What Needs to be Done to Raise Public awareness about the Impact of Climate Change?

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Abstract: - One of the main areas of increasing the effectiveness of adaptation is raising public awareness about natural hazards, their possible impacts on various population activities, and preventive actions that need to be taken before, in the moment, and after hazards. The population receives storm warning but does not effectively use them to their advantage due to a lack of understanding of possible impacts and a lack of systematized recommendations. It is necessary to teach the population to adapt to climate change. It is almost impossible for the population to determine the impacts of climate change on humans and the environment. Manual and even automated processes for identifying natural hazards do not allow a full assessment of impacts and mitigation of the consequences of climate change. To do this, it is necessary to collect and store impacts and recommendations in the form of a knowledge base. The author has collected, formalized, and classified types of impacts and recommendations for decision-making for 100 extreme and natural hazards. Demonstration services for issuing information on impacts and recommendations have been implemented.

Key words: - natural hazards, climate change, adaptation, impacts, public awareness, preventive actions

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1 Introduction

The increase in the number of natural hazards is already an irrefutable fact. To achieve the goals of sustainable development of society, comprehensive and properly planned actions are needed, which include activities to raise public awareness of natural hazards, and climate change.

In recent decades, many governments, public administrations, and the public have moved from wanting to know "what the weather will be like" to wanting to know, "what the socio-economic consequences of natural hazards will be" and "what to do"[1, 2]. Information is needed on what to do to ensure the safety of people and protect their property. Both governments and the public want to mitigate the impacts of natural hazards and reduce their risk. "Many people continue to be lost, and the socio-economic costs associated with natural hazards continue to increase, partly due to the lack of assessment and understanding of the impacts, and consequences of climate change"; "Timely hydrometeorological warning does not guarantee safety of life or prevent disruption to economic activity" stated in the WMO Guidelines for the forecasts of natural hazards taking into account impacts and warnings about them [3-7].

The WMO and WHO documents note that the issue of adaptation to climate change is becoming the main one. Michael Griffin (US National Aeronautics and Space Administration, 2005-2009) said: "It is not in the power of man to prevent climate change, but it is possible and necessary to adapt to global and local climate change". "The only thing left for us is to adapt and act to avoid even more serious natural hazards" [8].

The aim of the article is to consider the existing difficulties in the use of hydrometeorological information, to note directions of increasing the effectiveness of population adaptation to natural hazards and climate change by developing a new paradigm of hydrometeorological support, increasing public awareness of possible impacts on various types of population activities, enterprises and preventive actions that must be taken before, during and after the occurrence of natural hazards.

2 Difficulties in Using Hydrometeorological Information

History is replete with examples of the lack, untimely, or incompetent use of natural hazards information leading to the loss of fishing vessels and tens and even hundreds of thousands of people in tsunami zones. As early as 1963, a study [9] noted: "In some cases, the information presented in manuals is outdated. Only a few of them utilize practical experience. National Hydrometeorological Services (NMHSs) must clearly understand the need

to expand their responsibilities to include drawing practical conclusions from observational and forecast data, including assessing the potential impact of hydrometeorological conditions on the activities of enterprises and the population, and even issuing recommendations."

Organizations, responsible on hydrometeorological support (HMS) for the population, lose the knowledge accumulated during natural hazards due to the departure of individual employees. Each employee takes with them a piece of the collective competence and knowledge. Knowledge accumulated over years is not accumulated, is unmanaged, and is not fully utilized. Only the most general, trivial knowledge about population behavior during natural hazards is used.

The quality of presentation of accumulated experience also leaves much to be desired; transferring this experience to other enterprises and making it accessible to all communities is impossible, as each point has its own local hazard thresholds. Successful knowledge management requires creating an environment in which the population and enterprise leaders can share experiences and consult with one another. In the United States, "Ready" websites have been created in English (https://www.ready.gov/) and Spanish (http://www.Listo.gov). These websites provide information on natural hazards preparedness. In Russia, there is a "Mobile Rescuer" app containing brief recommendations on how to act in the event of a natural hazard. Unfortunately, the information on such websites and apps is poorly formalized and not structured by type of activity, decision-making levels, or hazard levels.

Domestic and international experience [10] shows that damage from natural hazards is associated not so much with the inability to prevent consequences as with insufficient public awareness and inadequate consideration of all available information. The absence of serious public complaints on this issue does not in itself mean anything, since people sometimes do not understand how to use this or that information. When using information about natural hazards, people often act intuitively, which is not always right. Some hope for a better outcome. Funds for preventive measures are insufficient, and people are passive and reluctant to leave their homes. There are numerous examples of natural hazards predicted in advance, but their consequences were not taken into account and/or underestimated, or the response to this forecast was inadequate.

In recent decades, numerous books, manuals, and instructions [11–18] have been published containing recommendations for behavior during various natural hazards. Unfortunately, these recommendations are very difficult to implement in practice. Firstly, the information is fragmented; secondly, it is neither formalized nor systematized. Thirdly, recommendations are not categorized into actions to take before, during, and after a natural hazard.

In some cases, it is possible to insure against damage. Forecasting the possible consequences of natural hazards and identifying risk zones [19] requiring insurance is the responsibility of property owners themselves.

Warnings about natural disasters are not always taken seriously by the population, and even when they are, preventative measures to avert or mitigate the impending danger are not always taken. They are simply unable to do so, or something is holding them back. For example, motorists often try to ignore SMS messages from the Russian Ministry of Emergency Situations about impending natural hazards. Drivers receive the following message on their mobile phones: "Rain, thunderstorms, and winds up to 15-17 m/s are expected in Moscow. Do not seek shelter or park under trees or unstable structures. Be careful and cautious." If a driver receives a warning but parks their car under a tree the same day, deliberately exposing their property to force majeure, they are at fault and are not entitled to insurance compensation. In such a situation, it is crucial to have a weather forecast for a specific city or district within a large city. Storm warnings must be sent in person, updating the forecast hourly [20].

Many atlases, reference books, and books on HMS of the population contain at least some information about the impact of natural hazards on settlements. The Russian EMERCOM prepares instructions for the people [13, 21]. The disadvantages of these documents are the vagueness of many recommendations; their fragmentation, insufficient completeness (detailed recommendations are available only for some natural hazards). The completeness of the impacts provided is influenced by a large number of factors (hazardous level, types of population activity, probability of natural hazards in time and space, characteristics of the objects of influence – settlement, population activity). These factors are not always taken into account in HMS of the population.

The population should be provided with the information, and only the information, that it needs and that will be used for analysis and decision-making in the form of a clear forecast text, the level of danger, a list of possible impacts of natural

hazards on the activities of the population and recommendations for carrying out preventive actions.

The impacts of natural hazards and extreme climate events (floods, extreme heat, droughts, freezing rains, etc.) show that most federal, state, and local governments are taking little action to reduce the negative impacts of global climate change. Main reasons for the ineffective use of climate data are the lack of information on the possible impacts of climate change on specific areas and insufficient funding for damage mitigation actions.

3 Development of a New Paradigm of Hydrometeorological Support

The future development of hydrometeorological systems should include a shift from informing the public about the current hydrometeorological situation to raising awareness of the potential consequences of natural hazards and providing recommendations for decision-making. In 2014, the World Meteorological Congress stated: "Forecasting the consequences of natural hazards for the population and their livelihoods is one of the areas of activity of hydrometeorological systems".

Modern tools allow for automatic diagnostics of hydrometeorological conditions, identifying precursors of natural hazards, recording their occurrence, and identifying areas at highest risk based on hazard indicators.

Storm warnings from the Russian Hydrometeorological Centre and its branches are communicated to government agencies using existing communication channels (telephone, fax, television, email, and websites). Many natural hazard indicators can be obtained using existing observation platforms: hydrometeorological stations, weather radars, aircraft, unmanned aerial vehicles, drifting buoys, satellites, research vessels, and voluntary observing vessels. Equipment installed on spacecraft can determine parameters such as cloud top phase structure, focal point coordinates, cyclone diameter, storm eye diameter, cloud direction, velocity, and spatial dimensions, precipitation. Based on data received from observers and sensors, forecasts of key parameters (atmospheric pressure, wind, precipitation, air temperature, Earth's surface temperature, and humidity) are calculated for periods of up to 120 hours.

Over the past 30 years, the international community has taken a number of measures related to climate change and adaptation at the international level and in individual countries (Table 1). The first document was prepared in 1992 – the Framework Convention on Climate Change, signed at the UN Conference on Environment and Development in Rio de Janeiro. The next most significant documents were the Kyoto Protocol, aimed at reducing emissions (1997), and the Paris Agreement, aimed at reducing emissions of climate-threatening gases into the atmosphere (2015). Developed countries then began preparing national adaptation plans.

On September 10, 2019, the Global Commission on Adaptation to Climate Change released a report stating that climate change has reached a point where its impacts can no longer be reversed; instead, adaptation to new climatic conditions is needed. The report warns that, despite all efforts, planetary change is inevitable. What should people do? Adapt. How can we adapt? We need to understand the potential impacts and appropriate responses.

WMO operates a global alert centre (http://alert-hub.appspot.com/publishers), which receives alerts from official sources registered in the International Register of Alert Authorities (http://www.wmo.int/alertingorg). Many countries already have national news feeds (https://www.alert-hub.org/). These national news feeds have become aggregators of news feeds for 2,000 major cities worldwide. Each city can have news feeds for various government agencies, such as police, fire, health, transportation, and others.

The decision of the 69th session of the WMO Executive Council (Geneva, Switzerland, 8–17 May 2017) states: "Initiate the development of guidelines on impact forecasting and warning, defining practical steps and procedures reflecting the experience gained since the publication of the WMO Guidelines for Impact Forecasting and Warning." The Global Framework for Climate Services defines climate information that helps individuals and organizations make informed decisions [22, 23].

Despite the large number of prepared regulatory and methodological documents, real actions to adapt to climate change are still lacking due to insufficient automation of this activity.

The accumulation of knowledge about the impact of the environment on human life is based on the synthesis of experience gained during natural hazards. This experience is partially documented in publications, media, and guidelines. However, the synthesis of such experience is hampered by the low frequency of some natural hazards.

Table 1. Evolution of the implementation of decisions related to climate change and adaptation to it at the international level and in individual countries

Year	Organization, country	Document title
1992	UN	The Framework Convention on Climate Change was signed at the UN Conference on Environment and Development in Rio de Janeiro.
1995	UNEP	The Integrated Coastal Zone Management (ICZM) document was developed.
1997	UN	The Kyoto Protocol, aimed at reducing emissions, was prepared.
2005	WMO	The Climate Observation Guidelines were released.
2007	China	The National Committee on Climate Change was established.
2009	EU	The White Paper "Adaptation to Climate Change: Towards a European Action Agenda" was adopted for implementation.
2009	Russia	The Climate Doctrine of the Russian Federation was approved by decree of the President of the Russian Federation.
2011	Russia	An Action Plan for 2011-2020 for the implementation of the Climate Doctrine was developed.
2014	WMO	The Global Framework for Climate Services (GFCS) was adopted.
2014	WMO	The World Meteorological Congress declared that "forecasting the impacts of hazardous events on industrial facilities is one of the areas of activity of the National Meteorological and Hydrological Service."
2015	UN	The Paris Agreement, aimed at reducing emissions of climate-threatening gases into the atmosphere, was signed. A document, "The Future of Climate Services," was developed based on risk assessment.
2019	WMO	ISO 14090: Adaptation to Climate Change: Principles, Requirements, and Guidelines was released.
2019	ISO	Common thresholds for hazard indicators (yellow, orange, and red) have been introduced to determine hazard levels.
2019	Russia	The Government approved the National Action Plan for the first stage of climate change adaptation for the period up to 2022.
2019	Russia	National adaptation plans have been prepared in various countries.
2019-2025	Developed countries	The Mission on Climate Change Adaptation prepared the report "Climate-Resilient Europe," which prepares populations for climate change and accelerates the transition to a sustainable Europe.
2020	EU	A presidential emergency plan for adaptation and resilience aimed at protecting vulnerable countries from the consequences of climate change has been developed.
2023	USA	The Ministry of Economic Development of Russia approved Methodological Recommendations for assessing climate risks, ranking adaptation measures by priority, and developing sectoral, regional, and corporate climate change adaptation plans. The Russian Government has approved the second National Action Plan for Adaptation to Climate Change through 2025.
2021	Russia	Adaptation Plans have been developed for the constituent entities of the Russian Federation (Rostov Oblast and the Republic of Bashkortostan) and several ministries (the Ministry for the Development of the Russian Far East, the Ministry of Health, the Ministry of Natural Resources, the Ministry of Construction, the Ministry of Industry and Trade, the Ministry of Agriculture, the Ministry of Transport, the Ministry of Energy, and the Ministry of Emergency Situations).
2023	Russia	Утвержден Правительством России второй Национальный план мероприятий по адаптации к изменениям климата на период до 2025 г.
2015-2023	Russia	Разработаны Планы адаптации для субъектов РФ (Ростовской области и республики Башкортостан) и нескольких министерств (Минвостокразвития, Минздрав, Минприроды, Минстрой, Минпромторг, Минсельхоз, Минтранс, Минэнерго, МЧС РФ).

To adapt, this knowledge must be collected, systematized, classified, and formalized for subsequent dissemination among users. Most importantly, it is necessary to formalize business processes for organizing activities aimed at improving of enterprises safety. These processes should begin with identifying situations where parameter local thresholds are exceeded and end with decision-making based on current, forecast, and climate parameter values. The following processes must be integrated into a single cycle:

– Monitoring actual and forecast hydrometeorological conditions;
– Identifying and warning about natural hazards;
– Predicting possible consequences;

– Preparing decisions;
– Selection of alternative courses of action;
– Implementing preventive measures;
– Analysis and evaluation of the results of these actions after natural hazards.

Situations before, during, and after natural hazards require easy and rapid access to information. The key is the ability to quickly obtain this information and analyse it for timely decision-making.

4 Adaptation to Natural Hazards and Climate Change

If we are aware of potential climate change, have forecasts of natural hazards, and understand their potential impact on the population, we can prepare in advance, plan our actions, and take reasonable steps to mitigate these consequences. Some people die during natural hazards simply because they did not receive timely warnings. This can happen in developed areas of the country, far from home, as well as in sparsely populated regions.

The need to raise public awareness is increasingly being discussed, even on social media. For example, one post [24] states: "Therefore, in the near future, weather forecasts will need to include not only warnings about magnetic storms or increased ultraviolet radiation levels, but also specific recommendations for people with coronary heart disease."

The public cannot always accurately assess the situation based on numerical values of natural hazard indicators (e.g., air temperature, wave height). They need to receive forecasts of consequences and assessments of potential damage. This gap complicates decision-making, often leading to the failure to take critical preventative measures, which ultimately increases natural hazards losses. Most people rely on intuition and experience when responding to natural hazards or climate change. However, they often lack a full understanding of what might happen, which can be the potential consequences (damages), what necessary to do, and to calculate the costs of preventative actions. A correct and timely assessment of the current situation is crucial for reducing or preventing damage [25].

The adaptation system must encompass all levels of government, from federal to local, taking into account regional natural and socio-economic characteristics. This requires coordinated actions at various levels of government and, most importantly, the creation of a unified knowledge base on the potential impacts of climate change and natural hazards on the population, as well as recommendations for decision-making [26].

Adaptation can yield significant economic benefits: the overall return on investment in resilience is high, and the benefit-cost ratio ranges from 2:1 to 10:1, and in some cases even higher [25]. To implement adaptation, it is necessary to:
– Identify the areas and population groups most vulnerable to climate change;
– Develop measures to mitigate the impacts of climate change and adapt to it, including financial and institutional mechanisms and technologies for reducing climate risks.

Impact assessments and recommendations should be used in the development of global, regional, and sectoral preparedness and response plans. Accumulated experience and knowledge can be converted into software products and services. For example, a Decision Support System (DSS) for natural hazards is being developed in Russia [26]. The most labour-intensive part of creating such a system is the formation of a database of potential natural hazards consequences and decision-making recommendations. The database structure includes:
– Name and definition of the natural hazard;
– Causes of the natural hazard;
– Natural hazard indicators and their values by intensity;
– Impact on infrastructure, population, business, transport, etc.;
– Types of activity (e.g., freight transportation, recreation);
– Recommendations for different levels of government;
– Associated natural hazards;
– Typical scenarios applicable to various natural hazards;
– List of references.

Significant attention is being paid worldwide for studying the impact of natural hazards and extreme events on businesses and communities. For example, the website of Tonkin + Taylor, a consulting firm specializing in environmental and engineering issues [27], published more than ten articles in 2024 alone on topics such as wildfires, heatwaves, coastal flooding, and other extreme events, all focused on community resilience to climate change.

The consulting firm Risalat [28] places significant emphasis on climate education, particularly regarding the impact of climate change on various sectors of economic. The company has developed more than 50 training programs, including:
– "Integrated River Basin Management";

– "Natural Hazards/Emergencies and Response";
– "Emergency Training";
– "Collection, Coordination, and Communication of Emergency Data";
– "Emergency Communication".

Training is conducted in many countries and across multiple continents. While training specialists and managers is undoubtedly important, it is equally important to educate the general public and business leaders on preparedness and response skills before, during, and after extreme events, using simulations based on formalized scenarios from decision support systems (DSS).

Unfortunately, far less attention is paid to formalizing impacts and recommendations or automating the issuance of information.

Research on DDS is underway in many countries [29-33]. One of the most notable systems is the Integrated Platform for Assessing Urban Resilience to Climate Change (HARMONIA) [34]. It leverages existing tools, services, and new technologies, operating within the global GEOSS data system. The platform aims to quantify the impacts of climate change on urban areas using satellite and ancillary data from various sources. GEOSS integrates demographic, environmental, and other datasets. The key goal of HARMONIA is to make existing knowledge and technologies accessible to all. Its unique feature is its focus on urban decision-making, addressing risks in health, air pollution, and climate change.

The EU has developed adaptation support tools [35] that enable the evaluation and prioritization of solutions based on selected criteria. The adaptation process includes:

– Preparing for adaptation;
– Assessing climate change risks and vulnerabilities;
– Identifying adaptation options;
– Evaluating impacts, time, and effort required;
– Prioritizing actions and selecting preferred options;
– Drafting a strategic document;
– Obtaining approval;
– Implementing, monitoring, and evaluating adaptation efforts.

5 Discussion

The poor use of information can be explained by the following. The population does not always react to the forecasts of the natural hazards in time. Therefore, it is necessary to organize forced notification by all possible means, including mobile devices or other communication channels.

The existing HMS system has the following barriers [26]:

– The volume of data prepared by the NHMS reaches tens of Gbytes daily, and the population does not need the entire volume of data, it needs data for a specific point (or several points). When using hydrometeorological information, the population needs information about certain natural hazards (environmental parameters) that can affect its activities;
– Iin most cases the hydrometeorological information is needed population only when the values of the natural hazard's indicators exceed local threshold values, while four levels of danger are distinguished (green, yellow, orange, red);
– There is no monitoring of the state of HMS (who produces, what information products, in what time are delivering to the population, in what form, format, the actual delivery time of information about natural hazards);
– Insufficient demand for climate information from government bodies due to underestimation of the potential value of climate information in decision-making processes;
– The multiplicity of information sources and the variety of formats in which information is transmitted;
– Low level of automation when using information about the natural hazards.

The main difficulties of ineffective use of hydrometeorological information are:

– Lack of automatic detection of natural hazards based on local threshold values for various types of activities and automatic dissemination of information to the population;
– Sometimes the delivery times for information on the natural hazards are unacceptable for decision-making;
– Lack of formalized information on the possible impact of the natural hazards on the population;
– Recommendations for implementing preventive actions to reduce or prevent the impact of natural hazards on the population have not been collected or classified;
– Not always and not for all natural hazard's connections between hydrometeorological conditions and decisions taken have been identified;
– Inadequacy of population's assessment of the situation based on digital hydrometeorological indicators.

Many people are afraid of earthquakes, tsunamis, but the rise in the level of the World Ocean is a much more global, destructive and irreversible process, despite the fact that the water level rises slowly. At a certain value of the rise in the ocean level, the system of global currents will change, especially tidal currents, which can lead to a change in the values of the tide level. That is, the expected values of the sea level rise of 0.5–1.0 m can become several meters in some areas due to the increase in the height of the tides associated with changes in the coastline and the depths of bays and coves. A comprehensive forecast of possible natural hazards and the accompanying impacts, manifested as a "domino effect", is needed [26].

The preparation of information on the possible impacts of natural hazards and of climate change on the population and the issuance of recommendations indicating the sequence of actions should be introduced.

Adaptation planning and action at various scales includes supporting the resilience of settlements and their infrastructure to climate change, expanding the range of long-term and ultra-long-term weather forecasts and their use, for example, in long-term planning for housing construction near river valleys.

The EMERCOM services begin evacuation and rescue work only after receiving a forecast or the onset of natural hazards. NHMS specialists are removed from forecasting impacts and issuing recommendations to support decisions, this is the prerogative of government agencies and enterprise leaders.

In order to successfully implement preventive actions, it is necessary to have close cooperation with specialists from the Russian EMERCOM and local administrations who have expert knowledge in order to provide services related to the impact of natural hazards on the population. The NHMS or EMERCOM cannot do alone this [26]. Therefore, it can be argued that the NHMS in partnership with the EMERCOM and government bodies is best prepared to predict possible impacts on the population and issue recommendations for decision-making. All that needs to be done is to help the EMERCOM to quickly obtain information about the impending event and provide information on possible impacts and recommendations to support decisions.

6 Conclusion

The growing reliance on natural disasters is explained by:

– The scattering of information across various sources – navigation charts, atlases, reference books, building codes and regulations;
– The large volume of data and information provided to users;
– The lack of automated methods for continuously recording performance indicators for decision-making;
– Increasing demands on the quality, volume, and methods of providing information.

To reduce damage from natural hazards it is necessary:

– Identify actions that may be useful in reducing potential losses and damages;
– Assess and reduce hazards risks and enhance society's ability to cope with them;
– Increase the resilience of society and the economy to natural hazards – use interdisciplinary knowledge and new technical solutions;
– Organize an effective and rapid response to natural hazards, including communications to inform the public and/or convey recommendations;
– Consider the full range of possible events associated with natural hazards;
– To increase the society's ability to recover from the natural hazards;
– To demonstrate to the public the results of natural hazards risk reduction, which will make society more resilient in the future.

The study proposes for the first time a new approach to raising awareness among business leaders and the public, based on the creation of a knowledge base of local threshold values for extreme events and a database of formalized information on the possible impacts of climate change on businesses and the public.

The main direction of adaptation development is to increase public awareness of natural hazards and climate change, their possible impacts on various types of population activities and preventive actions that need to be taken before, during and after hazards. It is necessary to continue developing a knowledge base of local thresholds for extreme climate events and natural hazards. Expanding the comprehensiveness and quality of formalized information on the potential impacts of climate change is a critical task. Experts from various industries affected by climate change must be involved in this work. An equally important area of development is the creation of models for assessing the impacts of climate change on various industrial facilities and urban areas. To improve the effectiveness of preventive actions, it is necessary to

develop optimization models. DSS must adapt to potential new climate threats.

References:

[1] Kuraev S. N. *Adaptation to climate change*. RREC, GOF, 2006, 16 p.

[2] Khandozhko L.A., Korshunov A.A., Fokicheva A.A. Selection of the optimal weather-management solution based on the forecast of natural hazards. // *Meteorology and hydrology*. 2003, Issue 1, p. 15-17.

[3] *WMO Guidelines for Impact-based Hazardous Forecast and Warning Services*. WMO No. 1150, 2015, 36 pp.

[4] WMO supports the 2030 Agenda for Sustainable Development. *WMO Bulletin*. 2016, Vol. 65 (1), p.10-11.

[5] *WMO Guide to Marine Meteorological Services*. Third edition. WMO No. 471. Secretariat of the World Meteorological Organization. Geneva, Switzerland, 2002, 162 p.

[6] *WMO Guidelines for Services forecasts and warnings on natural hazards taking into account their possible consequences*. WMO, No. 1150, 2015. Commission on Basic Systems. Extraordinary session. Asuncion, Paraguay, 8–12 September 2014. SUPPLEMENT to draft resolution 2.1 (1)/1, 27 p.

[7] *Climate Information & Early Warning Systems Communications Toolkit*. UNDP Program on Climate Information for Resilient Development in Africa. (Editor: Gregory Benchwick) March 2016. Prepared by The UNDP CIRDA Programme, 69 p.

[8] Kolenov S. *The World 2030: A Guide to Climate Hell*. 2019. URL: https://hightech.plus/2019/11/19/mir-2030-putevoditel-po-klimaticheskomu-adu . Access date: 07.06.2025.

[9] Shumeiko G.K. *Modern requirements of seafarers to meteorologists and oceanographers*. Book "Oceans and Seas". Geografgiz. Moscow: Series "Questions of Geography", 1963, No. 62, p. 27-34.

[10] White Gilbert F. *Natural Hazards: Local, National, Global*. Progress, 1978, 440 p.

[11] Atlas of natural and man-made hazards and risks of emergency situations. Edited by S.K. Shoigu. – Moscow, Feoriya Publishing House. VNIIGOCHS. 2011 (CD - ROM).

[12] *The impact of Natural Hazards on the main sectors of the economy: a memo*. Moscow: Roshydromet, 2011, 28 p.

[13] Gostyushin A. *Encyclopedia of extreme situations*. Moscow: Zerkalo Publishing House, 1996, 320 p.

[14] Ivanov D. *Arctic, Antarctic and Taiga: A Traveler's Hiking Encyclopedia*. Moscow: EKSMO, 2009, 416 p.

[15] Ilyin A. *School of survival in natural conditions. How to avoid starvation*. Moscow: EKSMO, 2003, 200 p.

[16] Ilyichev A. *The Great Encyclopedia of Survival in Extreme Situations*. M.: EKSMO, 2000, 496 p.

[17] *Climate Change Impact on Public Health in the Russian Arctic*. UN, 2011, 24 p.

[18] Govorushko S.M. *Natural processes and human impacts: Interactions between Humanity and the Environment*. Springer Pacific Institute Geography. RAS Far East Brunch, Vladivostok, Russia, 677 p.

[19] Dmitriev V.G. On the issue of possible risk reductions from the impact of natural hazards and extreme climatic phenomena for various types of activities in the marine Arctic. *Problems of the Arctic and Antarctic*, 2013, Issue 2 (96), p. 41-54.

[20] *Water and Climate Change. Executive Summary*. UN World Water Development Report. Paris/Geneva, 22 March 2020, UNESCO, Paris, 12 p. https://unesdoc.unesco.org/ark:/48223/pf0000372882_rus/PDF/372882rus.pdf.multi

[21] Gere J., Shah H. The Shaky Ground. *What is an Earthquake and How to Prepare for It*. Translated from English, Moscow: Mir, 1988, 220 p.

[22] *Hazards Risk Reduction for the User Interface Platform of the Global Framework for Climate Services*. WMO, 2014, 58 p.

[23] *Principles of Practice for Climate Services*. WMO, No. 1206, 2018, 66 p.

[24] Yanova Alesya. How does the weather affect human health? https://cemi-cvetik.ru/blog/43435000947/Kak-pogoda-vliyaet-na-zdorove-cheloveka, 09.06.2019.

[25] *Conference of the economic benefits of meteorological and hydrological services*. Geneva, 1994, WMO/TD No. 630, 390 p.

[26] Viazilov E.D. *Digital transformation of hydrometeorological support for consumers*. Volume 1. Implementation approaches. 2021, 365 p.; Volume 2. Application in various industries. 2022, 366 p.

[27] Tonkin + Taylor consulting company. https://tonkintaylor.createsend1.com/
[28] Risalat consulting company. https://risalatconsultants.com
[29] *Adapt now: a global call for leadership on climate resilience*. Global Commission on adaptation Report. 2019. 90 p. https://gca.org/wp-content/uploads/2019/09/GlobalCommission_Report_FINAL.pdf
[30] ESOTC, 2024, *European State of the Climate Report 2024*, Copernicus Climate Change
[31] Service (C3S) and World Meteorological Organization (WMO) (climate.copernicus.eu/ESOTC/2024) accessed 30 June 2025.
[32] *Participatory climate information services systems development: methodology guide*. 2019. 100 p.
[33] Gardner, J, Dowd, A-M., Mason, C. and Ashworth, P. A framework for stakeholder engagement on climate adaptation. CSIRO Climate Adaptation Flagship Working paper. 2009, No.3. http://www.csiro.au/resources/CAF-working-papers.html
[34] HARMONIA project. https://harmonia-project.eu
[35] Climate ADAPT Project: Sharing adaptation knowledge for a climate-resilient Europe. http://climate-adapt.eea.europa.eu

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