

SECTION VII. FIRE AND CIVIL SAFETY

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ASSESSMENT OF ADMINISTRATIVE UNITS OF THE REGION ACCORDING TO DANGER FACTORS AND TENSION OF THE OPERATIONAL ENVIRONMENT

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Abstract. *An approach has been developed to determine the factors that characterize the scope of tasks of the operational-rescue service in the territory and the grouping of administrative-territorial units of the region according to the level of tension of the operational situation. Indicators characterizing the volume of tasks of the operational rescue service were determined by the expert method. The application of this method of the main components will be allowed to determine the factors that adequately describe the level of potential danger of the regions of the region.*

Each territory has its own characteristics that affect the implementation of activities aimed at ensuring the safety of the population and territories [1-2]. Regions have significant differences in their characteristics (area, population density, number of administrative units, tension of the operational situation, etc.). Accordingly, the scope of tasks of the operational rescue service depends on a number of factors characterizing the territory. Taking into account the requirements of the Decree of the President of Ukraine [3], the issue of optimizing the forces and means of civil defense to the goals and objectives of ensuring the safety of the population and the territory becomes acute. In the conditions of reducing the number of central executive bodies, regulation of the quantitative composition of units must be carried out of based on a scientific approach in assessing the volume of tasks facing units and civil protection management bodies. The tasks facing civil defense bodies and units are complex in nature, which in turn requires the use of special approaches in assessing their volume, complexity, etc. The practical aspect of the optimization of forces and means, firstly, requires obtaining information on the general distribution of danger factors and the scope of tasks by administrative-territorial units of the region, and secondly, the determination of territories with similar danger factors and the scope of tasks facing the authorities and civil defense units. Accordingly, the grouping of administrative units of regions according to the level of danger and tension of the operational situation is an urgent scientific task.

In works [4-7] the issue of using dimensionality reduction methods for adequate description of objects is considered. Works [8-12] describe approaches to dividing objects into homogeneous groups based on characteristics. Works [13, 14] is devoted to the determination of the quantitative composition of the forces and means of operational rescue services for large cities.

The issue of the distribution of administrative units of the regions according to the factors of danger and the intensity of the operational situation was not considered.

In order to group administrative units according to the scope of tasks of the operational and rescue service, it is necessary to have indicators that fully and adequately describe the level of danger of the territory.

It is proposed to select such indicators using the method of principal components. The principal components are an orthogonal coordinate system in which the variances of the components characterize their statistical properties. The presence of a large number of initial signs characterizing the territories practically makes their comprehensive assessment impossible and forces the selection of the most significant from them and the study of a smaller set of indicators. The initial features are subject to transformation, which ensures minimal loss of information.

The method would allow you to take into account the effect of multidimensionality of data, and provides a concise or simpler explanation of multidimensional structures.

Indicators characterizing the volume of tasks of the operational rescue service in the service territory are determined by the expert method, such as: area of the territory; the rate of deaths during extraordinary events per 100,000 population; the number of cities in the service area; the number of urban-type settlements; the number of rural settlements; the number of potentially dangerous objects (PDO) on the territory; area of forests; the average number of fires over the past 5 years; the average value of direct losses from fires over the past 5 years; population and other indicators.

In the process of applying the method of main components for each specific region, due to the specificity of the initial signs and opinions of experts, a certain set of factors characterizing the respective territory will be obtained. The STATISTICA program for statistical research can be used to obtain results by the method of principal components.

The results of the analysis according to the given approach for the Kharkiv region are presented in Table 1.

Table 1

Loading indicators on factors

	Factor 1	Factor 2	Factor 3
Area of the territory	0,233340	-0,839907	0,079065
The rate of deaths during extraordinary events per 100,000 population	-0,245016	0,057700	-0,627010
The number of cities in the service area	0,770088	0,098769	0,275395
The number of urban-type settlements	0,913741	-0,143641	0,061610
The number of rural settlements	0,431894	0,570905	0,109103
The number of potentially dangerous objects (PDO) on the territory	0,295180	-0,237831	0,757628
Area of forests	0,064192	0,310741	0,825198
The average number of fires over the past 5 years	0,847054	0,170158	0,184256
The average value of direct losses from fires over the past 5 years	0,840352	-0,216072	0,354871
Population	0,940595	-0,044259	0,290904

[author's development]

Table 1 highlights indicators that have a factor load of more than 0.75. The first factor characterizes the territory from the standpoint of the occurrence of extraordinary events due to anthropogenic influence, the second takes into account the size of the territory, the third factor characterizes the territory according to the factors of scale and specificity of possible extraordinary events [15].

The application of the method of principal components makes it possible to determine the factors that adequately describe the level of potential danger in the regions of the region. Elimination at heterogeneity of units of measurement of indicators of territories should be carried out by means of standardization of indicator values as follows:

$$z = (x - \bar{x}) / \sigma, \quad (1)$$

where:

\bar{x} – is the average value of the indicator;

σ – root mean square deviation.

In order to group territories according to certain factors, it is necessary to solve the n -dimensional task of dividing territories into groups with similar indicators. Distances between administrative territories are determined according to the specified indicators according to the following ratio:

$$d_H(x_m, x_g) = \sum_{i=1}^k |x_m^i - x_g^i|, \quad (2)$$

where:

x_m^i, x_g^i – values according to the i -th standardized territory indicator m and g , respectively.

When grouping, it is advisable to use Ward's method [8, 9], according to which estimates of distances between groups are determined by methods of variance analysis. The distance $dis(Y, X)$ between groups X and Y is taken as the increment of the sum of the squares of the distances of the objects to the centers of the groups obtained by merging:

$$dis(X, Y) = \frac{n_x n_y}{n_x + n_y} (\bar{X} + \bar{Y})^T \cdot (\bar{X} + \bar{Y}), \quad (3)$$

where:

\bar{X}, \bar{Y} – radius-vectors of group centers;

n_x, n_y – number of elements in clusters.

Ward's method minimizes the sum of squares for any two groups that can be formed. At each step, such two groups are combined that lead to a minimal increase in the intra-group sum of squared distances.

The result of the implementation of this approach will be the grouping of territories according to the factors of danger and tension of the operational situation, which in turn will provide an opportunity to conduct an analysis of the adequacy of the quantitative composition of forces within the group and apply the regulation function in a scientifically justified manner in order to optimize the use of forces and means of civil protection in the region.

Conclusions. The proposed approach to the distribution of administrative units of the region according to the factors of danger and the intensity of the operational

situation allows to provide informational support for the process of justifying optimal decisions within the framework of the application of the regulatory function.

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