ANALYTIC AND SYNTHESIS MAPS ON GEOGRAPHIC SCHOOL ATLASES

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ABSTRACT

In the teaching-learning of Geography, since its institution as a schooling subject, on the second half of the 19th century, geographic school atlases gained credit among didactic materials. In 1868, the *Atlas do Império do Brasil* de Cândido Mendes de Almeida was published, the first Brazilian school Atlas, adopted by the Imperial Colégio de Pedro II do Rio de Janeiro. Nowadays, an enormous and assorted geographic school atlases gamma on printed, digital and electronic format, being they international, national, state, municipal and even local, is available. Elaborating a school atlas is not a simple task. As a first step for its coordination, we consider the integrated interlacement of two fundamental orientations: - ***the teaching of the map***, based on the theorist-methodological postures about the construction of the space notion by student and its respective representation; - ***the teaching through the map***, accomplished on geography, promoting the knowledge of the world from the spatial inclusion and continuity, starting by the nearby, experienced and well known – the place – to the distant unknown – the worldwide space – , with the possibility of being learned from its representation, being the scholar able to ratiocinate about such context laid out on a map, having not experienced it before. After that, we enter in the context of the geography methodological bases to organize the atlas content. The spatial outline definition, ranging from the local to the worldwide space, would come linked to the question of the thematic structure. Afterwards, the Thematic Cartography is taken into account, on which the map language has to be composed in a clear and practical way and has to be established according to the methodological purposes for it. The one that is based upon the map elaboration as a construction within the parameters that considers the graphic representation as a language can be adopted, integrating a monosemic semiotic system (having only one meaning). Within this context, the atlas thematic maps can be constructed taking several methods into account, each one more appropriated to the characteristics and forms of manifestation (on dots, on lines, on areas) of the phenomena of the real world took into account on each theme, being it on a qualitative, ordered or quantitative approach, on a static or dynamical appreciation. Yet, we emphasize that the real world to be represented on a map could be glimmered within analytic or synthesis reasoning. Analytic maps are the most diffused on school atlases. They represent places

characterized for attributes or variables. Involve a reasoning directed to the analysis of the geographic space, mobilizing proceedings of classification, combination and search of the elucidations about facts or phenomena seen on maps, but not being able to suggest the causality or to give explanations, but indicate new researches. Synthesis maps would not show the elements on superposition or juxtaposition anymore, but their fusion in "types". This means they have to identify groupings of places being characterized by groupings of attributes or variables. According to the purposes and stipulated fields of study, synthesis cartography can be done through several methods that had been developed along the search of such accomplishment. Basically two main groups can be pondered: graphic methods and statistic-mathematic methods. Among the graphic methods we consider: Tri-chromatic superposition, Cartographic method, Graphic matrix's method and Triangular graph method. In Tri-chromatic superposition, we would work on transparent maps of attributes or variables, which will be superposed three by three, in the colours blue (*cyan*), yellow and red (*magenta*). Spatial sets characterized by distinct combinations of the three components are delimited in this coloured visualisation. In the Cartographic method, synthesis would be done from analytic maps, in three steps: a) one map for each attribute or variable, solved in a visual order; b) intermediary synthesis, suggesting a preliminary spatial grouping; c) final synthesis with the delimitation of the "types" of space. In the Graphic matrix's method, synthesis would be obtained from a geographical data matrix. This table is transcribed into a graphic form with visual proportionality of sizes. Rows, as well as columns, are exchanged until the ones that are more similar get close, forming a second image, which has to be interpreted, corresponding to the synthesis that will be plotted on the map. The triangular graph method is employed for searching the "types" of ternary structures. The different combinations of the three components of the studied variable are synthesized trough dots within the triangle. Places are grouped according to the categories defined by the particular position they occupy in the graph. Synthesis is what will be laid out on the map. Synthesis cartography can also be worked on dynamical approaches like, types of phenomena evolutions for a certain period of time. Synthesis through statistic-mathematic methods will offer more objective results. For that, the adoption of Factor analysis methods is customary, complemented by the Cluster analysis method. Factors are determinate. Each factor represents a group of variables. With the Cluster analysis we get to the linkage tree. Regarding it, a certain level of aggregation is stipulated on which an acceptable quotation of minimal intra-groups variance and maximal inter-groups variance occurs. The cartography of the groups means synthesis on map. For the statistic-mathematic procedures, many specific programs were made available with the institution of informatics and, more recently, also the participation of specific functions available on the Geographic Information Systems. These methodological directions are considered imperative for the idealization of geographic school atlases when involving analytic and synthesis maps. They will confirm to them their pedagogic role in geography, assuring you that you will be

actively participating on the moulding of the citizen for the practice of social transformation.

INTRODUCTION

In the teaching-learning environment of Geography, since its institution as a schooling subject, on the second half of the 19th century, geographic school atlases gained credit among didactic materials, increasingly adapting themselves to this task in the classroom.

They have appeared as selections and simplifications of the great general reference atlases, which evolved from simple collections – easy ways of assembling maps –, to a systematic organization with specific and intellectual purpose, securely crystallized by the capitalist way of production, hegemonic from that period.

The "*Atlas général Vidal-Lablache: histoire et géographie*" of 1824, was a classic that inspired several derivations in France as well as in other countries of the continent.

Almost thirty years before, in 1868, the first Brazilian school atlas was published, the *Atlas do Império do Brasil* de Cândido Mendes de Almeida. It was adopted by the Imperial Colégio de Pedro II do Rio de Janeiro.

Fruit of a whole evolution and epistemological transformation of atlases cartography and of the affirmation of a market economy increasingly more globalized, nowadays an enormous and assorted geographic school atlases gamma is available on printed, digital and electronic format, being they international, national, regional, state, municipal and even local.

1. ATLASES METHODOLOGICAL BASE

Elaborating a school atlas is not a simple task. Neither simplifying maps, nor making them more attractive, nor even selecting the easiest themes, is enough. These elements have to be pondered, but they are not the essential ones. Such tradition persists neglecting a whole specific methodological foundation. This will have to start, on one hand, from the lucubration about the construction of the space notion by the student and its representation. We would have as a main source, among others, the psychogenetic studies of Jean Piaget and his team and of other pieces of work, like the ones from Vygotsky and Wallon, about the relationships between the speech as a symbolic activity, the structure of time and the construction of memory too (Piaget and Inhelder, 1972; Taille, 1992; Vygotsky, 1998).

In Brazil, we count on the contributions of Professor Doctor Lívia de Oliveira, who, in her pos-doctor research and other studies that came next, established the master lines for a correct orientation of these works, having instituted a proper school with high qualification disciples (Oliveira, 1978).

To elaborate a school atlas, we make a premise, that it will not be only a collection of maps, ready and finished, but a systematic organization of representations worked with a specific intellectual purpose. With this intent, the articulation of two fundamental methodological bases has to be taken into account: the methodological basis of the map and the methodological basis of the acquisition of knowledge in geography trough the map.

Besides, the selected thematic representations have to be constructed from consistent data, aiming to reveal the information content about the present, providing the student with the comprehension of certain questions which are placed to him, in search of the understanding of the real world around him (Wurman, 1989).

Therefore, maps would not be seen as they traditionally are, as mere illustrative figures of didactic texts, but as representations that reveal questions that will be tackled and discussed within the geographic speeches, opening space to a critical and conscious reflection.

For the atlas enterprise, we consider the integrated interlacement of two basic orientations as a first step for its coordination:

- ***The teaching of the map***, propagated on the theorist-methodological postures about the construction of the space notion and its respective representation by the scholar, involving initial cartography practices,

- ***The teaching through the map***, accomplished on geography, promoting the knowledge of the world from the spatial inclusion and continuity, starting by the nearby, experienced and well known – the place – to the distant unknown – the worldwide space –, but with the possibility of being learned from its representation, being the scholar able to ratiocinate about such context laid out on a map, having not experienced it before.

After that, we enter the context of the geography methodological bases to organize the atlas content.

The spatial outline definition, ranging from the local to the worldwide space, would come linked to the question of the thematic structure.

Afterwards, the Thematic Cartography is taken into account; on which the map language has to be composed in a clear and practical way; and has to be established according to the methodological purposes for it. The one that is based upon the map elaboration as a construction within the parameters that consider the graphic representation as a language can be adopted, integrating a monosemic semiotic system (having only one meaning) (Bertin, 1973).

Within this context, the atlas thematic maps can be constructed taking several methods into account; each one more appropriated to the characteristics and forms of manifestation (on dots, on lines, on areas) of the phenomena of the real world took into account on each theme, being it on a qualitative, ordered or quantitative approach.

On representations, we can also undertake an appreciation under the static point of view, constituting the static cartography, or dynamical, structuring the dynamical cartography. Yet, we emphasize that the phenomena that compose the real world to be represented on a map could be glimmered within analytic or synthesis reasoning. Thus, on one hand we have analytic cartography, giving attention to the constitutive elements of the real world, the places characterized by attributes or variables and, on the other hand, synthesis cartography, identifying and delimiting integrated spatial units, which mean groupings of places being characterized by groupings of attributes or variables.

2. ANALYTIC MAPS

Analytic maps are those that involve a reasoning directed to the scrutiny of the geographic space, mobilizing procedures of classification, combination and search for explanations about facts or phenomena seen indistinctly on the real world. These would be rational constructions, whose structure would be expressed on the legend, organized as a logical system. The mental operations undertaken, regarding analytic maps, will allow the student to formulate conjectures about what would elucidate the phenomena geography. However, before a more rigorous critic, we affirm that they would be not able to suggest the causalities or to give the explanations by themselves, but indicate new researches (Rimbert, 1968; Claval e Wieber, 1969).

These authors also say that analytic maps show patterns, dominant directions, groupings, constellations and shafts that reveal the information, of which we can take advantage. Yet, it leads to many questions, and these are the ones that bit by bit will allow us to reach new discoveries.

Analytic maps are the most diffused on school atlases. They can display representations on a qualitative, ordered or quantitative approach, considering manifestations on dots, lines, and areas, being they on a static or dynamical point of view.

Those qualitative express the existence, the location and the extension of the events on a certain situation on the time, that are distinguished by their nature, species, allowing them to be classified by criteria established by the sciences that study them. For example, themes like Political organization, Hydrographical basins, Navigable rivers, Mineral resources, Air-masses, Vegetation, Land use, Indigenous lands, Transport network, Airlines, Maritime routes and Environment.

Ordinate maps show, on a certain date, categories that are enlisted on a sole sequence, defining hierarchies, or focalize, on a single map, aspects that were being consolidated over the time. Examples of the first ones are themes like Relief, Functional hierarchy of urban centres, and of the second ones, the Geology.

Quantitative maps evidence the relationship of proportionality between quantities that characterize places or areas for a certain moment. For example, themes like Rainfall, Temperature, Winds, Population, Agricultural and cattle breeding production, Industrial production and Tourist accommodation offer.

From a dynamical point of view, maps can show qualitative and quantitative variations on the time or qualitative and quantitative directed movements on the space. For the qualitative variations we quote the theme Retraction of native vegetation. Those quantitative recall themes like Population growing rate, Migratory balance, Migratory surplus and Foreign trade. For dynamical maps of qualitative movements, we evoke themes like Atmospheric currents and Marine currents as examples. Of those quantitative ones, Cash flows, Migratory flows, Tourist flows, Passengers flows, Flows of goods, Maritime traffic and Aerial traffic are examples.

3. SYNTHESIS MAPS

To Claval and Wieber (1969: 103), synthesis maps would have, as their first function, pointing out the correlations, evidencing connections between distinct phenomena.

They warn us that, when superposing many themes, we are not always able to show the connections. Each theme would be lost in a confusion of symbols. So, they advise us to superpose simplified thematic maps, on which spatial relationships would appear clearer. However, synthesis is a necessity, but it has to be treated in a way that makes new configurations to emerge, completely different from those resulted of a simple sum of the

elementary configurations. Just in this manner, an overview of the real world would be achieved.

Synthesis maps, conceived this way, become a privileged instrument of the geographer, who, as much in the physical geography as in the human geography, is interested in regional studies. Nevertheless, they have to prudently make use of them, to avoid getting configurations that are not the more characteristic ones. It is necessary to pay attention then, neither to favour facts of static order, nor to give too much importance to the homogeneous areas, but to emphasize even more the functional or polarized spatial ensembles.

Despite this entire methodological base, established with the evolution of the cartographic science, we observe that still exist a lot of confusion about what synthesis cartography is. And this is transferred to school atlases.

Many people still conceive it, by means of maps stated – synthesis maps – but, not like logical systems, but like superposition or juxtaposition of analyses. Then, very confused maps appear, on which a lot of symbols, and even alphanumeric index, are accumulated, denying the very idea of synthesis.

On synthesis, we cannot have the elements on superposition or juxtaposition anymore – basic characteristic of analytic maps –, but their fusion in "types". This means that, regarding maps, we have to identify groupings of places – elementary spatial units of observation – characterized by groupings of attributes or variables. Or still, to get the gathering of such units according to many criteria and map the achieved results (Rimbert, 1968; Bertin, 1073).

To explain what synthesis reasoning is; we borrow the experimental piece of work done by Gimeno (1980: 174), realized with primary school pupils in Paris. Its aim was to discover which groupings could be formed in a set of 42 elementary data: seven objects related to six attributes. The figure 1 shows the transition of the analytic moment; where, in a matrix, each object relates to one or more attributes; to the synthesis moment, achieved with reiterated permutations between columns and rows of the matrix, revealing three groups of objects characterized by three groups of attributes. In this manner, the 42 data graphic treatment allowed the follow information to be revealed: the objects form three groups characterized by three groups of attributes. The group of objects "A" is characterized by the group "I" of attributes; the group of objects "B" is qualified by the group "II" of attributes (only one attribute); the group of objects "C" is marked by the group "III" of attributes.

[Fig. 1]

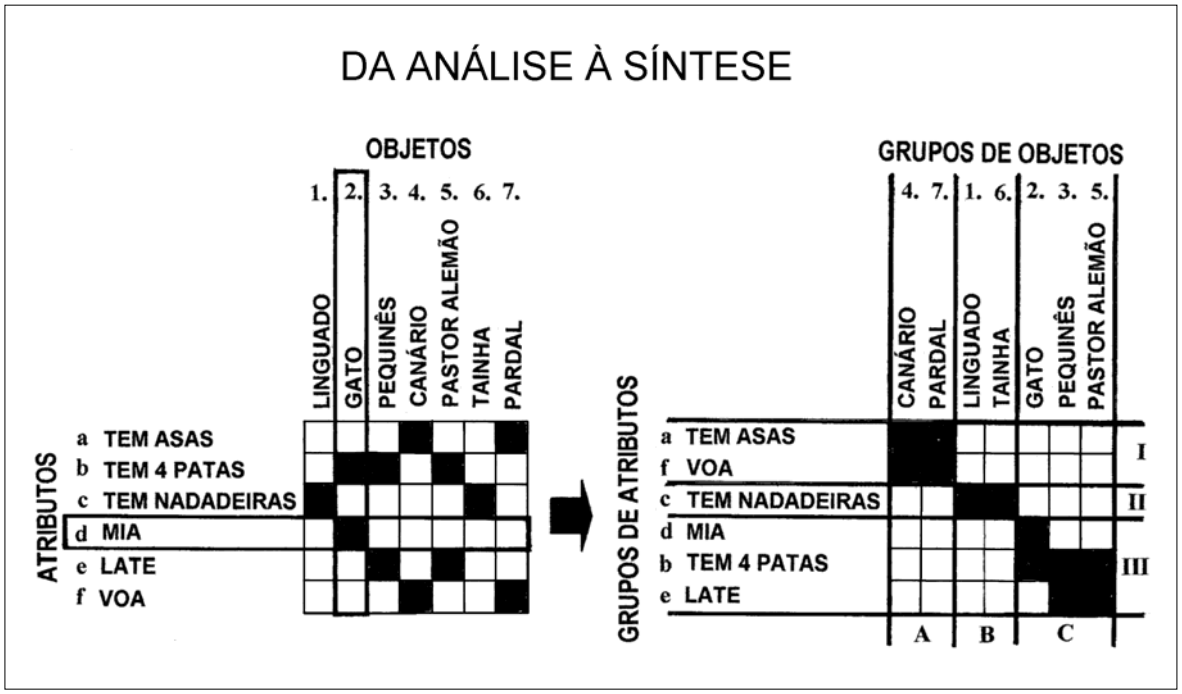

Figure 1: The transition of analysis reasoning to synthesis reasoning (Gimeno, 1980)

Traditionally, superposition and manual combination of many analytic thematic maps were always considered a starting-point to undertake synthesis cartography of the geography of a study area. This showed that, from the beginning, some tendency to a certain effort in favour of working with data in a multivariate way would have existed.

Thus, accordant to objectives and established fields of study, synthesis cartography can be done by an assorted gamma of methods that were being developed together with an accurate search, involving qualitative, ordinate or quantitative data, on a static or dynamical appreciation, referent to entities like dots, lines, areas.

Basically two main groups can be pondered: graphic methods and statistic-mathematic methods.

For the statistic-mathematic procedures, with the institution of informatics, many specific programs were made available and, more recently, also the participation of specific functions available on the Geographic Information Systems. **3.1. Graphic methods**

Among the graphic methods, we consider the procedures: Tri-chromatic superposition, Cartographic method, Graphic matrix's method and Triangular graph method.

In Tri-chromatic superposition, we would work on maps of attributes or variables selected on the same scale. They can be superposed three by three, as long as they are transparent, in the colours blue (*cyan*), yellow and red (*magenta*), the three primary colours of subtractive chromatic synthesis. Overlapping would permit us to delimit spatial ensembles characterized by distinct combinations of the three attributes or variables, revealed by the resultant secondary colours.

In Cartographic method, synthesis would be done from analytic maps, on three steps: a) collection of thematic maps, one for each selected attribute or variable, sorted by an ascending order of visual lightness; b) intermediate synthesis maps defining a preliminary spatial grouping; c) final synthesis map with the "types" of space (Bertin, 1977).

In the Graphic matrix's method, synthesis would be obtained from a geographical data matrix: the places would be laid out in the columns, the attributes or variables in the rows, and the presence or absence, the class of order, or yet, the absolute or relative value of such attributes/variables, in the cells. This table is transcribed for a graphical form, ruled in squares, with cells that will be filled using black or white on the first case; by an order of visual lightness on the second case and by proportional sizes on the last case. Thus, an orderable matrix is formed, which accepts permutations of the rows and columns. These permutations will be done trough reiterated approaches between the rows and the columns until the ones that are more similar get close, forming a second image – the ordinate matrix –, which has to be interpreted. This means distinguishing the groupings of places that were formed on this matrix, being characterized by groupings of attributes or variables, orienting the construction of the legend. The grouping of individual cells on the ordinate matrix will guide the configuration of the groupings on space, which will be delimited on the map, corresponding to the synthesis (Gimeno, 1980)

[Fig. 2].

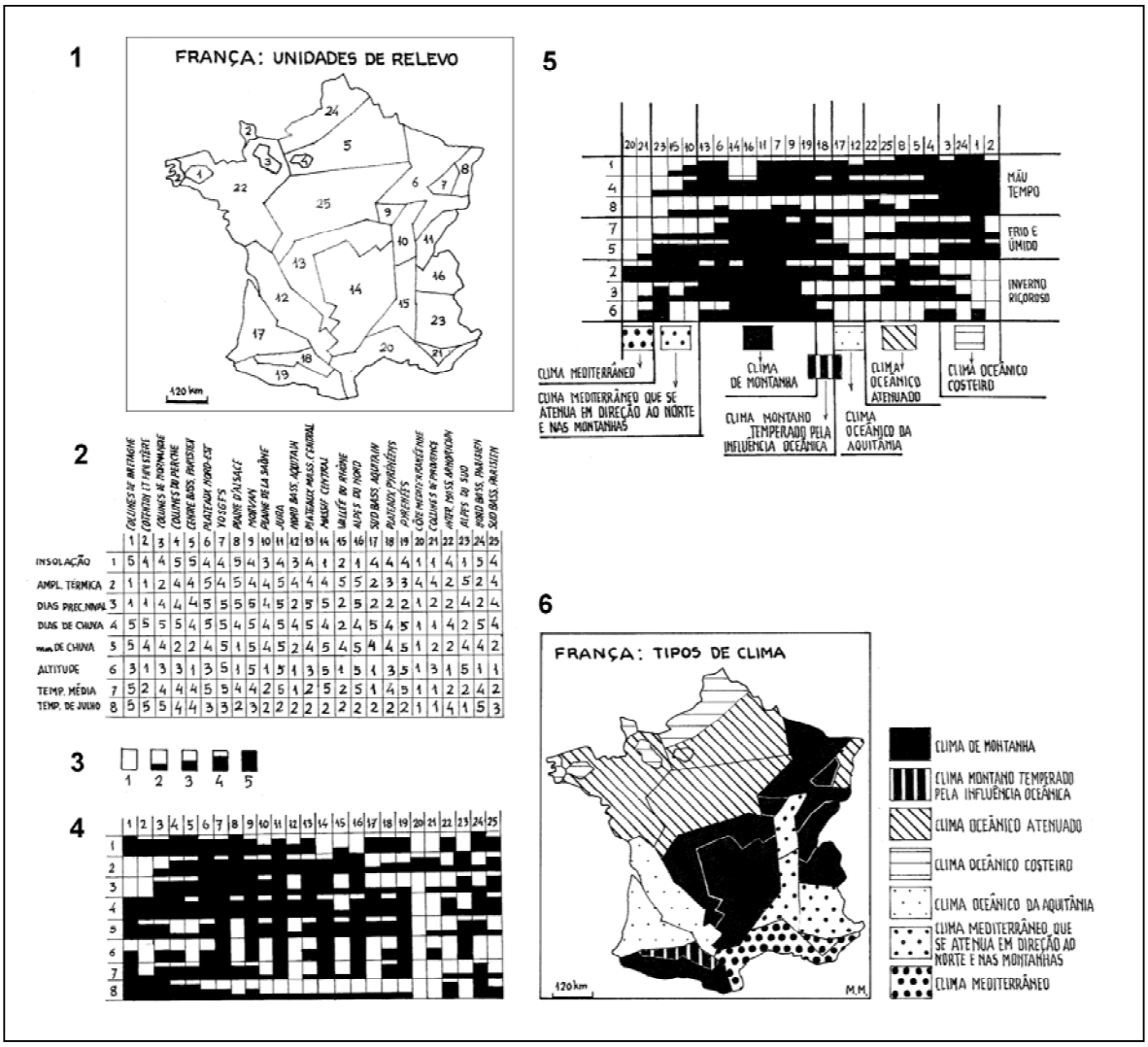
1
FRANÇA: UNIDADES DE RELEVO
120 km
2
3
4
5
CLIMA MEDITERRÂNEO
CLIMA MEDITERRÂNEO QUE SE ATENUA EM DIREÇÃO AO NORTE E NAS MONTANHAS
CLIMA DE MONTANHA
CLIMA MONTANO TEMPERADO PELA INFLUÊNCIA OCEÂNICA
CLIMA OCEÂNICO ATENUADO
CLIMA OCEÂNICO DA AQUITÂNIA
CLIMA OCEÂNICO COSTEIRO
MÁU TEMPO
FRIO E ÚMIDO
INVERNO RIGOROSO
6
FRANÇA: TIPOS DE CLIMA
120 km
M.M.
CLIMA DE MONTANHA
CLIMA MONTANO TEMPERADO PELA INFLUÊNCIA OCEÂNICA
CLIMA OCEÂNICO ATENUADO
CLIMA OCEÂNICO COSTEIRO
CLIMA OCEÂNICO DA AQUITÂNIA
CLIMA MEDITERRÂNEO QUE SE ATENUA EM DIREÇÃO AO NORTE E NAS MONTANHAS
CLIMA MEDITERRÂNEO

Figure 2: Example of Graphic matrix's method for the establishment of Types of climate in France. (Gimeno, 1980)

Triangular graph method is employed on a particular case in synthesis cartography, the one which searches for the representation of the "types" of specific ternary structures on space, that is, for variables formed by three collinear components. In this way, such graphic would participate as an algorithm for the treatment of the data and for the legend organization.

The different combinations of the three components I, II and III of the studied variable are synthesized trough dots inside the triangle. Since the variable refers to places, each dot of the graphic represents the structure of each one (Béguin and Pumain, 1994).

Based on the visual analysis of the resultant point pattern, the places are grouped according to categories defined by the position they assume in the triangle. Sometimes the groupings are not that easy to be discerned. A more accurate control is required. The categories, defined as such, will be later transferred to the map, which will represent the synthesis of the ternary structures grouped into significant classes. The triangular graph will be its legend, giving total transparency to the reasoning undertaken on the map construction [Fig. 3].

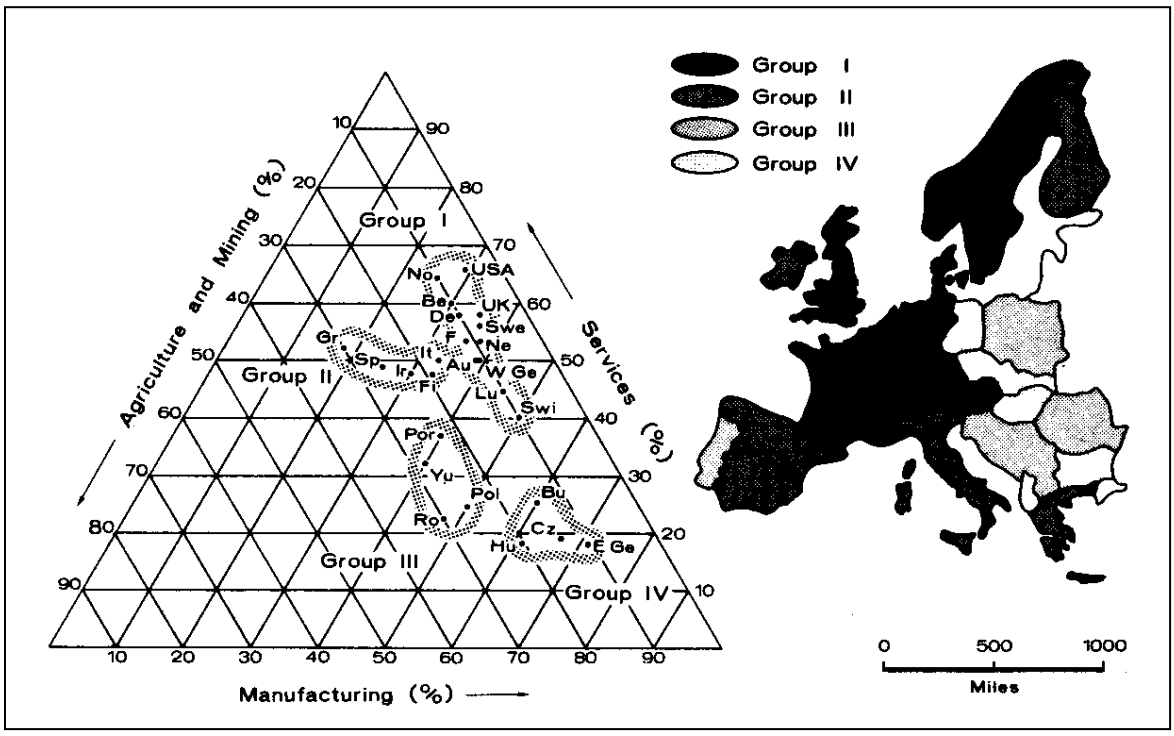

Figure 3: Example of triangular graph method for the establishment of Types of countries in Europe based on sectoral origin of Gross Domestic Product (Smith, 1977.

Generally, synthesis cartography worked by graphic methods, is explored along with static situations. But it is also possible to elaborate it in dynamical approaches like in the case of the establishment of demographic evolution "types" for a certain period of time with various censuses data.

To get to this synthesis, we mobilize a graphic treatment of the data, which consists in elaborating an evolution graph in semi-logarithmic graph-paper for each observation unit. After ready, these diagrams will be visually classified, approximating those that are more similar, trying to form groups with similar evolutionary characteristics. Each group will consist of a "type" that will be qualified on the legend by a symbol and its respective epithet, expressed in a concise manner.

Each rubric of the legend, thus specified, will receive an indicative colour or texture to be plotted on the map that will express the synthesis.

3.2 Statistic-mathematic methods

Certainly, synthesis obtained trough statistic-mathematic methods will offer more objective results, less liable to subjective visual interpretations. Thus, we will ingress into the domain of the treatment and multivariate representation of quantitative data.

This kind of analysis is denominated multivariate because it treats a set of geographic variables by means of many quantitative values. In this way, we open space for multivariate maps, which can express a cartographic synthesis.

To handle a reasonably big set of quantitative variables that characterize places – elementary geographic units – for which we want to obtain the synthesis, we usually adopt the Factor analysis methods, complemented by the Cluster analysis method.

Factor analysis is much diffused and consists in a procedure that has the role of comparing many thematic maps of quantitative data, absolutes or relatives. It is used in pieces of work that require the study of several variables at the same time.

We start from a geographical data matrix, which lays out the places in the columns and the variables in the rows. The respective values go into the cells. The Pearson product moment between each pair of variables is calculated, establishing the numeric results in a matrix, which will be symmetric. Afterwards, the proportion of the total variation is valuated in

percentage, among the variables accumulated on each factor. Each factor represents a group of variables of greater importance to it. Then, the load of each one of the variables is showed individually on the factors, organizing a matrix of places by factors (the two first ones are enough). Diagrams or maps suitable for this purpose, can visualize the results of these treatments done until here.

Now is time to apply the Cluster analysis to the factors, which is visually displayed trough a linkage tree, a dendrograma that exposes the similarities. It represents, therefore, a classification in a multivariate base. Regarding the dendrograma, we stipulate a certain level of aggregation to cut it, so as to obtain a reasonable number of groups of places, in a way that an acceptable quotation of minimal intra-groups variance and maximal inter-groups variance occurs on each one. The cartography of the groups signifies synthesis on map. Dynamical appreciation is also possible by these methods (Monkhouse e Wilkinson, 1971; Cole, 1972; Smith, 1977; Gerardi e Silva, 1981; Ferreira, 1997; Silva, 2003).

Synthesis maps, although neither that frequent, nor that easy to be assimilated by the scholars because they involve a more elaborate reasoning, mark their presence on school atlases. These maps give an overview, integrating many aspects that were considered on analytic level. Those like Types of relief, of Climate, of Landscape, of Structures of land use, Geo-systems, Agrarian systems, Industrial regions, Geo-economic Macro Regions, Structure of exports and Types of environment, appear mainly on a static approach. On a dynamical approach they are rarer, when in scholastic level. Themes like Types of population evolution and Types of evolution in the exports are mentioned.

FINAL CONSIDERATIONS

These methodological directions are considered imperative to sustain all and any undertaking directed to the geographic school atlases idealization, when involving analytic and synthesis maps. They will confirm to them, in consistently form, their pedagogic role in geography, assuring the certainty to be actively participating on the moulding of the citizen for the practice of social transformation. Certainly, they may increase to him the access to this mean of communication on printed, digital or electronic format, about the natural and social spaces on his quotidian on any place on Earth.

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