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DEVELOPMENT OF RECOMMENDATIONS REGARDING THE COMPOSITION OF FORCES AND EQUIPMENT FOR TOPOGEODESIC SUPPORT OF THE TROOPS OF THE OPERATIONAL COMMAND

The object of the research is the forces and devices of topographic support of the operational command troops. The work highlights the recommendations regarding the composition of the forces and devices of topographical support of the operational command troops.

The analysis of the nature of the armed struggle of the last decades shows a sharp increase in the need of the troops (forces) for information provision, in particular in the provision of topogeodesic information (geospatial information) of the armed forces, the timeliness and reliability of which affects the course and results of military operations. One of the types of geospatial data that is needed by the military both in peacetime and in a special period are topographic maps, they are the main source of information about the terrain and the objects on it. Nowadays, the state of topographic information on most nomenclature sheets of topographic maps of the territory of Ukraine does not meet the modern requirements of the troops.

The successful implementation of the task of updating topographical information is facilitated by the use of the most acceptable and economically justified composition of forces and devices of topographical support of troops. However, the experience of geodetic support during the operational training of troops (forces), the operation of the United Forces in the east of the country and the large-scale armed aggression by the Russian Federation showed that the currently available forces and devices of geodetic support of the troops are not capable of fulfilling the entire scope of the assigned tasks. This especially applies to operational commands. Therefore, in order to successfully carry out changes in the system of topographic support regarding the necessary composition of forces and devices of this support, appropriate scientific researches were conducted. This, in turn, will provide an opportunity to improve existing methods and develop recommendations regarding the necessary composition of forces and devices of topographic support for the troops of the operational command. The mentioned recommendations will make it possible to justify the composition of the forces and devices of topographical support of the troops of the operational command by the persons planning the operations of the groups of troops (forces).

Keywords: *operational command, topographic support, timeliness and reliability of information, geospatial data, topographic data.*

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1. Introduction

The analysis of the nature of the armed struggle of the last decades indicates a sharp increase in the need of the troops (forces) for information provision, in particular, the provision of topogodetic information (geospatial information) of the armed forces, the timeliness and reliability of which affects the course and results of military operations [1].

According to the guiding documents [2], one of the main tasks of the topographical support (TGS) of the Armed Forces (AF) of Ukraine is the early preparation of the territory of Ukraine in geospatial terms, the creation and accumulation of geospatial information about the foreign territory.

This task is performed by parts (subdivisions) of the topographic service of the Armed Forces of Ukraine in relation to all types of geospatial data (geospatial information).

Topographic maps are one of the types of geospatial data that are needed by the military both in peacetime and in a special period. They are the main source of information about the terrain and objects on it and one of the most important graphic documents used by the governing bodies and the troops (forces) in their activities. With the help of topographic maps, it is possible to determine the plan

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and height location of points on the earth's surface, conduct a research and assessment of the terrain, organize the interaction and management of troops (forces), carry out orientation on the terrain and target designation, topogodesic binding of elements of the battle formations of the troops.

One of the main requirements [3] for topographic maps, regardless of the purpose, form and scale, is a reliable and accurate and complete display of the state of the area for the year of the map creation in the current conventional symbols.

Over time, the relevance of this requirement is lost, and therefore topographic maps need periodic updating [4]. Depending on the physico-geographical zoning of the territory, man-made load and the number of changes in the area, this periodicity currently amounts to 5–15 years [3].

The successful implementation of the task of early preparation of Ukraine territory in geospatial terms is facilitated by the use of the most acceptable and economically justified composition of forces and devices (FaD) of the TGS of the troops.

However, the experience of the TGS during operational training of troops (forces), the operation of the United Forces in the east of the country, and the large-scale armed aggression by the Russian Federation showed that the currently available FaD of the TGS are not capable of fulfilling the entire scope of the assigned tasks. This is especially true for the FaD of the TGS of the troops of the operational commands (OC).

In order to successfully carry out changes in such a complex organizational and technical system of military use as the TGS system about the necessary composition of the FaD of TGS, relevant scientific researches were conducted [5, 6]. This became the basis for the development of recommendations regarding the necessary composition of the FaD of TGS of the OC troops that will be able to solve the task of early preparation of the territory of Ukraine in a geospatial sense based on its capabilities.

Because of this, the development of recommendations regarding the necessary composition of topographical parts of the OC and recommendations for topographical and cartographic divisions regarding the periodicity of updating topographical information (TGI) with their subsequent coverage in scientific publications is relevant today.

In recent years, scientists have paid enough attention to the researched issues of developing methods and methodical approaches to substantiating the necessary composition of the FaD of TGS [7–9].

The analysis of research and publications in the subject area under consideration showed that these developments are based mainly on scientific researches of the 70s and 80s of the 20th century [10], which no longer correspond to modern views on the problem and methods of solving it. In particular, not enough attention is paid to the research of issues related to changes in the requirements of the troops for TGI and they do not use the possibilities of modern modeling methods to research the process of its creation and updating.

Thus, *the object of research* is the forces and devices of topographic support of the troops of the operational command. *The purpose of the work* is to highlight the recommendations regarding the composition of the FaD of TGS of the OC troops and recommendations to the topographic and cartographic units regarding the periodicity of updating the TGI for the successful performance of the tasks by the topographic parts (subunits) in the interests of the TGS of the troops.

2. Research methodology

The following scientific methods were used in the research:
– the method of analysis while studying the existing system of topographic support;
– the synthesis method in the development of recommendations for the selection of the composition of forces and devices of topographic support.

3. Research results and discussion

As a part of solving the scientific task of improving the existing methods, scientific and scientific-practical results were obtained, one of which is an improved method of substantiating the composition of the FaD of TGS of the OC troops [11]. The results of the numerical experiment according to the relevant stages of the improved method [6] made it possible to identify the insufficient efficiency of the functioning of the TGS system due to the imperfect structure of parts and subdivisions of the TGS of the OC troops and to develop the relevant recommendations, given below.

1. *Recommendations regarding the composition of topogodetic parts of operational commands.*

In order to perform the entire complex of works on the renewal of the TGI in the area of responsibility of the OC, the necessary number of FaD of TGS was calculated (Table 1).

Table 1

The total number of topographic departments and the main weapons and equipment in the topographic parts of the OC

The names of departments, weapons and equipment	Proposed storage			
	OC «Pivnich»	OC «Pivden»	OC «Zahid»	OC «Shid»
The number of departments				
Geodetic	12	11	13	12
Topographical	4	3	4	4
Cartographic	2	2	2	2
Σ	*18*	*16*	*19*	*18*
The number of equipment				
Cars	27	26	28	27
Theodolites	12	12	13	12
Tacheometers	4	3	5	4
Navigation devices	16	15	16	16
Stereoscopes	4	3	4	4
Scanner-plotter system (SPS) «Scancard»	26	24	27	26

Thus, in each of the OC, it is necessary to have:
– geodetic – 12–13 departments;
– topographical – 3–4 departments;
– cartographic – 2 departments.

To ensure their activity, each OC must have:
– special cars – 26–28 p.;
– theodolites – 12–13 p.;
– tacheometers – 3–5 p.;

– stereoscopes – 3–4 p.;
– SPS «Scancard» – 24–27 sets.

In order to effectively manage and ensure the activities of these units in the organizational structure of each OC, it is expedient to form a topographic center (TGC).

A typical organizational structure of TGC of OC is shown in Fig. 1.

Based on the data given in the Table 1, the typical structure shown in Fig. 1, it is necessary to have:

– the structure of the TGS of OC «Pivnich» consists of 4 topographic departments (each of them includes 3 geodetic departments and 1 topographic department) and 1 cartographic department (which includes 2 cartographic departments and 1 department of topographic maps). Personnel consists of 73 servicemen; 27 units of special automotive equipment; 62 units of topographic equipment and devices;
– the structure of the TGS of OC «Pivden» consists of 4 topogeodesic departments (3 of them include 3 geodetic departments and 1 topographical department, and 1 of them include 2 geodetic departments) and 1 cartographic department (it includes 2 cartographic departments and 1 storage of topographic maps). Personnel consists of 65 servicemen; 26 units of special automotive equipment; 59 units of topographic equipment and devices;
– the structure of the TGS of OC «Zahid» consists of 4 topographic departments (3 of them include 3 geodetic departments and 1 topographic department, and the first of them includes 4 geodetic departments and 1 topographic department) and 1 cartographic department (which includes 2 cartographic departments and 1 warehouse of topographic maps). Personnel consists of 75 servicemen; 28 units of special automotive equipment; 66 units of topographic equipment and devices;
– the structure of the TGS of OC «Shid» is necessary to have 4 topographic departments (each of them includes 3 geodetic departments and 1 topographic department) and 1 cartographic department (which includes 2 cartographic departments and 1 department of topographic maps). Personnel consists of 72 servicemen; 27 units of special automotive equipment; 62 units of topographic equipment and devices.

At the same time, in addition to the main subdivisions, the TGS includes the center's management and support subdivisions, the composition of which is not covered in this work.

2. *The recommendations to geodetic and cartographic units regarding the periodicity of updating topogeodesic information.*

It is proposed to use a method of determining the required periodicity of updating topogeodesic information, which, unlike the existing ones, is based on the dependence of the update time on the aging indicator of the specified information. The recommended periodicity of updating the TGI (in years) was obtained depending on the permissible level of its aging (in %), which is shown in Table 2.

Therefore, taking into account the more correct values of the coefficients of various types of territory K_t obtained during the numerical experiment, the permissible value of aging of the TGI (makes no more than 20 % of the aging). Subdivisions (parts) of the TGS are recommended to carry out measures to update the TGI in the areas of responsibility of the OC:

– for industrially developed densely populated areas is at least once every 4.2 years;
– for agricultural areas with a medium population is at least once every 6.3 years;
– for mountain, forest and steppe sparsely populated areas is at least once every 8.4 years.

The limitations of the research should be considered the necessity of staffing the units with the necessary forces and devices for high-quality performance of tasks.

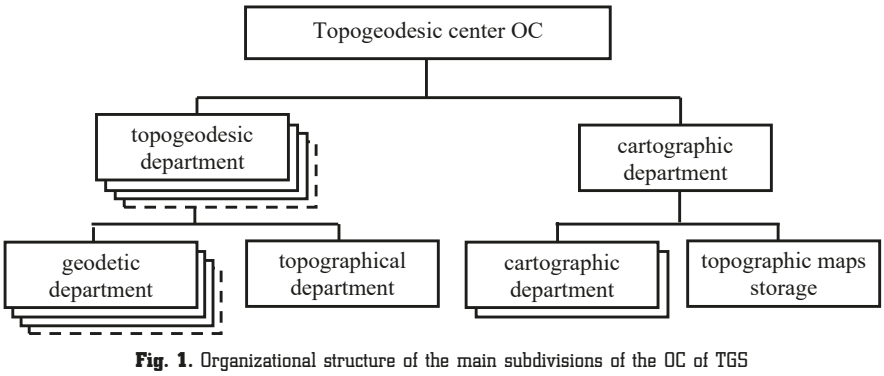

Fig. 1. Organizational structure of the main subdivisions of the OC of TGS

Table 2

The recommended periodicity of updating the TGI (in years) depending on the permissible level of its aging (in %)

The value of the coefficient of the area type, K_t	Permissible value of the TGI aging indicator, β_{turn}									
	5 %	10 %	15 %	20 %	25 %	30 %	35 %	40 %	45 %	50 %
0.67	0.6	1.6	2.8	4.2	5.9	7.8	9.9	12.3	15.0	18.2
0.8	0.8	1.9	3.4	5.1	7.0	9.3	11.8	14.7	18.0	21.7
0.9	0.9	2.2	3.8	5.7	7.9	10.4	13.3	16.5	20.2	24.4
1	1.0	2.4	4.2	6.3	8.8	11.6	14.7	18.4	22.5	27.2
1.1	1.1	2.7	4.6	7.0	9.7	12.7	16.2	20.2	24.7	29.9
1.2	1.2	2.9	5.1	7.6	10.5	13.9	17.7	22.0	27.0	32.6
1.33	1.3	3.2	5.6	8.4	11.7	15.4	19.6	24.4	29.9	36.1

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4. Conclusions

Recommendations regarding the composition of the forces and devices of the TGS of the OC troops and recommendations to topographic and cartographic units regarding the periodicity of updating topographic information are highlighted.

The use of this information will allow management bodies and parts (subdivisions) of the TGS to further organize and timely perform tasks related to the creation and updating of topographic maps.

The use of these recommendations will increase the efficiency of their tasks by up to 25 %.

Conflict of interest

The author declares that he has no conflict of interest in relation to this research, including financial, personal, authorship or other, which could affect the research and its results presented in this article.

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