

SOCIAL CONSEQUENCES OF FLOODS: CASE STUDY OF FIVE EMERGENCIES IN DIFFERENT GLOBAL DRAINAGE BASINS

Valeriy P. Bondarev^{1,2*}

¹Lomonosov Moscow State University, Faculty of Geography, GSP-1, Leninskiye Gory 1, 119991, Moscow, Russia

²Bauman Moscow State Technical University, Faculty of Social Sciences and Humanities, Rubcovskaya naberezhnaya, 2/18, 105085 Moscow, Russia

*Corresponding author: valery_bondarev@mail.ru

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ABSTRACT. Identifying social consequences is an essential aspect of considering emergency flood events. There needs to be more consensus in scientific publications on which social consequences of natural disasters, including emergency flood events, should be singled out and considered for the complete analysis of this issue and for further making the right management decisions. To clarify the structure and dynamics of scientific interest in social consequences, a line-by-line content analysis of more than 100 scientific articles on the five largest emergency floods of the early 2010s that occurred in various global basins of the world in countries with different levels of human development was carried out. As a rule, the cycle of interest in the events is 6-7 years, with a peak in the second or third year. There are exceptions to this trend due to either a completely unexpected event or the overlap of several significant events over several years. Social consequences, as the volume of consideration decreases, can be arranged in the following row (by the level of interest, %): death losses (23,1); social solidarity (18,3); management problems (13,4); horizontal mobility (11,3); psychological state (10,9); vertical mobility (7,0); social conflicts (6,2); social adaptation (5,4); health losses (4,4). The relationship of scientific interest in emergency flood events with the country's level of development has been evaluated. There are three types of connection. With the growth of the Human Development Index (HDI), interest in social solidarity, death losses and management problems increases (the correlation coefficient is 0,54; 0,42; 0,31, respectively); However, consideration of vertical mobility, social conflicts and health losses is typical for lower HDI (the correlation coefficient is -0,86; -0,70; -0,47, respectively). The third group of social consequences (social adaptation, horizontal mobility, psychological state of the population) is statistically poorly related to the level of HDI.

KEYWORDS: nature disasters; flood hazard; Human Development Index; climate change; flood risk analysis; flood consequences

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INTRODUCTION

Modern society is increasingly viewed from the perspective of the risks it generates (Beck 1996; Giddens 1994; Mythen 2021, etc.). In the theoretical works of U. Beck and A. Giddens and others have shown that we live in an era of risk society characterized by the ubiquity of unlikely, but high-level risks. It is not just humans' health and the environment that are at risk, but the social structure and dynamics of society. In this context, the problems of the social consequences of natural disasters are becoming

more acute every year, because the increase in population, the development and complexity of infrastructure, technical innovations lead to an increase in the risk component of society. In order to achieve the Sustainable Development Goals formulated within the framework of the UN (Sustainable Development Goals...), it is necessary to study these risks and create a basis for their forecasting and management.

One of the widespread natural disasters are emergency flood events. A recent report the Intergovernmental Panel on Climate Change (IPCC) showed that rising global

temperatures dramatically affect the water cycle, making flooding more frequent and extreme (AR6 Synthesis Report...). The report of the World Meteorological Organization (WMO) states that from 2000 to 2020, the number of catastrophic floods increased by 134% compared to the period from 1980 to 1999 (2021 State of Climate Services Water...).

Various researchers demonstrate an increase in the risk of emergency flood events in various regions of the world (Alekseevsky et al. 2016; Bloschl et al. 2017; Dobrovolsky 2017; Frolova et al. 2017; Yu Wang, Li 2022). The reasons for the increase in the number of the emergency flood events are natural and anthropogenic factors – changes in the water and climate balance, an increase in population density, the expansion and complexity of infrastructure. In addition, the increase in the volume of information about the emergency flood events is associated with the growing interest in this issue and the development of information technologies.

An important aspect in consideration of emergency flood events is the assessment of their social consequences. Over the past two decades, a number of papers have been published describing and quantifying various consequences of possible and already occurred the events (Convery, Bailey 2008; Xiao et al. 2014; Istomina, Dobrovolskiy 2016; Dar et al. 2018; Karunaratne, Lee 2020; Török 2018; Kroska, et al. 2018; Kirby et al. 2019; Fernández et al. 2019; Mullick et al. 2019; Tate et al. 2021; Emrich et al. 2020). Currently, various risk assessment methods are being created, as well as reducing the impact of emergency flood events (Zemtsov et al. 2016; Mabuku et al. 2018; de Voogt et al. 2019; Hudson et al. 2020; Tanır et al. 2022). One of the other important topics discussed is the problem of prevention and management of social risks arising from emergency flood events. The publications analyze the problems of organizing prevention, mitigating the social consequences of the events, establishing social justice, supporting victims, improving adaptation conditions, alerting, etc. (Brouwer, Van Ek 2004; Norris et al. 2005; Thaler et al. 2018; O'Hare, White 2018; Ciampa et al. 2021; Aznar-Crespo et al. 2021; Kopsidas, Giakoumatos 2021; Mol et al. 2021).

There is no single list of social consequences of emergency flood events. As a rule, while assessing the magnitude and structure of damages, the authors take into account the following points in various combinations: the number of settlements affected by the flood; the amount of material damage; a threat to life; the nature of damage to industrial facilities, residential buildings and road infrastructure; the size and structure of flooding of the developed territory; the degree of disruption of people's way of life and industrial activity; the need for evacuation of local residents; environmental degradation and other characteristics.

Earlier, an analysis of scientific papers was carried out, in which it was shown that several main discussed topics characterizing the social consequences of emergency flood events can be distinguished (Bondarev, Bolkhovitinova 2019). It was possible to establish the most frequently mentioned social consequences in scientific publications:

- **Death losses.** These are the most obvious and tragic consequences of a natural disaster. Deaths occur not only due to the floods themselves, but also as a result of infrastructure facilities being destroyed at the same time, electric shock, poisoning with chemical compounds, etc.
- **Health losses.** These are injuries, diseases as a result of hypothermia, exacerbation of chronic diseases, malaria, intestinal infections, poisoning, etc. Often there are more

victims from the consequences of a disaster than from itself.

- **Socio-psychological state.** Stress and panic may occur. The lack of reliable information generates rumors that have the effect of «infection» and can aggravate the situation.

- **Deviant behaviour,** i.e. the behaviour that violates social norms and informal violations of social norms. Crimes committed during the crisis period are associated with the community's unpreparedness for catastrophic events, confusion and weakening of will and external control, disorganization of public and government authorities, etc.

- **Vertical mobility.** Having lost their housing, job or breadwinner, people often lose their economic and professional status, which can be accompanied by marginalization, to overcome which it is necessary to adapt to new conditions, change the behaviour model and develop a strategy for social adaptation.

- **Horizontal mobility.** Emergency flood events cause an increase in the migration flow. At the same time, it is generally believed that natural disasters usually form short-term internal migration flows, since victims do not have financial opportunities, do not want to change their usual place of residence, etc. Normally, that mass movement of victims occurs if a disaster causes hunger or social tension.

- **Social conflicts.** It usually escalates due to the unfair distribution of social benefits and social, ethnic and other contradictions already existing before the disaster. It could be based on a) the allocation of blame; b) the allocation of resources for rehabilitation and recovery.

- **Social solidarity.** Natural disasters bring not only destructive, but also consensual potential, because they represent an external threat to the affected communities and seek to coordinate actions to solve this problem. Social communication during the tragedy and immediately after it helps to restore mental and emotional balance, as well as to contribute to obtaining the necessary resources.

- **Problems of managerial decision-making** that arise due to the need to make decisions in extreme conditions that are not typical of the ordinary life of the community. Difficulties may arise due to two circumstances: a) strengthening of destructive collective behavior; b) the interests of individual actors who use the current circumstances in their own interests (Gryzunova 2012).

The proposed article develops the approaches and ideas that were formulated in the previous work (Bondarev and Bolkhovitinova 2019), where, using the example of the five largest floods, the main social consequences that can lead to social transformations were considered in general terms. The aim of the work is to identify the structure of interest in the scientific community to various social consequences of emergency flood events.

MATERIALS AND METHODS

The research paper presents the review on social consequences of five large emergency flood events that took place in various global basins (Fig. 1). The large emergency flood events were selected based on several criteria: 1) occurred about the same time (2-3 years); 2) had significant human and economic losses; 3) happened in different global basins; 4) get significant response in the scientific literature; 5) different Human Development Index (HDI) of countries, where the events were take place. All floods were chosen so that they occurred in the early 2010s. Thus, it allows analyzing contemporary events close to us. At the same time, this interval makes it possible to estimate the time of occurrence, growth and decay of interest in the described the emergency flood events.

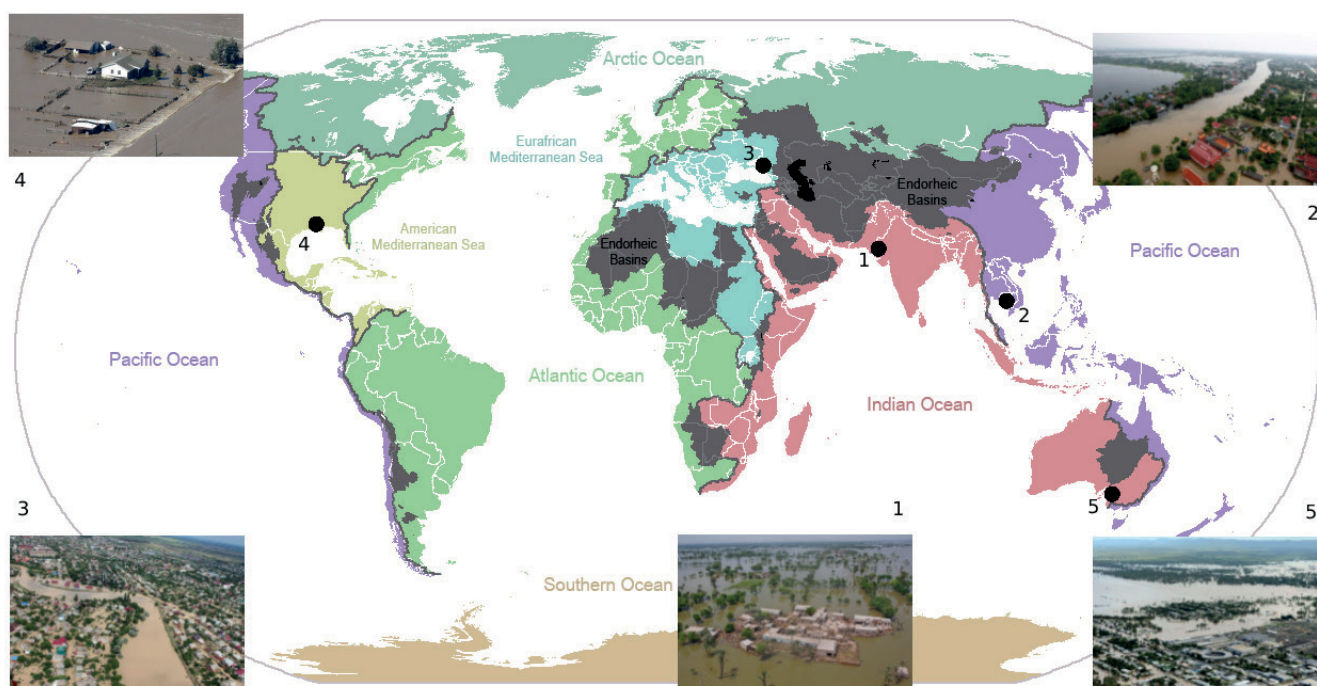


Fig. 1. Location of the large emergency food events within global basins: 1) Pakistan (28.07.2010 – 07.08.2010); 2) Thailand (05.08.2011 – 04.01.2012); 3) Russia (11.07.2012 – 11.07.2012); 4) The USA (12.09.2013 – 19.09.2013); 5) Australia (25.12.2010 – 04.02.2011)

Table 1 presents the main parameters of emergency flood events, which were analyzed in terms of social consequences (The Global Flood Database...; Kronstadt et al. 2010; Kirsch et al. 2012; Natural Disasters 2011...; About catastrophic rain ...; Nearly 35 thousand people...; Volosuhin, Shchurski 2012; Colorado flooding ...; Australian Storms ...; et al.). The Human Development Index was taken from the official UN website (Human Development Reports...), which shows an average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. It allowed us to assess the difference in interest in social consequences due to the level of development of the countries in which the flood occurred. The cases of flooding from various global basins that occurred in the early 2010s are considered. Floods occurred in various regions of the world on the territory of countries

with different Human Development Index (from 0.557 to 0.944). Floods were characterized by significant death losses (from 9 to 1985), affected (from 31 410 to 20 359 496) and economic damages (from \$ 600 000 000 to \$ 9 500 000 000).

The review is based on content analysis of scientific publications, which were chosen for that purposes, since, unlike media reports that emotionally and subjectively describe natural disasters, scientific publications are processed material obtained during an objective data analysis. The sample set totals 105 articles (21 articles for each emergency flood event). The database was compiled using the Google Scholar system. This search engine is widely known and well-established in the search for scientific publications. The sample set included practically all the articles found that mentioned discussed emergency flood events. Google Scholar made it possible to find

Table 1. Main parameters of the analyzed emergency flood events

Country	River Basin	Global Basin	Dates	Total Deaths	Total Affected	Total Damages ('000 US\$)	HDI
Pakistan	The Indus River basin and its surrounding areas	The Indian Ocean	28.07.2010 - 07.08.2010	1 985	20 359 496	9 500 000	0,557
Thailand	The Chao Phraya basin and the Mekong River basin	The Pacific Ocean	05.08.2011 - 04.01.2012	813	9 500 000	40 000 000	0,777
Russia	The Kuban River basin and its surrounding areas	The Eurafrian Mediterranean Sea	11.07.2012 - 11.07.2012	172	31 410	600 000	0,824
The USA	The Mississippi River basin its surrounding areas	The American Mediterranean Sea	12.09.2013 - 19.09.2013	9 (500 are Missing)	21 900	1 900 000	0,926
Australia	The Murray River basin and its surrounding areas	The Indian Ocean	25.12.2010 - 04.02.2011	35	175 000	7 300 000	0,944

articles from the journals of the largest scientific publishers in the world. Therefore, we can assume that the sample is representative.

The media reflected the main social consequences of the floods under consideration. Most often they indicated death losses. In each case, their specific social consequences were under consideration, which were especially noticeable due to the different flood conditions. Thus, during the flood in Pakistan (July 2010), a huge number of victims was associated with the deterioration of the sanitary and epidemiological situation (Kronstadt et al. 2010). The residents of rural areas were particularly badly affected. Having lost their property and almost all means of livelihood, they lost the chance to restore normal life (Kirsch et al., 2012). The flood in Thailand (July-September 2011) forced a huge number of people to leave their homes, many of them decided to leave their cities forever. This event had a detrimental effect on the economic situation in the country, on migrants, as it weakened their already vulnerable position (Disasters 2011...). Flood in Krymsk (July 2012) (About catastrophic...) it came as an uninspected to the ordinary population and the authorities (Nearly 35 thousand...). The consequences of the flood were aggravated by other unfavourable circumstances (Volosukhin, Shchursky 2012). Flooding in the USA (September 2013) had a strong impact on the transport infrastructure (about 30 bridges and several hundred kilometres of roads were destroyed). At the same time, the least amount of human losses was observed here, as the alert system contributed, as well as the work of more than 50 state and local religious organizations, etc. (Colorado flooding...). Flooding in Australia (January 2011) is also characterized by coordinated actions of the authorities. Due to the high degree of urbanization, about 90 cities were affected (Australian Storms...).

To identify scientific interest in social consequences of emergency flood events, content analysis was used – a method that is used in the processing of voluminous and unsystematic text data to measure and further obtain accurate and objective information (Drisko, Maschi 2016; Bell et al. 2022). The initial category of the study was the social consequence of the flood. The variables of the social consequences caused by the natural (the main topics) disasters under consideration were: death and health losses; social adaptation; horizontal and vertical mobility; psychological state of the population; social solidarity and conflict; management problems.

The mention one of the main topics in the article is taken as a unit of account. The measurement units were the ratio of the total number of mentions of a certain feature to the number of articles describing the emergency flood event, and the average volume of the text of a scientific paper devoted to the consideration of certain social consequences. At the same time, an encoding was developed, as well as a system of indicators. For example, indicators such as «in total died», «drowned in a car», «death occurred as a result of exacerbation of chronic diseases, malaria», etc. were used for the sign of «death of a person».

Correlation analysis was used to further analyze the relationship of scientific interest to the social consequences of the emergency flood events. The ratio of the studied social consequences depending on the human development index (HDI) helped to outline the main trends of scientific interest in the social consequences of the events in the countries with different levels of human development.

THE RESULTS OF THE ANALYSIS TO THE SOCIAL CONSEQUENCES OF THE EVENTS AND DISCUSSION

Any natural disaster, including emergency flood events, has a response in scientific publications, where it is analyzed, the causes of its occurrence are identified, and a forecast of the recurrence of such an event in the future is given. This leads to the improvement of management decisions and the creation of conditions for further reduction of death and material losses, as well as undesirable social transformations. It can be assumed that after a surge of interest in a particular event, the number of mentions of it will decrease over time, and the acquired knowledge will be attached to a body of knowledge about this type of event. To identify the duration of interest in a particular extreme flood event, a graph is constructed (Fig. 2).

According to Fig. 2, the following trend is visible. Immediately after the event, few articles are published, and then their number increases and remains high for several years. Then there is a decline in interest in this event. There are exceptions to the general rule. The first of them is the flood in Krymsk, which caused a wide resonance in Russia. This is confirmed by the increased number of scientific articles in the first year after the flood, as well as the presence of another peak of publications in the third year (the strongest of the five

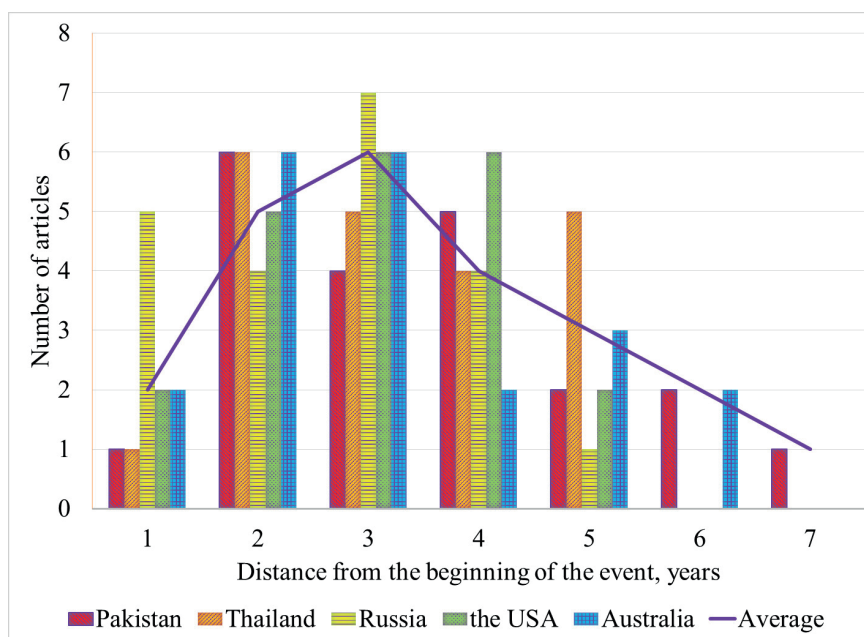


Fig. 2. Dynamics of the number of publications about the emergency flood events depending on the time distance

cases under consideration). Perhaps the first peak is because a catastrophic flood in this region turned out to be a suddenness, which caused the publication of operational data, and a deeper analysis of the situation corresponds to typical peaks of publicability. The second exception is the tragedy in Thailand. In the number of publications, describing this event, cyclicality and a peak are noted in the fifth year. Most likely, this is due to the regularity of catastrophic floods in the region, imposed on the large scale of the event.

Next, the frequency of mentioning in scientific publications of the main social consequences that were caused by the emergency flood events was considered (Fig. 3).

The greatest number of mentions of the social consequences, by which one can assess the general interest in the problem, was revealed in articles about flooding in Pakistan (71). Then there are the considered events that occurred in Thailand (66), Australia (65), the USA (57), and Russia (42). The most considered problems were the death losses, social solidarity and management problems. The problems of the psychological state, as well as horizontal and vertical mobility caused an intermediate interest. The least covered issues were health losses, social conflicts and adaptation.

Death losses are mentioned in almost 65% of articles as the most tragic and obvious consequence of the emergency flood events. However, publications rarely indicate the cause of death. At the same time, it is important to understand that with the development of infrastructure, these losses often occur not from direct impact, but from secondary factors (electric shocks, building collapses, etc.).

The analysis of social solidarity takes the second place in the frequency of mentions. This topic was especially discussed in the cases of the emergency flood events in Russia and Australia. In general, altruistic actions are usually described (monetary donations, gratuitous supply of clothing and medicines, work of volunteers, public organizations, states). In some articles there is information about the opposite trend, namely, the disunity of citizens and an increase in the level of discrimination based on gender, nationality and orientation.

The next frequently discussed social consequence is the reaction of the population to the actions of the authorities during the natural disasters. So, in the USA, management decisions were perceived positively in most cases. Exclusively negative aspects were indicated when describing the floods in Russia and Pakistan. In Thailand, against the background of negative assessments, such a positive factor as the interaction of the authorities with the media was noted twice, in the Australian case there are both positive and negative assessments.

During the emergency flood event, the cases of deviant behaviour are becoming more frequent. House robberies, thefts of essential items collected for victims and fraud on the part of financial criminals are recorded. At the same time, the cases of heroism are also mentioned.

The fifth level of discussion is horizontal mobility (migration). It turned out that there is no direct connection between the intensity of the emergency flood event and horizontal mobility. The decision to move depends not on the level of risk to which the local community is exposed, but on its financial capabilities of individuals living in the region. Unfortunately, the problems of horizontal mobility are not discussed in the Russian case.

The problem of vertical mobility (a movement through a system of social hierarchy or stratification) is also reflected in scientific publications. At the same time, in those countries where local communities do not have flood resistance, the loss of a house, a job or a family breadwinner more often leads to a decrease in social status. Thus, when analyzing the Pakistan case, phrases like «the poor have become even poorer» were often encountered.

The unequal distribution of resources for reconstruction causes an increase in social tension between different groups. The analyzed publications contain information about the formation of a conflict on this issue between individual groups of victims, as well as between the affected people and the authorities. Along with this factor, the following can be distinguished: the existence of personal interests among those making managerial decisions, assigning responsibility to someone for the consequences of flooding, as well as the dissatisfaction of victims with the actions of the authorities during an emergency flood event.

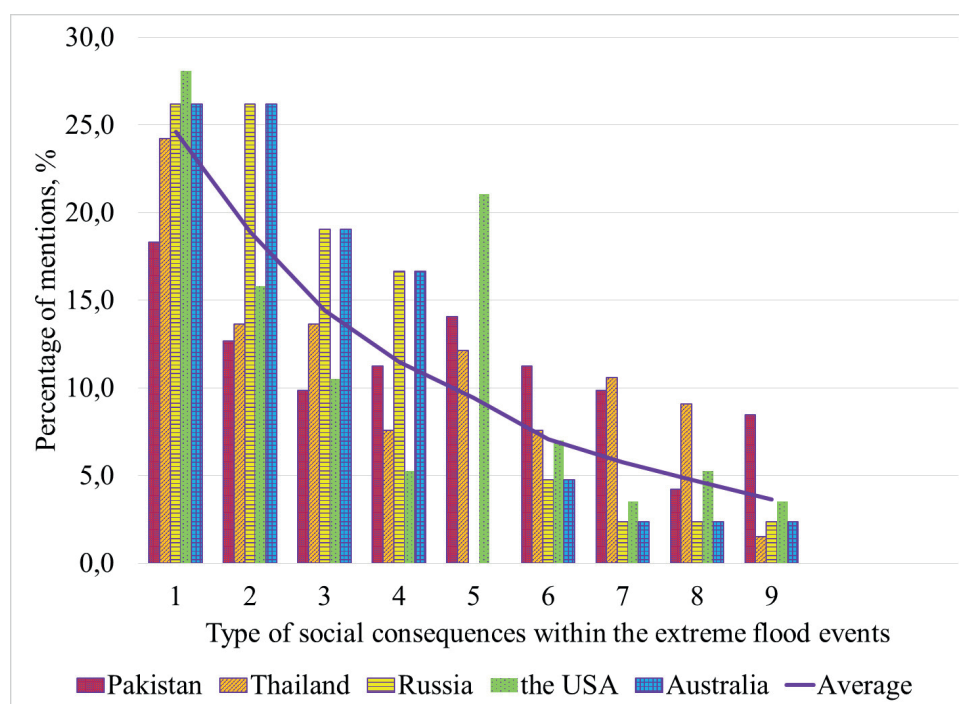


Fig. 3. Percentage of references to the social consequences in the total number of references. 1 – death losses; 2 – social solidarity; 3 – management problems; 4 – psychological state of the population; 5 – horizontal mobility; 6 – vertical mobility; 7 – social conflicts; 8 – social adaptation; 9 – health losses

The publication addresses general issues of community adaptation to the new conditions that developed after the flood. However, depending on geographical and social conditions, the affected population chooses different adaptation strategies. This may also be due to the duration, frequency and intensity of floods, the development of the economy, as well as the general socio-political situation in the country. Thus, when describing the Australian and American floods, the emphasis is more often on active adaptation, while when considering the Pakistan and Thailand cases, passive adaptation, as well as adaptation-avoidance (migration) are more common. It should be noted that in the last two cases, it was extremely difficult for the population to adapt to the prevailing conditions.

The interest in the problem of health losses turned out to be unexpectedly small. The increase in poisoning and the increase in the number of people infected with intestinal infections are discussed. It should be noted that most often scientific publications describing the Pakistan case contain this information, which is directly related to the unsanitary conditions prevalent in this territory.

In general, attention should be paid to the presence of a rather large variability in the general orientation of the topics discussed for each case. So, to emergency flood events in the USA, publications are more focused on describing problems related to the community's resilience to a natural disaster, that is, discussing specific actions taken by the population and authorities to prevent negative consequences from the natural disasters in the future. In Pakistan, the frequency of mentioning of these problems is more acute, since this community is distinguished by a high level of poverty. This explains the increased interest in studying the impact of the emergency flood events on vulnerable segments of the population. In publications about the Russian case, more attention is paid to the civil-legal aspects of the event than to the social ones.

Another important issue is to clarify the dependence of interest in the various social consequences of the emergency flood events, depending on the development of the country. Based on the material under consideration, it is only possible to estimate the corresponding trends in advance. For this purpose, the human development index (HDI) was used as the integral and widespread way to assess the country's development. The results of calculating the linear correlation of this interest with the HDI are presented in Table 2.

As one can see from Table 2, there are three types of statistical association of the social consequences of the

events with the level of development of the country. For example, social solidarity, death losses and management problems are discussed more often in countries with higher HDI. That is, we can expect that these problems become more relevant with the development of public relations. At that time, there is an inverse statistical relationship of vertical mobility, social conflicts and health losses with the HDI level. This may mean that the low level of social security, hygiene development, social structure and health care causes many problems with solving these issues. Finally, we can assume that there are issues (social adaptation, horizontal mobility, psychological state of the population) that are not so sensitive to the level of development of society and their discussion is influenced by other circumstances in which the emergency flood events occur. Of course, these are the first attempts to the problem with used limited data. There is a necessity to improve the knowledge about these interrelations.

CONCLUSIONS

Nature disasters are an element of a risk society, because regardless of the social and spatial position, an individual is in the zone of a potential natural cataclysm. The increase in anthropogenic interference in natural processes, an increase in the number and density of the population, as well as the complexity and increase in the technological infrastructure leads to an increase in the probability of emergency flood events. That inevitably entails a whole range of social consequences, expressed in death and sanitary losses, the emergence of migration flows, changes in the structure and functioning of local communities, the need to improve the systems of social adaptation and local governance.

A detailed analysis of the array of scientific publications of the five largest emergency flood events of the first half of the 2010s allows us to highlight the main topics that are relevant to the social consequences of these disasters: death losses, social solidarity, management problems, psychological state of the population, horizontal mobility, vertical mobility, social conflicts, social adaptation, health losses. The most discussed problems are death losses, social solidarity and management problems. To a lesser extent, scientific articles mention issues of the psychological state of the population, horizontal and vertical mobility. The problems of social conflicts and adaptation in general, as well as sanitary losses as a result of the emergency flood events, do not often fall into the circle of researchers' interests.

Table 2. The average level of interest in different social consequences of the emergency flood events and their correlation with the Human Development Index (HDI)

Social consequences	The level of interest, %	The type of relationship	The coefficient of correlation with the HDI
Social solidarity	18,3	Direct correlation	0,54
Death losses	23,1		0,42
Management problems	13,4		0,31
Social adaptation	5,4	No correlation	0,14
Horizontal mobility	11,3		-0,01
Psychological state of the population	10,9		-0,06
Vertical mobility	7,0	Inverse correlation	-0,86
Social conflicts	6,2		-0,70
Health losses	4,4		-0,47

In scientific publications, it is traditionally accepted to consider negative consequences (individual deaths and sanitary losses, the determination of the socio-psychological state of local community, the formation of conflict situations, and the strengthening vertical and horizontal social mobility). Along with this, there is a tendency to consider positive consequences: the activation of social adaptation processes, changing the level of social solidarity, the necessity to improve the structure of society and the tools of crisis management.

The scientific interest in various social consequences in some cases is due to the human development index (HDI) in different countries. Social solidarity, human losses and management problems are discussed more often in countries with higher HDI. Negative statistic interrelations are observed between vertical mobility, social conflicts and health losses with the HDI level. Sometimes (social adaptation, horizontal mobility, psychological state of the population) individual characteristics of flooding make a greater contribution to the formation of this interest. ■

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