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Justification of Optimal Scale Selection For Digital Cadastral Maps Based on Data Redundancy Criterion

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Abstract: *The new possibilities of data technology are to significantly change the work of land surveyors, to photograph objects and recommend them to the coordinate system, and to depict the objects currently measured in a modern way.*

Keywords: Choosing the scale of topographical photographs, drawing up a reconstruction project of settlements.

Introduction

Large-scale plans, as a source of information, are characterized by the maximum amount of information, which can be recorded in the process of taking a survey of relief elevation and scale. We call this amount of data a dataset of a large-scale topographic map.

In large-scale mapping of the territory, the data set is a quantitative classification, and IM maximum data per 1 square meter can serve as a quantity.

Let's imagine the classification of the spatial IM plan data set as a result of a large-scale survey of 1:M scale or plans made at this scale.

$$I_M = \sum_{i=1}^{5} I_{i,M}, (1)$$

in Buer; I1,M , I2,M..........I5,M – corresponding classifications of the data set determine the maximum amount of data going to 1, which can be obtained according to the plan:

1) Fields are described by scaled conditional symbols:

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2) Individual points and objects in place are described by non-scale conditional symbols:

3) With explanatory notes:

4) With explanatory numbers:

5) It is described by the horizontal lines of the topography.

I1,M, I2,M and I5,M datasets of relief and objects in place are different nebula fields 1number of classifications described in

The I3,M and I4,M data sets depend on the number and number of letters shown in the plan to explain the different nebula depicted and are not counted as data variants. They can be theoretically calculated based on certain formulas.

$$I_{3,M} = 4{,}35 N_{\delta,M} ,$$

$$I_{4,M} = 3{,}32 N_{Y,M} , (2)$$

here; $N_{\delta,M}$ and $N_{Y,M}$ The corresponding average number of explanatory notes, numbers and letters per 1 square meter.

The complete description of the objects and contours of the place is an important enough factor to justify the choice of scale of topographical photographs and to solve other tasks. Therefore, here we will consider a criterion that allows quantitative assessment.

The sum of the data set I1,M and I2,M

RM+ I1,M + I2,M (3)

Let's define by the formula and call their classification as a large-scale topographic planning scale-creating data set. We write based on the formula (3).

$$R_M = \frac{A_0}{1 + 6{,}0M * 10^{-3} \exp\left(-\frac{2500}{M}\right)} (4)$$

here; A0 – 1:500 scale plan data set scaler classification.

It is not possible to theoretically estimate the coefficient A0 in formula (4). Therefore, we take its value as the maximum amount of data, which are recorded in various topographical conditions in experimental works. A0 + 500 can be accepted as seen from the table. Therefore, we rewrite formula (4) as follows.

$$R_M = \frac{500}{1 + 6{,}0M * 10^{-3} \exp\left(-\frac{2500}{M}\right)} (5)$$

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We calculate the data redundancy of large-scale topographic planning with the following formula.

$$G=1-\frac{R_0}{R_M}, (6)$$

here; R0 is a classification of large-scale topographic planning data, under which the amount of data (per 1 ha area) required for users to receive lines of high responsibility in scientific production or other activities can be understood.

We also call the classification of numerical values R0 the data density of large-scale topographic planning.

$$Q=\frac{R_0}{R_M} (7)$$

It can be seen from the formula that the cost of planning for consumers is large if we assume that R0=RM. In this case, according to formula (6), redundancy G=0.

Following the terminology accepted in computer science, we call this equality resonance, when Q>1, it can be said that the density of generative data, as well as the set of plan data obtained from the results of the survey at the selected scale, does not satisfy the information requirements of experts.

If Q<1, the topographic map contains redundant information and resources spent on topographic surveying are inefficiently used.

Based on the above: the first is located through the data density, 0<Q≤1, which satisfies consumer demand; the second is the optimal selection of scales of topographic images, when the data density is maximal (max Q) or the redundancy is minimal (min G).

Based on the tests performed, it can be concluded that the cost of survey work is the classification of the RM function, that is, S=f (RM). Therefore, the selection of scales according to the criterion of data redundancy is similar to the criterion of selection of scales of topographical surveys at minimum costs.

We present a large-scale topographic planning calculation. We find the expression for the quantity RO.

$$RO + RK.P. + RZ.P. (8)$$

Here; RK.P. and RZ.P. - the amount of information required by consumers for 1 Ha of the plot, they must be shown on the plan with scaled conditional symbols: objects and individual points on the site, they must be shown on the plan with non-scaled conditional symbols. RK.P. we use this formula to calculate the data.

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$$\frac{P\ \max}{P\ \min,\Pi} \qquad \text{RK.P.+ NO.Plog2 ln (9)}$$

Here; NO.P is the average number of land plots per 1 ha, their depiction on the plan is therefore of interest to experts in the use of information in large-scale topographic plans.

P max - the value of the maximum area does not depend on the information requirements of experts, it is mainly determined by the category of land to be mapped, the geographical location of the survey object. For example: P max=100 Ha can be accepted for agricultural land.

Large-scale photographs of urban and rural areas were obtained on the basis of static processing of materials. You can choose from table 1.

We write the expression RZ.P to calculate the data value.

RZ.P = NZ.Pt (Z) (10)

Here; NZ.P is the average number of objects and individual points in the place corresponding to 1 hectare, the purpose of their depiction on the plan is to satisfy the information consumption of experts [5].

Table 1

Choosing the optimal scale for topographic photography

Pmin, the minimum contour area of M2	Number of people
1	3000
5	600
10	300
20	150
100	30

The criterion for choosing the optimal scale of topographical surveying is the following, corresponding to the requirements for complete representation of contours and objects in place.

$$\min_{(G \triangleright 0)} G=\min\left\{1-\frac{R_0\left[1+6{,}0M*10^{-3}\exp\left(-\frac{2500}{M}\right)\right]}{500}\right\}. \ (11)$$

We will explain using the formula (11) according to the data redundancy criterion in the

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example of choosing the optimal scale of the topographic survey for creating a reconstruction project of a settlement of the type of the district center in conditionally tex relief (B<20). The selection of the optimal scale of the topographic survey should be based on the construction of the reconstruction project of settlements. This can be expressed in the following table.

2 - table

Choosing the optimal scale of the topographic survey for the reconstruction project of settlements

On-site objects and plots of existing buildings should be described on the plan for project planning.	The average number of objects per 1 hectare
A. Plots depicted with scale symbols	
Residential buildings	10
Economic buildings (capital)	8
Administrative, cultural-household and other buildings separate plots (squares, avenues, passages, etc.)	1
Other contours in built-up territories	
Total:	1
	3
	23
B. Objects and points are depicted in scale-free symbols	
Capital lands are full	6
Output of networks of engineering devices (water distribution columns, plans, gas control pipes, etc.)	
Gas regulation points	3
Communication line and power poles	1
Dots symbol	5
Other objects	3
Total:	3
	21

Table 3

Scale of topographical images	**Data density** $Q = \frac{R_O}{R_M}$	**Data redundancy G, %**
1:500	0.16	84
1:1000	0.24	76
1:2000	0.74	26
1:5000	generative	-
1:10000	>>	-

Data obtained during field inspections of settlements, as well as from the materials of district architects: settlements to be reconstructed, the average density of buildings, data on the availability of networks of engineering devices and other data allow to obtain the numerical value of the quantities included in the formula (11). The minimum area of the contour should be indicated on the plan to solve the design task, field work inspections are organized according to P min + 20 M2. The results are presented in Table 2.

Using the formula (11) criterion, we solve the task of choosing a topographic survey scale for the indicated purposes, and place the calculation results in Table 3. According to the chosen criteria (Min G or Max Q), we conclude that it is necessary to carry out topographic surveys of reconstructed settlements on a scale of 1:2000. For the convenience of designing, a topographical plan obtained by photomechanically enlarging more tablets is used. We call these plans topographical bases, which are now accepted in production. Formula (11) can be used with a small difference to select the scale of topographic bases, the number of NO,P is replaced by the average number of contours of NO,P.

NO,P = NO,P + NO,PR (12)

Here; The average number of plots (objects) corresponding to the planned territories of NO, PR – 1 should be placed on the topographical basis as a result of their design. It can be seen that the scale of the topographic base is not smaller than the scale of the topographic survey, it can be larger when the number of projected objects is large. Magnification of materials, as in standards in action, in topographical surveys is not more than 2.5 factors. It is useful to calculate the scale of topographical bases. It is possible to receive information on the number of NO, PR for residential production complexes and other object-type design solutions. When calculating the scales of the topographic survey, we pay attention to the following situations. If the scale of the topographic survey is chosen in accordance with the criterion (11), the linear dimensions of the plots, If it is small, it will not be possible to depict conditional signs on a scale, when it has a small area, it is necessary to use the combinarized surveying method, that is, to determine the coordinates of several points analytically and to carry out the necessary linear measurements. Enlarged copies of the drawing tablets are then drawn with this information on the desired objects.

Using the combined survey method, it is economically profitable to carry out such plots on a scale with surveys selected according to criterion (11).

The optimal scales chosen for digital cadastral maps allow obtaining detailed information about the territory. Therefore, digital cadastral maps are created at different scales.

For digital cadastral maps, the possibility of using the map increases if the choice of scale is based on it.

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