E. S., & Santos, D. H. (2008). Erosão e conservação dos solos. Colloquium Agrariae, 4(2), 9–17.

Niemann, R. S. (2012). Levantamento do meio físico e classificação das terras. INPE.

Nóbrega, J. C. A., Lima, J. M., Nóbrega, R. S. A., & Alvarenga, M. I. N. (2003). Desertificação. Informe Agropecuário, 24(220), 94–102.

Nunes, L. A. P. L., Araújo Filho, J. A., Sousa, F. B., Silva, N. L., & Meneses, R. I. Q. (2005). Impacto do pousio na recuperação do solo. In Congresso Brasileiro de Ciência do Solo.

Oliveira, S. B. P., Leite, F. R. B., & Barreto, R. N. C. (2007). Sistemas ambientais do município de Itapipoca. In Simpósio Brasileiro de Sensoriamento Remoto (pp. 4103–4110).

Pedron, F. A., Poelking, E. L., Dalmolin, R. S. D., Azevedo, A. C., & Klamt, E. (2006). Aptidão de uso da terra. Ciência Rural, 36(1), 105–112.

Pereira, O. N. (2011). Reintrodução de espécies nativas em área degradada (Dissertação de mestrado). Universidade Federal de Campina Grande.

Pereira, R. A., & Barbosa, M. F. N. (2009). Diagnóstico socioeconômico e ambiental. Engenharia Ambiental, 6(1), 137–153.

Rampim, L., Tavares Filho, J., Behlau, F., & Romano, D. (2012). Determinação da capacidade de uso do solo. Bioscience Journal, 28(2), 251–264.

Santos, P. G., Bertol, I., Campos, M. L., Neto, S. L. R., & Mafra, A. L. (2012). Classificação de terras. Revista de Ciências Agroveterinárias, 11(2), 146–157.

Serafini Júnior, S. (2014). O semiárido e a caatinga. Revista Bahia Agrícola, 9(3).

Souza, B. I. (2011). Uso da vegetação e dos solos. GEOgraphia, 13(25), 77–105.

Sousa, R. F., Fernandes, M. F., & Barbosa, M. P. (2008). Vulnerabilidades e desertificação. Revista OKARA, 2(2), 190–202.

Teixeira, F. J. C., & Machado, J. (2015). Secas no Brasil. Parcerias Estratégicas, 20(41), 89–106.

Travassos, I. S., & Souza, B. I. (2011). Solos e desertificação. Cadernos do Logepa, 6(2), 101–114.