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GEOMORPHOLOGICAL ANALYSIS OF THE DRAINAGE BASIN OF THE CAIOCA CREEK, SOBRAL - CE

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ABSTRACT
Studies on drainage basins have become prominent recently, especially those related to the transformations motivated by the historical process of land use and occupation. In this context, the present work aims to perform a geomorphological analysis of the sub-basin of Caioca Creek. The geosystemic, by Bertrand (1972), and geomorphological, by Souza (2000), analysis assisted the performance of the research. According to Souza's (2000) classification, the three geomorphological units identified locally were the hinterland depression, inselbergs, and alluvial plain. The geomorphological analysis of the drainage basin identified aspects that can contribute to new studies related to its potential for use and occupation, its limitations, and its vulnerability resulting from the anthropic process.
Keywords: Drainage Basins. Geomorphological Units. Anthropic Actions.

ANÁLISE GEOMORFOLÓGICA DA SUB-BACIA HIDROGRÁFICA DO RIACHO CAIOCA, SOBRAL – CE

RESUMO
Os estudos em bacias hidrográficas vêm ganhando destaque nas últimas décadas, destacando principalmente pesquisas relacionadas as transformações que foram motivadas pelo processo histórico de uso e ocupação da terra. Neste contexto, o presente trabalho tem como objetivo realizar uma análise geomorfológica da sub-bacia hidrográfica do riacho Caioca. O suporte metodológico é pautado na análise geossistêmica, fundamentada por Bertrand (1972) e na proposta de análise geomorfológica de Souza (2000). De acordo com a classificação de Souza (2000), foram identificadas três unidades geomorfológicas a) Depressão Sertaneja; b) Inselbergs e c) Planície Fluvial. A análise geomorfológica da sub-bacia, proporcionou identificar os aspectos que poderão contribuir para novos estudos relacionados ao seu potencial de uso e ocupação, suas limitações e sua vulnerabilidade resultante do processo antrópico.
Palavras-chave: bacias hidrográficas, unidades geomorfológicas, ação antrópica.

INTRODUÇÃO

The way that people take over nature impacts directly or indirectly on the local socio-economic structure, which will facilitate further modification of the existing environmental conditions, making it necessary to understand more and more about such transformations. In

this sense, to try to understand the event is to suggest a preventive action of what could cause real damage to both the social and environmental structure.

Lima (2004) highlights that the intense use of natural resources can impact the environment and, due to the accentuated exploitation, studies on this issue are significant. Since resources are limited, there must be proposals of measures to mitigate or reduce the human impacts that have adulterated landscapes.

According to Lima (2012), there has been a great concern with the environment recently, having as a consequence an expansion and, at the same time, significant development of the sciences that deal with environmental issues. It is because of the increasing environmental degradation of natural resources that has reached proportions on a global level.

Thus, it is notorious that environmental systems are composed of elements related to each other, endowed with specific potentials and limitations. In several places, one can strongly identify the degradation due to the disorganized use of natural resources, mainly from agricultural and vegetal extractivist practices.

Bertrand (1972) analyzes the geosystem as the basis for environmental studies, which results from the combination of ecological potential (climate, hydrology, geomorphology), biological exploitation (vegetation, soil, fauna), and anthropic action. Moreover, he considers the landscape as the result of the dynamic combination, therefore unstable, of physical, biological, and anthropic elements that react dialectically on each other, making the landscape a unique and inseparable set in constant evolution (BERTRAND, 1972, P.141-152).

Troppmair and Galina (2006) see the geosystem as a natural, complex, and integrated scheme with a circulation of energy and matter and biological exploration, including by man. However, human action can occur minor alterations in the system, affecting some features which will be notorious only on micro scales and never with the intensity that the geosystem is uncharacterized.

In such a scenario, the study of geosystems has gained more and more importance and growing application. Among other objectives, they seek the conservation, rational use, and development of geographic space, benefiting the entire biosphere, especially human society.

Souza (2005) says the geomorphological analysis of drainage basins serves the recognition of the transformations resulting from the historical process of land use and occupation.

Lima (2020) highlights that framing drainage basins is essential from the economic and social viewpoints, especially when it is about quantitative and qualitative tracking of water resources in northeastern Brazil.

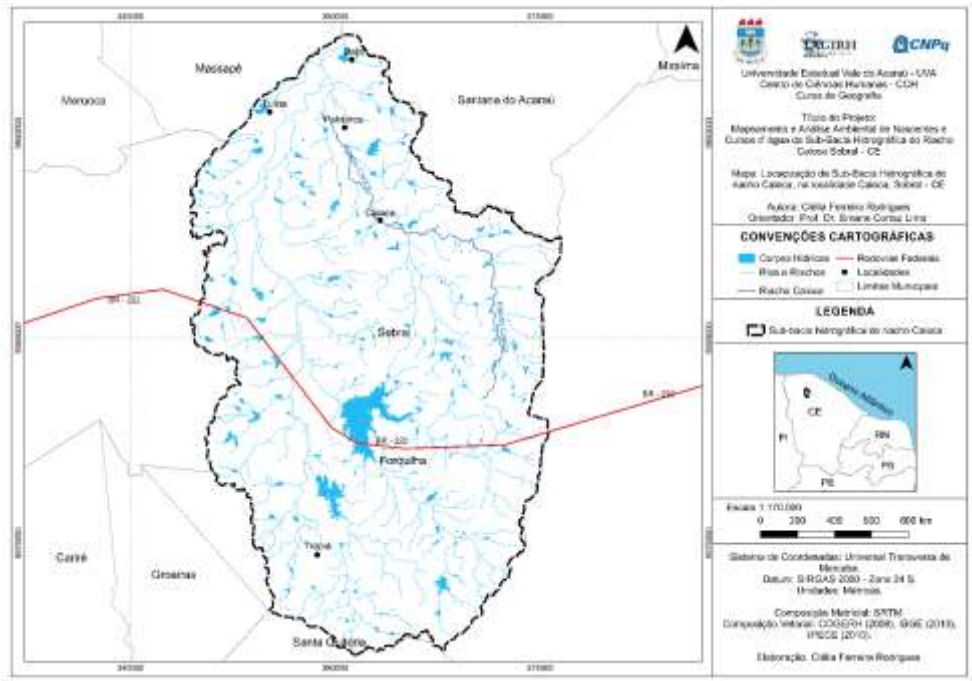
Trentin et al. (2012) analyze that the geomorphological studies can contribute to the planning and conservation of natural resources without abruptly changing the balance of the ecosystem. Still, according to the author, these studies also allowed the spatial-temporal analysis of the processes acting on the modeling of the terrestrial relief, enabling the identification or prevention of environmental degradation processes that find related to the physical elements.

Thus, the general objective of this paper is to make a geomorphological analysis of the sub-basin of the Caioca Creek in Sobral, Ceará. The choice of the geosystemic method aimed at geographic studies enabled an interconnected analysis, and when it comes to drainage basins with several conceivable attributes, the geosystem is indispensable.

AREA LOCATION

The analyzed sub-basin has an area of approximately 790km^2 in northwestern Ceará, occupying about 5.48% of the Acaraú Drainage Basin. Inserted within the limits of the municipality of Sobral and Forquilha, the sub-basin of the Caioca creek comprises the localities of Baía, Tuína, Patriarca, Caioca, and Trapiá (Figure 1).

Figure 1: Area location.



Source: Rodrigues (2020).

METHOD

The research relies on the geosystemic analysis, where the studies seek to analyze in an integrated way the variables or elements that make up a system and its interconnections, losses, and gains of energy and matter.

To carry out this research, it was initially necessary to conduct a desk study, where authors who work with geosystems, such as Bertrand (1972), Tricart (1977), and Troppmair (1985), were searched in the literature. Since the work involved a sub-basin, the collaboration of authors, such as Lima (2004, 2012, and 2020), was essential. Besides, Souza (1979) and Trentin et al. (2012) provided methods to reach the goal of geomorphological compartmentalization.

This first stage consisted of literature review and geo-cartographic materials, which supported the second stage, based on the fieldwork. Moreover, the cartographic production used the software QGIS 2.18 since it is free and easy to manipulate. With this, the interpretation of Landsat 8 images, available in the image catalog of the National Institute for Space Research (INPE), was essential to perform this step and contribute satisfactorily to the progress of the research.

The method of Souza et al. (1979), which divided the state of Ceará using topographic data, assisted the geomorphological analysis of the Drainage Basin of Caioca Creek. However, only three out of the nine units identified by Souza are present in the studied area, namely alluvial plains, hinterland depressions, and inselbergs.

Therefore, this paper has the geosystemic conception as ground, whose justification is in the General Systems Theory (GTS). It has foundations on the mutual relations among components, analyzing the phenomena fundamentally through the organization and interrelationship.

RESULT AND DISCUSSION

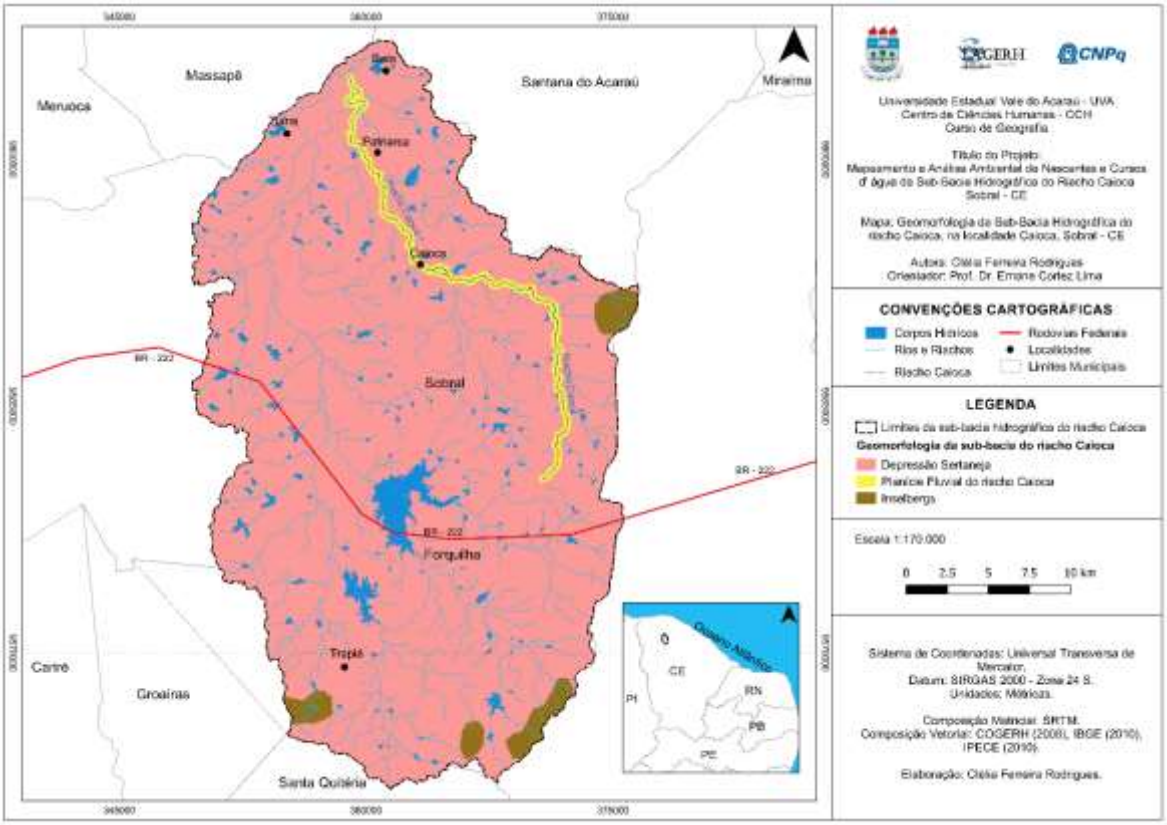
According to Trentin et al. (2012), the study of relief forms is an object of study of geomorphology, both regarding the aspects of genesis and development of these forms. However, even if the relief seems static, it is in a constant process of evolution with varying speeds and interacting at all times with the other components of the landscape.

In agreement with the mentioned author, he considers that the relief forms are not independent components in the landscape and, consequently, neither is its development. According to Barros et al. (2016), to understand the evolution of the relief form of a given area, it becomes necessary to consider the geological, climatic, pedological, and biological characteristics, as well as human activities, because man is also a component of the environment and a modifying agent of extreme action.

Thus, the landscape is not a simple addition of specialized geographical elements. According to Bertrand (1972), it results from the dynamic and unstable combination of physical, biological, and anthropic components, which react to each other, making the landscape a unique and inseparable whole in perpetual evolution.

The method of Souza et al. (1979) divides Ceará into nine topographic units, which assisted the geomorphological compartmentalization of the Caioca Creek Drainage Basin. However, in the studied area, there are only three of these units, which are the inselberg, alluvial plain, and hinterland depression. For interpretative purposes, the map made in QGIS 2.18 shows precisely where these listed relief forms are (Figure 2).

Figure 2: Compartmentalization of the geomorphological units of the Caioca Creek sub-basin.



Source: Rodrigues (2020).

Souza et al. (1979) explain the hinterland depression in terms of geographic extension as the most expressive unit, representing a surface embedded between crystalline and sedimentary plateaus ranging between 100 and 350 m with flattened or slightly undulated topography, and covered by caatingas of quite different sizes and flora depending on the location.

Inselbergs, according to Souza, are forms disseminated throughout the hinterland depression that implement the selective erosion effects in the course of the recent geological history of

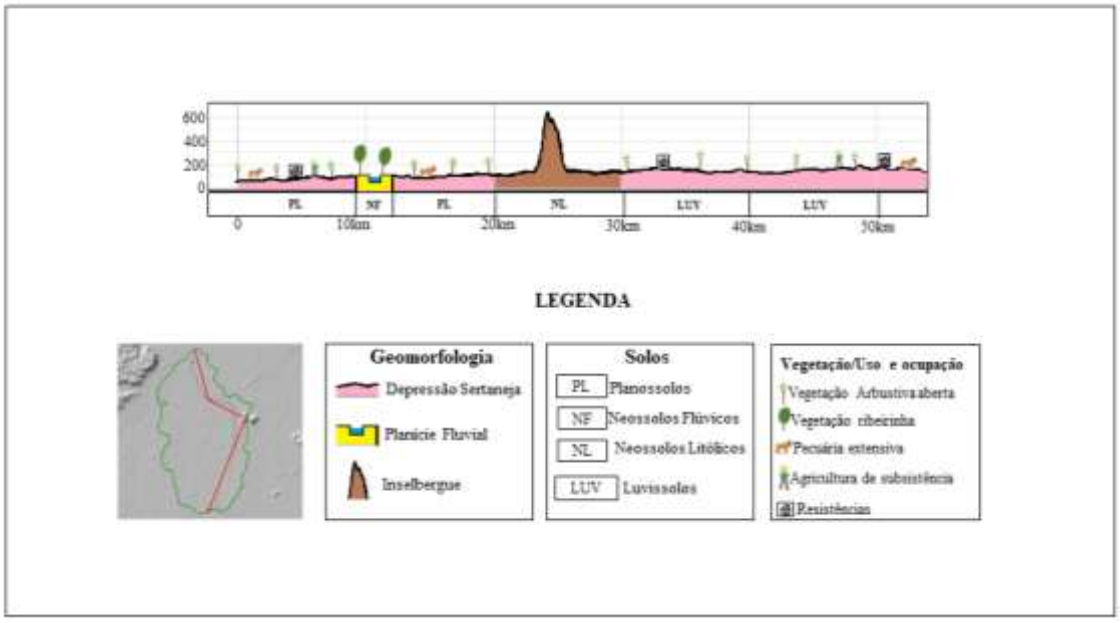
the region. They are generally areas stripped of soil or vegetation, and when pedogenesis takes place, it leads to the formation of litholic soils covered by bushy caatinga.

To Souza, the alluvial plains represent typical forms of alluvial deposition that offer better conditions for agricultural use, contrasting with the interfluvial sectors with more limiting soils for that type of use. The most expressive plain comprises the Jaguaribe, Banabuiu, Salgado, Acaraú, and Aracatiaçu Rivers, among others. Identified and homogeneous sectors are notorious transversally in these plains: the ebb comprises the thalweg and the minor river bed and is liable to periodic floods.

It is important to emphasize that although the alluvial plains constitute small compartments of relief of longitudinal disposition, the possibilities they offer to agricultural activities give them the most significant importance. In the studied area, it is represented by the Caioca Creek and its tributaries, favoring the population distribution along its course.

Figure 3 shows the synthesis of the characterization of geomorphological components found in the basin through the longitudinal profile of Caioca Creek in the North-South direction.

Figure 3: Longitudinal profile of the Caioca Creek, Sobral – CE.



Source: Rodrigues (2020).

In table 1, one can observe the characterization with a representative view of the geomorphological units of the Caioca Creek Drainage Basin.

Figure 4: Synthesis of the morphocultural units of the Caioca sub-basin.

	Unidades Geomorfológicas	Feições Morfológicas	Características Específicas
	Depressão Sertaneja	Superfície de aplainamento-sertões do riacho Caioca	Formas deprimidas com superfície erodidas planas e/ou ligeiramente dissecadas
	Inselbergues	Serras secas do complexo granítico do corrente	Formas residuais dissecadas
	Planície Fluvial	Planície fluvial do riacho Caioca	Formas de acumulação

Source: Adaptation from Costa (2015).

Therefore, the Caioca Creek Drainage Basin is a significant environmental system that has suffered from human actions such as the intensification of land use and occupation.

CONCLUSION

This research demonstrates the different geomorphological units in the Caioca Creek Drainage Basin and its details inserted in the northeastern semi-arid region.

From the methodology, systematized in the geosystemic analysis and results, it was possible to analyze in an integrated way the elements found in the studied area, realizing the rich diversity in the physical-natural environment and differentiations in the social and natural aspects.

The geomorphological analysis of the drainage basin shows that there is a high rate of human activity in the middle course because of the damming of water and reservoirs. It favors the development of socio-economic activities in the area with intensive soil use, partly by agriculture through irrigated perimeters and partly by urban occupation. Besides, the lower course of the creek presents a flattened relief with ranching activities and floodplain agriculture.

Thus, the geomorphologic compartmentalization is relevant for analyzing ecological degradation and is a rich methodological aid for environmental planning.

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