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The scales of Geography: bridges between the concepts of cartographic scale and geographic scale

As escalas da Geografia: pontes entre os conceitos de escala cartográfica e escala geográfica

Las escalas de la geografía: Puentes entre los conceptos de escala cartográfica y escala geográfica

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Abstract: In Geography, the understanding and use of the concepts of cartographic scale and geographic scale help to define scientific research. Starting from classic texts that deal with the subject, the objective is to verify the relevance of the criticisms to the cartographic scale and its opposition to a concept of a "truly" geographical scale, in addition to presenting a contribution to this problem, with the definition of differences, similarities, limits and possibilities of each concept. Thus, the stages of this research consisted of exploratory bibliographic research of articles and books, on digital bases of free access on the Internet, anchored in the technique of retrospective investigation, from a reference work. This analysis results in the idea that there is still a conceptual uncertainty as to the geographical scale, hence the adoption or, sometimes, confusion with the cartographic scale. It also highlights the lack of understanding of the scope of cartography as a language, taking the map only by the limits imposed by its scale, and underestimating its real possibilities of contribution to geographic analysis.

Keywords: Geographic analysis. Scale. Geographic scale. Level of analysis.

Resumo: Na Geografia, o entendimento e a utilização dos conceitos de escala cartográfica e escala geográfica auxiliam no delineamento da investigação científica. Dessa forma, o objetivo deste artigo é verificar a pertinência das críticas à escala cartográfica e sua contraposição a uma concepção de escala "verdadeiramente" geográfica, além de apresentar um aporte a essa problemática com a definição das diferenças, semelhanças, limites e possibilidades de cada conceito. A metodologia consistiu em pesquisa bibliográfica exploratória de artigos e livros, em bases digitais de livre acesso na Internet, ancorada na técnica de investigação retrospectiva, a partir de uma obra de referência. Por meio da análise, sobressai-se a ideia de que ainda há uma indefinição conceitual quanto à ideia do que seja uma escala geográfica, daí advindo a adoção ou, por vezes, a confusão com sua congênere cartográfica. Também se destaca a incompreensão do alcance da cartografia como linguagem, tomando-se o mapa apenas pelos limites impostos por sua escala e menosprezando suas reais possibilidades de contribuição à análise geográfica.

Palavras-chave: Análise geográfica. Escala. Escala geográfica. Nível de análise.

Resumen: En Geografía, la comprensión y el uso de los conceptos de escala cartográfica y escala geográfica ayudan a delinear la investigación científica. A partir de textos clásicos que abordan el tema, el objetivo es verificar la relevancia de las críticas a la escala cartográfica y su oposición a una concepción de escala "verdaderamente geográfica", además de presentar un aporte a esta problemática, con la definición de diferencias, similitudes, límites y posibilidades de cada concepto Las etapas de esta investigación consistieron en la búsqueda bibliográfica exploratoria de artículos y libros, en bases digitales de libre acceso en Internet, anclados en la técnica de la investigación retrospectiva, a partir de una obra de referencia. A través del análisis se destaca la idea de que aún existe una incertidumbre conceptual sobre la idea de qué es una escala geográfica, lo que resultó en la adopción o confusión con la escala cartográfica. También destaca la falta de comprensión del alcance de la cartografía como lenguaje, tomando el mapa solo por los límites que impone su

escala, y subestimando sus posibilidades reales de contribución al análisis geográfico.

Palabras clave: Análisis geográfico. Escala. Escala geográfica. Nivel de análisis.

Introduction

In geographic research, the scale involves an analytical cut and a way of approaching a given phenomenon. However, some initial questions permeate a definition of this research design: does scale determine the level of analysis? Or is the scale determined by a certain level of analysis? What relationships exist between the choice of the cartographic scale, which will define the level of visual representation of the phenomenon, and the appropriate geographical scale for its analysis?

Racine, Raffestin, and Ruffi (1980, p. 87, our translation) highlight the importance of the scale in geographic research. For the authors, "[...] we can not accept that still today a research be conducted without the scale having been clearly specified ". A criticism corroborated by Meentemeyer (1989, p. 163) states that, in Geography, the "[...] scale has always been a major issue; however, geographers do not seem to explicitly state their scales of analysis any more fully than scientists in other disciplines".

According to Gibson, Ostrom e Ahn (2000, p. 217), the difficult to understand the scale is not exclusive to geographers:

> While natural scientists have long understood the importance of scale, and have operated within relatively well-defined hierarchical systems of analysis, social scientists have worked with scales of less precision and of greater variety.

Castro's (1995) text, *O problema da escala* (in English *The problem of scale*), is a classic Brazilian production on this subject. In this text, the author discusses the problems of appropriation and use of the concept of cartographic scale by Geography, due to the historical association with Cartography. According to her, from this comes

1 "[...] on ne peut plus accepter aujourd'hui qu'une recherche soit conduite sans que l'échelle soit clairement spécifiée".

2 Enquanto os cientistas naturais há muito entenderam a importância da escala e operaram dentro de sistemas hierárquicos de análise relativamente bem definidos, os cientistas sociais têm trabalhado com escalas de menor precisão e de maior variedade.

the difficult to apply the concept of cartographic scale, given its supposed restrictions, arising from the "dimensional" tying: scale as a mathematical proportion that is established between the real size (of the phenomenon) and its representation (on the map).

The work of Castro (1995) is fundamental in this debate, besides being anchored in texts that also specifically discussed this subject, especially Lacoste (1976), Grataloup (1979), Racine, Raffestin, and Ruffi (1983). Nonetheless, several Brazilian authors have later focused on the problem of scale in Geography, such as Castro (2014), Silveira (2004), Melazzo and Castro (2007), Marques and Galo (2009), Santos (2013), Souza (2019), among others. The English literature on the subject is fruitful, as we will see below.

Despite this, some gaps remain. This study aims to contribute in this direction by establishing a comparative analysis of the concepts of cartographic scale and geographic scale. Initially, the objectives here are verify the pertinence of the criticism to the use of (or commitment) the cartographic scale in geographic analysis and, in this way, in conflict with a conception of "truly" geographic scale – something recurrent among the authors who have been discussing this theme. Thus, the objective of this study is to present a contribution to this problem, based on the definition of differences, similarities, limits, and possibilities of each concept.

The aim is not to produce a state-of-the-art on the subject, but rather select works according to a line reasoning that has privileged the technique of retrospective research, of reading the works that supported a reference text (CASTRO, 1995). Due to the context in which this research was conducted, in the midst of the coronavirus pandemic, which led to the blocked access to physical library materials, the search for the texts was mostly anchored in open access digital databases over the Internet. We must emphasize that this choice implies the possibility of omitting certain publications, either because they are unavailable for remote access, or because they only exist in printed or inaccessible versions, or simply because they have not been cited in the works analyzed here.

Criticisms of the cartographic scale

It is interesting to note that the origin of the word scale refers to the marking of space and of time. According to the dictionaries *Houaiss*, *Merriam-Webster*, *Online Etymology Dictionary,* and *La Langue Française*, its first historical records appear in Late Latin (imperial), around the 14th century, with the word *scala*, usually spelled in the plural, *scalae*, meaning "staircase" (which originated *escalera*, in Spanish), "steps". From this matrix are derived the terms *escala*, in Portuguese and Spanish; *scala*, in Italian; **échelle**, in French; and even *scale*, in English, and *skala*, in German, and some Slavic and Nordic languages. At the same time, the meanings of "series of registration marks to measure" (hence the scale of degrees, at temperatures) and "marks established to determine the distance along a line" appears, from which derives the association with "ports", as stopovers of a trip – sense later adopted also for airports, in air transport.

These same sources indicate that the sense of "pattern for estimation", such as large scale, small scale, etc., presents records already in the 15th century. The musical concept of sequence of musical notes ordered in time is from the end of the 16th century. In the 17th century, the term gained the meaning of "proportion of a representation to the real object", as is recognized in the definition of the cartographic scale. Grataloup (1979) also observed this in the famous French dictionary *Le Petit Robert*, which still records the emergence, in the 18th century, of the figurative sense of a progressive sequence, that is, a hierarchy, as a scale of values.

Even the modern senses recorded in dictionaries give an association of the word scale with measures, metrics of space, and time. The *Houaiss*, for example, presents the following definitions: time that vessels remain in a port; places (and time) of stops for fueling, shipment and landing of loads and passengers; table that determines working hours; and series of degrees or levels,

arranged according to the importance of each one, in ascending or descending order[3] (HOUAISS; VILLAR, 2001, our translation).

Etymology and semantics, therefore, give us indications about the domain of the cartographic sense attributed to scale. This can be observed in the classic text by Lacoste (1976), which does not use, even once, the term "geographic scale" – although it clearly discusses this idea, but anchored in spatial reasoning based in maps. According to Souza (2013, p. 85, our translation), Lacoste "[...] offered a contribution to the methodological renewal of the disciplinary field of Geography by emphasizing the specificity of the geographic understanding of scale and also by emphasizing the importance of multiscalar reasoning"[4].

Castro's (1995) article, the starting point of our reflection on scale, is the fruit of an earlier contribution by the author (CASTRO, 1992), expanded as a chapter of the book *Geografia: conceitos e temas*[5] – and therefore less accessible than the publications of articles on digital platforms. Castro (1995) begins the text by criticizing the analogy between the concepts of cartographic scale and geographic scale, assuming that this "has hampered the problematization of the concept"[6] (p. 117, our translation). Although the author acknowledges the importance of Lacoste's contribution, she criticizes the parallelism he establishes between levels of analysis and spatial cutouts, which would limit the concept of scale to measures of cartographic representation. Castro (1995, p. 123) also disapproves the use of the term "level of analysis", because it admits a sense of hierarchy, which for the author have been harmful to the approach to geographic space.

As highlighted by Castro (1995, p. 123, our translation), Lacoste "imprisoned the conception of scale"[7] by "defining

3 "tempo em que embarcações permanecem num porto; lugares (e tempo) de paradas para abastecimento, embarque ou desembarque de carga ou passageiros; tabela que determina horários de trabalho; e série de graus ou níveis, dispostos segundo a importância de cada um, em ordem ascendente ou descendente."

4 "[...] ofereceu uma contribuição para a renovação metodológica do campo disciplinar da Geografia ao sublinhar a especificidade do entendimento geográfico de escala e também ao ressaltar a importância dos raciocínios multiescalares".

5 CASTRO, I. E.; GOMES, P. C. C.; CORRÊA, R. L. (org.). Geografia: conceitos e temas. Rio de Janeiro: Bertrand Brasil, 1995.

6 "dificultou a problematização do conceito".

7 "aprisionou o conceito de escala"

previously significant orders of magnitude for analysis"[8]. Souza (2013, our translation) saw it as inspired by an analogous terminology developed by geomorphologist Jean Tricart. In fact, the text published by Cailleux and Tricart (1956), which proposed a taxonomic classification of geomorphological phenomena based on the adoption of seven orders of space-time magnitude, influenced a series of similar initiatives in many other areas of geographic research.

The later criticism presented, arising from the reflections of Grataloup (1979), is even more emphatic to cartography. As Castro put it (1995, p. 124, our translation), "the author attempts to put the map in its proper place"[9]. Probably when Grataloup (1979, p. 77, our translation) states "[...] that not every map (and therefore not every map reading) is strictly geographical in so far as our discipline [Geography] is not reduced to the study of locations, but rather analyzes the functioning of space"[10].

Grataloup (1979) also associates cartography with an empirical approach of conception and representation of an idealized space, which would disregard the different social scales: "Just because several things appear on the same map does not mean that they participate in the same orders of phenomena, in short, in the same spaces". (p. 74, our translation).

However, the author does not corroborate Castro's aversion to "levels of analysis". For Grataloup (1979), the scale is a hierarchy of levels. His proposal of geographic scale or social, spatial scale results in a hierarchy of levels of analysis of the social space identified as a confusing "interlacing of structures". Despite the interesting proposal of adopting a threshold and significant levels for social spaces, the author does not develop the idea, and his final criticism of the maps only reinforces the incomprehension about cartographic language.

8 "definir a priori as ordens de grandeza significativas para análise"

9 "o autor procura colocar o mapa no seu devido lugar".

10 "Ce n'est pas parce que plusieurs choses figurent sur une même carte, qu'elles participent aux mêmes ordres de phénomènes, bref aux mêmes espaces".

Furthermore, the conception of cartography as an "instrument" or "technique", and not as a "language", with all the wealth of communication possibilities that this implies, and which goes far beyond the restrictions imposed by the cartographic scale, is something that emerges in the works that have addressed the problem. An example is another text often quoted by Castro (1995), written by Racine, Raffestin, and Ruffi (1980). For the authors,

> [the] cartography is an available instrument, but it is not "geography". [...] The cartographic scale takes into account the representation of space as a "geometric form", while the scale that we could and, in many respects, should qualify as geographical, is responsible for representing the relationship that societies have with this "geometric form".[11] (RACINE; RAFFESTIN; RUFFI, 1980, p. 87).

Despite this, the link between geographical analysis and a concept of scale linked to cartography is almost always a striking element among the works that address this topic. Racine, Raffestin, and Ruffi (1980) uses this reasoning when they state that a progressive decrease in the scale corresponds to an increase in the probability of homogeneity of the environment studied. According to the authors, in most cases, the tendency to homogeneity increases at the inverse ratio of the scale. This is a clear analogy to the idea of reducing the scale of the map, which necessarily involves processes of cartographic generalization, such as the simplification of line and contour lines, elimination or fusion of points, lines or polygons, etc.

However, even the idea of homogenizing the space depending on the reduction of the cartographic scale or the inverse, of increasing complexity with its enlargement, depends on how that geographic space is like. In a hypothetical example, a map of land use can be very diverse on a medium or small scale (1:50,000 to 1:250,000), and becomes completely homogeneous on a large scale

11 [a] cartografia é um instrumento disponível, mas não é a "geografia". [...] A escala cartográfica leva em conta a representação do espaço como uma "forma geométrica", enquanto a escala que poderíamos e, em muitos aspectos, deveríamos qualificar como geográfica, é responsável pela representação da relação que as sociedades têm com esta "forma geométrica".

(1:5,000), within the limits of a monoculture farming. The same can happen with many other themes, such as relief, climate, etc.

On the one hand, Castro (1995, p. 127, our translation) emphasizes that Racine, Raffestin, and Ruffi (1980) present "a fundamental notion about scale as a mediator between intention and action"[12], and on the other, she criticizes the authors for "reduce the phenomenon to the measure"[13], since they associate the concept of scale with of the dimension of a phenomenon. However, Castro (1995) recognizes that every phenomenon has a more appropriate dimension of occurrence, observation, and analysis, in addition to considering the scale is a measure chosen to better observe, size, and measure the phenomenon.

The other authors and works with which Castro (1995) dialogues in her article do not present oppositions between cartographic and geographic scales. However, they collaborate with very interesting arguments for the design of a geographic scale. From her reading of the Merleau-Ponty (1964), for example, Castro (1995, p. 132, our translation) establishes three important assumptions: "1) There is no more or less valid scale, reality is contained in all of them; 2) The scale of perception is always at the level of the phenomenon perceived and conceived [...]; 3) The scale does not fragment the real, it only allows its apprehension".[14]

It is worth mentioning here Boudon (1991), who Castro (2015) quotes only at a few moments, although she returns to it in a later text (CASTRO, 2014), expanding this dialogue. Boudon (1991) puts relevant arguments on the theme: the scale is used to make a cut out of reality; it denotes an intention (to target an object/phenomenon); and it indicates a reference field from which the object or phenomenon is observed (BOUDON, 1991 *apud* LEPETIT, 1993, our translation).

In the latter part of the article, Castro (1995, p. 134, our emphasis, our translation) recognizes that the selection of the scale

12 "uma noção fundamental sobre a escala enquanto mediadora entre a intenção e a ação"

13 "reduzem o fenômeno à medida"

14 "1) não há escala mais ou menos válida, a realidade está contida em todas elas; 2) a escala da percepção é sempre ao nível do fenômeno percebido e concebido; [...] 3) a escala não fragmenta o real, apenas permite sua apreensão".

is the result of a "cut of the perceived/conceived reality according to the point of view, with the choice of the **level** of perception/conception"[15]. The author adds that this cut "corresponds to the choice of parts of equal value"[16], or "unit of conception, which do not necessarily have the same size or dimension, but which highlight relationships, phenomena, facts"[17] (p. 135, our translation).

Other later works also confronted the cartographic scale in its propositions on a conception of the geographical scale. The text by Silveira (2004, p. 88), one of the most known (considering *Google Scholar* search results), also evokes the notion of cartography as an instrument and the "inconvenience of the cartographic-scale analogy"[18], based on Grataloup (1979) and Castro (1995).

For Melazzo and Castro (2007, p. 135, our translation), the cartographic reference of the scale is "a notion, that is, an idea used in different discursive scientific matrices, [...] associated to a representation: the element that technically allows to represent the reality, wide, complex or even big, in a way to be apprehended, visualized, manageable"[19]. Thus, the cartographic reference would be a "measure" and "a strategy of reproduction of a precious and already given reality, leaving to those who map it the task of reproducing it"[20] (p. 136, our translation).

The emphasis of the authors on the verb "reproduce" gives the dynamics of their incomprehension that a map is not capable of (and should not try) duplicate reality, but rather represent it. This implies a subjective character related to the choices of the cartographer-geographer on the cut of this reality (what will be hidden or what will be highlighted), something essential to a cartographic construction. Once again, the cartographic scale

15 "recorte da realidade percebida/concebida de acordo com o ponto de vista, com a escolha do nível de percepção/concepção"

16 "corresponde à escolha de partes de igual valor"

17 "unidade de concepção, que não têm necessariamente o mesmo tamanho ou a mesma dimensão, mas que colocam em evidência relações, fenômenos, fatos".

18 "inconveniência da analogia escala cartográfica-escala geográfica"

19 "uma noção, ou seja, uma ideia utilizada em diferentes matrizes científicas discursivas, [...] associada a uma representação: o elemento que tecnicamente permite representar a realidade, ampla, complexa ou mesmo grande, de maneira a ser apreendida, visualizada, manejável"

20 "uma estratégia de reprodução de uma realidade anterior e já dada, restando a quem a mapeia a tarefa de reproduzi-la"

is taken as a unique reference ("mathematical measure") on the ability of cartography to establish its reading of reality.

In discussing and proposing a distinction between cartographic and geographic scales, Marques and Galo (2009) assume the last definition adopted by Ecology, in which a spatial scale is relative to the dimension of the phenomenon:

> [...] the relationship between the cartographic and geographic scales is inversely proportional, that is, the larger the area comprised by a phenomenon, the smaller the appropriate cartographic scale should be for its representation and the smaller the area of occurrence of a phenomenon, the larger the necessary cartographic scale should be for its representation.[21] (MARQUES; GALO, 2009, p. 49, our translation).

The authors approach the time scale as distinct from the geographical scale, without considering the latter, therefore, as a procedural scale (space-time) – although they mention the articulation between spatial dimensions and the time of occurrence of phenomena, as explained in the hierarchy levels of Forman (1995[22] *apud* MARQUES; GALLO, 2009).

Similarly, Souza (2013, p. 183, our translation) adopts the critical discourse in relation to the cartographic scale, highlighting the need to "emancipate the scalar reasoning beyond the narrow limits of cartography [...] in socio-spatial research."[23] For the author, the geographic scale should be subdivided into the scale of the phenomenon (the physical scope or processes related to the phenomenon), scale of analysis (the analytical level of apprehension of the phenomenon), and scale of action (the reflection on the spatial scope of practices of social agents).

In addition to recovering the contribution of Lacoste and other authors discussed in Castro's text (1995), the author emphasizes

21 [...] a relação das escalas cartográfica e geográfica é inversamente proporcional, ou seja, quanto maior for a área compreendida por um fenômeno, menor deverá ser a escala cartográfica adequada para a sua representação e quanto menor for a área de ocorrência de um fenômeno, maior deverá ser a escala cartográfica necessária para a sua representação.

22 FORMAN, R. T. T. Land Mosaics: The Ecology of Landscapes and Regions. Cambridge: Cambridge University Press, 1995. 535 p.

23 "se emancipar o raciocínio escalar para além dos estreitos limites da cartografia [...] na pesquisa sócio-espacial."

the master's dissertation of Bahiana (1986) and presents a large production of Anglo-Saxon origin on the theme "scale". Although initially considering a mistake "the identification of a fixed and constant number of levels"[24] for the scale "in the socio-spatial sphere"[25] (SOUZA, 2013, p. 187-188, our translation), in the end, the author proposes a typology, although not seen as "a rigid framework of references"[26]. The typology, which he specifies as "subject to various improvements" (p. 199), adopts an indistinction between "scale" or "level", and begins with the "scale (or level)" of the body, passing through the nanoterritories, the local (subdivided into micro, meso, and macro), the regional, the national, and finally the international "scale (or level)" (also subdivided into "groups of countries" and "global").

The possibilities of each concept

The literature review was conducted based on Castro's (1995) text and the works selected in the exploratory research and that allowed me to know other studies on the scale. Among these studies are the texts by Neil Smith and Sallie Marston, which are basic to the social and political discussion of the scale, or by Bahiana (1986), previously commented, and also Meentemeyer (1989), Sheppard and McMaster (2004), Sayre (2005). These surveys in the English language are very useful to study the scale, but, unfortunately, will not be explored in this article.

The research conducted by Gibson, Ostrom e Ahn (2000) is an example. In a similar way to Sayre's (2005) work, the authors propose to facilitate the dialogue between natural and social scientists, reviewing some of the most important aspects of the concept of scale, which they summarize in a table with key terms related to this theme (Table 1).

24 "a identificação de um número fixo e constante de níveis"
25 "no âmbito sócio-espacial"
26 "um quadro rígido de referências"

Table 1 - Definitions of key terms related to the concept of scale

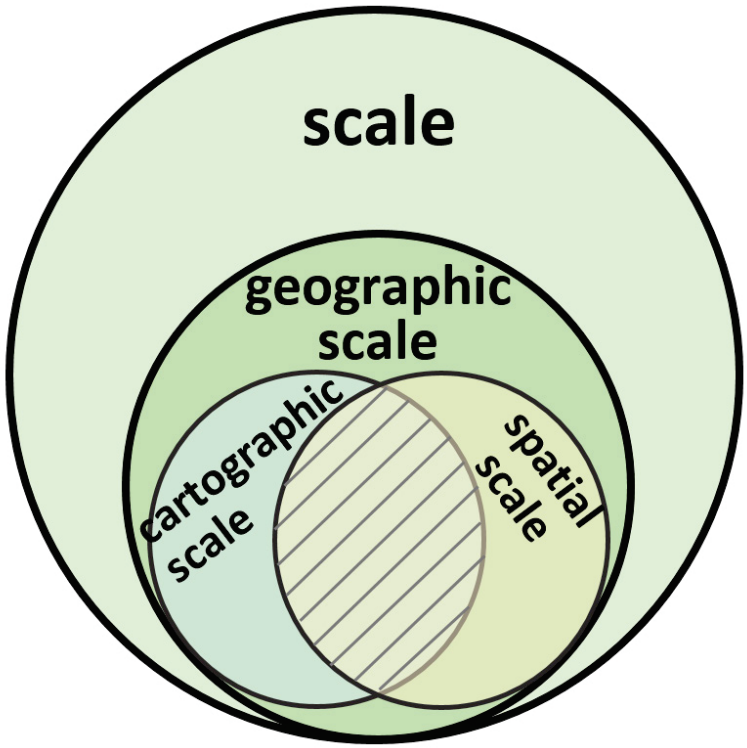
Term	Definition
Scale	The spatial, temporal, quantitative or analytical dimensions used to measure and study any phenomenon
Extension	The size of the spatial, temporal, quantitative or analytical dimensions of a scale
Resolution	The accuracy (of data and information) used in the measurement
Hierarchy	A conceptually and causally linked system of grouping objects or processes along an analytical scale
Inclusive Hierarchy	Groups of objects or processes classified as inferior in a hierarchy are not contained in subdivisions of groups classified as superior in the system (for example, modern taxonomic classifications – kingdom, phylum, subphylum, class, family, genus, species)
Exclusive Hierarchy	Groups of objects or processes classified as inferior in a hierarchy are not contained in subdivisions of groups classified as superior in the system (for example, military classification systems – general, captain, lieutenant, sergeant, corporal, soldier)
Constitutive Hierarchy	Groups of objects or processes are combined into new units, which are then combined into other new units, with their own functions and emerging properties
Levels	The analysis units located in the same position on a scale. Many conceptual scales contain levels that are ordered hierarchically, but not all levels are linked to each other in a hierarchical system
Absolute scale	The distance, time, or quantity measured on an objectively calibrated measuring device
Relative scale	A transformation from an absolute scale to one that describes the functional relationship of one object or process to another (for example, the relative distance between two locations based on the time needed for an organism to move between them)

Source: Gibson, Ostrom, and Ahn (2000, p. 218, our translation), Turner et al. (1989), Mayr (1982), Allen and Hoekstra (1992). Adapted.

Studies show an understanding of scale as an analytical resource has both a spatial or temporal dimensions and a philosophical, political and social dimensions. As highlighted by Racine, Raffestin, and Ruffi (1980), the scale appears as a filter that impoverishes reality, but preserves what is relevant in relation to a certain intention. In its turn, Meentemeyer (1989, p. 165) stresses that changes in the scale of analysis modify relevant variables, and that the value of a phenomenon at a given location can be (and usually is) driven by causal processes operating at different scales.

Thus, it is clear that the "scale" construct contains the so-called "geographic scale", which includes the spatial and cartographic scales in a relationship that could be schematized more or less as shown in Figure 1. In this figure, the spatial and cartographic scales do not combine to form the geographic scale, since they respond only to the dimensional aspect, due to the extension of the phenomenon or its representation, respectively. As shown in the bibliographic production in the field of Cartography, maps are representations that contemplate only a part of reality: the one which interests the cartographer-geographer, and of which the scale (of the mapping) indicates only one of the clippings. For this reason, the cartographic scale is not totally juxtaposed to the spatial scale – and even less to the geographical scale.

Figure 1 - The scales of Geography



Source: Elaborated by the authors, 2020.

With regard specifically to the presuppositions on the concepts of geographic scale and cartographic scale, the literature review

and the experience with their use and application allowed me to arrive at a summary table for comparison of some parameters (Table 2).

Table 2 - Comparing cartographic and geographic scales

Parameter	Cartographic scale	Geographic scale
Aim of the analysis	Representation of the phenomenon	Apprehension of the phenomenon
Approach of the phenomenon	Dimensional	Relational and dimensional
Focus	Spatial	Space-time (procedural)
Terms of reference (examples)	small, medium, large 1/1.000.000 1/100.000 1/10.000	local, regional, national, global micro, meso, macro scale
Relation with the phenomenon	Observation (direct or indirect))	Perception and conception
Reasoning chaining	Presupposes hierarchy (levels of analysis)	Malleable hierarchy (types and levels of analysis)
Perspective of the geographic space	Absolute	Absolute and/or Relative
Visual presentation	Maps	Maps, Networks, Corematic

Source: Elaborated by the authors, 2020.

We should point out again that, although the cartographic scale is defined according to the representation of the phenomenon, the map also indicates a cutout of reality related to a certain level of its apprehension (therefore, it is not reality itself), the result of which is the theoretical-methodological conception outlined in the legend. In other words, the relationship between cartography and the level of geographic analysis is not limited to the definition of the cartographic scale.

Likewise, even if the cartographic scale refers to a purely spatial cutout, this does not mean that the map does not have a temporal

dimension. The temporal relationship with the reality assimilated and represented is established both in static maps referring to representations of watertight moments of a theme and in maps that portray space-time movements (such as the evolution of land use, the growth of urban spots, the progression of deforestation, etc.).

The use of the cartographic scale presupposes an absolute space. Whilst that was a cause for criticism, given the metric ties of Euclidean space, it is not really a demerit. The existing methods of analytical cartographic representations or synthesis, for qualitative or quantitative relationships observable in the phenomenon, and the possibility of articulation of multiple scales, with the necessary generalizations, allow the construction of an enormous arsenal of images to subsidize the spatial reasoning of geographic analysis.

> Both absolute and relative space involve scale, but each approach tends to produce distinctly different research results. Moreover, the nature of the resulting models is influenced by scale, especially for spatial models produced from the relativistic point of view. (MEENTEMEYER, 1989, p. 165).

Although cartography has always contributed expressively to geographical analysis, the relational aspect of the geographic scale has always been a complex challenge. In this sense, other forms of representation, such as visual networks (flowcharts, cladograms, etc.) and Roger Brunet's "Coremas", which do not use conventional map backgrounds, can be a complement that favors the use of visual language in the analyses required to Geography.

Girardi (2007) seems to have identified exactly that, commenting on Fonseca's (2004) statement on the need to break with Euclidean metrics, in a world where dimensions and distances present a flexibility determined more by the degree of insertion or connection than by close relationships. In the words of Girardi (2007, p. 58, our translation), "concerns of this nature seem not to be addressed in geocartography. Perhaps because they lack the methodological/

procedural tools to do so"[27]. The author questions whether the improvement of hypermaps, reflecting the development of digital culture and its multimedia hyper networks, will not help us in the representation in other metrics, as mentioned by Fonseca (2004).

Final considerations

Judging by the analysis of the works discussed here, the definition of the cartographic and geographic scales is, of course, linked both to the characteristics of the phenomenon investigated, and to the objectives of the research, that is, to what is intended to be achieved in relation to the analysis of this phenomenon. In the case of the cartographic scale, this choice will be guided by the level of details (of the representation of the themes on the maps) and according to the spatial dimension of the phenomenon itself. In the case of the geographic scale, by the scope (space-time) of the relationships established, whose apprehension is necessary to reach the understanding of the phenomenon.

It should also be borne in mind that the scale (map or geographic) does not determine the level or type of analysis, although it can greatly influence it. The level (or type) of analysis should certainly determine the scale to be adopted (both cartographic and geographic). However, this is not always the case, either because of the difficulty of accessing suitable spatial information (for example map scale, image resolutions, refined cadastral data, etc.), or because of some technical-operational impediment, or even because of the researcher's malpractice in approaching the analyzed phenomenon.

It must be said that, in addition to the works discussed in this article, there is a relatively vast literature about scale, especially in English, as highlighted by Souza (2013). Examples include Smith (1992, 2002), Delaney and Leitner (1997), Marston (2000), Marston *et al.* (2005) and Moore (2008), which deal with the social

27 "preocupações desta natureza parecem ainda passar ao largo do fazer geocartográfico. Talvez por carecerem de instrumentos metodológicos/procedimentais para tanto"

and political dimension of scale. The already cited text by Gibson, Ostrom and Ahn (2000) and the work of Sayre (2005), in turn, discuss the interfaces of the scalar approach between Geography and other sciences. Furthermore, the collection organized by Sheppard and McMaster (2004) demonstrates the broad range of possible approaches about scale in geographic research.

However, gaps still exist, such as the contributions that cartography can make to the implementation of geographic analysis. Or even a discussion about the limits of each concept (cartographic scale, spatial scale, and geographic scale) and the interfaces between them – something that could perhaps have mitigated some of the criticisms here. These are, therefore, guidelines for future work.

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