IMPORTANCE OF CARTOGRAPHIC SEMIOLOGY AND SEMIOMETRY IN THEORETICAL CARTOGRAPHY DEVELOPMENT

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Map signs, as space-visual graphic elements, represent significant part of information system. All systems and various ways of informing and sign communication are researched by semiology. Cartographic sign and its system, as specific language of a map, has been exposed to general rules of semiology. As alphabet gets its real sense just after it is used for thoughts note, so the system of cartographic signs gets its real sense during the cartographic review. Analogicaly to spoken language, language of the map also undergoes general linguistic laws. Every sign which represents some object or appearance has certain significance, but only after its nomination and location, the map is created. Location is map threshold behind which a map is made. Signs are only graphic expression until they become an element of map contents as connotative. From that moment they begin to fulfill their language function. Signs are communicative and their mutual linking are possible. That linking is similar to linking letters into words and words into sentences. Map has an advantage over the natural language, because for particular kind of information it is considerable simple and much more perceptive. Application of signs gives map universality, because it is comprehensible in its basic shape and it is not dependent of written language.

Significance of quantification became important and recognized just after beginnings of computer use, i.e. of quick information processes. A need for measuring space indicators and their quantitative presentation have appeared. Application of quantitative methods, in researching of objects, appearances and processes, in particular time cross enable discovering of their correlations, trends, structure, spreading, frequencies, intensity and movement. Results of quantitative research are said numerically in the form of maps, graphics and tables. Although, the statistic method lies in the base of quantification, quantitative method can't be reduced only to statistic in cartography, because it includes wider range of methodical procedures. Cartographer can't use only official statistic but he must form his own statistic by cartometry. Semiometry, as a part of cartometry, helps him with that and its methods for calculations of values are researched on the basic of thematic map signs.

Different thematic is shown on thematic maps, which cause use of various signs. Heterogeneity is seen in differentiations of their metric elements: diameter, side, edge, high, angles etc. Such heterogeneity of signs makes difficult proportional cartographing, knowing and comparing values. Because of that, the use of semioscale cartography is necessary. On thematic maps three types of semioscale cartography can be applied: 1. differentiated, 2. comparative and 3. unified. On thematic map there are two systems of scale: the base of a map is areascale and the thematic of map contents is semioscale.

1 The Concept of Semioscale Cartography

On thematic maps, diverse themes should often have scale representation. This diversity requires the application of various signs. Different forms of signs have different metrics. These metrics can be rectilinear - scalars of signs (radius of the circle, side of the square, side of the hexagon, edge of the cube, etc.) and area or volume metrics - values of signs (area of the square, area of the triangle, volume of the

cube, volume of the sphere, etc.). Such a diversity of geometric figures, i.e. signs, aggravates scale cartography, understanding and comparison of the values of the parameters of different subjects of mapping.

In the modern conditions of science and practice development, the treatment of map contents has been qualitatively changed. It is necessary to introduce metrics into cartography and interpretation of the subject matter. The content of the map should be treated through a system of scales. In it, the field of the map is areascaled and the theme of the map is semioscaled.

"Semioscale cartography is a metric presentation of the thematic contents with the construction of the signs in the optimum semioscale, in a particular aspect of harmonization of their series, conditioned by generalization, in the aim of emphasizing the characteristics of the state and changing of the subject, by the collocation of its objects, phenomena and processes on the map, by the purpose of the map and by the way of informing about mapped contents" [1].

"Semioscale cartography is a metric presentation of numeric magnitudes of the cartographed object by the metric of geometric figures" [2]. Depending on the applied figure, the signs can be planimetric (square, circle, triangle, hexagon, etc.) and stereometric (cube, sphere, etc.).

In semioscale cartography, we can use:

1. one metric - rectilinear metric (side of the square, radius of the circle) for the scalar of the sign in the linear semioscale;

2. two metrics:

a) area metric (area of the square, area of the circle, etc.) or volume metric (volume of the cube, volume of the sphere) for the scaled area or volume cartography of the thematic contents of the map,

b) rectilinear metric for scalar representation by the scalar of the sign, by which it is possible to find on the map the numerical magnitudes of the mapped parameters;

3. several metrics: area and volume, rectilinear, etc.

The process of semiometrics of the map contents is made possible by the application of metrics. Semiometrics is the metric cartographing of the spatial thematic and the cartometric analysis of the map contents.

Semioscale cartography includes several operations: limiting - sizing of the smallest and the largest sign on the map, reducing - finding out the adequate semioscale, and scalaring - semioscale computation of scalars (s) of the signs in the process of representation of individual magnitudes of the parameter (g).

2 Types and Aspects of Semioscale Cartografy

Semioscale cartography can be scalar and value. The scalar one is performed by rectilinear metric of the particular geometric figure (radius of the circle, side of the square) taken as a scalar (s) of the sign for the treated theme of mapping in the scalar semioscale (1:j) and for individual series of signs in the poly-semioscale. It can be a differentiated semioscale cartography in the series of uniform or diverse signs and a comparative semioscale cartography in the series of uniform signs. Value semioscale cartography is realized with area metrics (f) for two-dimensional planes or with volume metrics (v) for three-dimensional figures, i.e. signs, taken as the value (f, v) for the treated theme of mapping in the value semioscale (1:J) and for individual series of signs in mono-semioscale. It can be differentiated, comparative and unified, all with uniform or diverse signs.

A series of signs is a set of signs by which the magnitudes of the parameter (g) of the particular object of mapping has been represented. A series of signs can represent one series of parameter (g) magnitudes in the case of a monosemic sign, or it can represent several series of parameter (g) magnitudes in the case of a polysemic sign. In the scalar semioscale (1:j), a series of signs is poly-semioscale, and in the value semioscale (1:J), a series of signs is mono-semioscale.

Uniform signs for all the series of signs on the concrete map are the same geometric figures (e.g. a square), but the signs in different series differ by the drawing of the contour, color or raster.

Diverse signs for individual series of signs on the concrete map are special geometric figures (circle, square, triangle, cube, sphere).

The character of the semioscale is the particular semioscale harmony of the treated theme of the map contents. There are the following characters of semioscale: poly-semioscale, equi-semioscale, and mono-semioscale. In poly-semioscale, the treated theme of the map contents is value poly-semioscaled. The contents of the map is cartographed in the scalar semioscale (1:j), so the individual signs are in the special value semioscales (1:J), and in this way the series of signs are poly-semioscaled with different semioscales per series of signs. In the equi-semioscale theme, the contents of the map is cartographed in the scalar semioscale (1:j), only with definite figures, or in the value semioscale (1:J), where all the signs in a series are in the same value semioscale (a series of signs is mono-semioscaled, and individual series of signs are in the special value semioscales). The mono-semioscale theme of the map, and the contents cartographed, are in the value semioscale (1:J) only, i.e. in the same semioscale (all the signs of one series are in the same semioscale and all the series of signs are mono-semioscaled).

There are three aspects of semioscale cartography: 1. differentiated, 2. comparative, and 3. unified.

1. The differentiated semioscale cartography is applied when the thematic map represents:

a) One series of numeric magnitudes with one series of signs in a particular semioscale. Instead of a semioscale, it is more simple to use a reducer or a modifier (T), by which semioscale has also been realized. The series of signs is mono-semioscaled.

b) Several series of numeric magnitudes with several series of different signs in several semioscales. An individual series of numeric magnitudes is represented by the corresponding series of uniform signs in the particular semioscale. An individual series of signs is specially mono-semioscaled. The thematic of the map contents is equi-semioscaled.

For some solutions of the differentiated semioscale cartography, the normative unification of the series of parameter (g) magnitudes is necessary.

Differentiated semioscale cartography can be scalar and value. The following series are cartographed in the scalar one:

a) Poly-semioscale series of signs. Individual signs of a series are in the same scalar semioscale, and in different value semioscales. Individual series of signs are in different scalar semioscales, so the thematic of the map contents is poly-semioscaled.

b) Mono-semioscale series of signs. The thematic of map contents is equi-semioscaled, with the rectangle with constant width b and variable length a = s, with quadrangular prism with constant base area a^2, with the rectangular parallelepiped with the constant base area ab, with the cylinder with the constant base area $r^2\pi$.

In the differentiated value semioscale cartography, by the value semioscale, the series of parameter magnitudes are cartographed as mono-semioscale series of signs. All the signs of a series are in the same value semioscale, i.e. mono-semioscale, and individual series of signs are in different value semioscales, so the theme of the map is equi-semioscale.

2. Comparative semioscale cartography is realized in the series of uniform or diverse signs unified with the appropriate base magnitude (G) and with equal magnitude of the definite metric of signs: i.e. base scalar (S) for uniform signs or values (f, v) for diverse signs. Base values of the parameter (G) per series correspond to the selected metric of signs. For this semioscaling, it is best to select one of the following base magnitudes (G) per series: totals of parameters (g) per series ($g \hat{=} G = 100\%$), averages of parameters (g) per series ($g_o \hat{=} G$) or the state in the cross section of the characteristic sudden change of the object ($g_{char} \hat{=} G$). The normative unification is not necessary.

The comparative semioscale cartography can be scalar and value. The scalar one is realized by the scalar semioscale with uniform planimetric or stereometric signs, where the following series of the parameter magnitudes are cartographed: a) poly-semioscale (thematic contents of the map is poly-semioscale), b) mono-semioscale (thematic contents of the map is equi-semioscaled).

In the comparative value semioscale cartography, by the value semioscale, the series of magnitudes of the parameter with mono-semioscale series of signs are cartographed, so the thematic of the map contents is equi-semioscaled. This semioscale can be with the series of uniform or diverse signs.

3. Unified semioscale cartography is applied when the thematic map represents:

a) Several series of numerical magnitudes with several series of uniform signs in the same value semioscale. An individual series of numerical magnitudes is represented by an individual series of signs in the common semioscale for all the series of signs on the map. The thematic contents of the map is mono-semioscaled. Visual, and graphical differences of signs between the series of signs of uniform figures are expressed by the design or by the drawing (color, raster, hatching, line shaping in sign figures).

b) Several series of numerical magnitudes with several series of different signs in the same semioscale. An individual series of numerical magnitudes is represented by an individual series of different signs in the common semioscale for all the series of signs on the map. The thematic contents of the map is mono-semioscaled.

Unified semioscale cartography is realized only with value semioscale, in which case value metrics of area and volume signs are conditionally mathematically equalized ($1\ mm^2 \hat{=} 1\ mm^3$). The cartography of diverse themes has been made possible, but the normative unification of all the series of parameter magnitudes is obligate.

The unification of semioscale cartography is the unified semioscale cartography of diverse themes with different signs in one map or in a set of atlas maps. The unification is double: normative unification of the parameters of mapped object and graphical unification of sign values [3].

Normative unification is the reduction of magnitude of the parameters (g) of diverse themes, in various measuring units, to a unique norm, as the common denominator with absolute or relative amounts of the same name.

Graphical unification is a causal mathematical equalization of the corresponding value metrics of geometric figures, i.e. values of different signs. Causal equalization equalizes different value metrics of the figures, e.g. areas of planimetric figures, volumes of stereometric figures, as well as common areas of planimetric figures and volumes of stereometric bodies ($1\ mm^2 \hat{=} 1\ mm^3$).

The determination of the reducer or the denominator of the value semioscale is made possible by adopting the basic sign, by determining the appropriate basic scalar of that sign, and by selection the base numerical magnitude of the mapped object parameters, as the optimum amounts in the limiting of the sign magnitudes. It is necessary to select one sign as a basic sign, among all the predicted diverse signs for diverse thematic maps. In relation to its determined metric, adopted for the basic scalar, the unification of

the appropriate metrics for different signs is realized. The magnitudes of metrics of the other diverse signs depend on previously adopted magnitude of the basic metric of the basic sign. They are the derived signs.

Graphical unification of signs can be: basic unification and total unification. Graphical base unification of signs equalizes only the basic magnitudes, e.g. basic scalars (S), values (f, v) of different signs and basic numerical magnitudes (G) of the mapped parameters of particular components of the structure of treated objects. Graphical basic unification of signs can be applied as single-term or two-term unification of signs. Graphical basic single-term unification of signs can be with the equalization of basic scalars or with the equalization of values of all the selected diverse basic signs. Basic two-term unification of signs consists of determination and equalization of basic scalars and basic numeric magnitudes of the parameters of the mapped object for each particular form of the sign. For all the diverse signs, the basic scalar and the basic numerical magnitude are the same.

In the total unification of signs, different numerical magnitudes of parameters of diverse mapping objects are represented in the same value semioscale, i.e. mono-semioscale with the corresponding values of all predicted diverse signs in one map or in a set of atlas maps. In this way, the value metrics or values of diverse area and volume signs in a particular set of signs are causally mathematically equalized, by which the normative unified numerical amounts of the parameters of a particular diverse object of mapping are represented by semioscale. The scalars (s) of these signs, as rectilinear metrics of geometric figures, are different for particular forms of signs, because their magnitudes are conditioned by mathematical equalization of the values of these figures.

The total graphical unification of signs can be realized in two ways: by the reducer (T) and by value semioscale (1:J).

According to the number of numerical magnitudes which are represented by one sign, the signs can be monosemic and polysemic.

A monosemic sign represents a numerical magnitude of a particular parameter. The sign is simple (circle, square, triangle).

A polysemic sign is compound sign with a complex figure for the representation of several numerical magnitudes of one or more parameters of the mapping object, so that it has simultaneously several meanings (the circle divided in sectors, etc.). A polysemic sign can be applied as a differentiated, comparative and unified sign.

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