GIS ANALYSIS AND TIME SCALE OF STATES OF NATURAL-TERRITORIAL COMPLEXES

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Abstract
Among the issues of the theory of cartography at the modern stage, such issues as dynamic generalization, time scale, and the cartographic form of temporal synthesis have gained special relevance. The research on the above-mentioned issues was carried out by us on the example of the cartography of the day-night condition (stexes) of natural-territorial complexes. One year was taken as cartography time. In a specific case, Stexes maps are drawn up for one year, and in total, we get a series of 365 maps. In this process, a cartographic form of time synthesis was investigated, which is directly related to cartographic generalization and time scale. It is impossible to lose space-time information on the map of stexes made for one specific year and 365 maps are somehow "packaged" into one map. In the stack mapping process, the time scale functions, which we interpret as the degree of generalization of the cartographic time entity.

Keywords: *Dynamic generalization, Time scale, Spatio-temporal synthesis, Natural-territorial complexes*

INTRODUCTION

Our task in the presented article is to cartograph the daily conditions of natural-territorial complexes and implement the spatio-temporal synthesis of a series of maps, which is directly related to the spatio-temporal generalization process.

The issue of time scale and cartographic generalization can be attributed to a group of issues in the process of constant research in cartography. The famous cartographer Konstantine Salishchev devoted several works to research the issue of cartographic generalization (Salishchev, 1972; 1976; 1982). In the works of Nikoloz Baranski, a researcher of economic geography, the issues of cartographic generalization occupy one of the central places. He established in cartography the concept of „map information capacity", which refuted the view that, as a result of carrying out cartographic generalizations, we do not receive new information. (Baransky, 1946; 1962). Other researchers also have noteworthy works in this direction. (Aslanikashvili, 1968; Berlyant, 1986; 1996).

It was as a result of the above-mentioned works that the scientific understanding of the concept of cartographic generalization was established. In cartography, generalization is called a scientifically accurate generalization of the specific content depicted on the map. Generalization accompanies the entire process of map creation, which starts with place planning and ends with the creation of the smallest-scale map. It should be noted here that generalization as a specific method is not the only characteristic of cartography. (Isachenko, 1958). It characterizes other fields as well as functions before obtaining the final form of cartographic images. Cartographic generalization takes place when drawing up the map.

RESEARCH AND MATERIALS USED

Cartographic generalization is a private form of manifestation of scientific generalization, in the broadest sense of the term. (Komkov, 1951). Without generalization, not a single cartographic image is completed. Scientific generalization is an essential link in the process of cognition in general. It leads from the private to the general, to the general laws and regularities of the development of objects and events. Any scientific description in cartography contains elements of generalization. Which uses a peculiar, specific "language“, and gives the generalization a special quality and character.

The result of cartographic generalization is that a map is fundamentally different from a perspective image, an aerial image, and a space image. Aerial photographs capture everything — essential signs and even random secondary details — the abundance of which does not necessarily prevent the main signs from being found in the same picture. The implementation of the cartographic generalization process has its stages and steps, which are gradually implemented, and finally, we get the most generalized cartographic image or generalized map to the level we are interested in. For all this, there is a system of means based on which this rather complicated process is carried out. (Baransky, 1939; Salishchev, 1974). According to these schemes, the generalization of all cartographable objects is carried out separately, which ultimately creates a specific cartographable space and content.

Before the actual cartographic generalization, there is a logical generalization, which is not included in the competence of cartography. Alexander Berlianti gives a classification of the types of generalization; their generalizability is considered an essential feature of all types of geoimages. Therefore, there are naturally different types of generalizations. (Berlyant, 1997).

Cartographic generalization involves the selection, generalization, and separation of the main, typical features of the cartographic object. This type of generalization refers to the spatial geometric forms of objects and their qualitative and quantitative cognitive aspects (transition from simple concepts to more complex ones). Cartographic generalization is often defined as the process of scientific abstraction, in which targeted decisions play an important role. It is determined by the purpose, scale, and features of the map's reflection. The author also singles out non-cartographic forms of generalization: remote, dynamic, logical-mathematical, and dialogic-cartographic. It is already becoming clear that generalization is carried out in space and time, as well as content parameters.

Among the above-mentioned types of generalization, dynamic or spatio-temporal cartographic generalization is especially interesting in our case, which takes place only during the cartographic analysis of the dynamics of events. The coverage of cartographic generalization from a new angle is considered a new stage in generalization research. Depending on what aspects of objective reality the map or other cartographic image reflects, after evaluating and deeply analyzing the existing views on cartographic generalization, Aleksandre Aslanikashvili investigated this problem from a completely different prism and took it to a new stage. (Aslanikashvili, 1974). The author examines the works of well-known researchers and introduces two main points, or sides, into the process of generalization, connecting the issues of cartographic generalization with the logical methods of abstraction and generalization. Because every map, or any other cartographic image, reflects two sides of objective reality — a specific space and the content encoded in it — cartographic generalization must necessarily consist of two parts. These are: a) the cartographic form of abstraction and generalization is directly related to the logical form of abstraction and implies the abstraction (simplification, schematization) of a specific space. b) The cartographic form of generalization implies the selection of the necessary elements of the cartographic content for the next stage of generalization. It should be noted here that the author does not ignore the etymological meaning of generalization but divides it into two forms according to their subjects.

A simplified, abstracted reflection of the spatial structure, this model is a map made with a specific sign system—the language of the map. Therefore, the first specific aspect of cartographic abstraction, which is conditioned by the object of abstraction itself, is that it is performed in the language of the map. i.e., cartographic abstraction is a specific form of logical abstraction that is not natural but comes to fullness through the language of the map. The main factor affecting the cartographic form of abstraction is the degree of abstraction (the scale of the image space). It should be noted here that the cartographic form of abstraction also contains elements of generalization, which does not take the image outside the private scope. In cartographically abstracted text, the creature is emphasized in the event, and the general is emphasized in the private. Therefore, the space abstracted in the map is a specific unity of the particular and the general. This is another specific aspect of cartographic abstraction. The specific spatial structure of the subject, which is reflected on the map, if it is really a structure that is the subject of cartographic research, necessarily contains elements of the following three categories: 1) shear spatial system; 2) spatial forms (contours on the map) of the research (cartographic) event; and 3) spatial forms of those objects in relation to which the form of coexistence (order of mutual arrangement) represents the interest of the research.

Four main stages are distinguished in the structure of the abstraction process:

The first stage involves preconceived abstractions of the space and content of the research subject. i.e., in each element of the map, the selection and separation of the object on which the further meaningful graphic impact should be made.

The second stage is the conceptual-graphical abstraction of the space of objects selected and allocated in the first stage, which takes into account their content at every moment of action.

The third stage is the generalization of the content of the same objects. At this stage, the generalized content should fill the abstracted space in the second stage.

The fourth stage is the final form of the process of abstracted-generalized objects — a cartographic image or map of the conceptual unity of diversity.

As we can see, the cartographic form of synthesis is accompanied by one of the constituent parts of cartographic generalization: cartographic abstraction.

The leading factor that governs the process of cartographic abstraction in its way is the purpose of the map. If we consider that the scale itself is primarily a function of the purpose of the map, then the purpose of the map can be seen as a leading factor in the process of generalization.

It follows from all the above that the scale of the map, i.e., the degree of abstraction of a specific space, is a function of the purpose of the map. i.e., changing the purpose of the map leads to a change in its function — scale (from a large scale to a small one). What can be said, with some exceptions, accompanies the cartographic form of both abstraction and generalization.

The second form, which Aslanikashvili singled out in the process of cartographic generalization, is a cartographic form of generalization that refers to the content aspects of cartographic reality.

The cartographic form of generalization implies the generalization of the content of cartographic reality. Unlike the cartographic form of abstraction, it is not considered a specific cartographic form. The reason for this is that the content generalization process is carried out in the language of ordinary natural words, and only the result of this process is reflected in the language of the map, together with the abstracted space.

The essence of content generalization lies in the brief rendering of the given specific versatility. It contains 1) the synthesis of space and content; 2) the synthesis of the diversity of the determined content of the components of the abstracted space; 3) the abstraction of the main, leading, and driving features from the determinations obtained as a result of the analysis at the previous stage and the removal (removal) of minor, random features from them. 4) Synthesis is the last step of content generalization. It establishes the relationship between different parties to the content. Which were abstracted at the previous stage, reveals the order of their relationship and forms all this in the language shell. As the content of each versatility in general.

In both cartographic abstraction and generalization, the scale of the map is considered a defining function of this process. The intensity of the generalization depends on the variation of the scale of the map (towards less detail). Thus, the process of cartographic generalization in modern cartography is represented by two parts: cartographic forms of abstraction and generalization. Both of these forms are determined and managed by the scale of the map, which is generally considered a function of cartographic generalization. Our task is to justify whether cartographic forms of abstraction and generalization function. And accordingly, the time scale in the cartography of dynamic events, and in particular in the process of temporal synthesis of maps of stexes. Since cartographic generalization was divided into two parts, we considered it appropriate to examine this issue separately — in the prism of cartographic forms of abstraction and generalization.

An interesting process among the types of generalization is dynamic generalization. Dynamic generalization This is a mechanical generalization of the image, which allows us to observe the main regularities as relatively stable over time. Typical long-term trends in the development of events. Dynamic generalization adds time to cartographic and remote generalization. (Gordeziani, 2012). As the author of this view, A. Berlyant points out, dynamic generalization occurs when an event is investigated or observed over a long period. In our case, the so-called „cartographic time“ for which spatial-temporal synthesis of maps is carried out is one year. The map of stexes, which is prepared for each day and night, is on a scale of 1:2500 000. This map is based on the landscape map of the Caucasus (Beruchashvili, 1979; 1980). The spatial scale of this is 1:1000 000. As a result of the two-step transition from the first scale, a more or less abstracted landscape map is obtained, which is the basis for further cartography. It can be seen from his very concept that the cartography of the stexes contains a dynamic element or is completely dynamic. If traditionally, during the implementation of the cartographic form of abstraction, there is a transition from a large to a small scale, which leads to the abstraction of a specific space — in our particular case, there is a reverse movement from a small to a large scale (Gordeziani, 1989). All of the above is required for the purpose of the compiled maps and spatio-temporal synthesis in general. Under the latter is meant the degree of readability and information capacity of the compiled maps. Because of our natural territorial The stexes synthesis was carried out in three main steps, so the scale required only one change in the entire process — At the stage of synthesis of maps of stexes in the month. The synthetic map made for one month was presented on a larger scale (1:1000 000), with more "packed“ maps in it (1:2500 000). Later, in two more stages of time synthesis, the scale was not changed, and the mapping continued at the same scale: 1:1000 000.

Have cartographic spatial forms been abstracted at the three stages of temporal synthesis mentioned?

To answer this question, let's consider the primary subject of abstraction: stexes maps compiled for the territory of Georgia in 1987 — a total of 365 maps. In this series, 789 contours of 172 types of stexes are recorded. The number of contours of these stexes interests us because each of them is represented on the map as a spatial form, and the latter appears to us as an object of abstraction. By increasing the scale, we move to the first stage of time synthesis — the synthesis of similar maps in one month, preserving the primary information. Every month, we choose so-called dominant stexes in terms of duration in time, and we map them with the same indices. The result is a synthetic map for each month. It becomes obvious that the number of contours on the synthetic map has decreased, and, accordingly, the number of stexes has also decreased from a spatial point of view. And the rest of the non-dominant (non-phonic) stexes were recorded in the so-called spatio-temporal diagrams. The number of background stexes for one year on the maps compiled by months is 95, and the contour is 572, i.e. The number of contours on the synthetic maps was reduced, but the information remained the same as encoded in the 365 maps compiled for the entire year. Spatial forms have been schematized, which is nothing more than their abstraction. Since this process takes place on a map, we are dealing with a cartographic form of dynamic abstraction.

The second stage of spatial-temporal synthesis envisages a qualitatively new synthesis of 12 synthetic maps compiled for all months of one year — By seasons and making four synthetic maps again and again without losing information. Here, the dynamic element of the cartographic content is fixed at the point using the above-mentioned method, and now, for the season, the dominant stexes are selected based on the content of the synthetic maps of the months. In the end, on four synthetic maps, we get a schematized picture compared to the previous maps; the number of contours has decreased (Table 1.). In this way, spatial forms were schematized, which is called abstraction in the language of cartography. Compared to the previous process, this time there was no change in scale. The information capacity of the spatio-temporal model did not change, but the specific space depicted in the maps was simplified — cartographic abstraction took place without changing the scale. We are dealing with a similar picture at the third stage of temporal synthesis. Here, too, cartography takes place on the same scale: 1:15000000. The primary information here is also unchanged; only the cartographic time shown on one map is different: 1 year. Spatial forms are relatively schematic and simplified. During abstraction, the element of dynamics is also fixed here by the method of spatio-temporal diagrams. It should be noted here that the "degree of syntheticity" applies when mapping stexes, which we calculate based on map legends. This parameter is determined by the ratio of the number of contours on the next map to the number of contours on the previous map (example: 572:786 = 0,72).

Thus, when synthesizing the maps of the stexes in time, there is a so-called dynamic generalization, and our attention is drawn to the dominant stexes. We abstracted them, and the spatial localization of the rest of the stexes was carried out using spatial-temporal diagrams.

Table 1. Cartographic form of dynamic abstraction

The scale of map space	Number of contours in the spatial-temporal model	Cartographic time	The number of maps in the spatio-temporal model	The degree of syntheticity
1:2500000	786	1 year (days and nights)	365	0,72
1:1500000	572	1 year (in months)	12	
1:1500000	258	1 year (depending on the seasons)	4	0,45
1:1500000	98	1 year	1	0,37

As mentioned above, in the process of cartographic generalization, the purpose of the map and its function — the scale of the map — are considered determining factors. It was also noted that the process of abstraction takes place only when moving from a large scale to a small one. All this is accompanied by the reduction of cartographic spatial information. We are dealing with other moments during the simultaneous-abstraction cartographic form of synthesis in time. During traditional cartographic abstraction, functional abstraction is characterized by the following properties:

1. When synthesizing stexes of maps in time, cartographic abstraction takes place, both when moving from scale to scale and without changing the scale. If we change the scale, we do something else, from small to large. In this way, a separate law is activated, which accompanies the traditional cartographic abstraction; this process is carried out only as a result of changing the map's purpose and function — the scale.

2. During functional abstraction during spatial-temporal synthesis, there is no place to change the information capacity of the map. It remains unchanged but loses the degree of detail in the localized space.

3. In the process of time synthesis, we are allowed to pay attention to events that are relatively stable in time — in our case, the so-called "dominant stexes.".

4. A cartographic form of abstraction that occurs when synthesizing dynamic maps in time can be called a cartographic form of dynamic abstraction. During its operation, there is a reduction in the number of dynamic maps in the spatio-temporal model.

5. During the three stages of time synthesis in dynamic event cartographing, the degree of synthesis decreases, and it depends on the number of maps in the spatio-temporal model.

The cartographic form of generalization refers to the content aspects of the events of objective reality and is directly related to the purpose of the map and its function — the scale of the map. Changing the latter leads to a change in the information capacity of the map, namely, a reduction. The detailing of the scale leads to the simplification of the content of the map, the ignorance of less necessary secondary objects and subjects, and, in the content aspect, leaving the first necessary objects in the spatial field of the map. A generalized map reflects the space of these primary objects and subjects. We discuss the cartographic form of the generalization through the legend of this map. In particular, we compare the legends of large-scale and small-scale maps on a spatial scale. In this way, it is possible to determine the degree of generalization, that is, the extent of the content. Consider how the cartographic form of generalization functions in the spatio-temporal synthesis of stexes maps. If we consider the legends of synthesizing maps, we will see that it is a set of conditional designations (or indexes) of stexes allocated in the territory of Georgia. Maps, similarly to the case of abstraction, are presented as of 1987. The initial spatial scale is still 1:2500000. There is a transition to a larger scale, in parallel with which we will perform a spatio-temporal synthesis of daily maps of stexes for one month. Here, the legend of the dominant stacks, whose spatial localization is provided by the compiled synthetic map, is of particular interest to us. The number of legend elements on this map is lower compared to the previous level. In the first case, 172 units (in our case, stexes) are represented in the legends of the 365 stexes maps compiled for one year. As a result of the implementation of the first step of the synthesis, when 12 synthetic maps by months were compiled again for a one-year period, 125 dominant stexes (units) were distinguished in their legends, and the degree of synthesis (time scale in our particular case) was 0.72 (so. 125:172 = 0,72) (Table. 2).

Table 2. Cartographic form of dynamic generalization

The scale of map space	Number of contours in the spatial-temporal model	Cartographic time	The number of maps in the spatio-temporal model	The degree of syntheticity
1:2500000	172	1 year (days and nights)	365	0,72
1:1500000	125	1 year (in months)	12	
1:1500000	52	1 year (depending on the seasons)	4	0,41
1:1500000	18	1 year	1	0,35

This means that the content of the second model was generalized 0.72 times compared to the first. At the second stage of spatio-temporal synthesis in time, four synthetic maps were compiled according to seasons for one year, and 52 dominant stexes were allocated in the model so that the transition to the scale did not occur (it remained 1:1500000). In this case, the degree of syntheticity was 0.41. Finally, at the third stage of spatio-temporal synthesis, one synthetic map is created for one year, on which 18 dominant stexes are distinguished, and the degree of synthesis is 0.35. At this stage too, the scale of the space is not changed.

CONCLUSION

GIS analysis of natural-territorial complexes, space-time synthesis of dynamic maps, and dynamic generalization (cartographic abstraction and generalization) allow us to conclude the following:

1. In the process of spatial-temporal synthesis of maps of stexes, there is a cartographic form of generalization for dominant stexes. The information capacity of the synthetic map as a whole is unchanged, which does not obey the specifics of the traditional understanding of cartographic generalization.

2. The degree of generalization of the dominant stexes leading to the scale of the content depends on the period during which the spatiotemporal synthesis is performed. Therefore, the longer the time to be cartographed, the lower the degree of syntheticity of the dominant stexes;
3. Because the cartographic form of generalization that occurs in spatiotemporal synthesis focuses primarily on dominant stexes (the longest-running stexes), it can be called a cartographic form of dynamic generalization.
4. In the process of stexes mapping, the time scale functions, which we interpret as the degree of generalization of the essence of cartographic time.

Thus, the spatio-temporal synthesis of natural-territorial complexes is a subsequent process of dynamic generalization and vice versa. The degree of syntheticity of stexes maps is directly related to the space-time to be cartographed. The time scale, which was explained by Aleksandre Aslanikashvili in his metacartography in the 1970s of the last century, in our particular case is a means of transitioning from a frequent time scale to a sparse time scale and is directly related to the space-time synthesis and dynamic generalization of stexes maps. In our particular case, dynamic generalization can be considered the result of the spatial-temporal synthesis of maps of states of NTC.

REFERENCES

1. Aslanikashvili A. Cartography issues of general theory. Tbilisi, publishing house "Science", 1968.
2. Aslanikashvili A. Metacartography. Tbilisi, “Metsniereba” Publishing House, 1974.
3. Baransky N. Economic cartography. Issue 1. M. 1939.
4. Baransky N. Generalization in cartography and text geographical description. “Scientific Notes of Moscow University”, issue 119. “Geography”, book 2. 1946.
5. Baransky N. Economic cartography. Moscow, 1962.
6. Berlyant A. Image of space: map and information, Moscow, Mysl Publishing House, 1986.
7. Berlyant A. Geoiconics. Moscow, Publishing House "Astrea", 1996.
8. Berlyant A. Geoinformation mapping, Moscow, Moscow State University Publishing House, 1997.
9. Beruchashvili N. Landscape map of the Caucasus. Tbilisi TSU Publishing House, 1979.
10. Beruchashvili N. Explanatory note to the landscape map of the Caucasus. Tbilisi TSU Publishing House. 1980.
11. Gordesiani T. Study of landscape-ethological situations based on cartographic methods. Abstract. Candidate's Dissertation. Tbilisi 1989.
12. Gordeziani T. Cartographic concepts (theoretical analysis). Tbilisi, publishing house "Geoid 2011", 2012.
13. Isachenko A. Physico-geographical mapping, part 1. Leningrad, Leningrad University Publishing House, 1958.
14. Komkov A. On the question of the essence and methods of generalization in cartography. Questions of geography. Collection 27. M. 1951.
15. Salishchev K. Generalization in its history and modern development. In the book: “Results of science and technology. Cartography". Volume 5. Moscow, 1972. Pages 6-23.
16. Salishchev K. A look at cartography in the aspect of the scientific and technological revolution. In the book: “Ways of development of cartography.” Moscow, MSU Publishing House. 1974. Pages 21-35.
17. Salishchev K. Cartology. Moscow, MSU Publishing House, 1976.
18. Salishchev K. Cartography. Moscow, Publishing House "Higher School", 1982.

BIOGRAPHY

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In 1984, he graduated from the Faculty of Geography and Geology at Tbilisi State University, majoring in cartography.
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