International Journal Semiarid

RELIEF CARTOGRAPHY AS A MEANS OF COMMUNICATION IN GEOGRAPHIC SCIENCE

José Falcão-Sobrinho
Prof. doctor from the State University of Vale do Acaraú / UVA, Brazil
Semi-Arid Research and Extension Network/CNPq
https://orcid.org/0000-0002-7399-6502

Bruna Lima Carvalho
Master in Geograpgy/UVA
http://orcid.org/0000-0003-3971-6885

ABSTRACT: This article discusses cartography, general systems theory, and relief. The three categories under analysis are undoubtedly pillars of geography, especially in nature studies. For this reflection, we sought classical scholars and recent approaches in which we can reflect on the particularities and confluences between these categories, a fact that can be verified, as well as a necessary conceptual and methodological application.
Keywords: relief; cartography; systems theory; research.

A CARTOGRAFIA DO RELEVO COMO MEIO DE COMUNICAÇÃO NA CIÊNCIA GEOGRÁFICA

RESUMO: O presente artigo busca dialogar com a cartografia, a teoria geral dos sistemas e o estudo do relevo. As três categorias em análises são indiscutivelmente pilares da Geografia, principalmente nos estudos voltados à natureza. Buscou-se para tal reflexão estudiosos clássicos e abordagens recentes em que possamos refletir sobre as particularidades e as confluências entre tais categorias. Fato que pode ser constatado, como também, necessário de aplicação conceitual e metodológica..
Palavra-Chaves: relevo, cartografia, teoria sistêmica, pesquisa.

Received: 12/01/2022 Accepted: 30/03/2023

INTRODUCTION

The map has become an increasingly relevant instrument since it is presented in the most diverse media, whether in newspapers, books, public and private spaces, advertising media, and different levels of education.

The history of cartography shows that man has always been interested in recording his space, way of living, and cultural traits, that is, his cartography.

Longo (2011, p.4) points out the relevance of historical cartography since it provides paths to blunt questioning related to geographic science and cartographic content built over the centuries. It is significant because cartography has undergone evolutionary processes over time. Thus, the function of a map is not only defined by techniques but also by conceptions about the world developed by various cultures at different times in history.

Cartography as a means of communication between society and the world it inhabits has always been present at every moment in history, since the early days, including the Middle Ages, highlighting the geography of places. Furthermore, cartography was in the

Renaissance period, contributing considerably to the development of cartography, especially Ptolemy's Geography, which attached importance to cartographic content.

Cartography stands out in the fifteenth century in sea voyages linked to the intensification of routes, facilitating the knowledge of the spaces to be discovered and colonized. In the twentieth century, especially due to the scenarios imposed by the two World Wars, cartography witnessed technical and scientific development, where there was a favoring of the implementation of systematic mapping with the use of technology, aerial photographs, satellite images, and radar (CARVALHO; ARAÚJO, 2008).

In the twenty-first century, the technological innovations assisting cartography contributed immensely to the expansion of knowledge in the area of cartography. It is worth noting that at the current moment, there is increasing use of geo-technology in cartography, where the products generated become more and more detailed and precise.

Thus, cartographic knowledge is relevant both in traditional historiography and modern approaches. According to Oliveira (1998, p.17), all people, without exception, have bequeathed maps.

Carvalho and Araújo (2008, p.1) point out that cartography as an area of knowledge has always been present in the life of human beings. Also, according to them, the representation of geographic space relates to the condition of social need due to possibilities provided by maps as means of location and visualization, expanding the range of the human condition.

Regarding the representation of geographic space within the context of human sciences, the General Systems Theory, according to Vale (2012, p. 90), is the application of the systemic conception to broader perspectives – large human groups, societies, and humanity. It is because the problem of human history stands out with the complete application of the systemic idea.

At a scientific level, this application reflects incorporating the Systemic Theory in the theoretical and methodological arsenal of science branches, including geography.

Given the importance of the cartographic language and the systemic support, this work seeks to understand the importance of cartography as a means of communication through its languages and symbols, emphasizing its relationship with geographic science.

The interest in the research is due to the one developed in the scope of relief cartography and systemic theory and several years of study. During this time, the authors have reflected on the lack of theoretical discussions, prevailing more on the technical. In this context, the survey has as its methodological path the theory based on foundations and reflections that support the development of the text. According to Luna (1996, p. 83), a theoretical review, in general, aims to circumscribe a given research problem within a theoretical reference framework that intends to explain it [...]. Thus, the first references were about a historical approach to cartography and its relationship with geography. The second ones were about physical geography, General Systems Theory, and geomorphological cartography.

The cartographic language and the use of symbologies

Through cartographic expression, maps have the purpose of expressing facts, ideas, phenomena and spatial occurrences, and for this concreteness the use of essentially visual

symbol systems is used, in this way cartography is considered a language of universal traits.

Longo (2011) brings a reflection on the map as a language as old as writing, in which human beings have always sought space for different purposes, the map is conceived as a representation and a form of expression and communication. With the increasingly sophisticated technical advances, new demands arise linked to the use of cartographic communication in the most different areas of society.

The understanding of a systemic cartography presents itself as a contribution capable of establishing an anchor between communication and information, awakening the cartographic language and contributing to discovery and reflection. The representation of maps contributes to a holistic understanding of space. Tuan apud Morais (2010, p. 24) reinforces this understanding.

> Maps drawn in sand, just to answer a practical question, have little or no artistic value. However, as soon as they are drawn on a more durable material – clay, wood, papyrus or paper – the artistic impulse finds expression. It is as if human beings are incapable of inscribing lines, angles, squares and circles without being engulfed in the aesthetics of design configuration. This impulse is even more powerful when color, pictorial representation of topography and man-made features are added.

In the history of cartography, maps have evolved according to the context of each era. It can be said that his contributions are as old as writing, which have always accompanied history, since the beginning, being so present today in the daily lives of the most diverse cultures.

> It is worth remembering that the maps generally have a merely descriptive appearance, almost invoking for themselves a certain character of naturalness, so dear to certain positivist traditions, which will oblige us to make a continuous effort of comparison and identification (rereading, therefore), without the which we will tend to remain in superficiality, a certain freezing of the phenomenon, which the cartographic language usually indicates to us (SANTOS, 2002, p.25-26).

Based on this understanding, it is opportune to reflect on the importance of cartographic language, since the map designates a language and this cannot be considered simply as information or illustration. In this context, it is interesting to pay attention to four constituent elements of the map, as explained by Almeida (2010), Martinelli (2010) and Joly (1990):

Proportion/scale: the map refers to a space, with political, administrative, religious, natural limits, among others. In this way, the representation of reality on the map appears in a reduced form. According to Carvalho and Araújo (2008, p.2), the cartographic image "should not and cannot be seen as if it were a reality, in view of the generalization inherent to the process of reducing the terrain (scale), which requires a selection often subjective, of the aspects to be visualized".

Symbology/caption: it constitutes a central element of the language, it refers to the way in which the theme/subject is being presented, which reveals the intentions intended by the organizer of the caption, ranging from the use of symbols, sizes, points, shapes, colors, areas

and lines. A key point is the construction of the legend, making it necessary that it be understandable and compatible with the theme of the map.

Point of view/projection: it is necessary to understand the map as if it were "seen from above", that is, to understand the map as an angle of vision.

Orientation/location: includes the geographic coordinate system (latitude and longitude and cardinal points).

Understanding these four elements is essential for understanding the language of the map as well as the use of its symbologies. These are presented according to Longo (2011, p. 9), as "necessary for the reading and interpretation of maps and other elements that constitute the cartographic language, such as title, caption and scale".

According to Longo (2011, p.7), "cartographic language has gained identity, as well as linguistic literacy, in the context of disciplines, both contributing to the social, political and economic development in which we are inserted as active and participatory subjects".

Considering that maps are two-dimensional representations of the Earth's surface, which use a language of symbols, it is necessary for maps to be really efficient and fulfill their objectives, as a means of universal visual communication, that users can make their own reading, since after being concretized they become a truth and present themselves as multipurpose.

In the context of cartography, which uses a visual language, the semiotic approach that can be defined as the general science of all languages or sign systems, which are linked meanings to objects. The semiotic approach, as explained by Carvalho and Araújo (2008), was studied in the 1960s by the Frenchman Jacques Bertin, who developed Graphic Semiology, a science that has as its objective the knowledge of the properties of graphic language, that is, language through of symbols.

Graphic semiology was highlighted in the works of Bertin (1967), where he systematized the graphic language as a system of graphic symbols with significance. As explained by Archela and Archela (2002), the meaning for Bertin was considered as the relations between the data to be represented. Such relations can "be of similarity/diversity, order or proportionality and must be transcribed on the map through visual variables that represent exactly the relations between the data that will be represented" (ARCHELA; ARCHELA, 2002, p. 164). These visual variables are used to transcribe the connections between the data being: size, value, texture, color, orientation and shape.

These variables allow the composition of graphic arrangements (signs), substantial to the expression of themes. About this Carvalho and Araújo (2008, p.7) explain that:

> The sign is formed by an idea and a physical stimulus. The idea, called meaning, is what one thinks about a certain reality, it is a concept one has about that reality or that thing. The physical stimulus is called a signifier, that is, it is the reality or the material object to which the idea refers. In other words: the signifier is agricultural production, the signified is its representation on a map. The signified is the content, the signifier is the expression of that content
>
> .

Based on the importance of cartographic symbology, this must be easy to understand and visually perceptible, so that it is possible to transmit the information to the reader. Joly (1990), clarifies that, when graphic semiology is applied to cartography, it allows to verify the advantages and limitations of the visual variables used in cartographic symbology, and consequently to elaborate rules for convenient and adequate uses of the cartographic language.

Cartography as a means of disseminating information as material and energy located in the defined space.

Currently, cartography assisted by technological innovations has come to be recognized in the most diverse areas of science, offering great support to knowledge and turning the real into an object. In the words of Pacheco (2019), "now science and technique are together, inserted in the valuation in the same system".

With technological advances, the concept of cartography is updated in Meneguette (2012), with regard to surveys and data collection for the representation of space through maps. In this way "Cartography can be defined as a discipline that includes "the art, science and technology of construction and use of maps, favors the creation and manipulation of visual or virtual geospatial representations, allows the exploration, analysis, understanding and communication of information about that spatial cut (MENEGUETTE, 2012, p.7).

In this perspective, the objective of cartography is to represent the earth's surface, or even part of it, in a graphic and two-dimensional way, which generically obtains the name of map or letter (DUARTE, 2008).

Through the use of cartography it is possible to approach and study the most different issues, since this is considered an indispensable resource for the knowledge of spatial phenomena. It can be emphasized that the cartographic language as a means of communication becomes a fundamental resource that contributes to the inquiries relating communication/signs, which are interconnected with the social elements.

The recurrent use of the map fulfills a communication role, in the reflection of Castrogiovanni (1992, p.35), "the map cannot be seen only as the most practical form of communication and representation of political and social understanding. They must be clear and informative-clear and precise-fascinating and surprising within the purpose they were built for".

In the words of Longo (2011), it is clarified that the maps are seen as didactic resources which facilitate the apprehension of information. This takes effect in simple day-to-day acts, maps help in locating unknown places, although when analyzing a map one does not use writing or punctuation, but rather another language format, such as "lines, colors, shapes, sizes, orientations, values and granulations when working with the cartographic language, logical-mathematical reasoning is developed, the notions of space, the production of writing and the understanding of representation" (LONGO, 2011, p. 10).

An important point to be stressed is about the contribution of technologies in cartography as a subsidy to the dissemination of information as material and energy that is located in the

delimited space. For Archela and Archela, (2002, p. 167), with the successful use of the map as a resource in scientific research:

> Contemporary cartography has expanded its horizons. Until a few decades ago, to list and process large amounts of information during the compilation of maps, especially synthesis maps, one often encountered difficulties that sometimes became even insurmountable. However, with the development of new technologies in Cartography, these difficulties were gradually eliminated. The improvement of communication systems took place in parallel with the great advancement of information technology, which enabled new ways of recording information. Currently, maps and other forms of cartographic representation can be made, observed and analyzed not only in the traditional analogue format, but also in digital and three-dimensional format..

Based on the previous citation, it is opportune to open a parenthesis for the contribution of technological advances in all scientific fields, especially cartography was assisted with these advances. Technological evolution in cartography found "fertile ground" and enabled increasingly precise and advanced mapping. However, parallel to the technical advances, it is important to have a theoretical cartography, which for a long time was left in the background, but it is as necessary as the technique, since it offers a whole reflective theoretical framework that makes it possible to see the essence of what is represented on the map in a systemic way, that is, see beyond and make associative interpretations.

According to Archela and Archela, (2002), Taylor (1994) draws attention to the impact of these technologies on Cartography. Arguing that technology is relevant, but it cannot be the only consideration to define new directions for Cartography. Its repercussions should be considered as a stimulus for the creation of a radically new concept.

Still according to the thinking of the authors op.cit, the conceptual and theoretical development of Cartography as a discipline was retarded due to the emphasis given to automated mapping and GIS which, according to its conception, are techniques. Also highlighting that despite Cartography being an applied discipline, the indispensability of developing and maintaining an applied theoretical essence is inevitable.

Insertion of Cartography in Geography.

When it comes to the relationship of Cartography in geographic currents, geographic knowledge was already present since prehistory. Geography has developed since the most remote times simultaneously with society. Andrade (2006), points out that ancient civilizations such as the Egyptian, the Greek, the Roman, among others, made many contributions to the development of geographic knowledge in antiquity. For the author, all these peoples contributed to geographic knowledge over time. Moreira (2007), explains that:

> In antiquity, geography was a cartographic record of peoples and territories. The State, travelers and merchants require strategic information from the geographer to guide them in their movements within the spatial ways of life of each people. In this way, geography and the geographer act and express themselves through the method and language that combine on the map the symbols of cosmology and the territorial information of each of the peoples, useful for the purposes of practical action. (MOREIRA, 2007, p. 14).

In the author's words above, the relevant role of maps can be noted, as well as their historically intrinsic relationship to Geographical knowledge. It is noted that even before Geography became institutionalized as a science, it maintained a close relationship with Cartography. In this way “in all these phases of time it was, therefore, the image of a science glued to space and to the map that was established in the minds of men as an identity trait of geography and its professional” (MOREIRA, 2007, p. 16).

This identity trait is so compact that even in the 21st century, when asking what Geography is, few would not make an automatic association with the map. It is indisputable that Cartography and Geography are associated with two fields of knowledge that have fundamental points in the understanding of socially constructed spatial relations.

In traditional Geography, this was considered a science based on the empirical, on observation and description. Therefore, Christofoletti (1985) states that in a complementary way, these observations should also be represented. With regard to representation in studies of Traditional Geography, Andrade (2006) considers that, [...] "he sought to develop Cartography to the maximum as a way of visualizing this distribution and trying to explain the great differences and contrasts that exist, with great concentrations in some points and true demographic voids in others” (ANDRADE, 2006, p.110).

Subsequently, the context that emerged as a result of the Second World War demanded new concepts and changes in the existing relationships between man and nature, which opened new paths to geographic knowledge.

Thus, the imminent need for a reformulation of geographic science was a disturbing concern for its scholars and contributed to the emergence of other theoretical currents, with emphasis in that context on New Geography. For Andrade (2006), this current initially developed in countries such as Sweden, Great Britain, among others, but it was in the United States that this current had its greatest expansion nucleus, with the University of Chicago being the center to spread their ideas. Regarding the expression New Geography or New Geography, this refers to the "set of ideas and approaches that began to spread and gain development during the fifties" (CHRISTOFOLETTI, 1985, p.16).

Regarding Cartography and the use of maps in New Geography, Girardi (2008) clarifies that:

> [...] The use of maps and mapping procedures are even more intense in Pragmatic Geography, as the advent of the computer made it possible to work more quickly and with a larger volume of data. The mapping process has become faster, increasing the possibilities of producing and reproducing maps (GIRARDI, 2008, p. 53).

With regard to the current of Critical Geography and Cartography, Girardi (2008) exposes that the position of Critical Geography was not completely favorable to the use of the map, consisting of a possible criticism of its positioning in relation to the map. This became just an instrument of information and not a tool for reading and changing society.

According to Girardi (2008), the imaginary was formed that the use of any instrument, practical or theoretical, linked to Traditional Geography and New Geography, would express the refusal of the renewal movement.

Longo (2011) explains that cartography is a science linked to geography. For this author, its nature and disclosure are incorporated into art. With the advances, it stopped presenting only the artistic aspect, acquiring new technical and documentary conceptions.

Cartography tries to contribute to the understanding of geographic space both in the present and in the past, converting possibilities into potentialities through the geographical transcription of phenomena. In this perspective, reflections and questions about which vision of geographic space Cartography built through its representations are fundamental. Such representations, like nature and society itself, in the understanding of Falcão Sobrinho et.al (2017), are deliberated through the General Systems Theory, a methodological theoretical approach that offers support to the integrated understanding of these representations.

After going through previously the understanding of the object of Cartography, it is possible to affirm that there are very clear relations with Geography. Therefore, according to the understanding of Oliveira (1988), it is listed that, among all the sciences linked to Cartography, Geography is one of the most important, in the proportion in which the facts and phenomena originate from various branches of Geography , whether in the physical, human, or economic area, etc.

Based on the previous understanding, Cartography and Geography are interlinked sciences. Silva and Brito (2019, p. 10), explain that "there is a strong relationship between both, in such a way that the geographer needs to make good interpretations, know some issues about Cartography (scale, projections, geographic networks, etc.)". In this way, it is not strange when it is said that maps are always present in the works of the geographer.

Regarding the role of the Geographer, they have the necessary knowledge and skills to transpose reality, situations and phenomena, which are organized and articulated for the understanding of the geographic space, the most diverse environmental issues, territorial planning in the graphic representation through the maps and cartographic techniques (SILVA; BRITO, 2019).

When it comes to maps, Martinelli (2010) corroborates that they appear as a symbolic representation for everything related to geography, using a planispheric logo or terrestrial globe.

Cartography, General Systems Theory and Relief

The methodological need for an integrated analysis occurs in the systemic analysis in which this understanding became real when Bertalanffy presented the GST (General Systems Theory), in an inaugural manner at the philosophical seminar in Chicago in 1937. of an approach that encompasses the environment as a whole, and in an integrated manner.

The introduction of TGS in Geography represented a new way of understanding how elements are related in the formation, production and organization of geographic space. It is worth mentioning that the systemic approach as a research method, especially in Physical Geography, has extended to virtually all branches of this science. The incorporation of this theoretical-methodological contribution provided geographers with a methodological framework for research analyzing the totality of nature.

Costa Falcão (2020) explains that the inclusion of the General Systems Theory in the treatment given to nature took into account the interaction of elements or their association. The applicability of such knowledge was inserted in Physical Geography, initially, in Geomorphology, through the works of Arthur Strahler (1950). The systemic approach allowed Physical Geography studies to replace the landscape morphology with a typology of spatial patterns (MENDONÇA, 1996).

In Geography studies, it is necessary to use the concept of system to understand the complex themes and how they are interdependent, consequently influenced and suffering actions of the elements (matter or energy) that constitute the flow relations in the great Earth system (COSTA FALCÃO, 2020).

Regarding the systemic approach in the context of cartography, this can be used as a fundamental basis, that is, as a basic instrument for cartographic studies. Reflecting on the cartographic representation of phenomena in general, supported by a systemic conception, it considers the integrated cartographic language, represented by means of a systematized caption, where the symbologies maintain interdependent explanatory relationships.

Cartography as a science that ranges from the production, dissemination and use of maps, needs a methodological apparatus that makes it possible through its language and symbology, expressed through letters, plans, maps, globes, satellite images, graphs, topographic profiles , models, sketches and other means to spatially represent the phenomena. This representation only becomes effective by reaching the objective of transmitting information about the geographic space, when interpreted under a systemic bias..

The cartographic study goes far beyond just contouring, delimiting, recognizing projections and calculating scale measures, working with the cartographic language with the use of its various symbologies, requires an integrated and systematic understanding of the various variables represented, where it is essential to know why the use of certain symbology and its interpretative relationships. Such interpretations require knowing that the map is not simply an isolated image of the spatial area studied, but that it is part of a larger set.

Within the logic that the map constitutes the representation of a given geographic space, it “interconnects and meshes its components, thanks to dynamic processes whose mechanism originates an organization and a hierarchy” (VEADO, 1998, p.3). The map transmits to the reader information about phenomena in a specialized way, such phenomena are not isolated, but interconnected.

Among the objectives of cartography, especially the map, is to locate places, natural and cultural aspects on the earth's surface, these aspects are interconnected belonging to certain systems. Both physical and human maps require an integrative analysis, like physical maps, geomorphological, climatic, hydrographic, biogeographical and pedological systems can be highlighted, all of which are made up of numerous elements that form an open system where there is material flow and energy.

With regard to cartographic elements, some points are of essential importance within the representation, which must clearly and articulately convey information to the reader. The title, scale, orientation, geographic coordinates and subtitles are fundamental elements in

map reading, when interpreted under a systemic bias it becomes possible an integrated analysis of all elements, where one is related to the other.

With regard to the application of TGS in the Geomorphological context, this extends to its various fields of study, as an example in Geomorphological Cartography. Correlating to the relief factor, which is presented as a guiding criterion in this study, Simon and Lupinacci, (2019, p.14), point out that:

> The analysis of relief from the perspective of the systemic approach in geography demonstrates that there is a dynamic relationship between its forming elements, whether intrinsic or extrinsic, showing that its configuration is the result of agents and processes, current and past. This is of paramount importance for proper land use and occupation. In this systemic relationship, any interference in any of the elements involved will have repercussions on altering a landscape. In planning, the understanding of this relationship, that is, the understanding of the functioning of a certain area, can provide good predictive results and help in solving environmental problems.

The systemic theory subsidizes the study of relief dynamics in a systematic way, both in the descriptive scope and in the classification, from the great structural lineaments to the punctual forms of relief, like an erosion process of the gully type. About this, Cunha (2001, p.35) emphasizes that:

> With regard to Geomorphology, it appears that it is impossible to understand relief without considering the flows of matter and energy responsible for its genesis and sculpting. In this way, understanding the landforms as a result of the interaction of the geological structure, the climate, current and past, and currently, the anthropic activity, whose relationships interfere in the pedological characteristics and in the vegetation cover, it is verified that the systemic view makes it possible to establish and analyze such interrelationships, as well as to understand the dependence links between these factors.

The theoretical-methodological framework of systemic thinking aims to interpret the spatial and temporal complexity of systems, according to their interactions, in the case of relief this possibility becomes real with this application. Since the systemic perspective is understood as a basis capable of assisting in the integrated representation of landforms. This representation is made through Geomorphological Cartography, which will be discussed below.

Geomorphological Cartography

According to Florenzano (2008), geomorphological cartography began in Poland and gained greater prominence in the World War, emerging as a fundamental method for the analysis of relief. It is worth noting that currently geomorphological maps have assisted not only geomorphology, but many other sciences that involve environmental planning.

Tricart (1963 apud ROSS 1992, p.52) considers that geomorphological cartography constitutes the basis of the research and not the graphic materialization of the research already done. More clearly, Tricart explains that it is at the same time, the basis and the result

of a study, which belongs to the line of research that concentrates most of the studies in the area of Geomorphology, the empirical one, comprising fieldwork, observations, descriptions and interpretations.

> The geomorphological cartography is an important tool in the spatialization of the geomorphological facts themselves, which allows the representation of the genesis, of the landforms and their relationships with the structure and processes, as well as the representation of the dynamics of the processes, leading into account its particularities, and should provide subsidies for the identification of all the essential elements for the understanding of the relief (CASSETI, 2005).

Still in this perspective, the cartographic representation of the relief offers data and information about, for example, the conditions of use of agricultural land, areas conducive to erosion processes, among many other issues. In short, it is a relevant subject from the current situation of intense land use (CUNHA; QUEIROZ, 2012).

However, geomorphological cartography constitutes a type of mapping whose complexity is inherent to the object to be represented (relief), (DANTAS, 2016, p 49). This element presents a multiplicity of forms and genesis, which were generated by different processes, so each relief pattern has its peculiarities, and mapping them correlating with the technogenic action consists, among other factors, of an environmental planning basis. Because once the environmental characteristics are known, it is possible to identify areas conducive to erosion, to know the degree of fragility, risk areas, areas suitable for agricultural cultivation, among others.

When elaborated, geomorphological maps are essential for environmental and social planning. To reinforce Doné (1981), he mentions that they clearly demonstrate the studied phenomena and their correlations.

It can be emphasized that geomorphological mapping constitutes the basis of environmental research. In addition to the cartographic representation of morphological features, the map, as a final product, is the synthetic relief conception, the foundation of geomorphological research. (SIMON; LUPINACCI, 2019).

Furthermore, it can be inferred that the effectiveness of environmental planning is closely related to the degree of knowledge about the dynamics of natural systems. In this line of reasoning, geomorphological mapping is a basic tool for understanding the agents and processes that model the relief, thus providing an understanding of the sustainability of such models for certain types of land use. In the following, it is explained in detail.

Random land use has the ability to profoundly modify the natural characteristics of the environment. To minimize these effects, planning actions based on local geomorphology are necessary so that there is a balance in the relationship between natural components and socioeconomic components, and the investigation of the environmental system and the elaboration of more restrictive laws and guidelines must be reconciled. Thus, the incorporation of detailed geomorphological mapping as one of the planning instruments would make it possible to outline guidelines that are more consistent with reality. (SIMON; LUPINACCI, 2019).

Geomorphological cartography can be used for various types of studies, such as erosion studies in agricultural areas (FALCAO SOBRINHO, 2006, 2007, 2014, 2020). Emphasizing

at this point that the sub basin under study has many agricultural areas, as the environmental characteristics of the region are quite favorable. In this regard, the mapping of relief features can show the action of denudation processes, such as topographic cuts, erosion grooves, ravines, among others. Simply put, mapping is essential to provide indications of areas more susceptible to erosion processes, in this way it is possible to identify the areas most conducive to certain uses, or even preservation.

As Lemos and Pires (2009) explain, one of the various methods used to understand natural environments is Geomorphological mapping, which in turn serves as an essential subsidy for some stages of Planning. In addition, mapping specializes and locates the morphoclimatic phenomena of a given region, assuming, therefore, a multidisciplinary character for understanding spatial structures and for defining guidelines aimed at studies related to the environment (FERREIRA, 2014).

In continuation of the context, Lemos and Pires (2009), emphasize that with the aid of technologies, Geomorphological Cartography enables the representation of different landscape morphologies, in addition to the characterization of relief forms and their main indicators. Among the instruments and techniques for studying relief, geomorphological mapping stands out. According to Kohler (2002, p.25), the best way to represent a geomorphological analysis is through cartography.

Following the argument, with regard to the analysis or modeling of the terrain, morphological and morphometric parameters are used that measure the physiographic characteristics of the relief, according to Ab'Saber (1969), which highlights the following:

- Relief Amplitude - is a parameter that measures the relief development between the elevation of the valley bottoms and the elevation of its watersheds in a drainage basin. This parameter depicts the degree of notching of a given landscape unit and the corresponding dimension of the relief forms present;
- Gradient – is a parameter that measures the slope angle of a slope or a drainage basin. It reflects, in general, the vulnerability of a landscape unit in the face of erosion-depositional processes.
- Drainage Density - is a parameter that measures the ratio between the total length of channels and the area of the drainage basin. Depicts the degree of dissection of a given landscape unit.
- Slope Top Geometry – consists of a morphological assessment that describes the denudation form of a given landscape unit, indicating the way in which the relief forms were modeled over geological time. The geometric shapes of tops can be classified as: sharp, or crests; rounded, or tabular. The geometric shapes of the slopes can be classified as convex, rectilinear and concave.

Regarding the production of the geomorphological map, this is an empirical process that requires both office and field work, largely supported by the use of topographic maps and their by-products: hypsometry, hydrography, clinometry, geological, pedological, use and occupation maps soil and remote sensing images (MONECHE, 2009). According to Tricart (1965), geomorphological maps are the base document to which modern research arrives, which allows to fully express and conclude with safer results.

For Ross (1992), geomorphological "cartographing" must concretely map what is seen and not what is deduced from the geomorphological analysis, therefore in the foreground the geomorphological maps must represent the different sizes of relief forms, in the compatible scale. Still in the ideas of the same author op.cit, this instrument, so important for research in this area of knowledge, becomes equally relevant for studies of environmental characterization, territorial physical planning, installation of large engineering projects and mineral exploration. Regarding the application of geomorphological cartography, it is added that:

> For geomorphological cartography, the same principles adopted for soil and geology cartography should be applied, where concrete aspects of these themes are represented, that is, the types of soils and rock formations, in order to provide further information below. related to age, genesis and other characteristics in a descriptive way in the caption body (FERREIRA, 2014).

Given the importance of mapping, and considering the current technological evolution, it subsidizes knowledge about the phenomena that act on the relief in more detail, such as, for example, the modification imposed by man, which has a series of consequences. Reinforcing this same line of thought, Flores (2012) explains that the greatest need now is to produce knowledge that can respond to current demands, which are almost always urgent, and future ones, in an attempt to minimize risk situations. In this sense, maps and charts from geomorphological mapping are documents that can help alongside other physical data, that is, a more interdisciplinary approach. (FLOWERS, 2012).

Geomorphological mapping, with new cartography techniques, must be associated with this premise regarding the prediction of facts and must compose the core of the sciences that constitute those that deal with knowledge and environmental care (FLORES, 2012). Correlating the study area, geomorphological studies gain notable importance in priority areas for environmental preservation, such as Ibiapaba, which has a high degree of biodiversity.

Geomorphological studies, as already mentioned, have many purposes, among them those aimed at environmental planning. It can be noted that one of its objectives is precisely the prevention and control of areas more prone to erosion, especially when an integrated study is intended, considering all environmental factors.

About the mapping, the detailed geomorphological maps allow a complete description of the relief and modeled elements. Rodrigues (2005), presents a geomorphological cartography that is no longer based exclusively on elements presented by nature, but defends a treatment of geomorphological research also based on human interference. This perspective differs in that it considers human action a geomorphological action.

The treatment of data and information are essential in the context of mapping, because when posted correctly they allow for more clarity. Thus, a good description presents, for example, morphographic data that make reference to landforms. (FLOWERS, 2012). This same author deals with the forms of dissection, being explained better below:

> The dissection forms are also relevant in a detail mapping, since forms that may appear to coincide on a scale in a detail mapping present different morphographic characteristics, denoting different processes of formation, in addition to constituting singular units, in turn, the accumulation areas will also coincide with the active process, giving the relief its own morphoclimatic character. The morphometric data represent another body of data that provide the analysis with important elements in the representation, as they give the metric dimension and the variation of vertical and horizontal values of the studied area. (FLORES 2012, p 56).

Structural data in geomorphological mappings are essential, as they present the existing relationship, such as the rocky framework, thus making it possible to understand the necessary geological data, which define the resistance to erosion. According to Griffiths and Abraham (2008) geomorphological maps enable the spatialization and understanding of current and past processes that created contemporary landscapes.

With regard to scale, Tricart (1965), specifies that the detailed geomorphological map must provide a rational description of all the elements of the relief studied, addressing the entire research area, in addition to the overlapping of forms. Detail charts are essentially oriented towards morphostructural phenomena, which, together with local climatic dynamics, condition the genesis of sculptural forms. According to Tricart (1965) and Cunha, Mendes and Sanchez (2003), detailed geomorphological maps must contain four types of information:

> **1. Morphometry –** capable of being represented by a topographical background, containing contour lines and drainage, and may contain other data, such as slope slopes, drainage network hierarchy, height of terrace edges, cornices or erosive edges. The representation of these data must be associated with the legibility of the letter;
>
> **2. Morphography –** identified through symbols that locate and specialize landforms, representing their extension. Symbols should convey the notion of the processes that gave rise to such forms;
>
> **3. Morphogenesis -** the symbology of the shapes must introduce the origin and genesis, making it possible to distinguish the morphogenetic processes active in the area;
>
> **4. Chronology –** must represent the moment in the morphogenetic history of the region, in which the forms or the set of these developed.

For the cited authors, one should also consider, in addition to these, the data referring to the structural framework. According to Tricart (1965), the importance of geomorphological mapping is associated with the genesis of surface relief forms, which in turn are associated with their resistance, the performance of processes and the characteristics of the lithological basement.

In continuation, emphasizing the importance of the addressed theme and its uses, Cunha, Mendes and Sanches (2003) point out that the evaluation of landforms for the occupation is reflected in the legislation and that many regulations on the use of the territory are based not

on only in relief forms, but, above all, in its attributes, such as minimum distance from riverbeds and springs, slopes and other aspects.

In this case, there is an emphasis on an integrated analysis of the landscape elements, as a subsidy to the research objectives. Knowledge of relief dynamics associated with an adequate scale of analysis is the foundation for correct human intervention in the environment.

Highlighting the Geomorphological Cartography assisted by the Systemic Theory, this contributes significantly to the integrated understanding of the relief and consequently to its representations. Through a systemic analysis it is possible to correlate and interpret a geomorphological legend making the necessary connections. And this interpretation requires something bigger, as is the case of the TGS, which explains, for example, why the geomorphological features.

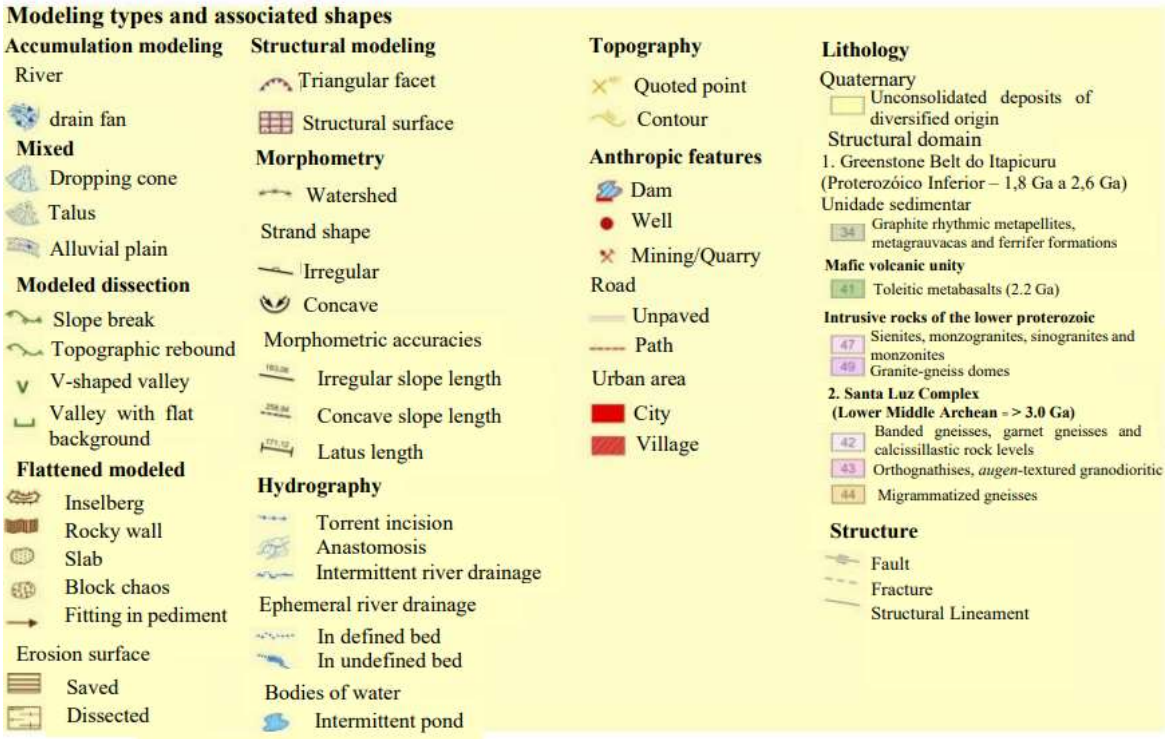
The interpretation of the relief in detail scale requires meticulous attention in which nothing can be understood separately, where several aspects must be considered within a geomorphological research.

From the perspective of geomorphological cartography, Lima and Lupinacci (2021, p.218), highlight the primordiality of "theoretical and practical knowledge of the properties and processes involved in the elaboration of the relief so that the mapping accurately and coherently represents the morphology".

Among the diversities of geomorphological mapping methodologies, we chose as an example of discussion and reflective analysis the following caption (figure 1), which is associated with the landforms organized by Lima and Lupinacci (2021) focused on geomorphological mapping of geomorphological detail of the semi-arid.

The legend expresses the representation of the relief through linear symbologies, for an integrated interpretation it is necessary to correlate the attributes of the relief and the processes involved in its elaboration.

Figura 1: Legend proposal for detailed geomorphological mapping



Source: SUDENE (1975), CPRM (2004), IBGE (2009), organized by Lima e Lupinacci (2021)

The geomorphological interpretation of this caption, which is being represented by means of symbologies the geomorphological scenario of the semi-arid region, requires an integrated analysis of the formation processes that originated the landforms, that is, the internal processes that gave rise to the forms and the external processes that carve and shape these shapes.

The systemic study within the geomorphological mapping allows the verification of the levels of interconnection of the lithological structure, referring to the bases that support the landforms. The attributes of morphography and morphometry under an interaction bias allow an interpretation between the genetic processes and the quantitative characteristics of the relief features.

The models of accumulation and dissection are the result of processes that act together in the accumulation of sediments and denudational processes respectively. The shapes of the slopes and the types of valleys refer to a more detailed individualization of the geomorphological features, being related to the slope factor, the lithology, the climatic and weather conditions, all these factors act together in the relief modeling process.

With regard to anthropic features, use in the geomorphological map is preferable. In the case of the proposed caption of Figure 1, these features are related to anthropogenic geomorphological action that is capable of promoting changes in the dynamics of landforms,

since nature is not static, so any change in one of its components has repercussions on the others.

Detailed geomorphological mapping from a systemic perspective helps in a "significant way to understand the spatial organization of landforms" (LIMA; LUPINACCI, 2021, p. 226).

Relief taxonomy

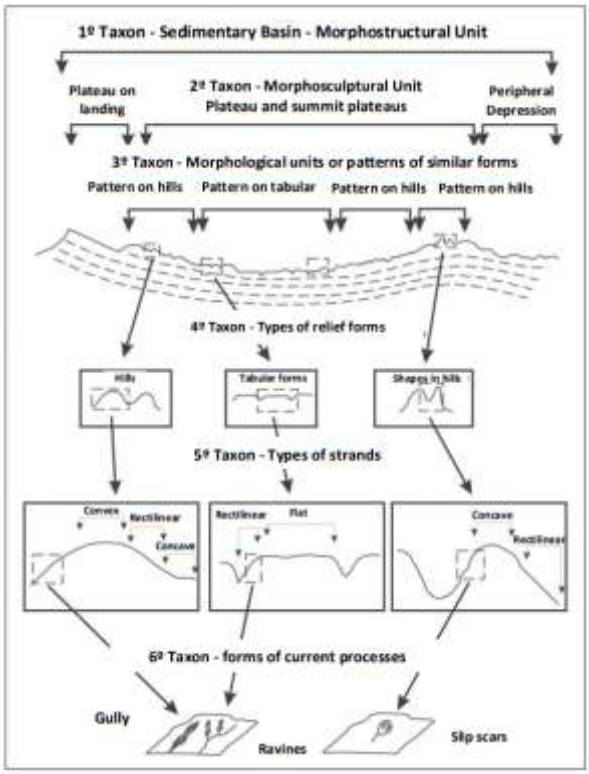
In this topic, a broad discussion of the relief will be presented, based on the methodology of Ross (1992). This representation is given by the composition of an integrated, structured caption, in the division of relief forms based on the concepts of morphostructure and morphosculpture. Mercerjacov (1968), explains that every terrestrial relief belongs to a certain structure that sustains it and shows a sculptural aspect that is due to the action of the current and past climate type that acted and acts in this structure (AMARAL; ROSS, 2006).

As explained by Amaral and Ross (2006), Morphosculpture is the way in which the relief presents itself in the face of zonality and exogenous processes, that is, the wear suffered by erosion, which sculpts the shapes of hills, hills and tops, among others. Emphasizing that technogenic action also changes the morpho-sculpture.

In Ross' proposal (1992), the shapes are classified according to the degree of detail (vertical and horizontal) in which the relief is analyzed. In this classification, six categories or taxonomic units are proposed, applicable at different scalar levels. According to Amaral and Ross (2006), a chronological order of geological time can be established, starting from the oldest formation (Morphostructural Unit) to the most recent current forms - ravines, gullies, among others.

Following this logic, Ross (1994), on the question of the taxonomy of landforms, which apparently arose due to the need to establish an organization and an order in things that refer to the different sizes of landforms and genesis.

Figure 2: Taxonomic Classification of Relief proposed by Ross (1992)



Source: Ross (1992)

The 1st taxon is characterized by the morphostructural units that correspond to the large macrostructures, referring to the genetic types of lithology groups and their structural arrangements that determine the landforms, (ROSS, 1992). This is characterized by a larger taxon (size), that is, the basic morphostructure, such as, for example, a sedimentary basin (DANTAS, 2016, p.89).

From the point of view of taxonomic mapping, with regard to macrostructure, Souza (2000) emphasizes the importance of intracranial basin nuclei for the diversification of morpho-sculptural features of the Brazilian semi-arid region. According to the author, the geomorphogenetic evolution of the relief of the Northeast results from the influence of complex variables reserved to the geological structure and lithologies alongside current paleoclimatic and morphogenetic factors.

In addition, Santos (2015) mentions that the interaction of this set of variables, or the predominance of one over the others, outlines morpho-sculptural features resulting sometimes from the structure, sometimes from the degradation or agradational effects.

The 2nd taxon corresponds to the morpho-sculptural units, which are equivalent to the compartments generated by climate action over geological time, with the intervention of tectogenetic processes. These morpho-sculptural units are inserted in a morpho-structural

unit, presenting sets of landforms that keep the same genetic characteristics of age and similarity of the patterns of the modeled, (ROSS,1992).

This is defined by a smaller taxon, that is, the morphosculptures such as, for example, peripheral depressions, plateaus, plateaus, among others (DANTAS, 2016, p.89).

3rd taxon: morphological units or pattern of similar shapes, corresponding to the grouping of shapes relative to the modeled, which are distinguished by differences in topographic roughness or relief dissection index, as well as by the shape of the tops, slopes and valleys of each pattern. It refers to the morphological units or relief type patterns, where current morphoclimatic processes begin to be more easily noticed. They are sets of minor relief shapes that differ in appearance from each other depending on the relief dissection index (DANTAS, 2016, p.89).

4th taxon: refers to the pattern unit of similar forms, individualized and inserted in the morphological units of the previous taxonomic level, relief. The forms in this category can be of aggradation or denudation (ROSS, 1992).

5th taxon: corresponds to the types of slopes or slope sectors of each relief form. Each type of shape of a slope is genetically distinct, (ROSS, 1992).

6th taxon: refers to smaller forms resulting from the action of erosive processes or current deposits (ROSS, 1992).

Relief Dissection

The relief dissection index has been used in Brazil since the RADAM project (BARBOSA et al, 1984), started in the 1970s. natural, since the intensity of the dissection is a good indicator of the potential fragility that the environment has (DANTAS, 2016).

Dissection is a feature of relief that reflects the energy that permeates a given geomorphological system throughout its recent sculpting. Therefore, the measurement of this variable is an important instrument for the morphodynamic assessment of the landscape (BERTOLONI; DEODORO, 2018).

According to the op.cit authors, very dissected reliefs are made up of deep or incised valleys and narrow tops. In addition to allowing the establishment of a geomorphological compartmentalization pattern, the degree of dissection also allows inferring different intensities in the recent denudational processes responsible for surface sculpting.

This methodology basically considers the interfluvial dimension and the degree of notching of the fluvial channels. The drainage density indicator associated with the degree of notching of the combined channels determines the topographic roughness, or the relief dissection index, which in turn characterizes the average interfluvial dimension of homogeneous sets of shapes or sets of similar shapes (ROSS, 1992).

According to Bertoloni and Deodoro (2018), the intensity of dissection or, as it is also called, the intensity of topographic roughness is the first major indicator of the potential fragility that the natural environment presents. The drainage density associated with the degree of notching of the combined channels determines the topographic roughness or the relief

dissection index, and obviously defines the average interfluvial dimension of homogeneous sets of shapes or sets of similar shapes, (ROSS 2003).

In continuation of the above, as already mentioned, the first way to evaluate the dissection of the relief was used by the RADAM BRASIL Project and by Ross (1992; 2003), considering the interfluvial dimension and the average notch of the valleys, (ROSS 2003).

Explaining better, five classes of dissection are considered, depending on this, with the intersection of these two variables (interfluvial dimension and average notch of the valleys), these are proposed. Bertolini and Deodoro (2018), clarify that the average notch is given as a function of the measurement from the two slopes of a valley section (indicated by random transects), starting from the bottom of the valley to its top.

Explaining better, Souza (2018) details that by crossing the values obtained in the quantification of these morphometric variables, we arrive at the Relief Dissection Indices that provide us with information about the potential energy (or erosion potential) available in a certain portion of the earth's surface. In the ideas of the author op.cit, this information is essential to use to rationalize any technogenic intervention in the landscape units, since the aforementioned action without a prior analysis of the dynamics of the landscapes can enhance the processes within them.

Below, chart 1 represents the "Matrix of relief dissection indices", proposed by Ross (1992), which is an adaptation of the framework Dissection of Forms of Denudation from the Radam Brasil project (1981).

Frame 1: Matrix of relief dissection indices

AVERAGE INTERFLUVIAL DIMENSION (CLASSES) ..... DEGREES OF CARVING OF THE VALLEY (CLASSES)	TOO BIG (1) >1500	BIG 1500 A 700	AVERAGE (3) 700 a 300	SMALL (4) 300 A 100	TOO SMALL (5) <100 M
Very weak (1) (< de 10 m)	11	12	13	14	15
Weak (2) (10 a 20 m)	21	22	23	24	25
Medium (3) (20 a 40 m)	31	32	33	34	35
Strong (4) (40 a 80 m)	41	42	43	44	45
Very Strong (5) (>80 m)	51	52	53	54	55

Source: Ross (1992)

In continuation of the above, Guerra (1993, p.168) defines dissected relief as the part of the earth's crust furrowed with great vigor by the drainage network or landscape worked by erosive agents. According to Souza (2018), the relief dissection will be heterogeneous throughout the earth's surface, since erosion agents are distributed irregularly in time and space, collaborating in the formation of different types of landscapes.

In line with Flores (2012), the dissection shapes are extremely relevant in a detail mapping, since shapes that may appear to coincide on a scale in a detail mapping have different morphographic characteristics. Thus, they denote distinct processes of formation, in addition to constituting particular units, in this way the areas of accumulation also presented in an equal way with the active process, giving the relief its own morphoclimatic character.

FINAL CONSIDERATIONS

Based on the above, it is evident that cartography and its language constitutes an essentially theoretical and applied means of communication, aligned with geographic knowledge. Cartography is a very rich resource that permeates not only geographic science, but many other areas of knowledge.

Supported by systemic analysis, it offers an efficient theoretical-methodological conclusion within geography studies. The proposal for presenting geomorphological mapping based on an integrated legend was based on the assumption that relief cartography is an important means for carrying out geomorphological studies based on the General Systems Theory, regardless of the context of the environmental study.

It is emphasized that it is necessary that the cartographic language has central emphasis in the geographic reflections, being fundamental that they aim to deepen not only the practical questions, but also the theoretical ones about the interconnection of Geography and Cartography. By appropriating the theoretical there is the possibility of a practical reorganization in an efficient way, expanding the significant results, since the theory is seen as a basis capable of subsidizing readings and interpretations through the cartographic language.

Therefore, the importance of Cartography as a means of communication is clear, maps and their language have always been present in history, linked to the transmission of socio-spatial communication. In this way, the history of Cartography and Geography have always been present in relation to each other.

Thus, it is recommended that cartography, and in particular geomorphological cartography, make use of theoretical and practical reflections on the shapes and objects to be mapped, in order to avoid misinterpretations.

Support: CAPES (Coordination for the Improvement of Higher Education Personnel) - financial resource

REFERENCES

AB'SABER, A. N. Um conceito de geomorfologia a serviço das pesquisas sobre o quaternário. **Geomorfologia,** São Paulo, n. 18, p. 1-23, 1969.

ALMEIDA, L, D. **Do desenho do mapa**. (org) 2. Ed. Reimpressão, São Paulo: Contexto, 2010.

AMARAL, R.; ROSS, J. L. S. A classificação taxonômica do relevo como um instrumento de gestão territorial – uma aplicação ao parque estadual do morro do Diabo, município de Teodoro Sampaio (SP). **VI Simpósio Nacional de Geomorfologia** – Geomorfologia Tropical e Subtropical: processos, métodos e técnicas. Goiânia (GO), 2006.

ANDRADE, M. C. **Geografia**: ciência da sociedade. Recife: ed. Universitária da UFPE, 2006.

ARCHELA, R ,S; ARCHELA, E. **Correntes da cartografia teórica e seus reflexos na pesquisa**. Geografia (Londrina), Londrina - PR, v. 11, n.2, p. 161-170, 2002.

BARBOSA, G. V. *et al.* Evolução da Metodologia para Mapeamento Geomorfológico do Projeto Radambrasil. **Boletim Técnico Projeto Radambrasil.** Série Geomorfologia. Salvador, out. 1984.

BERTALANFFY, L. von. **Teoria geral dos sistemas**. São Paulo: Vozes, 1975.

GREGORY, K, J. **A natureza da Geografia Física.** Rio de Janeiro. Bertrand Brasil. 1992.

BERTIN, J. **Sémiologie Graphique***:* les diagrammes, les réseaux, les cartes. Paris:Mounton e Gauthier-Villars. 1967.

BERTOLINI, W. Z.; DEODORO, S. C. Estudo da dissecação do relevo no alto rio Piranga (MG). **Geociências**, v. 37, n. 1. UNESP, São Paulo, p. 183-192, 2018.

CARVALHO, B.L.; BRAGA, C. A.; GOMES, M. R.M.; SOBRINHO, J.F. Tecnologias sociais de convivência com o semiárido no município de Reriutaba-Ce. Revista **GeoUECE (Online)**, v. 08, n. 14, p. 62-75, jan. 2019. ISSN 2317-028X.

CARVALHO, E. A.; ARAÚJO, P. C. de . **Leituras cartográficas e interpretações estatísticas I** : geografia. 1. ed. Natal: EDUFRN, 2008. v. 01. 248p.

CASSETI, V. **Ambiente e Apropriação do Relevo.** Contexto. São Paulo, 2 ed.: 147p., 1995.

CASTROGIOVANNI, A, C. **Construir a geografia**. Boletim Goianio de Geografia. Porto Alegre: AGB-PA. Edição Extra XII EEPG, 1992.

CUNHA, C. M. L.; QUEIROZ, D. S. A cartografia geomorfológica de detalhe: uma proposta visando à multidisciplinaridade. **CLIMEP-Climatologia e Estudos da Paisagem**, v. 7, n. 1-2, 2012.

CUNHA, C. M. L.; MENDES, I. A.; SANCHEZ, M. C. Técnicas de Elaboração, Possibilidades e Restrições de Cartas Morfométricas na Gestão Ambiental. **Geografia**, Rio Claro – SP, v. 28, n. 3, p. 415-429, 2003.

CUNHA, C. M. L. **A Cartografia do Relevo no Contexto da Gestão Ambiental.** 2001. Tese (Doutorado em Geociências e Meio Ambiente) – Instituto de Geociências e Ciências Exatas, Unesp, 2001.

CHRISTOFOLETTI, A. **Perspectivas da Geografia**. São Paulo: Difel, 1985, p.11-36.

CHRISTOFOLETTI, A. **Análise de sistemas em Geografia.** São Paulo, Edgard Blucher. 1979.

COSTA FALCÃO, C. L. C. A Teoria Geral dos Sistemas e o Entendimento dos Processos Erosivos em uma Bacia Hidrográfica. **Revista Equador**, v. 9, p. 21, 2020.

DANTAS, G. K. M. **Estudo geomorfológico a partir do uso de sistema de informações geógraficas (Landsat 8 e Topodata):** um estudo de caso na sub-bacia do Riacho Santana-RN. 2016. 256f. Dissertação (Mestrado em Geografia) - Centro de Ciências Humanas, Letras e Artes, Universidade Federal do Rio Grande do Norte, Natal, 2016.

DUARTE, P.A. **Fundamentos de Cartografia**. 3ª. Ed. Florianópolis: Editora da UFSC, 2008.

DONÉ, S. S. B. Mapas Geomorfológicos e suas legendas. Uma contribuição para estudos analíticos. **Notas Geomorfológicas**, Campinas, v. 21, n. 41, p. 85-110, 1981.

FALCAO SOBRINHO, José**. O relevo, elemento e âncora, na dinâmica da paisagem do vale, verde e cinza, do Acaraú, no Estado do Ceará,** FFLCH/USP, São Paulo, 2006.

FALCAO SOBRINHO, José**. Relevo e Paisagem: proposta metodológica**. Edições UVA, Sobral, 2007.

FALCAO SOBRINHO, José. **A compartimenção geomorfológica do Vale do Acaraú: distribuição das águas e pequeno agricultor**. Mercator, Fortaleza, v. 5, n. 10, p. 91 a 110, nov. 2008.

FALCAO SOBRINHO, José **A Inserção Antropogênica na Construção e Reorganização do Cenário da Paisagem do Vale do Acaraú, CE.** Revista Brasileira de Geografia Física 7 (6), 1078-1092, 2014.

FALCÃO SOBRINHO, J., SOUZA, A.P.M. de, FALCÃO, I.L.C.; FALCÃO, Ítalo L.C. Natureza, Meio Ambiente e a Teoria Geral dos Sistemas Bases Ambientais, Econômicas e Jurídicas. **HOLOS**, 8, 104-125. 2017. https://doi.org/10.15628/holos.2017.3485.

FALCAO SOBRINHO, José. **A Natureza do Vale do Acaraú: um olhar através das sinuosidades do relevo.** Editora SobralCult, 2020. https://doi:10.35260/87429137-2020

FERREIRA, A. R.; ROSS, J. L. S. **Geomorfologia, geodiversidade e análise da fragilidade ambiental das paisagens do parque estadual Serra Ricardo Franco, MT-Brasil.** 2014.Universidade de São Paulo, São Paulo, 2014.

FLORENZANO, T. G. Cartografia *In:* FLORENZANO, T. G. (Org.). **Geomorfologia:** conceitos e tecnologias atuais. São Paulo: Oficina de Textos, p. 105-128, 2008.

FLORES, D. M. **Análise Geomorfológica da Bacia do Ribeirão Balainho Suzano-SP.** Programa de Pós-Graduação em Geografia Física – FFLCH – USP, São Paulo, 2012.

KOHLER, H. C. A Escala na Análise Geomorfológica. **Revista Brasileira de Geomorfologia.** São Paulo, ano 3, n. 1, p. 21-31, 2002.

GIRARDI, P. E. Cartografia geográfica crítica: uma proposta teórico-metodológica. In:_____**Proposição teórica-metodológico de uma cartografia geográfica crítica e sua aplicação no desenvolvimento do atlas da questão agrária brasileira.** Presidente Prudente, 2008. p. 42-85.

GRIFFITHS, J. S.; ABRAHAM, J. K. Factors affecting the use applied geomorphology maps to communicate with the different end-users. **Journal of Maps.** United Kington, 4:1, p. 201-210, 2008.

GUERRA, A. T. **Dicionário Geológico Geomorfológico.** 8ª. ed. Rio de Janeiro: IBGE, 1993.

GUERRA, A. J. T. (Orgs.). **Reflexões sobre geografia física no Brasil.** Rio de Janeiro: Betrand Brasil, p. 111-128, 2004.

JOLY, F. **A cartografia**. Trad.: Tânia Pellegrini. Campinas: Papirus, 1990.

LEMES, D. P.; PIRES, C. A. F. Classificação Geomorfológica do Município de Quaraí-RS e as Áreas de Ocorrência Mineral. **Geografia:** Ensino & Pesquisa, Santa Maria, v. 13, n. 2, p. 197-208, 2009.

LIMA, K. C. ; LUPINACCI, C. M. . Geomorfologia do semiárido: proposta metodológica de representação cartográfica e interpretação do relevo em escala de detalhe. **Revista Brasileira de Geomorfologia**, v. 22, p. 217-234, 2021.

LUNA, S. V. de. **Planejamento de pesquisa: uma introdução**. São Paulo: EDUC,1996.

LONGO, V, A, A. **A história da Cartografia e suas contribuições para a linguagem cartográfica nas séries do ensino Fundamental**. Presidente Prudente, 2011.

MARTINELLI, M. Mapas da Geografia e cartografia temática. 5. ed., 1º reimpressão. São Paulo: Contexto, 2010.

MECERJACOV, J. P. – Les concepts de morphostruture et de morphosculture: um nouvel instrument de l'analyse geomorphologique. Annales de Geographie 77 année- nº 423. Paris, 1968.

MENDONÇA, F. **Geografia física:** Ciência humana? 4 ed. São Paulo: Editora

Contexto, 1996.

MENEGUETTE, A.A.C. **Cartografia no Século 21: revisitando conceitos e**

Definições. Revista Geografia e Pesquisa, Ourinhos, v.6, n.1, jan./jun., 2012.

MONECHE, M. S. F. **A Perspectiva Geomorfológica:** Subsídios a análise ambiental. Monografia (departamento de Geografia), Universidade Federal do Espirito Santo. Vitória, 2009. 84p.

MORAES, A. C. R. **Geografia pequena história critica.** São Paulo, Editora Annablume, 2005.

MOREIRA, R. **Pensar e ser em Geografia**: ensaios de história, epistemologia e ontologia do espaço geográfico. São Paulo: contexto, 2007.

OLIVEIRA, H. T. Potencialidades do uso educativo do conceito de bacias hidrográficas em programas de educação ambiental. *In:* SCHIAVETTI, A.; CAMARGO, A. F. M (Orgs.). **Conceitos de bacias hidrográficas:** teorias e aplicações. Ilhéus: Editus, p. 25-128, 2012.

RODRIGUES, C. Morfologia original e morfologia antropogênica na definição de unidades espaciais de planejamento urbano, exemplo na metrópole paulista. **Revista do Departamento de Geografia**, n. 17. São Paulo. FFLCH – USP, 2005.

OLIVEIRA, C de. **Curso de cartografia moderna**. Rio de Janeiro: IBGE, 1988.

PACHECO, A. P. **O uso de tecnologia da informação e comunicação no ensino e aprendizagem de geografia: "uma proposta de educação continuada"**. Tese de Doutorado. (CCEN- UFPB), João Pessoa, 2019. 241p.

ROSS, J. L. S. Análise empírica da fragilidade ambiental dos sistemas naturais e antropizados. **Revista do Departamento de Geografia (USP)**. (6): 63-74. 1994.

ROSS, J. L. S. O registro cartográfico dos fatos geomórficos e a questão da taxonomia do relevo. **Revista do Departamento de Geografia**, FFLCH-USP, n. 6. São Paulo, 1992.

ROSS, J. L. S. **Geomorfologia Ambiente e Planejamento.** Ed. Contexto. São Paulo. 85p. 2003.

SANTOS, F. L. A. **Bases Geográficas ao Zoneamento Ecológico-Econômico do Planalto da Ibiapaba:** Municípios de Tianguá e Ubajara- Noroeste do Ceará. 2015. 218 f. Dissertação (Mestrado Acadêmico ou Profissional em XX) – Universidade Estadual do Ceará, 2015.

SANTOS, D. **A reinvenção do espaço:** diálogo em torno da construção do significado de uma cartografia. São Paulo: UNESP, 2002.

SILVA, M. V. C. de; BRITO, E. G. Cartografia. Livro Digital 7,27 MB Adobe PDF Coleções Livros Digitais, 2019. Disponível em: http://educapes.capes.gov.br/handle/capes/552595. Acesso em: 18 de maio. 2022.

SIMON, A. L. H.; LUPINACCI, C. M. (Org.). **A cartografia geomorfológica como instrumento para o planejamento**. 1. ed. Pelotas: UFPEL, v. 1, 2019. 172p.

SOUZA, E. A. **Mata da Amem, Cabedelo/PB:** Possibilidades de CoGestão. 2000. Dissertação (Mestrado em Desenvolvimento e Meio Ambiente) Universidade Federal da Paraíba. João Pessoa, 2000.

SOUZA, L. J. **Estudo integrado da paisagem, geomorfologia e geotecnologias:** proposta de automatização dos índices de dissecação do relevo. Salvador, 2018. 37 f.

TAYLOR, D.R. F. Uma Base Conceitual para a Cartografia: Novas Direções para a Era da Informação. **Caderno de Textos - Série Palestras,** LEMADI–DG/USP, São Paulo, v. 1, n.1, p.11-24, ago. 1994.

TRICART, J. **Principes et Méthodes de la géomorphologie.** Paris, Masson et Cie Editeurs. 1965.

VIADANA, A. G. Biogeografia: natureza, propósitos e tendências. *In:* VITTE, A. C.; GUERRA, A.T.G. **Reflexões sobre a Geografia Física no Brail**. Bertand Brail. Rio de Janeiro, 2007.

VEADO, Ricardo Wagner ad-Víncula. **Geossistemas de Santa Catarina**. Rio Claro, UNESP/ IGCE, 1998. (Tese de Doutorado).