https://doi.org/10.33266/2070-1004-2023-1-18-22
УДК 614.84 (100)

Оригинальная статья

МЕДИКО-САНИТАРНЫЕ ПОСЛЕДСТВИЯ КРУПНЫХ ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЙ В МИРЕ, 2012–2021 гг.

В.И.Евдокимов[1], В.Ю.Рыбников[1]

[1] ФГБУ «Всероссийский центр экстренной и радиационной медицины им. А.М. Никифорова» МЧС России, Санкт-Петербург, Россия

Резюме. *Цель исследования* – проанализировать и обобщить данные о медико-санитарных последствиях крупных чрезвычайных ситуаций (ЧС) в мире за 10 лет (2012–2021).
Материалы и методы исследования. Объект исследования – база данных о крупных ЧС в мире (The Emergency Events Database, EM-DAT: OFDA/CRED) [https://public.emdat.be/]. Среднегодовые данные представлены медианой, верхним и нижним квартилем (Me [q_{25}; q_{75}]). Риски погибнуть, получить травму или заболеть вследствие ЧС вычисляли на 1 млн населения (x10^{-6}). Анализ динамики изменения медико-санитарных последствий крупных ЧС в мире проведен при помощи анализа динамических рядов с расчетом полиномиального тренда 2-го порядка и коэффициента детерминации.
Результаты исследования и их анализ. В базе данных EM-DAT за период с 2012 по 2021 гг. представлены 5533 крупных ЧС, из них природных – 3807, техногенных – 1726. При невысоких коэффициентах детерминации полиномиальные тренды демонстрируют, как правило, тенденцию уменьшения количества ЧС, риска погибнуть в них, получить травму или заболеть и риска возникновения ЧС с медико-санитарными последствиями.

Ключевые слова: база данных EM-DAT, крупные чрезвычайные ситуации, медико-санитарные последствия, риски

Конфликт интересов. Авторы статьи подтверждают отсутствие конфликта интересов

Для цитирования: *Евдокимов В.И., Рыбников В.Ю.* Медико-санитарные последствия крупных чрезвычайных ситуаций в мире, 2012–2021 гг. // Медицина катастроф. 2023. №1. С.18-22. https://doi.org/10.33266/2070-1004-2023-1-18-22

https://doi.org/10.33266/2070-1004-2023-1-18-22
UDC 614.84 (100)

Original article

MEDICAL-SANITARY CONSEQUENCES OF EMERGENCY SITUATIONS IN THE WORLD, 2012–2021

V.I. Evdokimov[1], V.Yu. Rybnikov[1]

[1] A.M.Nikiforov Russian Center of Emergency and Radiation Medicine, EMERCOM of Russia, St. Petersburg, Russian Federation

Summary. *Investigation purpose* – to analyze and summarize data about medical-sanitary consequences of major emergency situations (ES) in the world for last 10 years (2012–2021).
Materials and methods of the investigation. An object of investigation – data base about major ES in the world (The Emergency Events Database, EM-DAT: OFDA/CRED) [https://public.emdat.be/]. Average annual data is presented by median, upper and lower quartiles (Me [q25; q75]). Risks of injury, illness or death because of ES were calculated for 1 million people (10^{-6}). Analysis of dynamic of changing medical-sanitary indicators of consequences of major ES in the world were provided by analysis of dynamic series with calculating of 2nd stage polynomial trend and determination coefficient.
Investigation results and their analysis. From 2012 till 2021 in EM-DAT data base 5533 major ES were presented, including 877 natural disasters, 1814 technogenic disasters. With low determination coefficients polynomial trends show, as rule, a tendency of ES number reduction, decreasing of risks of injury, illness and appearance of ES with medical-sanitary consequences.

Key words: *EM-DAT data base, major emergency situations, medical-sanitary consequences, risks*

Conflict of interest. The authors declare no conflict of interest

For citation: *Evdokimov V.I., Rybnikov V.Yu.* Medical-Sanitary Consequences of Emergency Situations in the World, 2012–2021. *Meditsina Katastrof* = Disaster Medicine. 2023;1:18-22 (In Russ.). https://doi.org/10.33266/2070-1004-2023-1-18-22

Контактная информация:
Евдокимов Владимир Иванович – докт. мед. наук, проф.; гл. науч. сотр. Всерос. центра экстрен. и радиац. медицины им. А.М. Никифорова МЧС России
Адрес: Россия, 194044, Санкт-Петербург, ул. акад. Лебедева, д. 4/2;
Тел.: +7 (921) 933-46-16
E-mail: 9334616@mail.ru

Contact information:
Vladimir I. Evdokimov – Dr. Sc. (Med.), Prof.; Principal Research Associate of Nikiforov Russian Center of Emergency and Radiation Medicine, EMERCOM of Russia
Address: 4/2, Academica Lebedeva str., St. Petersburg, 194044, Russia
Phone: +7 (921) 933-46-16
E-mail: 9334616@mail.ru

A number of modern scientific works indicate that at present there is a tendency of increase in number of emergency situations (ES). At the same time, improvement of preventive measures, prediction of risk of natural disasters and recognition of their precursors, improvement of working conditions and safety can lead to a decrease in the number of emergencies.

The aim of the study is to analyze and to summarize data on the health consequences of major ES in the world for 10 years (2012-2021).

Materials and methods of the study. The object of the study is a database of large emergencies in the world — The Emergency Events Database (EM-DAT: OFDA/CRED) [1, 2]. The database was created with the support of the World Health Organization (WHO) and the Government of Belgium. The Centre for Research on the Epidemiology of Disasters (CRED) at the Catholic University of Leuven (UCLouvain) and the Office of Foreign Disaster Assistance (OFDA) of the United States Agency for International Development (USAID) support EM-DAT.

EM-DAT database allows to search the data on emergencies by their type (natural, man-caused, complex), medical and health and socio-economic consequences for the population of the world, separate continents and countries. Search results can be presented in the form of Excel tables or cartograms [https://public.emdat.be/] - fig. 1.

The basis for the inclusion of emergencies in the EM-DAT database are the following indicators — as a whole or separately:

- number of deaths — 10 people or more;
- number of victims — 100 and more;
- number of injured — 100 and more;
- emergency state in the region;
- application for international assistance.

In Russian normative documents there is no concept of "large emergencies". According to the scale and consequences emergencies are divided into local, municipal, inter-municipal, regional, inter-regional and federal[1]. We believe that, according to EM-DAT, local regional, inter-regional and federal emergencies may be referred to major emergencies. A list of some of the major ES in the world in the years 2002-2006 was presented in the articles by V.A. Akimov and I.I. Sokolov [3, 4].

In many scientific publications EM-DAT database has been used for analysis of the consequences of major ES in the world including Russia [5-8]. The articles by A.A. Vostrikova and O.A. Morozova present a comparative analysis of the domestic and foreign data on emergencies in Russia in 2010-2020 and identify the problems associated with taking statistical data into account [9, 10]. It was pointed out that it is necessary to synchronize the information presented in the annual state reports of the Ministry of Emergencies of Russia "On the state of protection of the population and territories of the Russian Federation against natural and man-made emergencies" with EM-DAT data, in particular, to correctly assess damage from various types of man-made and natural disasters on a global scale[2].

[1] On the classification of emergency situations of natural and man-made character: Decree of the Government of the Russian Federation of 21 May 2007 [1]304 (with amendments and additions). URL: http://www.consultant.ru/document/cons_doc_LAW_68490/

[2] On the State of Protection of Population and Territories of the Russian Federation from Emergencies of Natural and Man-Made Nature in 2021: State Report of the Academy of Civil Defense of Russia. M., 2022. 251 p.

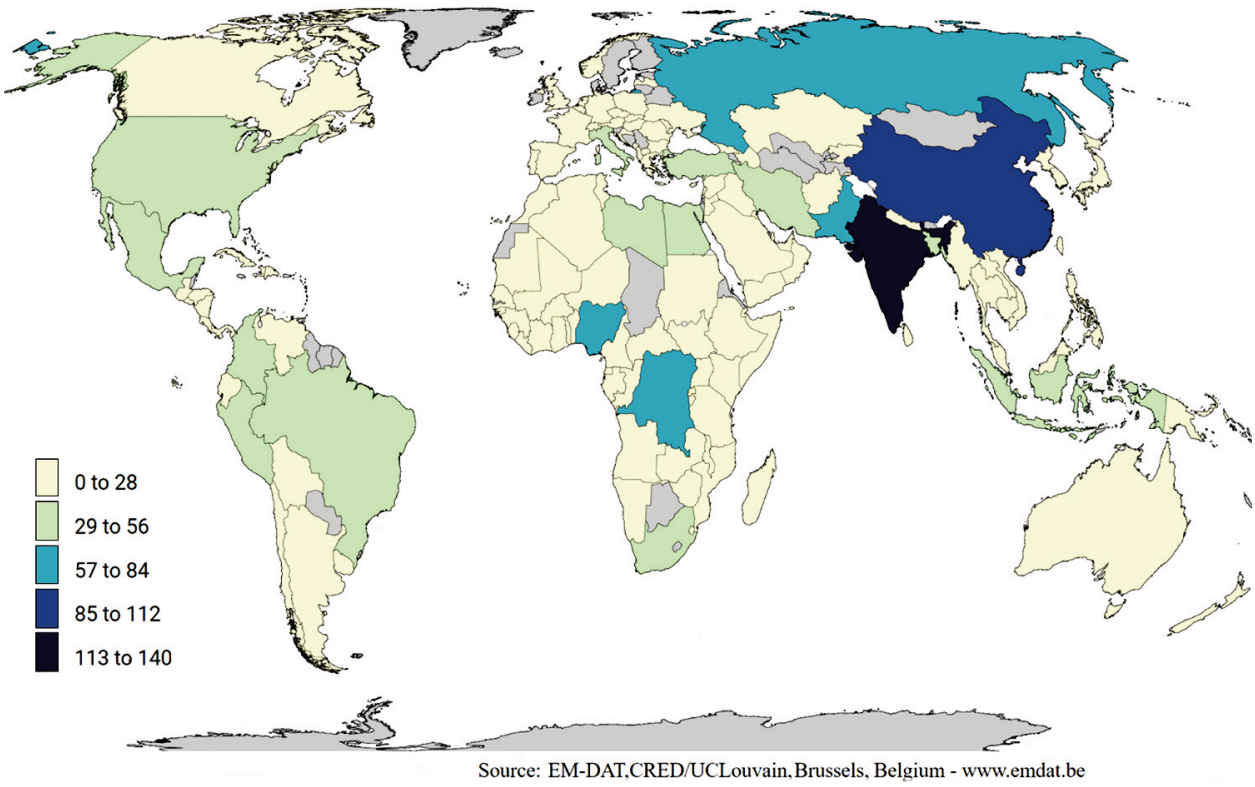

Рис. 1. Картограмма стран мира по количеству крупных техногенных ЧС (2012–2021)
Fig. 1. Cartogram of the countries of the world by the number of major technological emergencies (2012–2021)

This study analyzes data on the number of emergencies, including natural and man-made, the number of people killed and injured or sick as a result of emergencies.

Based on data on the number of individuals in the world at risk in an ES and the number of negative consequences of an ES, individual risks of dying and being injured or becoming ill as a result of an ES are calculated. The resulting risks are likely to be used only for large-scale scientific generalizations, since specific regions have their own probabilities of negative consequences, such as natural disasters in Southeast Asia or Oceania. It is likely that they characterize the so-called acceptable risks and direct regional leaders to develop measures to prevent disasters or minimize their consequences.

The results of the study were tested for the normality of the distribution of signs. Given the relatively short observation period and the marked variability of the indicators, the mean annual data are represented by the median, upper and lower quartiles (Me [q_{25}; q_{75}]). Risks of death, injury, or illness due to emergencies were calculated per 1 million people ($\times 10^{-6}$). Population numbers by year were taken from [https://countrymeters.info/ru/]. Since usually the data on the number of emergencies are provided at the end of the year, and the population number on the website — at the beginning of the year (as of January 1), in determining the risks the data on the population were taken for the previous year. The dynamics of the data were determined by analyzing the dynamic series with the calculation of the polynomial trend of the 2nd order and the coefficient of determination (R^2) — the more was R2, the more objectively formed the trend [11]. The consistency of the trends of the signs under study was assessed using Pearson correlation coefficient (r).

Results of the study and their analysis.

Total number of emergencies. From 2012 to 2021, 5,533 large-scale emergencies are presented in the EM-DAT database, with an annual average of 549 emergencies [533; 588]. In the world, 225,100 people died in 10 years as a result of large-scale emergencies; the average annual figure is 19,400 [17.7; 27.4]. [17,7; 27,4]. The highest number of people killed in emergencies — 33.7 thousand — was in 2015, mainly due to natural disasters (floods, storms, tsunamis) in Asia and Oceania.

The number of persons injured or sick in emergencies was 2 million 670 thousand over 10 years. It should be noted a marked variability of indicators in dynamics, the average annual indicator — 161.8 [112.3; 261.8] thousand people. The ratio of the number of people who died to those who were injured or sick was 1:12.

For the world's population, the risk of death in a major ES was 2.56 [2.30; 3.78]×10-6 persons/year; the risk of injury or illness in an ES was 21.27 [15.48; 34.87]$\times 10^{-6}$ persons/year. The probability of death in a major ES was about 3 people per 1 million population per year, and the risk of injury or illness was 21 people per 1 million population per year.

Fig. 2 shows the dynamics of generalized indicators in major emergencies in the world.

With low coefficients of determination, the polynomial trends show: the number of major ES tends to a flat U-curve with an increase in 2016 due to meteorological ES and in 2019 due to biological ES (viral infections) — see Fig. Figure 2A; number of deaths in an ES (see Figure 2B) and risk of death in an ES (see Figure 2C) — trend of decreasing data; risk of injury or illness — trend of increasing data with decreasing indicators in the last observation period — see Figure 2D. Of note, this risk was in 2019 165×10^{-6} due to a significant increase in the number of victims — 1 million 166 thousand people — in biological emergencies as a result of viral infections.

The congruence of indicators of the number of ES and the number of people killed in them is moderately positive and close to statistically significant — r = 0.540; p < 0.1.

Natural emergencies. In 2012-2021, 3,807 major natural disasters were recorded in the EM-DAT database, with an annual average of 371 [349; 402]. During the analyzed period, 169.1 thousand people in the world died in these emergencies, the average annual index — 15.2 [11.9; 22.2] thousand people; 2 million 609 thousand people were injured or fallen ill in emergencies, the average annual index — 156.7 [108.1; 257.4] thousand people. The ratio of the number of people killed in natural emergencies to the number of those injured or sick was 1:15.

In the structure of all large ES the share of natural ES was 68,8%; the share of those who died — 75,1; the share of those who were injured or sick — 97,7%, due to which the dynamics of the listed indicators almost coincided with the data on the total number of large ES — see Fig. 2.

In large natural ES the average annual risk of death was 1.98 [1.65; 2.93]$\times 10^{-6}$ persons/year; the risk of injury or illness was 20.59 [14.90; 34.29]$\times 10^{-6}$ persons/year.

Man-made emergencies. During the analyzed period we indexed 1726 major man-made disasters in the EM-DAT

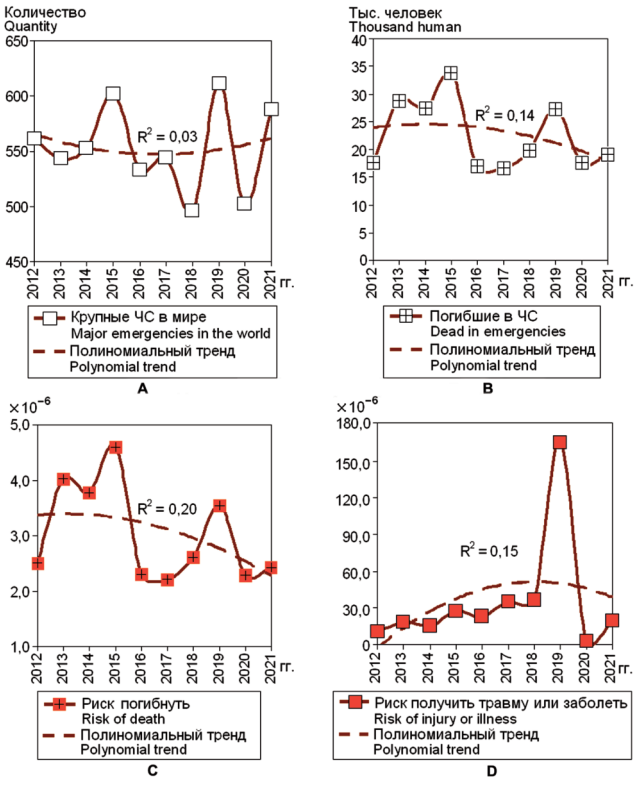

Рис. 2. Динамика: количества крупных ЧС в мире - A; числа погибших в них - B; риска погибнуть в них - C; риска получить траву или заболеть - D

Fig. 2. Dynamics of the number of major emergencies in the world (A), deaths in them (B),risks of death (C) and injury or illness due to emergency (D)

database, with an average annual number of 187 [170; 204]. There were 56 thousand people killed in man-made emergencies, the average annual number being 5.4 [4.6; 6.5] thousand; the number of people injured or sick in man-made emergencies who received emergency medical aid was 61.4 and 5.3 [4.4; 8.1] thousand respectively.

In large natural emergencies, the ratio of those who died to those who received emergency medical assistance (injured and sick) was 1:1.1.

The risk of death during large man-made ES was 0.74 [0.61; 0.89]×10^{-6} persons/year; the risk of injury or illness was 0.71 [0.58; 1.04]×10^{-6} persons/year. With different significance coefficients of determination, the polynomial trends of the number of large man-made emergencies (Fig. 3A), the number of deaths in them (Fig. 3B), the risk of death in them (Fig. 3C), and the risk of injury or illness (Fig. 3D) showed a decreasing trend in the data.

Using information on major emergencies provided in the EM-DAT database, risks of health consequences in China, India, and the United States were calculated. As would be expected, the risks of death in emergencies in these countries were significantly lower than in the world, and the risks of death in natural emergencies were higher than the risks of death in man-made emergencies (Table).

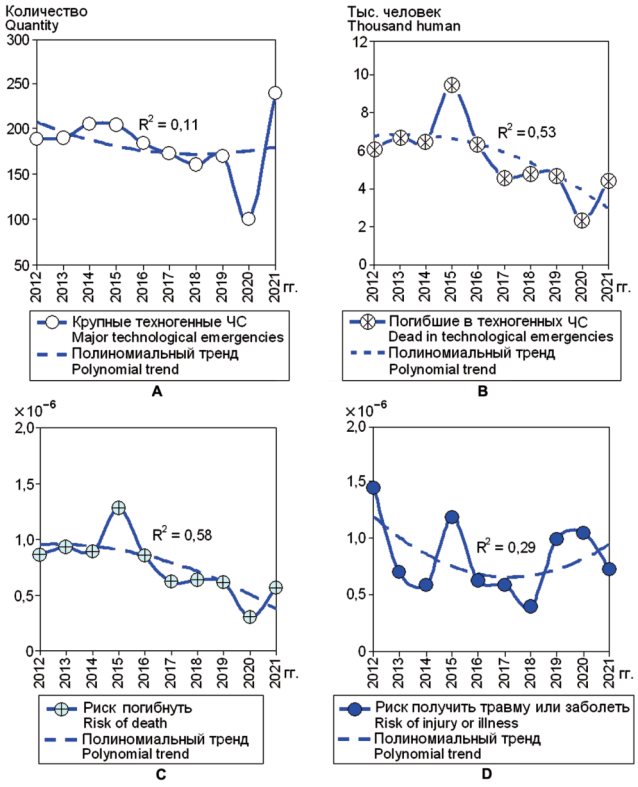

Рис. 3. Динамика: количества крупных техногенных ЧС в мире - A; числа погибших в них - B; риска погибнуть в них – C; риска получить травму или заболеть - D
Fig. 3. Dynamics of the number of major technological emergencies in the world (A), deaths in them (B), risks of death (C) and injury or illness due to emergency (D)

Таблица / Table

Риски погибнуть в крупных ЧС, 2012–2021 гг.
Risk of death in major emergencies, 2012–2021

Крупные ЧС Major emergencies	Риск погибнуть Risk of death	R^2	Динамика Dynamics
Россия / Russia			
Природные Natural	0,08 [0,03; 0,21]	0,52	∪↓
Техногенные Technogenic	0,84 [0,68; 1.51]	0,35	∩↓
Китай / China			
Природные Natural	0,39 [0,33; 0,92]	0,43	↓
Техногенные Technogenic	0,20 [0,11; 0,28]	0,33	∩↓
Индия / India			
Природные Natural	1,61 [0,86; 1,78]	0,05	↓
Техногенные Technogenic	0,27 [0,18; 0,42]	0,57	↓
США / USA			
Природные Natural	0,86 [0,67; 1,02]	0,41	∪↑
Техногенные Technogenic	0,08 [0,04; 0,24]	0,39	↑

With low coefficients of determination, the polynomial trends in China and India showed a downward trend in the risks of health consequences of major emergencies. In the United States, there was an upward trend in the risks of death in major emergencies (see table).

Conclusion

1. The EM-DAT database for the period from 2012 to 2021 recorded 5,533 major emergencies, of which 3,807 were natural and 1,726 were man-made.

2. With low coefficients of determination, polynomial trends generally show a downward trend in the number of ES, the risk of death in an ES, the risk of injury or illness, and the risk of health consequences of an ES.

3. For the world population, the risk of death in major natural emergencies was 1.98 [1.65; 2.93]×10^{-6} persons/year; the risk of injury or illness was 20.59 [14.90; 34.29]×10^{-6} persons/year; in man-made emergencies the indicated risks were 0.74 [0.61; 0.89]×10^{-6} and 0.71 [0.58; 1.04]×10^{-6} persons/year respectively.

4. The presented risks can be characterized as admissible and direct the heads of regions to develop measures for the prevention of emergencies or minimize their medical and sanitary consequences.

СПИСОК ИСТОЧНИКОВ

1. Human Cost of Disasters: An Overview of the Last 20 Years (2000–2019) // Centre for Research on the Epidemiology of Disasters (CRED), UN Office for Disaster Risk Reduction (UNDRR) / Ed. Mizutori M., Guha-Sapir D. Brussels, 2019. 29 p.

2. *Jones R.L., Guha-Sapir D., Tubeuf S.* Human and Economic Impacts of Natural Disasters: Can we Trust the Global Data? // Scientific Data. 2022. V.9, No. 1. P. 572. DOI: 10.1038/s41597-022-01667-x.

3. *Акимов В.А., Соколов Ю.И.* Наиболее крупные чрезвычайные ситуации 2002 года // Стратегия гражданской защиты: проблемы и исследования. 2013. Т.3, № 2. С. 283–352.

4. *Акимов В.А., Соколов Ю.И.* Наиболее крупные чрезвычайные ситуации в России и мире в 2006 году // Стратегия гражданской защиты: проблемы и исследования. 2014. Т.4, № 1. С. 392–456.

5. *Ries M., Zielonka M., Garbade S.,* et al. Disasters in Germany and France: an Analysis of the Emergency Events Database from a Pediatric Perspective // Disaster Medicine and Public Health Preparedness. 2019. V.13, No. 5-6. P. 958–965. DOI: 10.1017/dmp.2019.24.

6. *Ahmad J., Ahmad M.M., Su Z. et al.,* A Systematic Analysis of Worldwide Disasters, Epidemics and Pandemics Associated Mortality of 210 Countries for 15 Years (2001–2015) // International Journal of Disaster Risk Reduction. 2022. No. 76. P. 103001.

7. *Brennenstuhl H., Garbade S., Ries M.,* et. al. Patterns of Extreme Temperature-Related Catastrophic Events in Europe Including the Russian Federation: a Cross-Sectional Analysis of the Emergency Events Database // BMJ Open. 2021. V.11, No. 6. P. e046359. DOI: 10.1136/bmjopen-2020-046359.

8. *Дедученко Ф.М.* Проект противодействия развитию катастроф на природнотехногенных объектах инфраструктуры России // Надежность и безопасность энергетики. 2021. Т.14, № 3. С. 111–117. DOI: 10.24223/1999-5555-2021-14-3-111-117.

9. *Вострикова А.А., Морозова О.А.* Мировые интеграционные процессы в области статистического учета катастроф и стихийных бедствий // Технологии гражданской безопасности. 2021. Т.18, № S. С 185–192. DOI: 10.54234/CST.19968493.2021.18. S.25.185.

10. *Вострикова А.А., Морозова О.А.* Усовершенствование международной базы данных EM-DAT для корректного статистического учета катастроф и стихийных бедствий на примере Российской Федерации // Технологии гражданской безопасности. 2022. Т.19, № 1. С. 87–94. DOI: 10.54234/CST.19968493.2022.19.1.71.18.87.

11. *Афанасьев В.Н., Юзбашев М.М.* Анализ временны́х рядов и прогнозирование. М.: Финансы и статистика, Инфра-М, 2001. 320 с.

REFERENCES

1. Human Cost of Disasters: An Overview of the Last 20 Years (2000–2019). Centre for Research on the Epidemiology of Disasters (CRED), UN Office for Disaster Risk Reduction (UNDRR). Ed. Mizutori M., Guha-Sapir D. Brussels, 2019. 29 p.

2. Jones R.L., Guha-Sapir D., Tubeuf S. Human and Economic Impacts of Natural Disasters: Can we Trust the Global Data? Scientific Data. 2022;9;1:572. DOI: 10.1038/s41597-022-01667-x.

3. Akimov V.A., Sokolov Yu.I. Major Emergencies in 2002. *Strategiya Grazhdanskoy Zashchity: Problemy i Issledovaniya.* 2013;3;2:283–352 (In Russ.).

4. Akimov V.A., Sokolov Yu.I. The Largest Emergencies in Russia and the World in 2006. *Strategiya Grazhdanskoy Zashchity: Problemy i Issledovaniya.* 2014;4;1:392–456 (In Russ.).

5. Ries M., Zielonka M., Garbade S. et al. Disasters in Germany and France: an Analysis of the Emergency Events Database from a Pediatric Perspective. Disaster Medicine and Public Health Preparedness. 2019;13;5-6:958–965. DOI: 10.1017/dmp.2019.24.

6. Ahmad J., Ahmad M.M., Su Z. et al. A Systematic Analysis of Worldwide Disasters, Epidemics and Pandemics Associated Mortality of 210 Countries for 15 Years (2001–2015). International Journal of Disaster Risk Reduction. 2022;76:103001.

7. *Brennenstuhl H., Garbade S., Ries M.* et. al. Patterns of Extreme Temperature-Related Catastrophic Events in Europe Including the Russian Federation: a Cross-Sectional Analysis of the Emergency Events Database. BMJ Open. 2021;11;6:e046359. DOI: 10.1136/bmjopen-2020-046359.

8. Deduchenko F.M. Project of Counteracting Catastrophic Developments at Nature-Man-Made Objects in Russia. *Nadezhnost i Bezopasnost Energetiki* =Safety and Reliability of Power Industry. 2021;14;3:111–117. DOI: 10.24223/1999-5555-2021-14-3-111-117 (In Russ.).

9. Vostrikova A.A., Morozova O.A. Global Integration Processes in the Field of Statistical Accounting of Disasters and Natural Hazards. *Tekhnologii Grazhdanskoy Bezopasnosti* = Civil SecurityTechnology. 2021;18;S:185–192. DOI: 10.54234/CST.19968493.2021.18.S.25.185 (In Russ.).

10. Vostrikova A.A., Morozova O.A. EM-DAT International Database Improvement for the Correct Statistical Accounting of Disasters and Natural Disasters on the Example of the Russian Federation. *Tekhnologii Grazhdanskoy Bezopasnosti* = Civil SecurityTechnology. 2022;19;1:87–94. DOI: 10.54234/CST.19968493.2022.19.1.71.18.87 (In Russ.).

11. Afanasyev V.N., Yuzbashev M.M. *Analiz Vremennykh Ryadov i Prognozirovaniye* = Time Series Analysis and Forecasting. Moscow Publ., 2001. 320 p. (In Russ.).

Материал поступил в редакцию 07.12.22; статья принята после рецензирования 24.01.23; статья принята к публикации 23.03.23
The material was received 07.12.22; the article after peer review procedure 24.01.23; the Editorial Board accepted the article for publication 23.03.23