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THE SEARCH MODEL FOR RATIONAL SOLUTION OF RESOURCE DISTRIBUTION

Introduction

The worldwide attention is attracted today to the problem of the quality of drinking water, as the use of poor-quality drinking water can cause illness with severe and even fatal consequences for humans. In Ukraine, only during the years of its independence there were registered numerous cases of disease cholera, typhoid, hepatitis A, dysentery, salmonellosis etc., associated with water and in particular drinking water. Drinking tap water, in the case of bacterial contamination may cause the emergence and spread of intestinal infections, and can also be a potential source of harmful chemicals getting into human body with general toxic, sensitizing, carcinogenic effect and can cause genetic consequences.

Epidemiological studies have confirmed the association of the chemical composition of drinking water to the population incidence of cardiovascular disease, cholelithiasis and urolithiasis, dental caries, etc. The consequences of chemical pollution, particularly heavy metals, pesticides and radionuclides, especially through contaminated soil and water, were evidenced by the increase of morbidity and mortality of population [1].

The long-term use of underground sources of water supply in the Kherson region led to their pollution by more mineralized waters of downstream aquifers, in according 45% of artesian wells give water that does not meet the sanitary requirements for mineralization, the dry residue, hardness, nitrates, sulfates, chlorides (Figure 1).

In spring and summer most of the population of Belozersky, Beryslavsky, Vysokopolsky, V.Aleksandrovsky, Genichesky, Kahovsky and Chaplynsky areas stay without water [2].

With aggravated medical and biological history, and adverse social conditions, the effect of the negative impact of anthropogenic factors is manifested stronger [3].

Thus, the poor quality of drinking water can cause different problem epidemiological situations in the region, for the elimination of which is necessary to attract more material and human resources.

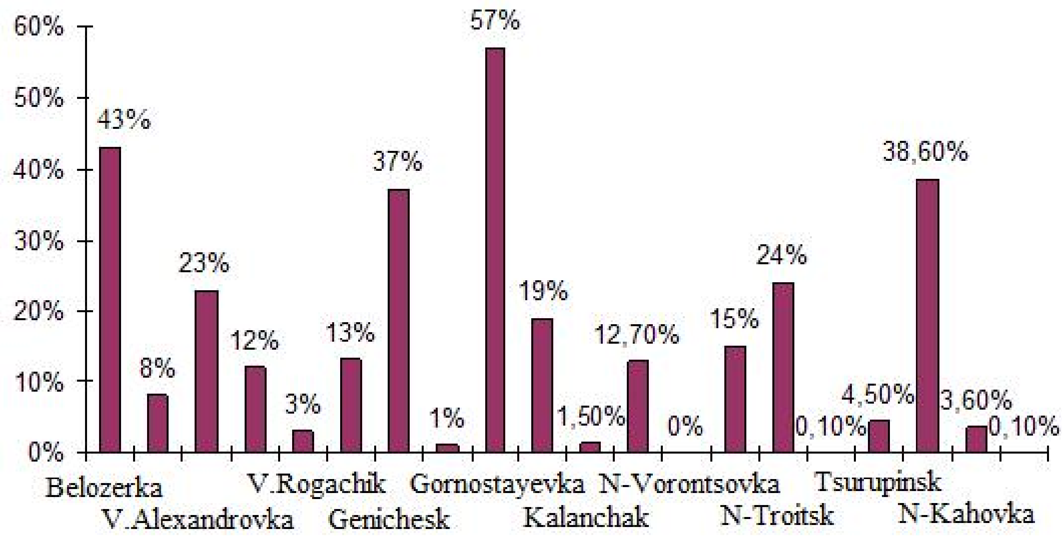

Figure 1 – The percentage of non-compliance to the total number of samples

The purpose

To develop operational and reasonable decisions on resource management and rescue activities it is necessary to use adequate models of training and assessment options for the distribution of resources in the dangerous infectious area admitting an effective computer implementation and being comfortable to understand. The known approaches in solving the problems of resource distribution are based on the mathematical optimization of functions defined on the set of combinations of discrete variables [4].

The iterative methods for finding optimal solutions to these problems are characterized by the rapid growth of computational complexity when the number of variables grows and does not allow proposing the optimization algorithm in the foreseeable analytical form.

The improvement of the efficiency and validity of decisions in terms of occurrence of the problem situation is possible with the help of formal logic models for the distribution of resources, allowing a relatively simple computer implementation [5]. In this article, we propose a search model for a rational resource distribution solutions using logic function selection, which is built on interactively based expert knowledge.

The main material

Suppose that in a certain region (Kherson region) r mini-regions fell into the epidemiologically dangerous area (regional area) in each of which, for ease of review in this area misses s micro-regions (cities, towns, villages), i.e. $\lambda = 1, s$ for all $\mu = 1, r$. For each λ micro-region experts establish situational characteristics that determine the causal relationships between the predicted situation and necessary rescue interventions. Situational characteristics can be set in advance by the alternative scenarios of stereotypical situations.

Rescue measures are provided by the following set of components $\alpha = 1, n$:

- the number of doctors,

- the number of medications,

- the number of medical equipment.

To perform the work of the same kind of resources (capabilities) can be of different types: doctors of the highest qualification, nurses, population. Each type $\beta = 1, m$ of these resources is characterized by a certain capacity, depending on the skill level of doctors and equipment means. Resource productivity is measured by the volume of work performed per unit time.

In relation to existing management practices and rescue activities, we introduce the following parameters:

a_λ- required amount of care α species in the λ microregion;

h_β- performance of Biomedical Resources β-type μ th miniregion for medical care α species;

T_μ - time allowed for medical care α species in the μminiregion.

Using these indicators, we construct a matrix of time-consuming resources μminiregion to perform works αspecies in each microregion λ (see. Table.).

For the rational distribution of resources based on this matrix is necessary to define the logic function selection. As a logical basis using multi-valued operations of disjunction, conjunction and inversion, which together with its arguments take values from the set of real numbers.

With the help of these operations we establish such logical dependencies between parameters table time costs that will ensure rational distribution of resources by the criterion of minimizing the time of care.

For each resource (table row) is necessary to ensure selection of the micro-region (column), where the amount of medical care for a period is not exceeding the allowable and will be the highest compared to other micro-regions. In turn, all of the resources necessary to define a β resource, which is selected for it by the maximum amount of health care in the λmicroregion can do it in a minimum of time compared with other resources. In this case, we assume that transport costs disproportionately small compared to the cost to perform the bulk of the work on the rescue activities.

Selected as a result of these logical operations βrow and λcolumn are deleted from the table 1. The subsequent steps are performed similarly for the remaining resources and microregions until all rows and all columns erased.

Table 1

A matrix of time-consuming resources

	a_1	a_λ	a_s
h_1	τ_{11} …	τ_{21} …	τ_{s1}
h_β	τ_{12} …	τ_{22} …	τ_{s2}
h_m	τ_{1m} …	τ_{2m} …	τ_{sm}

Thus, as a result of no more than m-1 transits is made the rational distribution of internal resources of miniregions for first aid.

This also holds for the second etc. medical care after appropriate adjustments of required and possible scope of work. If internal resources in μ miniregions (μ = 1, r) are not sufficient to perform all work within the allowed time, free resources involved neighboring ν miniregions (ν = 1, q), outside the region. In this case, a table of time spent at the level of the region including all its affiliated miniregions in aggregated form. The columns of this table represent the amount of work required in the μ miniregions that are not provided inside resources, and lines - the possible scope of work with available resources ν miniregions and executed the distribution of free resources on unsecured miniregions. The results of this distribution allow to correct local time consuming table.

With a lack of regional resources, the above process can be raised to higher levels of management.

So, at the first sign of an epidemic situation - namely, the number of patients and the number of carriers is approaching epidemic proportions in some situational zone region, epidemic department Regional Sanitary-epidemic station provides data to the City Commission for emergencies, which will decide on the interaction services. Telephone messages are sent to take action in all public institutions contact: kindergartens, schools, institutions, etc. - All are ought to wear masks, to establish quarantine, etc. If the scale of the epidemic reaches a viral disease, with the help of the media the vaccination is announced (vaccination, nasal drops, etc.) in the clinics or in the workplace.

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In the presence of the epidemic situation the rescue activities in this situational area are carried out as follows. From all the cases of disease are highlighted critical, requiring emergency hospitalization and emergency medical care, the provision of which depends on the patient's life. From the current number of doctors is allocated the brigade, which is directed at the elimination of these critical cases. In turn, the remaining medical workers are working in accordance with the basic algorithm. Then after assisting in all critical cases the brigade joins the main group of doctors, and with them continues to work on the basic algorithm.

Conclusion

The considered search model of the rational solutions allows us to formulate an algorithm of resource management at the elimination of problematic situations, the main stages of which are as follows:

1. Assess the situation, determine the initial data for the calculation.

2. Determine the required total a_{λ} health care αtype in the μ miniregions.

3. Determine the possible total $h_{\lambda\mu}$health care αtype of internal medical and biological resources of μminiregion for allowed time.

4. Determine the mismatch between the desired and the possible amount of care αtype in μminiregions.

5. If the discrepancy is greater than zero, then seek assistance from neighboring regions on the value of the error, otherwise go to step 6.

6. Identify possible volume of $h_{\lambda\mu}$ health care of αtype available biomedical resources in μminiregion for allowed time.

7. Determine the duration $\tau_{\lambda\beta\mu}$ care of αtype of internal medical and biological resources of βtype in μ miniregion for the allowed time.

8. Distribute internal biomedical resources of μminiregion between λ micro-regions.

9. Analogically distribute free medical and biological resources of ν miniregions between μ miniregions.

10. Distribute internal biomedical resources of μ miniregion between external and free λ micro-regions.

11. Determine the current situation after the intervention; determine the quantitative values of the characteristics. If necessary, repeat the procedure in accordance with the algorithm.

The algorithm is verified on the model problem management of sanitary and epidemic situation in the region.

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