

## Methodological bases for assessing socio-demographic and migration consequences of man-made disasters

### МЕТОДОЛОГИЧЕСКИЕ ОСНОВЫ ОЦЕНКИ СОЦИАЛЬНО-ДЕМОГРАФИЧЕСКИХ И МИГРАЦИОННЫХ ПОСЛЕДСТВИЙ ТЕХНОГЕННЫХ КАТАСТРОФ

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#### Abstract

The purpose of the research is to develop methodological bases and principles for assessing the socio-demographic (including migration) consequences of man-made disasters. A method of rapid assessment of possible outgoing migration flows that may occur in the event of a man-made emergency of various scales is proposed. The initial data for this method are quantitative statistical register data on housing stock and population, as well as operational data on the scale of destruction obtained using contactless methods of information collection. The author summarizes the legal acts regulating the work on prevention and elimination of consequences of man-made and other emergencies in Russia, as well as establishing the principles for assessing their consequences. The author proposes a rearrangement of the set of consequences of man-made disasters, including three main directions of the impact of emergency situations on various spheres: demographic (including damage to life and health, as well as the migration component), socio-economic, and natural and environmental. Indicators reflecting the consequences of the disaster have been developed for each of the

#### Аннотация

Цель исследования состоит в разработке методологических оснований и принципов оценки социально-демографических (в том числе миграционных) последствий техногенных катастроф. Предлагается методика оперативной оценки возможных исходящих миграционных потоков, которые могут возникнуть в случае разворачивания техногенной чрезвычайной ситуации различного масштаба. В качестве исходных данных для данной методики выступают количественные статистические реестровые данные о жилом фонде и численности населения, а также оперативные данные о масштабах разрушений, полученные благодаря использованию бесконтактных методов сбора информации. Обобщены нормативно-правовые акты, регламентирующие работу по предотвращению и ликвидации последствий техногенных и других чрезвычайных ситуаций в России, а также устанавливающие принципы оценки их последствий. Предложена перегруппировка множества последствий техногенных катастроф, включающая три основных направления воздействия чрезвычайных ситуаций на различные сферы:

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areas. The necessity of creating a classifier of man-made disasters in order to forecast their consequences is substantiated.

**Keywords:** technogenic disaster, consequences of disasters, ecological migration, socio-demographic consequences.

## Introduction

A man-made disaster is a disaster caused by a failure in the operation of technical systems, which caused an accident at an industrial complex, energy, and transport facility (Ismagilov, 2010: 184). Currently, the topic of risk-taking of industrial facilities and technical systems is becoming more relevant, and, due to their steady impact on the natural system, it is about the formation of a socio-technogenic-natural system (Bagrova, Bokov, Mazinov, 2012: 9), indicating the relationship of three subsystems, within which interrelated biological, biochemical, physical-chemical, social and technical processes operate (Arbeláez-Campillo, & Rojas-Bahamon, 2020).

At the beginning of the study, we decided to clarify the theoretical concepts, first of all to determine which phenomena belong to the category of man-made disasters, and also to give a classification of types and types of disasters, which will help to establish differences in the impact on objects of the external environment.

Classification "Interagency methodology for assessing the damage from emergency situations of technogenic, natural and terrorist nature, as well as the classification and accounting of emergency situations" refers to manmade emergency situations the following points:

- "transport accidents and disasters;
- fires;
- explosions;
- accidents with release of hazardous substances;
- collapse of buildings;
- accidents in electric power systems;
- failures of life-support systems and treatment facilities;

демографическую (включая ущерб жизни и здоровью людей, а также миграционную составляющую), социально-экономическую, и природно-экологическую. Для каждой из сфер разработаны показатели, отражающие последствия катастрофы. Обоснована необходимость создания классификатора техногенных катастроф в целях построения прогноза их последствий.

**Ключевые слова:** техногенная катастрофа, последствия катастроф, экологическая миграция, социально-демографические последствия.

- hydrodynamic accident: breakthrough, weirs, dams, sluices, bridges, etc., other man-made emergency situations".

At the same time, we believe it is important to determine the quantitative characteristics of emergencies, accidents and catastrophes, since even an accident without victims and destruction of a small transport object fits the above definitions of a man-made disaster and emergency. So for emergencies in relation to the response of the health system proposed a definition specifying some of the quantitative parameters: an emergency is "a situation in the disaster where the number of affected in need of emergency medical care beyond the capabilities of their timely provision of forces and means of local public health services" (Kuzin, Patlin, Sukhanov, 2005: 22). A similar criterion is put forward in the international register of disasters, where a natural disaster is defined as "a situation or event that exceeds local capacity that requires a request for external assistance at the national or international level" or "an unforeseen and often sudden event that causes great damage, destruction and human suffering" (EM-DAT <https://emdat.be/Glossary>). However, this approach is intended to define catastrophes in General, without considering the specifics of the sphere of their occurrence: natural or technological. Thus, a man-made disaster is the cause and determines the current man-made emergency.

The Russian Federation has adopted several legislative acts regulating the prevention and elimination of the consequences of man-made disasters. The main one is the law "on protection of the population and territories from natural and man-made emergencies". Separate definitions given in the text of the said law allow us to speak

about the directions of the impact of emergency situations and their spheres of influence: emergency response activities are aimed "at saving lives and preserving people's health, reducing the amount of environmental damage and material losses, as well as at localizing the zones of emergency situations, terminating the effects of their characteristic hazards (part in the version introduced since January 11, 2009 by Federal law No. 309-FZ of December 30, 2008)". As a result, the social and environmental consequences of man-made disasters are comparable to large -scale military conflicts. Accidents and catastrophes do not have national borders, because they lead to loss of life and create social and political tensions. On all continents of the Earth, thousands of potentially dangerous objects are operated with such volumes of stocks of radioactive, explosive and toxic substances that in the event of an emergency can cause irreparable losses to the environment or even destroy life on Earth.

#### Literature review

Despite the importance of the topic and its timeless relevance, there are few studies of the phenomenon of man-made disasters and their numerical characteristics. Much more work is devoted to the consequences of disasters, including environmental consequences (Chernogor, 2006; Grishin et al., 2019), socio-psychological consequences (Abdullin, 2006), economic and socio-economic consequences (Dolenina, Ryabova, 2013; Budaeva, Stankevich, 2011), methodology and principles of impact assessment (Avdot'in, Dzibov, Samsonov, 2012; Ntreba, Poyarkov 2004; Porfiriev, Makarova, 2014), as well as the tactics of various services in response to consequences (Kuzin, Patlin, Sukhanov, 2005; Makhnev, 2008), risk reduction (Goldobina, Gusev, Orlov 2009; Orlov, Goldobina, 2010; Degtyarev , 2005; Melnikov, Sobolev, 2011). In most of them, mathematical modeling tools prevail.

Dolenina O. E. and Ryabova E. V. consider the economic consequences of natural and man-made disasters (Dolenina, Ryabova, 2013) in the context of the relationship with the effectiveness of environmental policies of European States. To assess the economic impact, the following indicators are used: "environmental expenditure (the cost of measures aimed at reducing, preventing and eliminating pollution or any other degradation of the environment); the amount of environmental taxes; GDP of European countries; the share of environmental

expenditures in GDP", between which multiple correlation coefficients were calculated, demonstrating the presence of significant relationships (Dolenina, Ryabova, 2013).

The article by Ntreba A.V. and Poyarkov V. A. describes the structure of multi-level GIS as a means of predicting spatially distributed data, and considers an example of input and output parameters of the program for assessing the "consequences of accidents associated with the release of toxic or radioactive substances" (Ntreba, Poyarkov, 2004: 148). This approach was the basis for the methodology developed by the authors of this article to assess the socio-economic consequences and migration consequences of migration.

Analysis of risk energy facilities is presented in Bagrova L. A., Bokov V. A., Mazinov A. S. A. Celebrated the relationship between natural and technological systems often causes accidents of the same type are different: technological hazards arise from adverse natural impacts, and sometimes the opposite – "contributed to the intensification of natural hazards" (Bagrova, Bokov, Mazinov, 2012). It describes the largest disasters at the world's nuclear power plants, as well as at other energy facilities: power transmission systems and water and hydroelectric facilities, by country. The regularities of the spread of man-made emergencies of the XX and XXI century are revealed. among them, in the context of research interest, we should note "an increase in the severity of emergencies when the density of production reaches a certain level, above which the "Domino" principle is manifested – the spread of accidents to adjacent objects", "an increase in proportion to the technical complexity of production, population density, production density", as well as the predominance of transport disasters among others (Bagrova, Bokov, Mazinov, 2012: 11).

#### Methodology and materials

The scheme of emergency situation and formation of emergency situations in accordance with the approach of Menshikov V. V. and Shvyryaev A. A., includes: the field of initiation, the event initiating the incident, the incident itself, the field of striking factors, a set of recipients. "The recipients of the accident are people, as well as the fauna and flora that make up the biota, as well as abiotic elements of the natural environment (atmosphere, surface water,

soil) and material objects of anthropogenic origin" (Menshikov, Shvyryaev, 2003: 31).

It can be assumed that the elements of modeling the consequences for the complex of recipients of the disaster should include the following blocks:

- information about the impact fields: terrain (data on the digital terrain model, layers of the hydrological network and territorial river basins), population (number, composition, structure); objects of economic activity (housing and utilities, social infrastructure, other industrial facilities – - set model parameters, constants;
- information about the disaster (location, object of the disaster, type of destruction, intensity of the disaster) - independent input variables entered by the user;
- other information about the behavior of environmental objects that mitigate or aggravate the impact of the incident on the damage fields-independent variables.

The type and scale of a man-made disaster is the main determining factor in assessing the consequences, as well as the first parameters included in the model for assessing the consequences. We do not consider many causes of an accident: equipment failure, errors of production personnel, deviations from technical regulations, and external causes, since we propose to use the classification of the incidents themselves, regardless of the cause of the emergency. The assessment of the risk of an emergency is also accompanied by an assessment of the frequency of incidents based on the methods of the failure tree or event tree, which in our opinion is not necessary to resort to, since the assessment of consequences focuses not on the risks of certain consequences, but only on their scale, provided that the event is 100% likely to occur. This proposal will simplify the assessment methodology by eliminating the need to measure the frequency of equipment failures and get only a set of scenarios for emergency situations. However, to obtain numerical predictive estimates of damage and consequences, it is necessary to simulate incidents depending on the type of object and the type of disaster that determines the set of sources of damaging substances. For example, for objects of the chemical industry, these will be models of sources (emissions of superheated liquids and liquefied gases, spreading of liquid substances, etc.), models of striking fields, models describing recipients, models of mitigating factors and models of damage (Menshikov, Shvyrev, 2003:

48). Such a complex simulation of an incident should be carried out by a research team consisting of specialists from a few research fields. Dependent variables will represent numerical estimates of losses, damage, and consequences for multiple recipients in each of the impact fields (the three areas discussed below).

The EM-DAT resource offers several variables for evaluating the intensity of incident parameters, which are units of measurement. However, if 8 units are proposed for natural disasters, only two are proposed for man-made ones: radiation – Curie, chemical spill – m3 [<https://emdat.be/guidelines>]. Therefore, as part of the work on assessing the socio-economic consequences in terms of expanding the model's input parameters, it is first necessary to determine the units for measuring the intensity of the incident that caused the disaster for each group of incidents listed in table 1. However, from the point of view of the proposed approach to assessing the intensity of migration flows, such a revision is not necessary (Lukyanets, Ryazantsev, Maksimova, Moiseeva, Manshin, 2019).

At the same time, if we are talking about demographic damage and damage to the health of the population, it should be noted that health-saving and medical technologies and methods of protection are being improved, which contributes to reducing human losses (Cherkasova, Saad But, Karabulatova, Mkrtumova, Zabiroya, Kim, 2019). Therefore, forecasts of demographic damage assessment based on the frequency of emergencies and disasters are very approximate and necessitates the development of a methodology for assessing demographic damage that is not based on the experience of damage in the past.

## Results

The methodology for assessing the consequences of man-made disasters relies on the development of a set of predictive scenarios depending on the scale and type of disaster, despite the inherent nature of its randomness and the inability to predict the full range of events that make up the disaster. First, "a conceptual model is created (without a clearly defined danger or in its absence there is no risk) " (Menshikov, Shvyryaev, 2003: 7). Nevertheless, existing technologies and "methods allow predicting natural disasters with a high probability" (Sukhoruchenko, 2010: 18), in contrast to man-

made disasters, scenarios of which are implemented suddenly. However, in accordance with the Minutes of the meeting of the Government Commission for the prevention and elimination of emergency situations and fire safety No. 7 dated December 13, 2019 (Minutes of the meeting of the Government Commission) it is planned to analyze the improvement and need to develop new modern models for the development of emergency situations at nuclear power facilities and emergency situations with radiation factor.

At the international level, there is an EM-DAT database that accumulates a lot of natural and man-made disasters since 1900. However, to enter disasters in it, at least one condition must be met: 1) the number of dead is not less than 10 people; 2) at least 100 people are injured, injured or homeless; 3) the affected country declares a

state of emergency and (or) calls for international assistance (<https://emdat.be/>). Therefore, the database does not cover smaller-scale disasters. The classification of types of natural disasters presented in this resource is much broader than the classification of man-made disasters, which is much poorer (table 1). In our opinion, despite the fact that the presented classification covers all the set of disasters, it has a low level of specificity and spatial definitions, so it needs to be supplemented with the type of object where an industrial accident occurred (energy objects, chemical objects, etc.), since each of them has a different level of risk (for example, for chemical objects there are 4 degrees of chemical hazard (Menshikov, Shvyryaev, 2003: 35), and also specify the category "various accidents", which includes accidents, not related to industrial objects.

**Table 1.**

*Classification of man-made disasters in accordance with the methodology EM-DAT.*

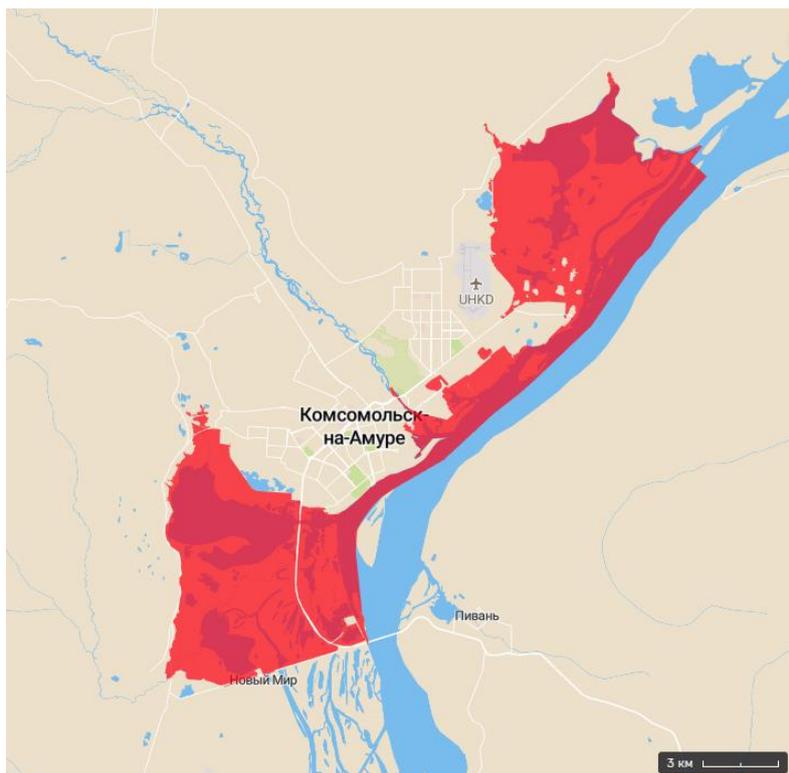
Technogenic accidents		
Industrial accident	Various misadventures	Transport accidents
The diversion of chemical precursors	Destruction	Air
destruction	detonation	railway
bursting	conflgration	road-transport
fire	another	Water
Gas leak		
Spill oil		
Poisoningse		
Emission/ Radiation		
Other		

Source: EM-DAT International Disaster Database. URL: <https://emdat.be/guidelines>

Decree of the Government of the Russian Federation of May 21, 2007 N 304 "on the classification of natural and man-made emergencies" establishes six levels of emergency situations based on territorial localization: local, municipal, inter-municipal, regional, interregional and Federal. Each level also has criteria for the minimum number of victims and the minimum amount of material damage (Resolution of the Government of the Russian Federation, 2007). However, such a classification is only a tool necessary for making managerial decisions at a level of territorial division and can serve the purposes of forecasting only as one of the levels of a more extended classification. Also, the unified state system of emergency prevention and response functions at the Federal, interregional, regional, municipal and object levels (Article 4 of the

Federal law on emergency situations). Therefore, it is necessary to assess the consequences of the disaster at the Federal, regional, and local levels (municipal and object).

The complexity is the development and description of the entire set of scenarios of incidents and behavior of the disaster object, as well as its recipients in real conditions. However, now there is experience in predicting possible consequences of disasters. This is an interactive map "Atlas of risks and threats", currently available on the website of the Ministry of emergency situations of Russia and allows you to get information about forecasts of natural and man-made emergencies. In relation to forecasts of man-made risks, this tool still has limited capabilities, since accidents, fires and heat points are considered as man-made risks (Fig.1).



Pic.1. Predicted flooding zones in 2019 in the city of Komsomolsk-on-Amur when the water level rises by 8.2 m in accordance with the ATLAS of risks and threats of the EMERCOM of Russia (URL: <https://atlas.mchs.ru/#/events>).

It is obvious that the greatest damage will be caused by disasters of the same scale in the area where the population concentration is higher, where a greater number of industrial and cultural facilities are located. Information-analytical system of monitoring of potentially dangerous objects (hereinafter SEN), including "the Territorial registries of potentially dangerous objects" (for example, the Decree of the Council of Ministers of the Republic of Crimea), is intended "to give a complete qualitative and quantitative description of all technological hazards, scenarios of occurrence and development of accidents and technological disasters on the territory of the region" with the goal of preventing (Kobernichenko, Sovetkin, Tyagunov, Yaroshenko, 2003: 76). The development of a methodology for assessing the consequences of man-made disasters should be based on the availability of a database of information about the General and special characteristics of VET in the regions, as well as a tool for building models for various scenarios of man-made disasters. There is also the issue of data compatibility in the model due to different nomenclatures and data standards (Migliorini et al, 2019). Each newly built industrial facility that

is put into operation must be reflected both in the database and in the input parameters of the models.

The impact assessment should be performed multiple times: immediately after the incident and after some time, resulting in short-term and long-term impact assessments. From the point of view of duration periods, it is fair to focus on the traditional short-term (week, month, quarter, year), medium-term (3-5 years) and long-term (5-10 years) periods in forecasting. However, it is necessary to take into account the characteristics of each man-made disaster and set minimum criteria for the degree of damage to the need to build forecasts for the medium and long-term period.

In assessing the consequences of emergency situations at the Federal level, there is "a single interagency methodology for damage assessment from emergency situations of technogenic, natural and terrorist nature, as well as the classification and accounting of emergencies" (approved. EMERCOM of Russia 01.12.2004) (the common method), under which "the main task of accounting for the influence of emergencies on the socio-economic development

of the Russian Federation is to determine the impact of damage from emergencies recorded at the level of "primary care", on macro-economic indicators characterizing on socio-economic development of the country as a whole." This method is "of a recommendatory nature and is the starting point for the development of private methods for evaluating indicators of socio-economic consequences of man-made, natural and terrorist emergencies in industries and sectors of the economy." This is the basis of the methodology developed by the authors for assessing socio-economic and demographic consequences. There is a need to obtain information at three levels: lower (enterprise, municipality), middle (branches and subjects of the Federation) and upper (Federal). At the Federal level, if there is data on the frequency of events of a certain class and known amounts of damage, estimates of total damage are made in accordance with the proposed formula. It allows you to assess the damage caused both in kind and in monetary terms. However, the proposed method has a significant drawback that does not allow us to build estimates of damage due to

events that occur quite rarely, the data about which do not represent a set of information sufficient to construct functions of a random amount of damage depending on the scale of the event. However, in this case, it is necessary to rely on the average values obtained from the registered information about events.

In accordance with the Unified methodology, there are four areas of impact of emergency situations: medical and biological, socio-economic, socio-political and environmental. In accordance with the authors' proposals, it is advisable to expand these areas to three: demographic (including damage to life and health, as well as the migration component), socio-economic, and natural-environmental, since socio-political consequences that involve damage to the state are part of the socio-economic sphere, with the only caveat that most of them (in a Single methodology) are calculated at the Federal level (table 2). The non-considered natural and ecological sphere assumes three objects of influence: flora and fauna, water and air space.

**Table 2.**  
*Socio-economic and demographic consequences of man-made disasters.*

Scope of influence	Type of consequences	Object of influence	Indicators for direct post-incident assessment	Indicators in the evaluation of the passage of time
demographic	socio-demographic indicators	population size	total demographic losses (updated system of indicators of the Unified methodology)	total demographic losses (updated system of indicators of the Unified methodology)
		population structure	loss of labor resources and human capital	loss of labor resources and human capital the number of people who left (people), the number of people who returned to their place of residence
	migratory	migration flow	number of departures	
Socio-economic	financial	the amount spent by the country to eliminate the disaster Housing and utilities facilities (housing stock, non-residential premises, water supply, heat supply, gas supply, electricity supply, localization, and other objects of the housing and communal sphere)	assessment of total financial loss	assessment of total financial loss
	инфраструктурные		assessment of current damage	assessment of current damage based on the residual principle (less restored)

Social infrastructure objects (healthcare, trade and supply, education and culture, and other social objects)	assessment of current damage	assessment of current damage based on the residual principle (less restored)
other production facilities	assessment of current damage	assessment of current damage based on the residual principle (less restored)

In the Unified methodology, economic damage is considered as financial losses, as opposed to physical damage: "before proceeding to the economic assessment of damage from emergencies, work must be carried out to determine the destruction and other losses in natural (physical and other) meters, i.e. the physical damage from emergencies is determined" (Article 1.2. Generalities). In our opinion, this approach requires clarification, and economic damage can be estimated in physical terms, as it is damage caused to the economy, that is, economic activity of people, in which one of the links of national wealth are, for example, buildings and structures. The same that a common methodology is understood as economic damage, is actually a financial loss.

We consider **financial loss** as the sum of the following indicators:

- direct losses of a technical object (calculated as the cost of repairing or replacing equipment and / or the object as a whole);
- (direct) payments to victims and victims' families;
- indirect losses in the form of lost profits from the failure of the object and / or part of it;
- indirect losses in the form of additional costs for consumers and producers of goods or services.

As part of the assessment of demographic losses from emergencies, the following set of indicators is provided in the Unified methodology (table 3).

**Table 3.**  
*Indicators for assessing demographic and labor losses*

<b>Indicators of population loss</b>	<b>Indicators that characterize the loss of labor resources:</b>
population in the emergency zone (people)	loss of the working population (people))
number of people affected by emergencies, total, including: children under 6 years, children from 6 to 12 years (people)	the loss of jobs (units)
sanitary losses of the population, total, including: children under 6 years , children from 6 to 12 years (people)	expenses for the reallocation of labor resources (thousand rubles)
fatal population losses, total, including: children under 6 years , children from 6 to 12 years (pers.)	number of reallocated people (pers.)
number of affected families (units))	the average cost of creating each new workplace (restoring previous working conditions) in the subject of the Russian Federation (thousand rubles)
material losses of the population (thousand rubles)	

Source: "unified interagency methodology for assessing damage from man-made, natural and terrorist emergencies, as well as classification and accounting of emergencies" (approved by the

Ministry of emergency situations of the Russian Federation) . EMERCOM of Russia 01.12.2004) We include the calculation of a different indicator of **total demographic losses**:

- direct losses due to the death of personnel serving the disaster site, as well as other persons not participating in its maintenance, living on the territory of the disaster, conducting economic activities, or present at it for other reasons;
- losses as a result of death due to the consequences of the disaster, including personnel involved in the liquidation of the consequences of the disaster, and other persons living on the territory of the disaster, conducting economic activities, or present at it for other reasons;
- lost births (indirect losses), which are calculated as the hypothetical number of children of women of fertile age who died as a result of an emergency, suffered and lost the physiological ability to give birth to children, as well as left the territory, minus the already realized births, that is, children born by these women.

We calculate **labor losses** based on the first two points of demographic losses. We consider persons of working age or persons outside of working age who are engaged in work.

Parameters for determining **human capital losses** include:

- determining the cost of costs for the formation of lost human capital, based on the sum of demographic losses for the first two points of their assessment. This estimate represents the total loss of human capital both among the personnel serving the disaster site;
- estimation of the cost of human capital formation necessary to restore the previous level of functioning of the disaster object. This assessment is made only as part of the restoration of personnel serving the disaster site.

For global catastrophes (type 7) it is necessary to consider also the social impact assessment that represent the excitement, tension, accusations in the direction of "guilty", civil court etc. However,

quantitative indicators of these effects, is very specific and can be designed, for example, based on psychometric methods or expressed by the number of cases related to the above consequences. For smaller catastrophes – social impact assessment is hardly appropriate due to its resource-intensive nature.

Therefore, we offer an alternative method for assessing the migration flow from the emergency zone. In addition, the unified methodology under consideration was approved by the Ministry of emergency situations of Russia in 2004, so it requires adjustments in terms of introducing new automated information processing tools that allow significantly improving actions to prevent and eliminate emergencies, as well as evaluating and predicting possible consequences.

The scheme of the proposed algorithm for operational forecasting is as follows: incident-removal of data on the ground about the degree of destruction – obtaining data on the dead and injured – assessment of the outgoing flow. Thus, the outgoing migration flow, including organized and independent relocations, will represent the number of people left without places of residence and other life-support facilities, and will be calculated as the number of people living in residential premises located on the territory of the affected zone, minus the dead and missing. Modern technologies allow us to assess the degree of destruction by comparing the damaged residential premises and the same before the incident.

## Conclusion

The assessment of the consequences of a disaster should be based on the development of scenarios for its unfolding. The complexity of building such scenarios lies in their multi-variant nature. We believe that the modern level of society requires the creation of the most complete and accurate multi-level classifier of many man-made disasters. This classifier is important for predicting disaster scenarios. We see the following levels of the classifier:

- 1) localization (object, municipal, intermunicipal, regional, interregional, Federal);
- 2) type of disaster object (industrial object: energy object; transport object, other objects);
- 3) the scale of the incident (quantitative indicators: volume of emissions, area of destruction, fire area).

We are based on the capabilities of currently available tools for rapid assessment of the scale of migration flows. We propose to develop methodological foundations and test an algorithm for estimating the range of the expected migration flow, provided that quantitative data on the housing stock, the number of people living in it, and operational data on the degree of its destruction obtained by aerial photography by unmanned aerial vehicles are combined. There is a need to create tools in the form of software for modeling a variety of scenarios for the development of a disaster, depending on the incoming parameters, which must be specified, collected and systematized in the form of data sets.

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