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Review

Risks to the Health of Russian Population from Floods and Droughts in 2010–2020: A Scoping Review

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Abstract: Climate change and natural disasters caused by hydrological, meteorological, and climatic causes have a significant and increasing direct and indirect impact on human health, leading to increased mortality and morbidity. Russia is a country that suffers from frequent climatic and weather disasters. This is mainly due to its vast territory, complex geographical and ecological environment, and widely varying climatic conditions. This review provides information on climatological and hydrological extremes in Russia in 2010–2020, floods and droughts, and their impact on the health and well-being of the country's population. A literature search was conducted using electronic databases Web of Science, Pubmed, Science Direct, Scopus, and e-Library, focusing on peer-reviewed journal articles published in English and in Russian from 2010 to 2021. Four conceptual categories were used: "floods", "droughts", "human health", and "Russia". It is concluded that while most hazardous weather events cannot be completely avoided, many health impacts can potentially be prevented. The recommended measures include early warning systems and public health preparedness and response measures, building climate resilient health systems and other management structures.

Keywords: climate; floods; droughts; human health; Russia

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1. Introduction

Climate change and the emergence of climate-sensitive disasters (of hydrological, meteorological, and climatic origin) are impacting human health and leading to in-creased mortality and morbidity [1–7]. The Intergovernmental Panel on Climate Change (IPCC) describes extreme weather events [8] as unusual or less than the 10th or 90th percentile of the calculated probability density function. Long-term changes in the Earth's energy balance increase the frequency, intensity, and duration of extreme weather events, seriously threatening living beings, agricultural production, and hu-man health and well-being, causing damage and significant loss of life [9–11]. Accord-ing to some projections of future greenhouse gas emissions, the likelihood of complex events may increase. The type and character of natural disasters may change, e.g., floods and droughts occurring in the same region, requiring the population to be pre-pared for complex extreme events [5,12,13].

Many definitions for the term "disaster" have been introduced to the scientific so-ciety. Turner (1976) defined natural disaster as "an event, concentrated in time and space, which threatens a society or subdivision of a society with major unwanted con-sequences as a result of the collapse of precautions which had previously been cultur-ally accepted as adequate" [14]. Alexander (1993) used the wording for a natural disas-ter as a "rapid, instantaneous or profound impact of the natural environment upon the socio-economic system" [15]. UNISDR determined disaster as "a serious disruption of the functioning of a community or a society at any scale due to hazardous events in-teracting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and im-pacts" [16]. Centre for Research on the Epidemiology of Disasters (CRED) described disaster as "a situation or event which overwhelms local capacity, necessitating a re-quest to a national or international level for external assistance; an unforeseen and of-ten sudden event that causes great damage, destruction and human suffering" [17]. According to WHO (2017), disaster was defined as "a serious disruption of the func-tioning of a community or a society involving widespread human, material, economic or environmental losses and impacts . . . " [18], which we used in our study. We also used the term "hazard", which "refers to natural . . . phenomena which have the poten-tial to cause harm and damage" [18].

According to the general classification from EM-DAT (2022), both floods and droughts are considered as disasters from the natural group, hydrological and clima-tological subgroups, respectively. Despite their different origin, they are jointly con-sidered in the human-water interaction framework, representing two extremes of the hydrological cycle [19–21]. The literature search provides many examples of a rapid drought–flood transition and hence, need in development of joint water management and adaptation strategies [19–23].

Floods are the world's most common type of natural disaster; annually they lead to loss of life and property. In the last 20 years the number of strong floods increased more than twice, from 1389 to 3254, which is 44% of all extreme natural events, or ap-proximately 163 floods a year [24]. Compared with other natural disasters, floods are significant events, because they lead to the greater number of victims [1,25–27]. In the period from 2000 to 2019 floods caused damage to about 1.6 billion people, and lead to 104,614 deaths [24].

Flood is a serious damaging event occurring in different parts of the world. The Federal Emergency Management Agency, USA, defines flood as "a general and tem-porary condition of partial or complete inundation of normally dry land area or of two or more properties" [28]. Ward (2003) described flood as a "body of water which rise to overflow lands which are not normally submerged" [29]. The glossary of Hydrology (1992) determined flood as a "relatively high stream flow that overtops the stream banks in any part of its course, covering land that is not normally underwater" [30]. The Australian Government introduced the standard definition of flood for certain in-surance policies. For this purpose, flood is defined as "the covering of normally dry land by water that has escaped or been released from the normal confines of any lake, or any river, creek or other natural watercourses, whether or not altered or modified; or any reservoir, canal, or dam" [31].

Nowadays, we should pay attention to the possible increase in the number of floods due to climate change [8,32–38]. As a rule, cities are formed and develop in low-lands, coastal areas, and close to rivers, the areas, which are the most at risk of being damaged from floods. Thus, the growing population of such cities is at high risk [39,40]. Floods are not only natural but also socioeconomic events, quite often occurring in the densely populated developed regions [19].

When assessing damage from floods, the events included are not just those hap-pening at the rivers, lakes, or near the coast. Other types of flooding events are in-cluded, such as: heavy rainfall, storm surge, tsunami, fast snow and ice melting, ice jam, mudslide, and damage of water supply constructions (i.e., dike failure) [19,26,41,42].

Flooding events can directly harm the population health (injuries, hypothermia, and animal bites) or lead to loss of life (death from flood/drowning) [18,43]. The level of damage depends on the intensity of the event [1,44,45]. The most common types of injuries during floods are caused by cuts, falls, and falling or floating objects. At the same time there are indirect consequences with short- or long-term impacts [1,26].

Among indirect consequences with short-term impacts, quite common is the exacerbation of chronic illnesses among flood victims and rescuers [44,46,47]. At the same time, flooding can affect ecosystems and lead to releasing of toxic chemicals al-ready present in the soil and microbial proliferation [43]. Thus, there might be consid-erable toxic and microbial effects on the health of the population living close to the in-dustrial or agricultural areas due to floods. Toxic waters may cause different conditions, such as: cholera, diarrhea, hepatitis, leptospirosis, different kinds of parasitosis, shi-gellosis, and typhoid [48,49]. A population that suffers from floods has increased mor-tality and morbidity rates during the first year after the flood [1]. Among other diseas-es often occurring during floods are dermatitis, conjunctivitis, and ear, nose, and throat infections [45,50]. Regular flooding of the same areas creates a wet environment and leads to abundant fungal growth and exacerbation of allergies and respiratory infec-tions [51,52]. Health risks are also increased due to disruptions in healthcare infra-structure, including reduced availability of medical help, evacuation, and medications [44]. Indirect consequences with long-term impacts include wound infection and other injury complications, poisoning, psychological trauma and mass depression, chronic diseases, physical disability, and diseases of poverty including hunger and malnutri-tion [43,53–58].

There is evidence that some groups of a population are more vulnerable to the impact of floods, people with low incomes, the elderly (over 60), women, children, and those who are disabled or heavily ill [39,59,60]. Hospitals, ambulance stations, nursing homes, schools, and kindergartens located in areas threatened by flooding are at par-ticular risk: evacuation of patients and other vulnerable groups of the population may be particularly difficult. The identification of such vulnerable groups before the onset of a flooding provides baseline indicators for a better understanding of the additional needs of the healthcare system [18,61]. Social communities with their entire infra-structure, including physical, economic and social systems, are very vulnerable to flood hazards [62–64].

Drought is "a significant, compared with the norm, prolonged lack of precipita-tion in spring or summer, at elevated air temperatures, as a result of which the soil dries out" [65] (p. 286). It leads to crop destruction or lower yields, affecting primarily agriculture and forestry. Droughts, tropical cyclones, and floods are the three most dangerous natural disasters [24]. Drought effects on health are numerous [9,66,67], mainly indirect, and are mediated by other circumstances, such as loss of income. Firstly, these are the consequences associated with malnutrition, including general malnutrition, hunger, and death due to micronutrients deficiency and imbalance. Sec-ondly, these are diseases associated with poor quality of drinking water and outbreaks of infectious diseases, including cholera and those caused by E. coli, and algal blooms. Thirdly, these are airborne and dust diseases; vector-borne diseases, including malaria, dengue fever, and West Nile fever. Similar to other natural disasters, droughts also have mental health consequences such as stress and other mental disorders [68]. Other effects on health have also been noted, such as the impact of air pollution during forest fires, the displacement and subsequent migration of significant groups of the popula-tion, and damage to infrastructure [13,24,66,67,69–74]. Although droughts account for only 5% of all natural disasters, the total number of people affected by droughts in the world during the period 2000–2019 was 1.43 billion or 35% of all affected by natural disasters. This makes droughts the second most significant type of disaster, in the number of affected, after floods [24]. Sometimes droughts last for years, causing exten-sive long-term socio-economic losses [24]. In a changing climate, droughts are pre-dicted to become more intense in some parts of the world, exacerbating the impact on human health [13,24,73–75].

As a country with vast territory, diverse landscapes and climate types, Russia is one of the countries where people often suffer from extreme environments and weather events [76,77]. Climate extremes in Russia include different events which oc-cur often, vary greatly depending on the season and the region, and have diverse ef-fects [3]. Extreme weather events may lead to natural disasters with consequences for population health, ecosystem well-being, and national economy. The purpose of the current research is to provide a scoping review of studies on floods and droughts as extreme hydrological events in Russia during the last 11 years (2010–2020) and their in-fluence on health and well-being of the Russian population. The years 2010–2020 were selected to show the situation on the topic in the time interval after preparation and publishing the "Second Roshydromet Assessment Report on Climate Change and its consequences in the Russian Federation" [78].

The overview (1) summarizes the information and supplements the available evi-dence on the impact of floods and droughts on the health and well-being of people in Russia, and (2) recommends plans to mitigate the consequences of natural disasters. In Section 2, materials and methods are described. Section 3 provides results of the re-view: both floods and droughts as extreme events in Russia are presented in separate Sections 3.1 and 3.2 of Results. Section 4, Concluding Comments, includes some addi-tional aspects: floods, mental health and social consequences are discussed in Section 4.1; measures that can contribute for flood risk mitigation, problems and solutions are considered in Section 4.2; droughts, drinking water and public health preparedness are proposed in Section 4.3; philosophical aspects of floods and droughts as Noah and Jo-seph effects are debated in Section 4.4. Section 5 provides the main conclusion.

2. Materials and Methods

A literature search was conducted using the electronic databases Web of Science, Pubmed, Science Direct, Scopus, and e-Library, focusing on peer-reviewed journal articles published in English and in Russian from 2010 to 2021. Hand searching of the applicable literature was also performed in relevant journals and bibliographies of included studies. Four conceptual categories were used: "floods", "droughts", "human health", and "Russia", revealing a total of 273 records. We sought the key words "flood", "extremely high water", "typhoons", and/or "droughts", "hot and dry weather", and "human health", "fatalities", "mortality", "well-being", and "Russia", "Russian Federation (RF)", and "regions of the RF" in the title and the abstract of the papers, and looked for studies cited in the recognized articles. Papers discussing mortality/drowning, morbidity/injury and long-term flood and drought effects on people were included to the final search. The papers with duplicate and overlapping results were excluded from the review and were not included in the final table placed at the end of the Results section. Finally, the search identified 22 studies that were selected for the review. We did not impose any restrictions on study design.

3. Results

3.1. Floods in Russia

In Russia, some regions are at higher risk of flooding. They are the southern re-gion, the Northern Caucasus, Far East, and the so-called "zonal mid-latitude" region, the zone in the temperate latitudes, crossing the basins of the rivers Volga, Don, Ob, Tobol, and Yenisei [20,26,79]. Other flood prone regions include the rivers in the Mid-dle Lena basin, Aldan, Vitim, and Olekma [26]. We find the following main causes of floods: high water from spring-summer snowmelt, freshet caused by heavy rainfall, flooding caused by ice-jam; storm surge, flooding caused by obstruction of rocks and glaciers, flooding due to damage of a dam, and tsunami [26,79–81]. The main trends of the last 30 years are: in Primorsky Krai and the Northern Caucasus frequency and wa-ter level of freshets caused by heavy rainfalls are higher; in the rivers of East Siberia floods caused by ice-jams are stronger and occur more often [82].

The strongest and most catastrophic floods in Russia during the period from 2010 to 2020 are listed as: Siberia (Irkutsk Region, summer 2019), Far East (Khabarovsky Krai, Jewish Autonomous Region and Amursky Region, August–September 2013 and 2019), Black Sea region (summer 2012 and 2015, autumn 2018), Northern Caucasus (May 2017), and Altaisky Krai (spring 2014).

In the summer of 2019, two waves of catastrophic floods caused by freshet were recorded in the Irkutsk region. The towns of Tulun and Nizhneudinsk, on the Iya and Uda rivers, in the foothills of Eastern Sayan, suffered the most. Freshet was caused by heavy rainfall in addition to increased water levels caused by snowmelt in the moun-tains [83,84]. Rapid increase in water level led the water coming over dikes and dam-aging buildings and infrastructure [83]. According to the Russian Ministry of Emer-gency Situations, in the flooded area, the most common damage to health were skin injuries, respiratory diseases, and diseases of the digestive system, which means the floods are highly probable to cause injuries and often lead to the spread of infectious and parasitic diseases [85].

In the Russian Far East floods are common [26], mainly in summer. The cata-strophic flood in August–September 2013 in Khabarovsky Krai, Jewish Autonomous and Amur Regions (in the basin of the Amur River) was caused by heavy rainfalls during the passage of deep cyclones. In Russia, due to the rescue services, the flood led to low numbers of victims and severe injuries [86]. Mass media reports one soldier dy-ing during rescue operations [87]. At the same time, in Heilongjiang province of China (in the basin of the Songhua River), more than 200 people were reported dead or miss-ing; more than 800,000 people were evacuated from the area [34]. Six years later, in August–September 2019, there was a severe flood in the lower part of the Amur basin with a duration of high-water levels from one and a half to two months; the cause of this catastrophic flood was also extreme precipitation (2–2.5 times exceeding the norm), caused by deep cyclones, and three consecutive typhoons [88]. In late August–early September 2016, a severe flood was observed in the southern part of Primorsky Krai, caused by heavy precipitation of two consecutive typhoons [45].

In recent years, several catastrophic floods occurred on the territory of the Krasnodarsky Krai (Black Sea coast). They led to loss of life, injuries, and property damage [41]. In this region freshets on the rivers are caused by snowmelt and prolonged rains, mainly in the autumn-winter-spring period of the year. Catastrophic phenomena occur in summer and early autumn. Mainly flooding is caused by water overflow. In the set-tlements, floods from rainfalls are more hazardous, due to poor functioning of storm sewers. Often, in the densely populated areas downriver and in the mouths of rivers, these phenomena are exacerbated by storm surge [41,89]. In general, the annual eco-nomic risk from floods (of mixed genesis and from water overflow) is estimated at ap-proximately USD 13.3 million, and the social risk is two people. The flooded area con-tains 74 settlements with more than 18,000 inhabitants [41]. In the summer of 2002, two floods from heavy rainfalls occurred at once, because of which 114 people died [26,53,90]. Ten years later, in the summer of 2012, a catastrophic flood with loss of life occurred in the city of Krymsk, near the cities of Novorossiysk and Gelendzhik. Over the next years, almost every year floods happen here, causing loss of life and property.

In the spring of 2014, a catastrophic flood occurred in the Altaisky Krai, caused by a combination of heavy rainfall and snowmelt [91,92]. Other times catastrophic floods occurred here were in the years 2016 and 2018 [45,92]. In all cases, drinking water sup-ply was disrupted and the water quality was poor due to an increased number of pathogenic microorganisms [45].

Figure 1 shows examples of floods in Russia, focusing on the most devastating events in terms of human health, well-being, and economic losses: (a) in Krymsk, Krasnodarsky Krai, 2012; (b) in Tulun, Irkutsk Region, 2019; (c) and in Khabarovsk, Khabarovsky Krai, 2013, where the map of the flood frequency over Russia was con-structed based on literature search and data from the Ministry of Emergency Situations of the Russian Federation [26,93,94].

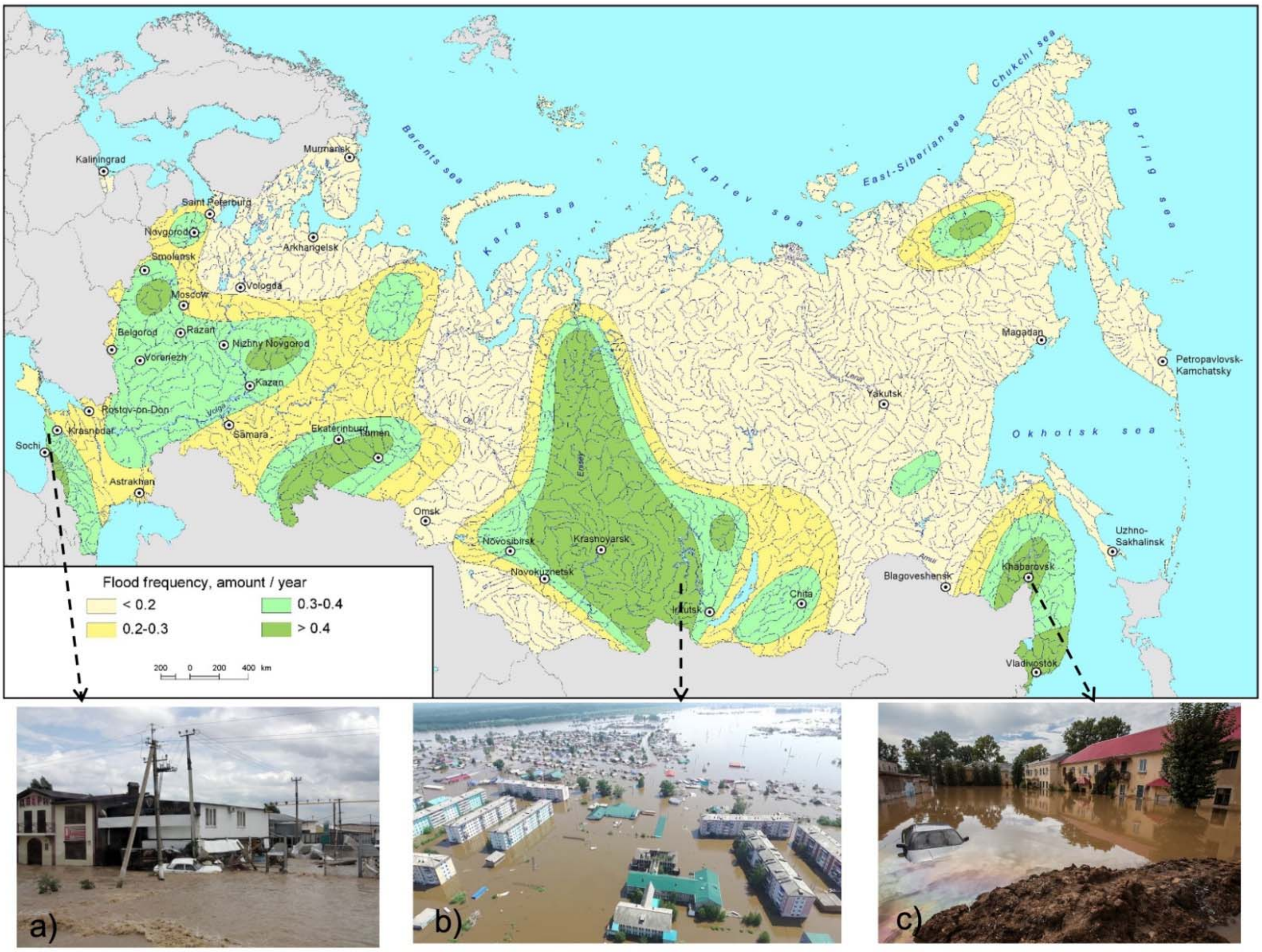

Figure 1. The central panel shows the flood frequency over Russia (after [95]): (**a**) Krymsk (Krasnodarsky Krai), 2012 (credits: [96]); (**b**) Tulun, Irkutsk Region, 2019 (credits: [97]); (**c**) Khabarovsk, Khabarovsky Krai, Russian Far East, the Amur River, 2013 (credits: [98]).

3.2. Droughts in Russia

In Russia, droughts are a frequent phenomenon. They occur in almost all grain-producing regions, from the Central Chernozem and southern regions of the European territory of Russia (ETR) to the Urals, Siberia, and Transbaikal, leading to desertification and land degradation [70,73,75]. Table 1 provides information on the main drought events over the past decade. The main reason for the extensive drought in the summer of 2010 in the ETR, the southern Urals, and Western Siberia was a blocking anticyclone, which resulted in abnormally hot and dry weather [73,99–101]. Another reason was the preceding anomaly of negative soil moisture [102]. Peat and forest fires were registered on more than 200,000 ha in 20 regions of Russia [73]. A severe but shorter drought covered the north of the Southern Federal District, the Volga region, the south of Siberia, and the Urals in June–July 2012 [102,103].

In 2015, a severe drought was observed in the Irkutsk Region; high fire risk was also noted in Khakassia, Buryatia, Transbaikal and Krasnoyarsky Krai, and on the Lower Volga territory [35]. In August–September 2016, an extreme drought was recorded in the south of Western Siberia [104]. In general, it can be noted that at the beginning of the XXI century there was an increase in aridification, primarily in the southern part of the ETR. This can lead to increase in droughts, their frequency, intensity, and duration and, thus, to the destabilization of agricultural production [73,75].

Table 1. The impact of extreme weather events on the population health, well-being, and economy.

Natural Disaster	Region	Period	Impact on Human Health, Well-Being and Economy	References
Floods	Irkutsk Region	Summer 2019	More than 45,000 people suffered; according to various sources, 25–26 people died, including one child; 6–7 people were missing; 496 people were hospitalized; the economic damage caused estimated at several billion rubles	[36,83,85,105]
			Applications to primary healthcare for diseases of the skin, respiratory, and digestion diseases; cases of infected blister feet, other wounds of feet	[85]
	Far East, Amur River Basin	August–September 2013	More than 360 settlements were affected; more than 25,000 people evacuated from flooded areas, the total number of victims exceeded 170,000 people; the total direct damage estimated at RUB 34 to 90 billion	[26,34,57,86,87]
		August–September 2019	More than 360 settlements flooded, about 70,000 people suffered, about 3000 people were saved	[105]
	Far East, Primorsky Krai	August–September 2016	Many settlements flooded, all crops and livestock killed; risks to public health increased due to contamination of drinking water; the total damage estimated to about EUR 500 million	[45]
	Krasnodarsky Krai	Summer 2012	171 people died in Krymsk, Novorossiysk and Gelendzhik; more than 34,000 people suffered; total damage about USD 600 million	[3,106]
		June 2015	Mediterranean cyclone caused heavy rains, thunderstorms, and squalls, which led to rising water level in the rivers and mudflows; emergency mode declared in Sochi	[35]
		Fall 2018	29 settlements flooded; 6 people died	[106]
	Altaisky Krai	Spring 2014	Flood affected 25 municipal formations, about 18,000 people; damage estimated from RUB 5 to 5.9 billion	[19,92]
Drought	ETR, southern Urals, southwestern regions of Western Siberia	Summer 2010	Crop loss recorded on 13.3 million hectares of yield reduction on the remaining area down to 56% of the maximum harvest in 2008	[107]
			Spring and winter wheat harvested 67% of the 2009 harvest	[100]
			Seed offspring of the 2010 harvest turned out to be non-viable	[108]
	North of the Southern Federal District, the Volga region, the south of Siberia and the Urals	June–July 2012	Atmospheric and soil droughts, combined with frequent dry winds, led to the death of grain crops on an area of almost 6 million hectares and a significant decrease in the gross grain harvest	[73,102]
			In the Tomsk Region, because of abnormally hot and dry weather, most crops damaged; yield less than 50% of planned indicators; because of the shallowing of the rivers, navigation stopped, which led to the failure of contracts for the supply of goods, causing damage to river transport	[104,109]
	Irkutsk Region	Spring–summer 2015	13 municipal formations affected, grain harvest was significantly smaller. The greatest damage caused to the Cheremkhovsky District: the volume of lost products here amounted to about 20,000 tons. Crops of grains and perennial grasses, potatoes and vegetables suffered from dry weather; the total damage is estimated at RUB 308.3 million	[110]

All results from research studies mentioned above are listed in Table 1, categorized in two types of natural disaster events: flood and drought. The following characteristics were extracted: the region where the event occurred; the period of the year and the year when the flood or drought was detected; its impact on human health, well-being and economy; and research (year of publication). For some events, references were taken from the media, as there was no detailed information in the scientific literature; these references were not included in the final list of reviewed papers.

4. Concluding Comments

4.1. Floods, Mental Health and Social Outcomes

The main damage caused by floods to the population can be direct: health damage and life loss (drowning, injury), flooding of settlements and agricultural land. Indirect effects are primarily chemical and biological water pollution, leading to an increased number of various diseases, including infectious diseases. In the work of A.N. Zolotokrylin et al. [45] the authors study the Central Chernozemny region, an area with growing frequency of summer precipitation, leading to floods. There was shown an increase in cases of infectious bacterial diseases of tularemia and leptospirosis [45]. The long-term health consequences include development of post-traumatic stress disorder (PTSD) as it was revealed for residents of the town of Krymsk after the flood of 2012 [56]. An acute period of mental trauma was the first three weeks after the emergency. The manifestation of various signs of PTSD can happen in the period from one to three years after the event [56]. Deterioration in mental health was also shown after the catastrophic flood in the basin of the river Amur in 2013. It was expressed in an increase in negative emotional reactions in affected residents after prolonged involvement in the extreme situation [57].

Significant material and social damage from floods are caused not only by natural causes (flood strength) but can be additionally worsened by the human factor. This includes violation of land use conditions, ignoring the potential danger by the population and the construction of buildings in areas located in the flood impact zone; inadequate level of flood protection requiring repair and improvement; and insufficient accuracy of forecasts and low awareness of the population [26,42,88,89,111]. According to A.V. Shalikovsky et al. [83] people are often convicted that "only the state is obliged to compensate for damage from natural disasters" [83] (p. 61). Therefore, instead of fighting the floods, preventive measures are necessary to adapt to the natural processes of periodic flooding [42,83]. Methods of protection against floods include regulation of river flow with the help of reservoirs; creation of protective engineering structures, for example, the construction of dams; artificial elevation of territories, clearing of riverbeds, etc. The best way to mitigate the flood consequences is still a good warning system and a ban on building houses in dangerous areas. In addition, it is necessary to develop an insurance system in flood-prone areas, considering the risk of floods, adoption of legislative measures at the state level. For example, after the catastrophic flood in the Amur River basin in 2013, changes were made to the Water and Town Planning Codes, aimed at avoiding material and social damage in the future. An example of the traditional measures is the construction of the additional 18 km of dams in Khabarovsk after the disastrous flooding of 2013, that protected the city from flooding in 2019 [42].

There is a knowledge gap in the research on floods because it usually focuses on a single event. Meanwhile in many places floods are repeated events with different effects on mental health. On the one hand, increased knowledge and readiness improve resistance to consequences after floods in the future [112]. On the other hand, prolonged effects from a previous flood can lead to decreased psychological stability: those who suffered from floods in the past report more significant long-term consequences from the latest event [113].

4.2. Mitigation of Flood Risk: Problems and Solutions

In any case, decrease in the number of flood victims is a core goal on both the local and international levels, requesting the definition of several personal and group risk determinants, along with a comprehension of their individual consequences and the elaborative linkages between them [114]. The main problems identified during literature search are: low awareness of the local population about actions and rules of conduct in the event of flooding; imperfection of the forecast system, early warning and interaction in case of flooding; unsatisfactory condition of flood dams and floodgates; insufficient level of interaction with the threat of flooding (local, transboundary, international); lack of attention to natural ecosystems; and underestimation of the impact of climate change. The requirements and recommended measures include: a preliminary assessment of flood-related risks; hazard and risk maps preparation using GIS technologies and remote sensing methods; changing the type of land use in areas of potential flooding, the introduction of environmentally friendly technologies and restoration of floodplain lands; the reconstruction and repair of small dams that regulate water flows; developing of flood risk management plans, including early warning systems and public health preparedness and response measures, building climate resilient health systems and other management structures; informing the public and profile institutions about the flooding risks; and increasing the level of readiness of the population to respond effectively to the threat of flooding (conducting joint exercises with the participation of the population, etc.). The most important solution would be to move from hydro-technical solutions to flood risk management, basing on the priority of response and elimination of consequences over preventive measures; mutual interests and support of local authorities; common technical experience; and mutual training and friendly relations between public, local and government authorities.

Significant considerations regarding the vulnerability of communities should be noted here. A standardized tool or quantification framework should be developed that can measure the impact of community-based sustainability approaches to improve flood risk management [63]. In order to improve flood risk management at the community level, community resilience management guidelines should be developed that recommend a robust research program to increase community resilience to future flood-related hazards [62,64]. The dissemination of information on flood risk to vulnerable groups and their involvement in flood preparedness should be considered as an important part of the risk alert strategy [18,61].

4.3. Droughts, Drinking Water and Public Health Preparedness

Other thoughts can also be discussed regarding droughts. As a result of hot and dry conditions during and after severe drought events, problems with drinking water can be exacerbated. The most difficult situation with the quality of drinking water exists in the Republic of Kalmykia characterized by continental arid climate. Here, only 11% of the population is provided with high-quality drinking water. In 2019, compared with 2016, the quality of drinking water even worsened both in terms of chemical and microbial indicators. In 2017–2019 there was 3.3-fold increase in the incidence of chronic bronchitis among children [115], which is possibly associated with dust storms. Dust storms are a problem not only in Kalmykia, but in almost all areas of the south of the European part of Russia, the Central and Volga regions.

Drought and extreme heat can increase the risk of forest and peat fires, infectious diseases among the population, mass diseases among animals, plant death, etc. For droughts during warm season, if there is no rain for a long period with hot weather, special plan for a public health preparedness should be organized, which includes: construction of water reserves; frugal water use; prohibition of an open fire near residential buildings; and information of local executive authorities about the situation and performing of recommended actions in these extremely hot and dry conditions.

4.4. Floods and Droughts: Noah and Joseph Effects

One more philosophical consideration can be added. Floods and droughts have climatological and hydrological nature and are related to hydrological cycle, water use and water resources, and caused by the irregularities of precipitation [12,116]. Extreme floods and droughts are natural extreme events, and can be related to the Noah and Joseph effects, known from the Holy Book and used in the theory of fractal analysis. They present two dual forms of violent variability, two tails in the probability distribution function of precipitation [12,117]. A catastrophe on the Noah tail, a flood as a discrete event, can be succeeded by the Joseph effect, drought, and major shock at the Joseph tail as a prolonged phenomenon with a continuously accumulating effect [12]. As it can be seen from the above results, many places in Russia tend to both extremes. Eastern Siberia with Irkutsk Region, Altaisky Krai in Western Siberia, southern parts of European Russia, are illustrative examples of the areas at risk of both floods and droughts. In urban districts, proper infrastructure, construction, and administrative practices should be carefully studied to reduce damage from destructive events. The Noah and Joseph effects are an alarming call to people about the need for favorable interaction with nature. If the principle of "God does not like miseries" is taken into account, then society will not produce waste and emissions more than necessary, and thus a natural balance will be maintained.

5. Conclusions

Direct and indirect consequences of extreme flood and drought events, as well as many other climatological, meteorological and hydrological disasters, impact the population health in different ways. Most of them are expected to be negative and worsen significantly due to climate change. Identification of the most vulnerable groups of population and potentially dangerous regions is necessary to prevent extreme events and develop adaptation measures. While most of the hazards of floods and droughts cannot be completely avoided, many health effects can be potentially prevented. It is necessary to develop early warning systems, improve public health preparedness and response measures, health systems resilient to climate change, and other governance structures. Prevention of climate change and reduction in climate-sensitive risk of disasters requires well-planned, effective adaptation in the short, medium, and long term. Recognition of the vulnerable regions including construction of maps with flood and drought frequency can be used in special plans for the management of risk from natural disasters in order to reduce the negative consequences on human life and health, environment, cultural heritage, economic activities, and strategic infrastructure. Improving healthcare systems is especially important among different measures aimed at risk reduction in disasters, adaptation to climate change, and sustainable development. Elimination of causes of climate change, investing in a healthy environment, and other health-related changes, are vital to reduce consequences of diseases and improving public health. There are problems that require immediate resolution from federal authorities. It is necessary to solve problems with early warning of the population about the onset of hazardous climatological and hydrological events.

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