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THE CRITERIA OF CARTOGRAPHIC METHOD CLASSIFICATION

An explicit and generally recognized classification of terms is an important indicator of the progress and maturity of a science. Cartography, which on the one hand has only been recognized as an independent science for several dozen years and, on the other, has many centuries of practical application behind it, is one of those disciplines where the degree of agreement reached on terminology varies greatly. The notions connected with its practical side (map editing and reproduction) and those used in mathematical cartography are relatively well defined, while there is considerable arbitrariness as regards the classification and definition of the terms linked to cartographic representation methods. Most methods of representation employed on topographic maps, which have a relatively long tradition, are precisely defined (e.g., methods of relief representation). On the other hand, the classification and terminology of the methods used in thematic maps, socioeconomic maps in particular, have not been agreed to a satisfactory extent.

The discrepancy in the classification of the methods of cartographic representation will be noted if one compares some manuals on general and thematic cartography.

A Polish manual by L. Ratajski (1973) distinguishes eight methods, divided into two groups, i.e.,

1. qualitative methods (cartographic symbols, range method, chorochromatic method), and
2. quantitative methods (diagrammatic, dot, choroplethic, isarithmic and dasymetric methods).

An American manual by A. Robinson, R. Sale and J. Morrison (1978) divides the methods of representation into similar two classes, i.e., symbolization of qualitative and quantitative data, but the further classification is different:

1. symbolization of qualitative data, i.e., point symbols, line symbols, area symbols;
2. symbolization of quantitative data, i.e., point symbols (dot map and graduated symbol map), line symbols (isarithmic mapping, flow

lines), area symbols (choroplethic and dasymetric mapping, shading, layer tinting).

In the German manual *Thematische Kartographie* (1970) Werner Witt discusses the methods of representation according to kinds of thematic maps and introduces the following classification:

1. qualitative maps, i.e., distribution maps (*Positionskarten*), maps with areal symbols (*Arealkarten*), maps with pseudo-areal symbols (*Pseudoarealkarten*);¹

2. quantitative maps, i.e., isarithmic maps, maps with absolute representation, maps with relative representation.

The most original classification of the methods of representation was offered by J. Bertin in his well-known work *Semiologie graphique* (1967). Similarly as Witt, Bertin, discusses the methods of representation according to kinds of maps. He divides all maps into three types according to the number of components of the information they contain and distinguishes the following:

1. maps with one component (geographical component),
2. maps with two components (geographical and some other components),
3. maps with three or more components (geographical component and at least two other components).

The second type of maps (with two components) is divided into three groups according to the kind of non-geographical component (qualitative, ordinal or quantitative). Then, within each of these groups point, line and area representations are discussed.

The manuals by K. Salishtchev (1982) E. Arnberger (1966) and E. Imhof (1972) do not introduce any general, hierarchic classification of cartographic methods. In the manuals by Salishtchev and Imhof the classifications of methods are not significantly different, while Arnberger's classification is much more detailed, and the denotation of terms used is usually different than in the other two manuals.

Even such a general look at classifications of the methods of cartographic representation gives one an idea of the variety of approaches to the basic methodological problems in cartography. This variety results from the fact that cartography is a young science as well as from the diversity of traditions and cartographic schools in different coun-

¹ This refers to area representation of dispersed point objects.

tries.² Besides, the richness and variety of the cartographic language, whose different elements are often difficult to define and classify precisely, are not without importance.

In spite of these difficulties, attempts should be made to improve the classification of cartographic methods. This is of vital importance for mutual understanding among cartographers as it would offer them an opportunity of laying the foundations of international standardization in this discipline.³ Besides, a logical and precise classification of the methods of cartographic representation is of substantial importance in teaching cartography and thus permits the proper use of the methods and stimulates the inventiveness of future map makers.

The diversity of classifications of cartographic representation methods largely results from the application of different criteria on which these classifications are based. As we have seen here, one classification often uses a number of criteria. The basis and starting point of every classification should be to establish and define the criteria. Therefore, any attempt to put the classification of the methods of cartographic representation in order should begin with defining the criteria of these classifications. Each criterion produces a division of the methods of cartographic representation into a number of basic categories, each of which comprises a number of more or less varied representation methods.

It seems that the basic kind of characteristics which is to be shown in a map can be adopted as the first criterion of method classification. This criterion is to some extent used for map classification in the literature in German (e.g., E. Imhof, 1962 distinguishes distribution maps, maps of dispersion and maps with representation of density) and in the literature in French (e.g., Joly, 1976 distinguishes static and dynamic maps).

Adopting this criterion, one can distinguish eight characteristics significant from the point of view of cartographic representation methods, which can be divided into the following three groups:

- A. Spatial features, i.e.,
 - location,
 - degree of dispersion (density),

² Bertin's manual, which represents a completely new approach to cartographic problems, is an exception here.

³ Unfortunately, the multilingual dictionary of cartographic terms (*Multilingual Dictionary* 1973) cannot serve as this kind of foundation, for it presents cartographic methods in a cursory manner only.

- spatial differentiation of relative values (e.g., relief, elements of the climate);
- B. Static quantitative features, i.e.,
 - volume (in statistical and not spatial sense),
 - structure;
- C. Dynamic quantitative features, i.e.,
 - movement,
 - changeability in time.

The first of the above-mentioned features (location) is naturally represented on every map. Nevertheless, it has been distinguished here as there are maps or methods whose main purpose is to show the location of different objects or phenomena.

The second criterion of method classification, most frequently applied, is based on the possibility of representing qualitative and quantitative characteristics (Ratajski, Robinson, Witt). Attempts have been made by American cartographers to modify this traditional division by adopting the so-called measurement scaling nominal, ordinal, interval and ratio (Muercke 1972, Robinson 1978), already in use in other sciences. It has turned out, however, that the system of measurement scaling can only have a limited application in cartography. First of all, from the point of view of cartographic representation methods, it is not essential to distinguish between interval and ratio scaling. These two types of scaling are equivalent to the traditionally distinguished quantitative characteristic, while nominal scaling is equivalent to the qualitative characteristic. It appears, however, that distinguishing ordinal scaling as an intermediate between qualitative and quantitative characteristics is useful from the cartographic point of view, for there are some kinds of representations which can hardly be labelled either qualitative or quantitative ones (e.g., distinguishing small, medium and large industrial centres). Thus traditional data classification (qualitative-quantitative) is complemented by introducing ordinal data as intermediate (Bertin 1967, Cuff 1970). Besides, from the point of view of cartography it is essential to divide the quantitative characteristic (scaling) into range-graded scaling and proportional grading. In this way the following four kinds of scaling are obtained, arranged from the lowest level (most general information) to the highest one (most precise information):

- qualitative scaling,
- ordinal scaling,
- quantitative range-graded scaling,
- quantitative proportional scaling.

If we assume after Bertin (1967) that every symbol in the map has a definite location (x , y coordinates of an area) and represents a cer-

tain feature of the presented phenomenon (z coordinate), which determines the qualification of the map as a space-like symbol model (Ostrowski 1979) then the above four kinds of characteristics define z coordinate with increasing precision. To a cartographer more important, or at least more specific, is the problem of defining location qualified by x , y coordinates (labelled by Bertin as the geographical component). The precision in defining location depends on map scale and is closely related to the extent of generalization. Nevertheless, the precision and even possibility of defining location are different for different methods of representation and this dependence can also be used for the classification of cartographic representation methods.

The first group includes these methods which, at a given scale and within the limits resulting from generalization, enable us to locate the presented facts topographically, the location of symbols corresponding to the locating of the facts they represent.

The second group of representations, marginal in comparison with the previous one, is made up of symbols providing some additional information, related to points, lines or small areas, but not located topographically (e.g., cartographic symbols of harbours or airports on small-scale general geographical maps, names of point or line objects, or tourist symbols placed under names).

The third and fourth categories relate to methods which mostly give quantitative characteristics of an area. Such areas are commonly described within the limits of certain reference units. The limits of such units can either be dependent on represented values (e.g., dasymetric areas) or independent of them (statistical or geometrical units). In the first case, a more precise spatial representation is obtained (third category) than in the second one (fourth category), naturally assuming that the sizes of reference unity and class divisions are similar.

The least precise information about distribution is provided by these kinds of symbols which represent only selected information on the spatial order (e.g., spatial relations, directions of movement), while their distribution gives us only very general information about the distribution of phenomena represented by them.

Thus the following five groups of cartographic representations have been obtained, providing from the most precise to the most general spatial information:

1. topographically located symbols,
2. complementary information located non-topographically,
3. characteristics within the limits of "quantitative ranges",
4. characteristics in statistical and geometrical units,
5. symbols representing some spatial relations only.

The fourth criterion of method classification, quite frequently used, is the manner of occurrence of represented data considered at a certain scale and at a certain degree of generalization. This manner of occurrence defines the number of spatial dimensions and characteristics which can be obtained from a map: no spatial dimensions (location only) for point elements; one dimension (length, direction, tortuosity) for line elements; and two dimensions (area, shape) for surface elements. Besides, a map can present some information which does not refer either to a point, a line or an area, but only shows some relations between different elements. Thus the following four classification groups may be distinguished:

1. characteristics of point,
2. characteristics of lines,
3. characteristics of areas,
4. characteristics and spatial relations.

The fifth criterion is closely linked to the previous one, but concerns not the manner of occurrence of phenomena but usually (though not always) the kind of symbols corresponding to this manner (point-line and area symbols). This criterion needs to be distinguished from the former one because area elements can be represented both by means of area symbols or point or line symbols. In addition to the three basic kinds of categories of symbols, we could also distinguish volume symbols, not in the literal sense, but from the point of view of how they are perceived. Thus there are four classification categories in this case, too:

1. point symbols,
2. line symbols,
3. area symbols,
4. volume symbols.

It seems that the five criteria of method classification presented above give us a fairly comprehensive view of the forms of cartographic representation. These criteria refer to, respectively: the kind of represented characteristics (Arnberger 1966) the potential of the characteristic denoted by z coordinate (Bertin 1967), and the potential of the spatial characteristic denoted x, y coordinates (Cuff 1970, Imhof 1972, Imhof 1962).

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