MINISTRY OF EDUCATION AND RESEARCH OF THE REPUBLIC OF MOLDOVA
STATE UNIVERSITY OF MOLDOVA
DOCTORAL SCHOOL OF NATURAL SCIENCES

With manuscript title
C.Z.U: 551.583:574(478)„20”(0432)

CAZAC VALERIU

THE IMPACT OF METEO-CLIMATE RISK PHENOMENA FROM THE WARM PERIOD OF THE YEAR ON THE TERRITORY OF THE REPUBLIC OF MOLDOVA AT THE BEGINNING OF THE XXI CENTURY AND POSSIBILITIES OF MITIGATION

166.02 - ENVIRONMENT PROTECTION AND RATIONALE USE OF NATURAL RESOURCES

Summary of the Doctoral Thesis in Natural Sciences

CHIȘINĂU, 2023

The thesis was developed within the Doctoral School of Natural Sciences, State University of Moldova

Scientific Advisor:

CODREANU Igor	Associate Professor. PhD in Geography, "Ion Creangă" State Pedagogical University

The composition of the committee for public defense of the doctoral thesis:

DUCA Gheorghe	Full Professor, PhD in Chemical Sciences, Academician, Institute of Chemistry, State University of Moldova – **president**
CODREANU Igor	Associate Professor. PhD in Geography, "Ion Creangă" State Pedagogical University
BEJAN Iurii	Associate Professor. PhD in Geography, Institute of Ecology and Geography - **reviewer**
PUȚUNTICĂ Anatolie	Associate Professor. PhD in Geography, "Ion Creangă" State Pedagogical University - **reviewer**
BREABĂN Iuliana Gabriela	Associate Professor, Doctor Habilitatus, Ioan Cuza University in Iași, Romania – **reviewer**

The defense will take place at **26th JANUARY 2024, 03:00 pm, room 222**, within the meeting of the public defense of the doctoral thesis within the Doctoral School of Natural Sciences, headquarters - State University of Moldova (http://www.usm.md), 60 A. Mateevici str., block 4, room 222, MD-2009, Chisinau, Moldova.

The doctoral thesis and the summary can be consulted in the National Library of the Republic of Moldova, Central Library of State University of Moldova (MD 2009, Chisinau municipality, 60 Alexei Mateevici str.), on the NAQAER website (www.cnaa.md) and on the web page of SUM (http://www.usm.md).

The summary was sent on „____" December " 2023.

The President of the Doctorate Commission
Full Professor,
Doctor Habilitatus in Chemical Sciences,
Academician
DUCA Gheorghe

Scientific Advisor:
Associate Professor, PhD in Geography,
"Ion Creangă" State Pedagogical University
CODREANU Igor

Author: CAZAC Valeriu

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CONCEPTUAL BENCHMARKS OF THE THESIS

Topicality and importance of the problem addressed. The increasingly frequent manifestations of meteo-climate risk phenomena during the warm period of the year, such as dryness and droughts, strong winds, torrential rains, floods, thunderstorms, hail, heat waves, early and late frosts, to which are added the multiple harmful interventions by the human factor, have a direct influence both on the security and well-being of the population, as well as on the sustainable development of the economy and the sustainability of the environment with a direct impact on the life of each person and society as a whole.

The topicality and importance of addressing the problems of meteo-climatic risk phenomena has become a primary task, because during development, humanity has been influenced by climate, weather and water, and currently the impact of these phenomena on humans has increased significantly. At the same time, it is important to realize that human activity has triggered the reverse process of human action on climate elements, water resources and the natural environment.

The economy of the Republic of Moldova, with the basic branch - agriculture, is directly dependent on climatic factors, and the meteo-climate risk phenomena increasingly stop economic progress and endanger the well-being and socio-economic security of the population.

The natural growth of the world's population, the rapid development of industry, extensive and intensive agriculture, urbanization, the expansion of infrastructure and communication lines, the increase in traditional energy consumption, massive deforestation, the drying of swamps and river meadows condition climate change and, consequently, catalyze the manifestation of natural calamities, of which 90% are those of meteorological and climatic origin.

Knowing the genesis and spatio-temporal evolution of meteo-climate risk phenomena, but also the degree of vulnerability and impact on the population and the economy of the Republic of Moldova, is an indisputable and logical necessity for the development and implementation of the national adaptation strategy and program and mitigating the consequences of risks, caused by meteo-climate risk phenomena.

For this purpose, in order to implement local plans and national action programs and to apply appropriate measures to mitigate the negative consequences, but also to protect and rehabilitate the regions affected by meteo-climate risk phenomena, it is required deep knowledge both of the circumstances of the occurrence and the legalities of the manifestation of meteo-climate risk phenomena, of the degree of vulnerability of the population, the economy and the environment to meteo-climate risk phenomena, as well as the research and evaluation of the impact on people, the economy and the environment, with the identification of measures optimal mitigation and adaptation.

The earliest and most accurate forecast of natural disasters is of prime importance. An informed person, warned in time about the danger, is better prepared to face it.

Although the meteo-climate risk phenomena cause enormous damage to the national economy and the environment, often causing numerous damages and sometimes human victims, they remain until now insufficiently studied both in their essence and energetic origin, the circumstances of their occurrence and the legalities of their repetition, as well as the estimation of the impact and of the damage caused by them.

The aim of the paper is to evaluate the impact of the meteo-climate risk phenomena from the warm period of the year since the beginning of the XXI century from the territory of the Republic of Moldova, highlighting, arguing and proposing adaptation and mitigation measures in relation to them.

Research objectives:

- the identification of meteo-climate risk phenomena, which manifest themselves during the warm period of the year in the territory of the Republic of Moldova;
- creation of the database regarding meteo-climate risk phenomena for the period 2000-2021;
- the preparation of a database on the spatio-temporal distribution of the damage caused by the meteo-climate risk phenomena from the warm period of the year in the last 22 years on the territory of the Republic of Moldova;

- the processing of statistical data that characterize the spatio-temporal manifestation of the impact of meteo-climate risk phenomena from the warm period of the year on the territory of the Republic of Moldova at the beginning of the 21st century;
- establishing the spatio-temporal variability of the risks produced by risk meteo-climate phenomena, identified on the territory of the Republic of Moldova;
- developing maps and other graphic materials, using the tools of the Geographical Information System (GIS), which reflect the geographical space affected by the meteo-climate risk phenomena at the beginning of the XXI century;
- highlighting and proposing measures to adapt and mitigate the effects induced by meteo-climatic risk phenomena.

Scientific research methodology. To achieve the purpose and objectives of the doctoral thesis, there were used specialized research methods [35, 23, 2], as well as others, such as the method of observation, induction, analysis, synthesis, historical, comparative, statistical, etc. a.

In the process of carrying out this study, there were used modern means of work, methods of observations in the field, collection and processing of statistical data, the comparative and analysis method, the calculation program in the Visual Basic programming language under the OFFICE 365 platform through EXCEL, GIS in data processing and map development, the cartographic method of processing and graphic representation (maps/diagrams) of the results obtained, etc. The primary data, used in the study to characterize the meteo-climate risk phenomena and the damage caused by them, were systematized, processed, interpreted graphically and cartographically. The use of these methods made it possible to evaluate the exposure of the territory of the Republic of Moldova to the spatio-temporal manifestation of the mentioned meteo-climate risk phenomena and the development of a set of cartographic materials, which reflect the impact with different degrees of vulnerability of the territory in administrative-territorial profile against each phenomenon in part, as well as against the complex of studied risks.

The scientific novelty of the results obtained. The elaborated work is up-to-date and represents a detailed study, through which new approaches are formulated and applied to estimate the negative impact of meteo-climate risk phenomena from the warm period of the year in the Republic of Moldova for the period 2000-2021.

The scientific novelty of the study carried out in the framework of the current doctoral thesis focuses, mainly, on the identification of the impact of these phenomena on a new conceptual-theoretical principle of differentiated estimation, which consists ***in the identification of the estimated impact through the damage produced by the meteo-climate risk phenomena, reported to the administrative-territorial unit (district).***

In accordance with the theme of the given thesis, there was processed and analyzed the IGSU database from the last 22 years regarding the exceptional situations and the impact produced by the meteo-climate risk phenomena during the warm period of the year, and by applying GIS and statistical processing methods of the data, there were developed geographic materials (maps, diagrams, tables) regarding the spatio-temporal distribution of the impact induced by these phenomena, as well as evidenced adaptation and mitigation measures to the mentioned risk phenomena.

As a result of the conducted study, there were evaluated and described:

- the main characteristics and spatio-temporal trends of the meteo-climate risk phenomena during the warm period of the year on the territory of the Republic of Moldova between 2000-2021;
- the conceptual-theoretical principle of differentiated estimation of the negative impact of meteo-climate risk phenomena in time and space on the territory of the Republic of Moldova;
- the damage caused by the meteo-climate risk phenomena during the warm period of the year on the territory of the Republic of Moldova since the beginning of the XXI century.
- measures to adapt and mitigate the impact of meteo-climate risk phenomena from the warm period in the Republic of Moldova.

Important scientific problem solved:

- the assessment of the impact of the meteo-climate risk phenomena from the warm period of the year on the territory of the Republic of Moldova on a new conceptual-theoretical principle, which consists in: ***identifying the estimated impact through the damage caused by the meteo-climate risk phenomena, reported to the administrative unit- territorial (district).***

- highlighting the adaptation measures and mitigating their negative consequences on the economy, the population and the environment.

The theoretical significance of the study consists in carrying out a spatio-temporal analysis of the characteristics of the meteo-climate risk elements, estimating the impact of the meteo-climate phenomena from the warm period of the year on the territory of the Republic of Moldova, with the elaboration of a set of cartographic materials using GIS techniques.

There was formulated a new conceptual-theoretical principle for the differentiated assessment of the negative impact of the meteo-climate risk phenomena from the warm period of the year on the territory of the Republic of Moldova during the years 2000-2021 and for the application of measures to adapt and mitigate their effects.

The applicative value of the work. The results of the conducted study are recommended to be used in the development and implementation of policies, projects and measures to prevent and mitigate the impact produced by the meteo-climate risk phenomena during the warm period of the year for each administrative district of the Republic of Moldova. Through the creation of geographical materials (maps, diagrams, graphs) it was possible to identify the spatio-temporal distribution of the meteo-climate risk phenomena, reflecting the extent of the impact produced by them, proposing measures to adapt and mitigate the consequences. The highlighted measures can be used by the decision-makers for the purpose of the rational planning of the territory of the republic and the effective management of crisis situations.

The conclusions of the given study can be used in multiple fields of activity: economy, education, research, management, etc.

The scientific results proposed for support: a new differentiated estimate of the negative impact of meteo-climate risk phenomena, specific to the warm period of the year from the beginning of the 21st century on the territory of the Republic of Moldova, in relation to the extent of damage per unit of territory (administrative district); a new theoretical approach, regarding the spatio-temporal distribution of risks for the warm period of the year for the duration of 22 years, by estimating the economic damages induced by them, and practical (the review of national security policies in risk management), which reflects the impact spatio-temporal risks on the national economy, the population and the environment of the Republic of Moldova; highlighting measures to adapt and mitigate these risks.

The implementation of scientific results: In accordance with the theme of the doctoral thesis, the cartographic materials developed on the basis of GIS, as well as the highlighted measures to adapt and mitigate the impact of the mentioned risks, the scientific results obtained are proposed for use in: the development of new damage assessment methods, in the concept of guidelines regarding civil protection etc.

The results obtained:

- the database with reference to the spatio-temporal distribution of the meteo-climatic risk phenomena from the warm period of the year, recorded and systematized in the period 2000-2021 on the territory of the Republic of Moldova;
- the database regarding the spatio-temporal distribution of the damage caused by the meteo-climate risk phenomena from the warm period of the year in the last 22 years on the territory of the Republic of Moldova for territorial units (district);
- a new conceptual-theoretical principle of differentiated estimation of the negative impact of the meteo-climate risk phenomena from the warm period of the year in the territory of the Republic of Moldova, which consists ***in identifying the estimated impact through the damage caused by the meteo-climate risk phenomena, relative to the territorial unit (administrative district);***

- the maps and diagrams regarding the spatio-temporal redistribution of damage caused by the meteo-climate risk phenomena in the warm period of the year since the beginning of the 21st century, developed in GIS are proposed to be used by GIES, APC, APL and other decision-makers

At the same time, the results can serve for the development and implementation of policies, projects and programs for the civil protection of the population, the environment, in the agricultural sector, energy, transport, tourism as well as in the teaching of specialized courses in higher education (geography, pedology/pedogeography, environmental protection, agronomy, etc.) for professional training.

THESIS CONTENT

1. SCIENTIFIC-METHODICAL BASES FOR RESEARCHING METEO-CLIMATE RISK PHENOMENA IN THE WARM PERIOD OF THE YEAR

The chapter includes the analysis of the research on the meteo-climate risk phenomena, which take place in the Republic of Moldova during the warm period of the year from the beginning of the XXI century for 22 years. In the monitoring and forecasting of the meteo-climate risk phenomena, there were highlighted the aspects related to the legal framework, the role and the task of the State Hydrometeorological Service (SHS), national authority in the field of weather and climate monitoring on the territory of the Republic of Moldova, in providing the population, decision-makers, economic agents information about the state and evolution of the weather, climate and surface waters, but also about the risk meteo-climatic phenomena.

For the purpose of researching the given theme, there were used both reports and statistical data from the database of SHS, GIES and NBS. From the SHS archive, factual and material data there were analyzed regarding the meteo-climate risk phenomena from the warm period of the year, recorded at the 18 meteorological stations. The collected data were structured within the Microsoft Excel program, then analyzed and systematized in tabular form. Statistical programs (Statgraphics, Instat Plus and ArcGis) were used in the processing, graphic and cartographic presentation of the initial database used in the elaboration of the present study.

In order to evaluate the impact produced by the meteo-climate risk phenomena during the warm period of the year, as informative and statistical primary materials, there were used the data from the GIES archive on the number of exceptional situations in relation to each meteo-climate risk phenomenon for the period 2000-2021 and the material damages calculated for each administrative-territorial unit (district).

1.1 The conceptual framework of the study regarding meteo-climate risk phenomena

The concerns associated with the study of climate phenomena were grouped according to their approach in scientific works, in which from the study of special cases it was moved to a more complex analysis of the phenomena, grouped according to certain characteristics, danger criteria (for example torrential rains), proposing forecasting methods [55, 53]. The first complex monograph on the climate of the territory of Moldova "Климат Молдавской ССР", published in 1978, also describes some aspects of meteorological risk (fog, blizzard and blowing snow, hail, complex ice deposits) [52]. Subsequent research was oriented towards the study of climatic and agroclimatic resources in order to highlight the specifics of their distribution in time and space and to evaluate the climatic risk phenomena [54. Some aspects related to the characteristics of unfavorable weather phenomena can be found in the work "Агроклиматические ресурсы Молдавской ССР", and the theoretical part is accompanied by a rich statistical material [47]. Atmospheric phenomena such as: blizzard, stormy phenomena, dust storms, hail, frost, fog, etc. are also described in other works [55].

The systematic research of the regional characteristics of climate changes over several decades and up to now, as well as the forecast of possible changes, generated the preparation and editing of the Atlas "Climatic Resources of the Republic of Moldova" [38]. The extensive work

reflects the geomorphological and climatic risks for the Republic of Moldova. The development of the Atlas represented a necessary element in the face of accelerated environmental changes, a fact that entails an increased degree of natural and anthropogenic risks.

The studies carried out by Coșcodan M., Sofroni V., Boian I., Boboc N., Lalîkin N., Melniciuc O., Cojocari R., Topor V. are of particular importance in the research of meteo-climatic phenomena in the Republic of Moldova, Puțuntică A., Domenco R., etc. [3, 4, 13, 24, 29, 31, 26, 44, 45].

Information about meteo-climate risks on the territory of the Republic of Moldova can be found in the climatological works carried out by the researchers Mișcenco Z., Constantinov T., Nedealcov M., Sofroni V., Boian I., Topor V., Cojocari R., etc.[7, 8, 9, 21, 22, 33, 39, 38, 40, 41, 46, 48, 49, 51].

In the current bibliographic works, the mentioned meteo-climate risks are analyzed through the prism of their genesis, and there is little information about their impact on the population, the economy and the environment. There are insufficiently treated the issues with reference to ***the impact of the meteo-climatic risk phenomena from the warm period of the year and the damage caused by them***.

The study carried out in the framework of the current doctoral thesis focuses mainly on ***the identification of the impact***, *evaluated by the damage produced by the meteo-climate risk phenomena, reported to the administrative-territorial unit (district)* ***by applying a new conceptual-theoretical principle of differentiated estimation of this one.***

The mentioned aspects served as the basis for initiating the present study, in which the emphasis was placed on the research of the impact of the meteo-climate risk phenomena, the extent of the damage recorded and the highlighting of measures to adapt and mitigate the consequences induced by the respective phenomena. In addition to those highlighted in the bibliographic works mentioned above, the present work brings new data on the impact produced by the meteo-climate risk phenomena and their consequences in the Republic of Moldova for the beginning of the XXI century.

1.2 Methodological approach and application in the research of the meteo-climate risk phenomena

The research was carried out in the period 2000-2021, with the objective of establishing the impact of the meteo-climate risk phenomena during the warm period of the year on the territory of the Republic of Moldova at the beginning of the 21st century and mitigation possibilities.

In carrying out the present study, there were used multi-year meteo- climate data from the archives of the State Hydrometeorological Service (SHS), the General Inspectorate for Emergency Situations (GIES) and the National Bureau of Statistics (NBS). From the annual reports of the SHS, "with reference to unfavorable hydrometeorological phenomena and sudden changes in the weather reported on the territory of the Republic of Moldova", there was followed the evolution of the meteo-climate risk phenomena. The assessment of the impact produced by the meteo-climate risk phenomena during the warm period of the year was carried out on the basis of the primary informative and statistical materials from the GIES for the period 2000-2021, which reflects the number of exceptional situations in relation to each meteo-climate risk phenomenon and the damages products reported to administrative-territorial units (districts). For a more complete picture in order to prepare the materials of the paper, there were also consulted the published yearbooks of NBS.

The primary data collected from the mentioned archives were included into Excel format files, later processed through statistical programs (Statgraphics, Instat Plus and ArcGis). The work used classic methods (catographic, inductive, analysis, synthesis, comparative, historical) and current methods of spatio-temporal estimation of the parameters analyzed in the study, methods

widely used in specialized literature [35, 23, 2]. Through the statistical method, there was evaluated the impact of the meteo-climate risk phenomena on the population, the economy and the environment, and there were elaborated cartographic materials and diagrams on the differentiated distribution of the impact produced by these phenomena.

In order to apply the research methodologies of the meteo-climate phenomena, there were analyzed the approved national standards in the field of meteorology and climatology. It was found that the meteorological and climatological field in the Republic of Moldova has deficiencies in the approval of national standards, currently being used and applied standards from the former USSR and the World Meteorological Organization (WMO). Currently, some WMO standards are approved in the Republic of Moldova.

1.3 Analysis of the legal framework regarding the monitoring and forecasting of meteo-climate risk phenomena

The national authority in the field of weather and climate monitoring on the territory of the Republic of Moldova is the State Hydrometeorological Service (SHS). The main task of the SHS is to provide the population, decision-makers and economic agents with information on the state and evolution of the weather, climate and surface waters, as well as meteo-climate phenomena.

Operational and regime information is used to develop forecasts regarding the state of the weather and the environment, warnings regarding unfavorable meteorological phenomena, to inform governing bodies and economic agents, of the meteorological and climatic regime of the territories, the creation of the national climate data base, etc. [41].

Currently, the national climate monitoring network in the Republic of Moldova operates in accordance with:

- Law no. 1536-XIII of February 25, 1998 "On hydrometeorological activity".
- Government Decision no. 935 of October 11, 1999 "On the use of hydrometeorological information in the economic activity of economic agents".
- Government Decision no. 401 of April 3, 2003 "On some aspects of the hydrometeorological activity in the Republic of Moldova".
- Decision of the Government of the Republic of Moldova No. 330 of 03.04.2006 for the approval of the nomenclature of the services provided free of charge and against payment by the State Hydrometeorological Service and the way of using the special means of the State Hydrometeorological Service.
- SHS Regulation.
- Parliament decision no. 210-XIII of July 29, 1994 for the accession of the Republic of Moldova to the World Meteorological Organization.

2. MONITORING NETWORKS OF THE STATE HYDROMETEOROLOGICAL SERVICE

2.1 National Meteorological Observation Network of the State Hydrometeorological Service

The State Hydrometeorological Service of the Republic of Moldova (SHS) is the only institution responsible for meteorological monitoring and issuing warnings to central and local public administration bodies, and respectively providing economic agents and people with meteo-climatic climate information. For these purposes SHS manages the National Network of Meteorological Observations (MNMO).

The history of meteorological research has its beginnings in 1844 when the first attempts to make meteorological observations took place on the territory between the Prut and the Dniester. The first established station, where instrumental meteorological observations were regularly recorded, was opened in Chisinau in 1886, then in Briceni (1887), Soroca (1890), Comrat (1892), Plopi (1894) and Tiraspol (1898).

Currently, MNMO includes 18 meteorological stations, of which 14 on the territory of the Republic of Moldova and 4 in Transnistria (the region to the left of the Dniester), 34 automatic meteorological stations with a simple configuration of sensors or mini-AWS, 16 agrometeorological stations and 25 hydrological stations with meteorological observations. There is also a C-band Doppler weather radar owned by SHS. This radar is located at Chisinau International Airport and is operated by MOLDATSA. There are 9 other S/X-band meteorological radars operated by other institutions, especially for hail suppression (fig. 2.1).

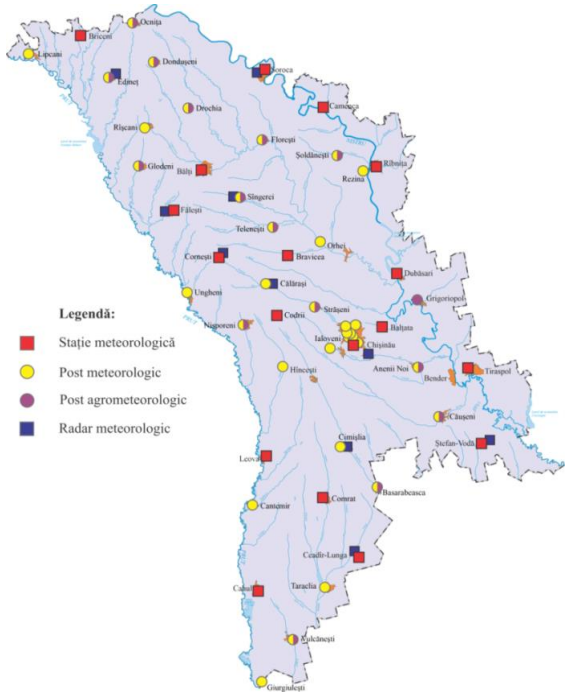

Figure 2.1. National Meteorological Observation Network
Source: developed based on SHS data

Analyzing the distribution of meteorological stations, we can deduce that they are located, relatively, evenly throughout the country, (each station, together with those on the left of the Dniester/Transnistria, having approximately 1900 km2 of observations), as well as the equipment at the automatic meteorological stations and textbooks is in accordance with WMO recommendations.

The information collected by (SHS) at the end of each observation period is coded in special telegrams called SYNOP and transmitted to the world meteorological centers. The data on meteorological risk phenomena are also codified and transmitted operatively from all meteorological stations to the Directorate of Meteorological Forecasts. SHS offers the following products and services: *immediate and very short-term weather forecasts (up to 6 hours); short-range weather forecasts (24 hours with 12-hour resolution); medium-term weather forecasts (2-7 days); long-term weather forecasts (up to 1 month); multi-risk early warnings: flood, storm, hail, drought, lightning, sleet and ice, heavy rain and snow, extreme temperatures, forest fires, sand or dust storms.*

2.2 National Hydrological Monitoring Network of the Hydrometeorological Service State

The history of hydrological observations on the territory of the Republic of Moldova begins in 1878 with the organization of the first hydrological station on the Dniester River, in the town of Tighina. In the interwar period, the hydrological network experienced a slow expansion. In 1940, the hydrological network was expanded to 20 stations, in 1950 there were realized the first forecasts of rain floods on the Dniester and Prut rivers, from 1953 - the forecast of the volume of flood discharge on the Dniester, and from 1978 forecasts are made on the Prut river.

Currently, the National Hydrological Monitoring Network of the Republic of Moldova consists of 2 hydrological stations – the Dniester, based in Dubăsari and the Prut, based in Balti and 53 hydrological stations, of which 40 are managed by the SHS of the Republic of Moldova, and 13 by Tiraspol Hydrometeorological Center. Hydrometric observations and measurements are the basis of hydrological research and they consist of: *observations on the water level; water flow velocity and direction measurements; depth measurements; liquid and solid flow measurements; studying the granulometric component of suspended and bottom alluvium, etc.*

A new stage in hydrological monitoring in the Republic of Moldova began with the implementation of new technologies, equipped with automated monitoring elements, which have the possibility to monitor the water level, temperature and speed in real time. The first automated stations were installed in the Răut river basin, where in 2008 the first automated hydrological stations appeared (Bălți, Jeloboc on the Răut river, Cubolta on the Cubolta river, Sevirova on the Căinari river and Telenești on the Ciulucul Mic river). On the Prut river, hydrological stations were installed at Lipcani, Ştirăuți, Costești-Stânca, Branište, Ungheni, Leușeni, Leova, Cantemir, Cahul, Brânza and Giurgiulești, the latter being later liquidated. In the period 2010-2015, 14 hydrological monitoring stations were installed on the Dniester river. The hydrological stations collect data about the water level in rivers: 34 of them are predestined for flow measurements, 27 are forecast stations and 9 - lake stations (6 at the Dubăsari reservoir and 3 at the Costești-Stânca reservoir) [Annex 2].

3. CHARACTERIZATION OF THE METEO-CLIMATE RISK PHENOMENA IN THE WARM PERIOD OF THE YEAR

3.1 Generalities

The Republic of Moldova generally has favorable climatic conditions. The climate is temperate-continental, with a transitional character from the oceanic-Atlantic climate to the eastern-European continental climate. There are 4 seasons of the temperate zone. The warm period of the year represents the period when the average daily air temperature passes the value of +5ºC in the direction of its increase [Annex 3]. In the Republic of Moldova, this transition takes place in spring, on average in the 3rd decade of March, and the transition of the temperature through the +5ºC value in the direction of decrease is signaled in autumn, on average in the 1st decade of November. The warm period of the year lasts approximately 235 days, which practically coincides with the vegetation period of agricultural crops, as well as with the intensification of some meteo-climate risk phenomena, such as: dryness and drought; strong winds; torrential rains; floods; thunderstorms; hail; heat waves; early and late frosts.

3.2. Dryness and drought

Dryness and drought can be considered the most complex climatic phenomena, because several factors participate in their triggering, namely: atmospheric precipitation, soil water reserve accessible to the plant, air humidity and temperature, evapotranspiration, wind speed, etc., these being the main climatic parameters that define the state of dry or droughty weather [26]. In the Republic of Moldova, drought represents one of the most dangerous natural phenomena, which is a specificity of the regional climate, a state of irregular distribution in time and space of precipitation because of high temperatures [44, 42, 43]. In the last 20 years, droughts have occurred quite often, becoming more and more intensive. Therefore, in the period 2000-2022, there were 8 years of droughts of varying intensity in the country (2000, 2001, 2003, 2007, 2011, 2012, 2015, 2020), which caused a significant reduction in agricultural production. In 2003, the drought lasted almost the entire vegetation period (April-September). The State Hydrometeorological Service analyzed the hydrothermal coefficient (CHT) in detail and established that the value of CHT $\geq$ 1.0 characterizes sufficient humidity, CHT $\leq$ 0.7 indicates a dry climate, CHT = 0.6 - a mild drought, CHT $\leq$ 0.5 - a strong and very strong drought.

The catastrophic drought of 2007 started already in the autumn of 2006. In the period September 2006 - August 2007, the amount of precipitation that fell on the territory of the republic constituted 50-70% of the climatic norm.

Table 3.1

Hydrothermal coefficient (CHT) for the period April - August 2007, 2012, 2015 and 2020

Year	CHT for the period April - August	% of territory CHT≤0,5	% of territory CHT≤0,6	% of territory CHT≥0,7	% of territory CHT ≥1,0
		Strong and very strong	mild	droughty climate	sufficient humidity
2007	0,6	45	20	20	5
2012	0,7	20	15	40	5
2015	0,4	85	10	5	0
2020	0,8	15	15	65	5

Source: old.meteo.md

In 2007 (April-August period) the hydrothermal coefficient (CHT) was on average 0.6 on the territory of the country, which corresponds to strong and very strong drought. In 2007, (fig. 3.1) for 45% of the country's territory, the CHT was below 0.5, which corresponds to strong and very strong drought, 20% of the territory was characterized by mild drought, 20% - dry climate and only on 5% of the territory the humidity was sufficient (tab. 3.1)

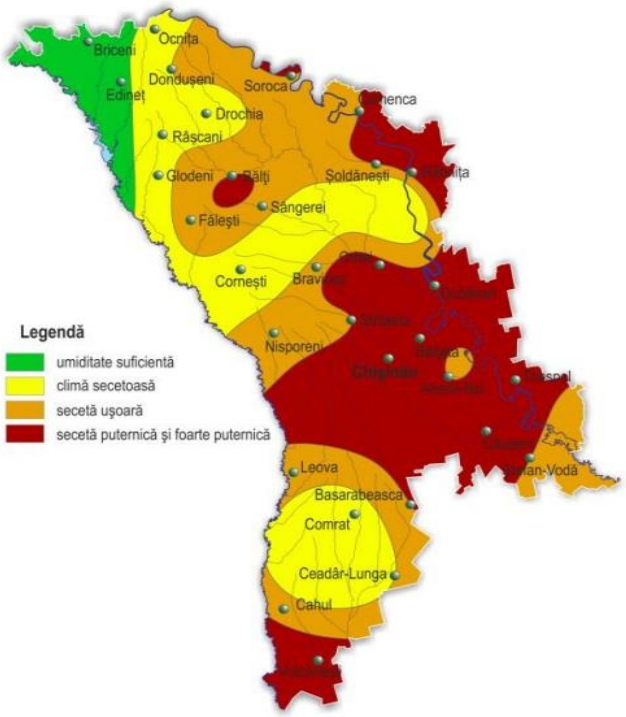

Fig. 3.1. The hydrothermal coefficient (CHT) for the period April-August 2007

Source: old.meteo.md

The catastrophic drought of 2011. During 2011, rainfall was very irregular. A considerable deficit of precipitation was reported on 60% of the country's territory. Their sum was 290-415 mm (50-75% of the annual norm). Between August 1 and October 8, high temperatures (2-2.5°C higher than the multi-year norm) and insufficient precipitation (10-50% of the norm) were reported everywhere, which caused the catastrophic drought which affected over 80% of the country's territory.

The drought of 2015 is characterized by the lack of regional precipitation, which has a predominantly local character, as well as by the lack of precipitation in some regions of the country in the May-July period.

The drought of 2020. The year 2020 was characterized by high temperatures. The average annual air temperature in the territory was +10.7..+13.1ºC, exceeding the multiannual norm by 2.6-3.7ºC. The maximum air temperature during the summer rose up to +38ºC (August, SM Tiraspol, Ștefan-Vodă). Very hot weather was recorded in August. The average monthly air temperature exceeded the norm by 2.5-4.0ºC and was +21.5..+ 24.5ºC. The summer of 2020 in Moldova had a rainfall deficit, especially in the months of July and August on a large part of the territory. Thus, the amount of precipitation on 80% of the territory did not exceed 15-60 mm (15-45% of the norm).

For the year 2020 (April-August period) the hydrothermal coefficient (CHT) (fig. 3.2) on the territory of the republic was equal to 0.8, which represents a dry climate. Thus, this year for 15% of the country's territory the CHT was below 0.5, which corresponds to strong and very strong drought, for 15% of the territory mild drought was characteristic, 65% - dry climate and only 5% of territory the humidity was sufficient (table 3.1).

Thus, from the data presented, we can conclude that the drought in the Republic of Moldova is not an accidental natural phenomenon, but a regularity, therefore we must consider its possible manifestations not episodically, but permanently, preventing the release of its destructive force.

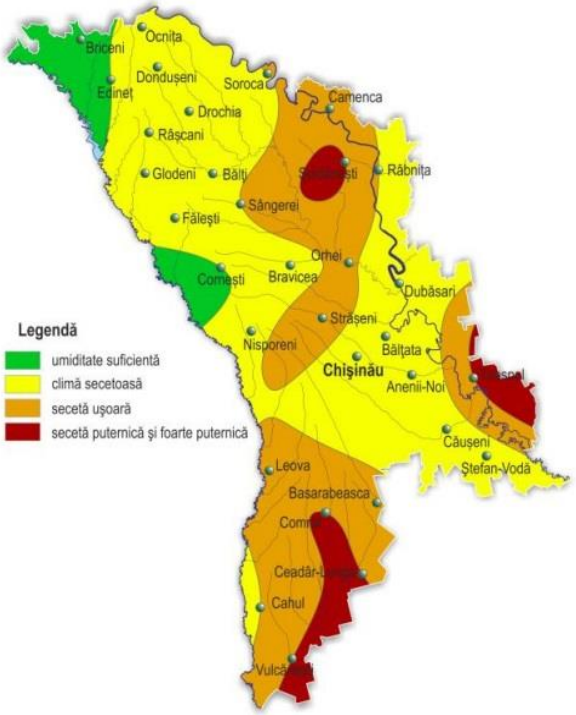

Fig 3.2. The hydrothermal coefficient for the period April-August 2020
Source: old.meteo.md

3.3 Strong winds

Dry spells are dry, scorching winds, which determine the increase of evapotranspiration, loss of flexibility and condition some dysfunctions of plant organs [18]. In the Republic of Moldova, dry spells occur in the case of an anticyclonic branch or the periphery of an anticyclone in a region where south-westerly air masses meet with an advection of warm air from the Balkans. The average duration of strong dry weather is 2 days and usually occurs in July and August. Very strong dry spells are rarely recorded. Even in the southern part of the Republic, it does not appear every year. In different districts of the country, the annual evolution of drought phenomena has different particularities of manifestation. In the northern and central districts they reach a maximum in May (on average 1.6-2.9 days), and in the southern and southeastern districts - in August (3.23-3.66 days).

3.4 Torrential rains

Torrential rains or downpours are characterized by a large amount of precipitation, falling in a very short period of time, which implies a major intensity and, therefore, can have serious consequences on soil erosion and washing of nutrients, as well as on agriculture in general, destroying pastures and agricultural crops" [3, 10, 39].

Based on SHS observations, it was established that the maximum intensity of torrential rains on the territory of the Republic is equal to 0.5-1.9 mm/min and only in exceptional cases it can be higher than 5 mm/min.

The average duration of torrential rains in the Republic of Moldova is 1.5 hours. The intensity of torrential rains is inversely proportional to its duration, thus rains with an intensity below 1 mm/min last for about 60 minutes, and those between 1 and 2 mm/min - for about 30 minutes, etc. Both throughout the year and from month to month, heavy rains fall irregularly. They know a great non-periodic variability, depending on the characteristics of the general circulation of the atmosphere on the territory of the country, as well as on the local characteristics of the active surface.

Heavy torrential rains fell on the territory of the country in 2005, in the months of May and August. The amount of precipitation was 60-110 mm (1-2 monthly norms), 140-160 mm or 2.5-3.0 monthly norms, which is recorded on average once in 8-10 years.

3.5 Floods

Floods are the most dangerous natural hazards. In recent decades, flood damage has increased exponentially. This is often exacerbated by inadequate flood planning and management practices [8, 18, 31, 33, 32].

In the Republic of Moldova, the main factor that causes floods are the heavy torrential rains, from May to August. On the Dniester and Prut rivers, the floods, to a large extent, are generated by torrential rains and melting snow.

During the last 20 years, on the course of the big rivers in Moldova (Nistru and Prut), there were recorded about 10 major floods, the biggest being in 2006, 2008 and 2010. While, on the small rivers of the Republic, floods of large scale were recorded in 2005, 2020 and 2021.

Between June 16-17, 2003 and August 7, 18-19, 2005, there occurred significant floods, caused by heavy rainfall. These led to the flooding of some watercourses, as well as the formation of intense runoff, which caused enormous material losses in various sectors of the national economy.

In 2008, the flood on the Prut river (Sirăuţi hydrometric station) constituted 60% of the annual discharge norm. In July 2008, there was recorded the maximum flow of 4560 m3 at the entrance of the Prut to the Republic of Moldova.

Between May and July 2010, quite a large amount of precipitation fell on the territory of the country. Between May 1 and July 15, the amount of precipitation that fell on a significant part of the country's territory was 200-400 l/m2 or 50-80% of the annual norm, exceeding the multi-year average for this period of 1.5- 2 times.

In June 2020, the amount of precipitation that fell in June in the Prut river basin was 6 times higher than the multi-year norm. The amount of precipitation that fell in the hydrographic basin of the Prut river (Ukraine) between June 24 and 29 caused a continuous increase in the water level of the Prut river in the Criva - Costesti sector by 1.8-2.2 m.

The flow of water in the Dniester river for the month of June was far above the norm and constituted about 250% in the Naslavcea - Dubăsari sectors (norm 364 m3 /s), Dubăsari - Bender 240% (norm 321 m3 /s), Bender - Talmaza 230% (norm 319 m3 /s) and Talmaza - Tudora 220% (norm 300 m3 /s) of the multiannual average volume.

In the summer of 2021, the amount of precipitation, which fell during the season on 60% of the territory, was 170-305 mm (100-160% of the norm). In the rest of the country, in the central and southeastern districts, their sum reached 320-450 mm (170-225% of the norm), which is recorded on average once every 10-30 years.

3.6 Thunderstorms

Lightning and thunder are two natural phenomena that often appear together during storms, being called *thunderstorms.* In most cases, thunderstorms accompany storms with rain showers. In the Republic of Moldova, the average annual number of days with thunderstorms is 30-36 days. During the year, thunderstorms occur more often in the warm season. In spring (April – May) the number of days with thunderstorms gradually increases and in June reaches maximum values (8 – 10 days). In September, the number of days with thunderstorms decreases to 2-3 days. In winter (with the exception of January), thunderstorms can occur from time to time throughout the territory of the republic, both in December and February.

The highest number of days with thunderstorms can vary between 45 and 60. The highest frequency of thunderstorms is observed over the plateaus in the central and south-eastern regions of the Republic of Moldova (55 – 60 days) [43]. In the south of the Republic, the number of days with thunderstorms can reach 45-50.

3.7 Hail

In the Republic of Moldova, hail usually falls in the warm season and accompanies showers and storms, which further increases the damage caused by it. The fall of hail on the territory of the country most often (70% of cases) is favored by the crossing of cold fronts.

Although hail manifests itself in isolation, the phenomenon is most often recorded in regions with higher relief, such as the Codrilur Plateau, where the average number of days with hail exceeds 1.5 days (fig. 3.3). In the lower regions of the north and south of the country hail has a lower frequency, they being the least affected. According to the maximum number of days with hail (fig. 3.4), it can be observed that it prevails in the center of the country with more than 7 days per year, but also in the north of the country - from Balti to the northeast, their number increases from 5 to more of 8 days a year. [43].

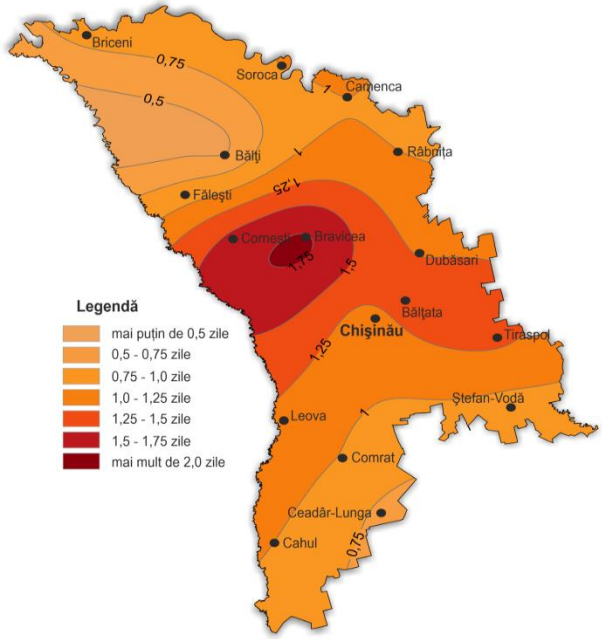

Fig. 3.3. Average number of days with hail per year

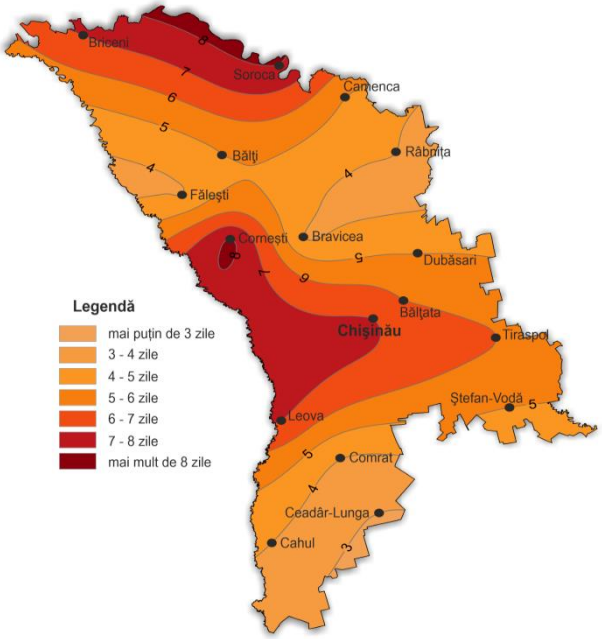

Fig. 3.4. Maximum number of hail days per year

Source: developed based on GIES data

Most days with hail are recorded in the central region of the country (fig. 3.5), respectively the Codrilur Plateau region. The presence of high slopes compared to the rest of the country favors the intensification of the degree of atmospheric turbulence/convection in the air layer near the underlying surface, which leads to the active development of convective haze.

The territories of the Southern Moldavian Plain, the Lower Dniester Plain, the southwestern part of the Tigheci Hills and the Northern Moldavian Plain are areas with a smaller number of hail days.

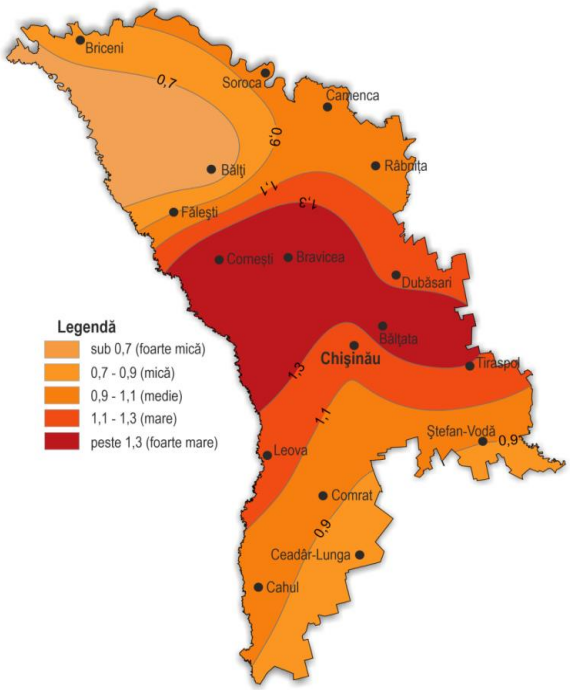

Fig. 3.5. The territory of the Republic of Moldova more frequently affected by hail
Source: developed based on GIES data

3.8 Heat waves

Heat waves are usually characterized by high temperatures, high humidity and little or no rainfall. They are becoming more frequent and more intense due to climate change, as rising temperatures increase the probability of extreme heat events.

"In the last century, in the Republic of Moldova there were numerous situations in which absolute maximum temperatures were over 30°C in the hottest months of the year (July-September). The strongest warmings were recorded in 1924, 1938, 1946, 1951, 1954, 1988, 1994, 1996, 1998, 2000, 2003, 2007, 2012-2021. In this interval of more than a century, there were recorded more than 400 cases with $t \geq 35.0$ °C [11].

In the Republic of Moldova, the summer of 2012 was very hot and dry, characterized by a series of extreme heat waves lasting several weeks, with temperatures constantly exceeding 35 degrees Celsius, and in some areas reaching up to 42 degrees Celsius. The passage of the average daily air temperature through +15°C (the beginning of the meteorological summer) in the northern districts of the country took place on April 24-25, and in the central and southern ones - on April 22-23, being by 15-25 days earlier than usual terms.

The average air temperature for the June-August period was higher than the norm by 3.0-4.5°C and was +21.7..+24.8°C on 70% of the country's territory, this being recorded for the first time during the entire period of instrumental observations, surpassing the previous record by 0.1-0.8°C.,,At SM Fălești on August 7, the highest air temperature was recorded in the Republic of Moldova for the entire period of observations instrumental temperature of +42.4ºC, being 0.9ºC higher than the absolute maximum value recorded previously (2007). [43]. The heat wave had a negative impact on the health of the population, agricultural crops, due to drought conditions.

3.9 Early autumn and late spring frosts

Early autumn and late spring frosts are meteo-climatic risk phenomena that occur when temperatures drop below freezing during transition periods between seasons. Frost occurs when the temperature of the air layer near the ground drops below 0°C during the warm period of the year (crop vegetation period) [15, 19, 35].

The territory of the Republic of Moldova, being located in the southeast of the continent, is crossed by several trajectories of cold air masses, which cause frosts. Early autumn and late spring frosts have become more frequent and severe in some regions due to climate change. Changes in temperature and precipitation affect the timing of the seasons and increase the probability of the meteo-climatic risk phenomena.

Spring frosts in the air can occur in Moldova until April 10-15 in the air, and on the ground surface until April 20-25. However, in some years frosts are also recorded in May (fig. 3.6).

These frosts have a strong negative impact on agriculture, especially crops sensitive to low temperatures (fruit trees, berries, vegetable varieties), and can also damage infrastructure such as roads and buildings.

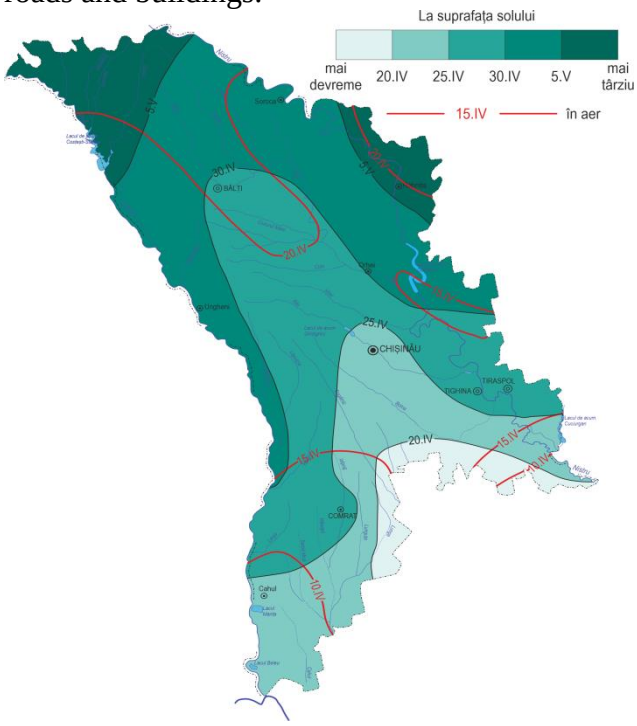

Fig. 3.6. The average date of occurrence of the last spring frosts

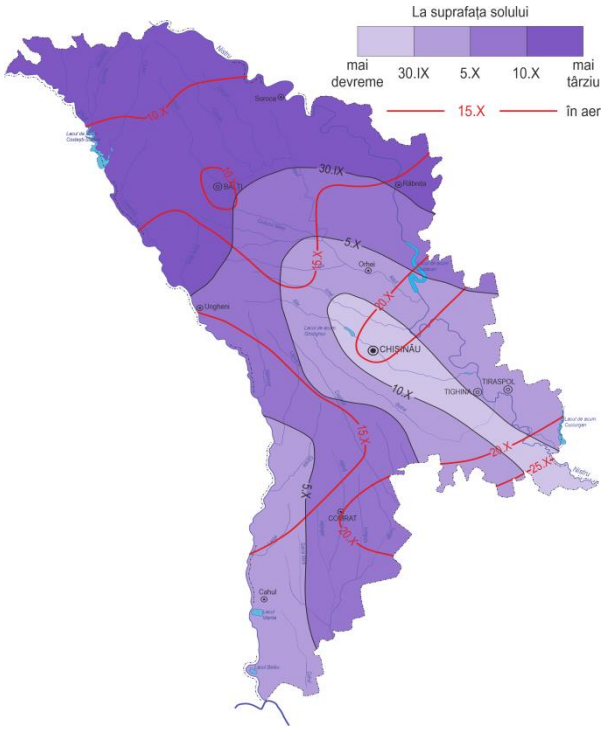

Fig. 3.7 Average date of the first frosts in autumn

Source: adapted by the author from the Physical Geography Atlas of the Republic of Moldova, 2002

The evaluation of the intensive autumn frosts allows us to state that the north of the Republic is affected by the dangerous frosts on the ground surface in autumn, namely on September 30, in the central part - on October 5 and in the southern part precisely on October 10 or even later. In the air, autumn frosts appear in the north starting on average on October 10, in the center of the country - on October 15-20, and in the south - on October 20-25, that is, as in the case of spring frosts, with 2-3 weeks later than in the north of the country (fig. 3.7).

4. IMPACT OF THE METEO-CLIMATE RISK PHENOMENA FROM THE WARM PERIOD OF THE YEAR IN THE REPUBLIC OF MOLDOVA AT THE BEGINNING OF THE 21ST CENTURY

4.1 Damage caused by the meteo-climate risk phenomena during the warm period of the year in the Republic of Moldova

The meteo-climate phenomena during the warm period of the year are among the most destructive and long-lasting. These phenomena, by their destructive nature, cause the greatest material damage to both the national economy and the environment. In the last 22 years on the territory of the Republic of Moldova, there were reported 1433 exceptional situations that caused damage to the economy in the amount of over 17.1 billion lei [Annex 4, Table 1 and 2].

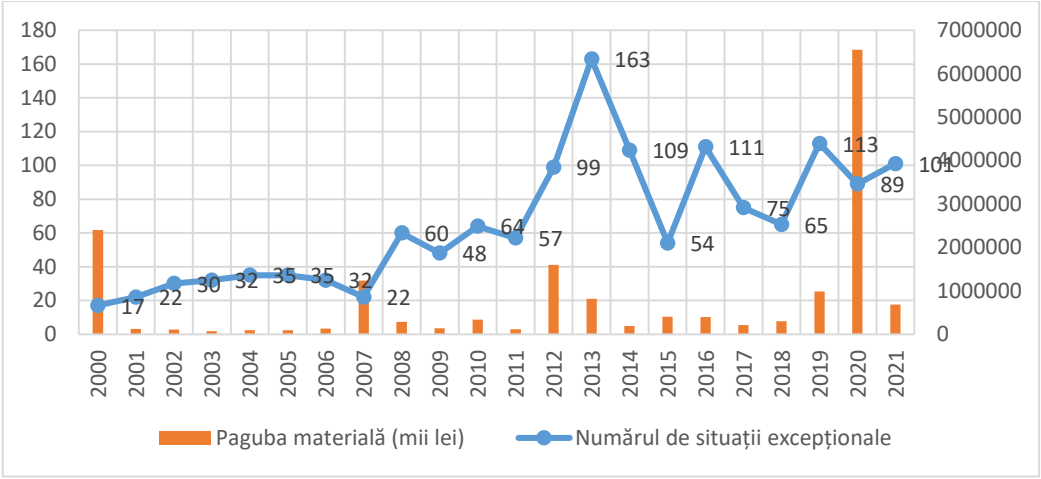

Fig. 4.1. Material damage and the number of exceptional situations recorded during the years 2000-2021
Source: developed based on GIES data

Analyzing the graph (fig. 4.1) we can see that in 2013 there were recorded the most exceptional situations related to the meteo-climate risk phenomena- 163, and according to their destructive nature the material damage amounted to 816.9 million lei, much less compared to other years, such as 2020 when there were 89 (or 45% less than in 2013) exceptional situations, but after material damage, 2020 was the most affected year – with 6.5 billion lei.

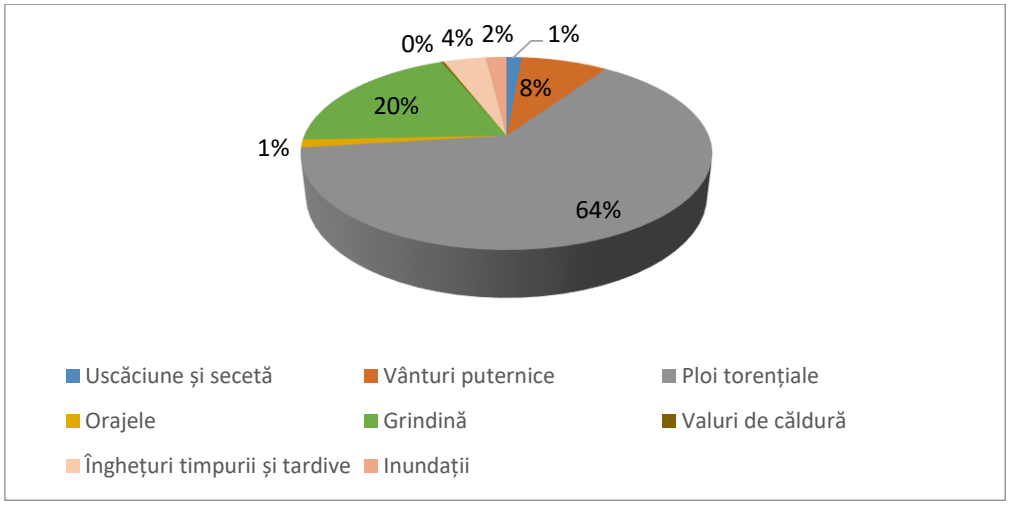

Fig. 4.2. The share of different categories of exceptional situations from the period 2000-2021, %
source: developed based on GIES data

Not all the mentioned phenomena cause damage year after year. If, for example, torrential rains and frosts cause damage every year, then droughts, heat waves and floods - once every few years, with high intensity, bringing the greatest damage to the national economy, localities and the environment. Analyzing the graph (fig. 4.2), it can be seen that in the last 22 years more than half of the total number of exceptional situations (64%) are torrential rains, followed by hail with 20% and strong winds with 8%, the other phenomena returning only 8% of the total.

If, according to the number of exceptional situations, *dryness and drought* account for only 1% of the total, then in terms of material damage, they account for 62% of the total (fig. 4.3). This is explained by the fact that the agriculture of the Republic of Moldova is largely dependent on climatic conditions, and the drought, unlike other phenomena, is long-lasting. The second most damaging phenomenon, after drought, is *torrential rain*, with 25% of the total. Torrential rains are the main factor that causes *floods* to form, and being accompanied by *strong winds*, they account for 2% of the total damage to both material and the natural environment. Hail follows with 6% of the total damage, which is mostly damage to agriculture.

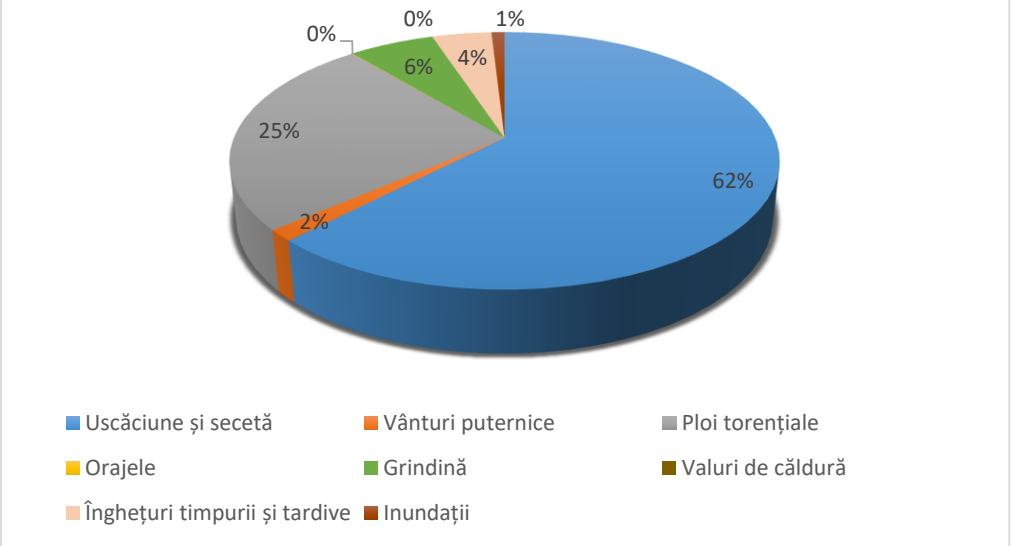

Fig. 4.3. The share of material damage caused by meteo-climatic phenomena during the years 2000-2021, %
source: developed based on GIES data

In order to achieve the objectives assumed in the research of the given theme, there was identified variability in time and space of the risks caused by the meteo-climate phenomena from the warm period of the year in the Republic of Moldova and there were established cartographic materials, which reflect the geographical space affected by the risk meteo-climatic phenomena at the beginning of the XXI century, for this purpose there were analyzed data from the GIES archive for the last 22 years.

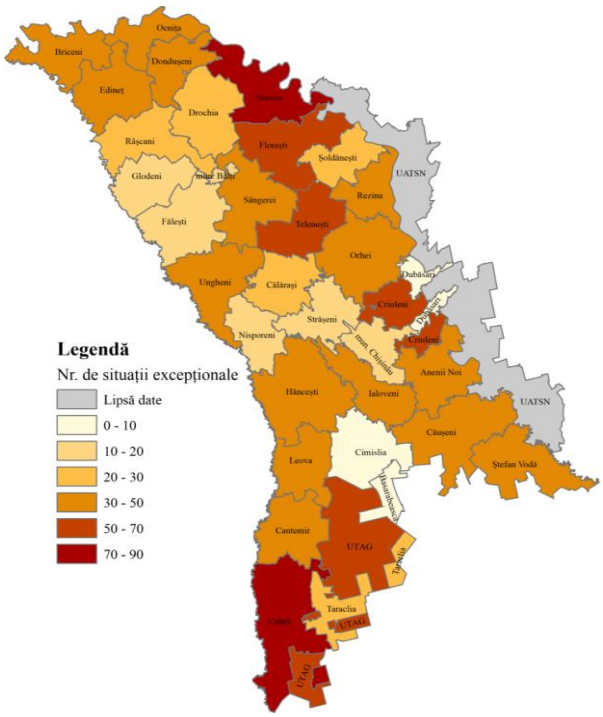

Fig. 4.4. The number of exceptional situations by district for the period 2000-2021
source: developed based on GIES data

Applying the tools of the Geographical Information System (GIS), there was highlighted the spatio-temporal redistribution at the territorial administrative unit (district) level of the number of exceptional situations and the total damages produced for each district cartographically exposed in Fig. 4.4, and Fig. 4.5.

Analyzing the information included in Fig. 4.4 it was deduced that the most numerous exceptional situations in the last 22 years were registered in Soroca 87, Cahul 74 and Florești 61 districts, and the fewest in Basarabeasca 8, Dubăsari 9 and Cimișlia 10 districts [Annex 5, Table 1].

As for the total damage caused by the risk meteo-climate phenomena recorded by the GIES on the territory of the Republic of Moldova since the beginning of the XXI century, there were highlighted the following districts which reported the greatest damages, namely: Cahul over 1 billion. lei, followed by Orhei.- with 956.7 million lei and Ungheni 873.7 million lei [Annex 5, Table 1]. The districts with the least damage were Glodeni with 9.8 million lei, Nisporeni with 23.6 million lei and Clărași with 476 million lei, (Fig. 4.5).

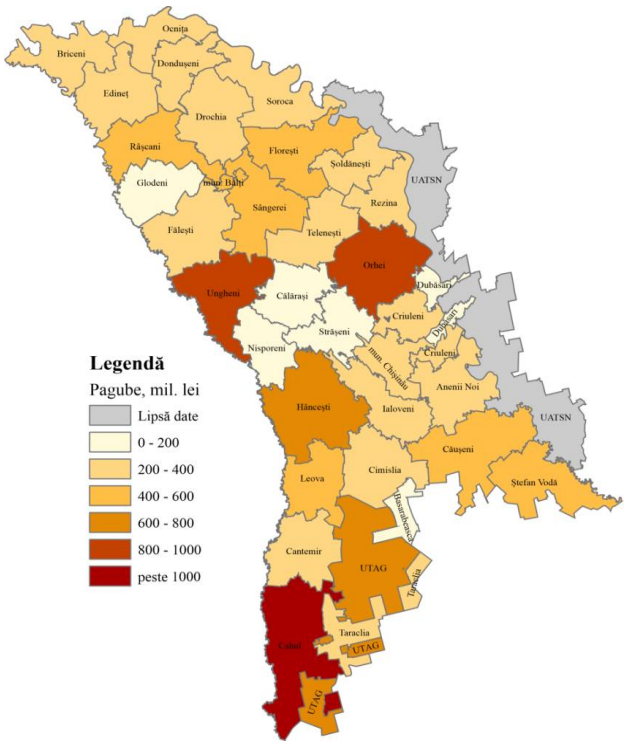

Fig. 4.5. Total damage for the years 2000-2021
source: developed based on GIES data

4.2 Damage caused to the environment by the meteo-climate risk phenomena during the warm period of the year in the Republic of Moldova

The meteo-climate risk phenomena during the warm period of the year have a direct influence on the lives of citizens, society as a whole, the economy, and the environment. Together or separately, the respective phenomena are responsible for a number of processes such as soil and surface water erosion/pollution (strong winds, torrential rains, floods), fire production (heat waves, drought, storms), drying up of water bodies (droughts, heat waves) etc.

Erosion. *Torrential rains, floods and strong winds* have a major impact on the environment, namely through erosion, which negatively influences the natural environment, presenting a serious source of surface and underground water pollution by washing different fertilizers from the slopes. Erosion is also responsible for the clogging of riverbeds and reservoirs, causing the intensification of pedological drought, contributing to the expansion of desertification processes and the reduction of soil fertility, especially in the southern areas of the Republic of Moldova.

From table 4.1 and the graph (Fig. 4.28) it can be seen that in the last 55 years the eroded surfaces have expanded considerably. If in 1965 we had 594.2 thousand ha affected, then in 2020 their surface reached 1015.7 thousand or 58.5% more than in 1965 [36, 37]. The greatest increase is observed in the period 1965-1995 and 2005-2010, and from 2010 to the present there is a slowdown in the process of expanding the eroded soil surfaces.

Table 4.1

Areas affected by erosion in the period 1965-2020, thousand ha

Erosion Degree	1965	1975	1995	2001	2005	2010	2020
Slightly affected	302,4	341,9	485,3	504,3	504,8	553,4	572,4
Moderate	195,6	213	244,6	252,7	259,3	279,3	300,3
Strongly affected	96,2	99,5	94,2	101,7	114,2	116,8	143,2
Totally	594,2	654,4	824,2	858,6	877,6	949,5	1015,7

Source: https://am.gov.md/ro/content/e2-aria-afectata-de-eroziunea-solului

This is explained by the fact that, during the given period, the soils were processed with many violations, for example through the intensive exploitation of the soils, the distribution of inappropriate fertilizers, another factor being the predominance of crops, which need to be sowed, etc.

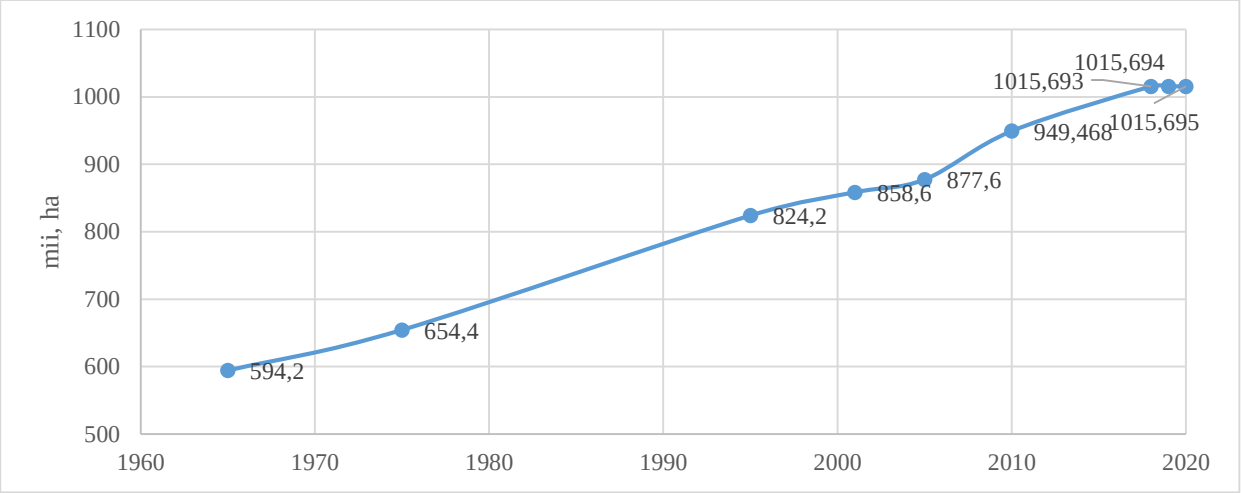

Fig. 4.28. The evolution of the degree of soil erosion during the years 1965-2020, thousand ha
Source: https://am.gov.md/ro/content/e2-aria-afectata-de-eroziunea-solului

Another phenomenon that leads to soil erosion is torrential rains. This is raindrop erosion. The size of the drop, the intensity of the rain and its duration are the main factors that lead to erosion. The raindrops following the impact with the ground detach the soil particles and throw them at distances from a few cm to 1-1.5 m.

The floods. Besides *being an important source of erosion*, they are also a serious cause of *soil and water pollution.* During floods the waters carry all the waste in their path over great distances. At the same time, water can destroy oil product transport pipelines or warehouses where dangerous substances are stored. Thus, floods not only pollute surface waters, but also soils. Chemicals in water can lead to the destruction of aquatic flora and fauna.

Floods also have *geomorphological effects*, because through erosion the river slopes are changed, sediments are deposited on the beds of rivers/lakes, which leads to clogging, etc.

Vegetation fires. *Thunderstorms, heat waves and droughts* are the phenomena that most often cause wildfires.

Most natural fires are caused by lightning during the dry or drought period, when the vegetation is dry due to lack of water. Fires caused by lightning are the most destructive and difficult to locate, because they occur isolated on hard-to-reach terrains and at great distances from human settlements, which prevents their operative extinguishing [61].

Besides all these damages, fires are also *a serious source of air pollution*. Thus, it was found that for one ton of vegetation burned in the atmosphere, it is sufficient a quantity of about 50 kg of CO (carbon monoxide) and about 20 kg of other harmful particles, resulting from the burning of plastic, tires and other objects [62].

Fires *cause great damage to flora and fauna* by destroying rare plants, destroying animal habitats, depriving them of food and protection. Thus, the spring and early summer fires have an extremely strong negative impact on the fauna of insects, birds, mammals, etc., given the fact that during this period they reproduce. The nests of field birds are destroyed, the populations of insects, which serve them as food, are reduced, causing the destruction of other groups of animals (amphibians, reptiles, mammals). In other words, wildfires affect biodiversity species and ecosystems in general by: reducing food sources for terrestrial fauna; they damage natural and artificial habitats, leading to the reduction of herds and even the disappearance of species from their specific biotopes.

Contrary to the concept, that the ash serves as fertilizer after burning dry vegetation, it has been proven that only 50% of the elements obtained after burning end up in the soil, the rest being transported by air currents. In addition to everything, two important elements such as carbon and nitrogen are lost from the soil after burning.

Vegetation fires, depending on how long they last, destroy the layer of humus that is on the surface of the soil and that comes into direct contact with the fire, destroying organic substances, which are an important source of food for plants. Also, following the fires, the soil remains without natural protection and is more strongly exposed to wind erosion and rain erosion. Also because of the fires, *the water reserve in the upper layers of the soil is reduced*, which leads to the movement of water from the lower horizons, which, being mineralized, respectively causes the movement of salts to the surface.

Another consequence of fires *is acid rain*, which leads to acidification of water; causes damage to vegetation; pollutes soils; destroys microorganisms in soil and water; it damages artificial surfaces and, last but not least, presents a real danger to human life.

5. MEASURES FOR ADAPTATION AND MITIGATION OF THE IMPACT OF METEO-CLIMATE RISK PHENOMENA DURING THE WARM PERIOD IN THE REPUBLIC OF MOLDOVA

At the present moment, in the context of climate change analysis at the regional level, it is found that global warming does not represent only a gradual spatio-temporal increase in temperature, but also a change in the frequency and intensity of many extreme phenomena such as droughts, floods, heat waves etc. [6, 25, 8, 31, 11]

As the meteo-climate risk phenomena manifest themselves more and more intensively in Moldova in recent years, it was necessary to identify measures and plan effective actions to adapt and mitigate their negative effects.

Adaptation to the meteo-climate risk phenomena refers to the process by which individuals, organizations and communities adjust their behaviours, activities and strategies to minimize the negative impact of a risk phenomenon/process. Adaptation involves both proactive (actions taken before a risk event occurs, such as implementing safety protocols, building infrastructure to withstand natural disasters or diversifying investments to reduce financial risk) and reactive (actions taken after a risk event occurs, such as implementing disaster recovery plans, providing aid to affected individuals or communities, improving security measures to prevent future disasters, etc.).

Mitigation refers to actions taken to reduce greenhouse gases and emissions, which are primarily caused by the major consumption of non-renewable energy resources (hydrocarbons) [16].

The change in the spatial and temporal patterns of natural risks, with implications on human activities and the state of the environment, requires adaptation strategies and actions specific to each field of activity. Adaptation to climate change involves anticipating negative effects and taking appropriate measures to prevent risk phenomena and minimize the damage they can cause.

Successful adaptation to climate risk requires a combination of technical expertise, risk management strategies, effective communication and collaboration between stakeholders. It also requires a willingness to learn from past experiences, continuously improve risk mitigation strategies and build resilience.

It is necessary to draw up a single database, with homogenized figures according to a single common principle, which can be easily accessed and used by decision-makers, as well as for studies/research, etc.

The evaluation carried out must take into account not only each individual risk, but also multi-risk situations. Opportunities are also taken into account when analyzing the impact of

climate change, because the effectiveness of adaptation depends on its inclusion as part of socio-economic development.

In order to adapt to these risks, the Government of the Republic of Moldova adopted Decision no. 1009 of 10.12.2014 "Regarding the Approval of the Strategy of the Republic of Moldova for adapting to climate change until 2020 and the Action Plan for its Implementation" (Published on 19.12.2014 in the Official Gazette no. 372-384, art. no. 1089), as well as the National Climate Change Adaptation Program until 2030 and the Action Plan for its implementation, approved in the Government meeting on August 30, 2023. These documents outline a series of adaptation measures, recommending the APC to develop sectoral policy documents regarding adaptation to climate change, and for APL, to undertake the necessary measures to achieve their provisions.

The legal framework for adapting to climate change in the Republic of Moldova is provided by the Ministry of the Environment, and the implementation of adaptation activities is carried out under the auspices of the UN through the United Nations Framework Convention on Climate Change (UNFCCC) [16], ratified by Decision of the Parliament of the Republic of Moldova no. 404-XIII of 16.03.1995.

In this chapter, there was carried out a differentiated study of the impact produced by each meteo-climate risk phenomenon, and there were proposed adaptation and mitigation measures.

5.1 Adaptation and mitigation measures to the effects of the meteo-climate risk phenomena in the sectors of the national economy

According to the World Bank (WB) in 2016, the Republic of Moldova ranks as the most vulnerable country in Europe in terms of climate and the impact of climate change on social, economic and environmental dimensions.

It is predicted that the impact of climate change on the social, economic and environmental dimensions will intensify in the medium and long term. This fact will have devastating effects on the key economic sector – agriculture, and especially on the rural population, for whom agriculture is a major source of income and food. Climate change will reduce surface water flows by 16–20% by 2030. Medium-term projections indicate a continued increase in average annual temperature between 2010 and 2040 by 2°C.

Regarding the risks of climate-related natural disasters, the Republic of Moldova is especially prone to floods and droughts. According to information published on the World Bank (WB) Climate Change Knowledge Portal, average annual drought losses were approximately $19 million per year during 1996-2004. Severe droughts occurred in 2007, 2012 and most recently in 2020 and 2022. According to WB estimates, in 2007 our country suffered the worst drought in its modern history, affecting more than 80% of the territory and 135,000 people, causing respective losses of approximately $1 billion. WB estimates from 2016 show that the total cost of inaction regarding adaptation to climate change amounts to about 600 million USD, equivalent to 6.5% of GDP, a value that could double by 2050, reaching about 1.3 billion USD. In this context, since 2013, the Republic of Moldova has engaged in a national climate change adaptation planning process (NAP), in accordance with the Cancun Adaptation Framework, approved during the 16th Conference of the Parties to the
United Nations Framework Convention on Climate Change (UNFCCC) in 2010.

In the research of the given theme, the possible adaptation measures to the meteorological and climatic risk phenomena that occur during the warm period of the year in the Republic of Moldova were analyzed and highlighted. Adaptation and mitigation measures need to be focused in complementary strategies to address the effects produced by these phenomena.

Adaptation measures focus on policies to adapt to the impacts of climate change, which are already happening or expected to happen in the future. These measures aim to *reduce the vulnerability of communities and ecosystems to the effects of extreme weather events, rising temperatures and other climate-related risks.*

Mitigation measures, on the other hand, focus on *reducing greenhouse gas emissions* to slow and ultimately prevent further climate change. These measures address the root causes of climate change by reducing the amount of greenhouse gases emitted into the atmosphere.

From the perspective of sustainable development, adaptation and mitigation measures under climate change conditions must act *synergistically*, jointly to achieve a positive result. There are opportunities to implement a wide range of existing measures and examples of good practice, aimed at improving the management of environmental components such as *soils and water*, which can synergistically provide adaptation and mitigation benefits to the environment and the economy.

Thus, climate change adaptation measures for *the rural environment* must be oriented towards *the conservation of water resources, reducing the erosion potential of precipitation and preventing the formation of local floods.*

There are several methods of conserving water resources, both on and off-farm. The most widespread and accessible measures are *the promotion of conservative agriculture* that would reduce the need for water, the creation of rainwater ponds to store irrigation water, the creation of wetlands in river meadows (which will store the surplus water from wet periods), the promotion of water saving technologies, including irrigation.

The main actions required to minimize the erosion potential caused by heavy rainfall is a*fforestation*, both compact (in the form of massifs) and in the form of forest strips.

Based on the above, it is obvious the need to adopt a territorial organization plan for each community, taking into account the particularities of the landscape.

Of all the economic sectors, *agriculture* is the most dependent on the climate and therefore very vulnerable to the meteo-climate risk phenomena.

Some of the effective adaptation measures in the agricultural sector are: the use of varieties and hybrids for agricultural crops of autochthonous origin; implementation of adapted cultures; use of cover crops and artificial ground covers; crop diversification and rotation; no tillage and minimal tillage; ecological agriculture [17, 47].

The industrial sector is one of the largest generators of greenhouse gas emissions and is therefore one of the biggest drivers of climate change. Adaptation measures in the industrial sector can reduce emissions, improve energy efficiency and decrease vulnerability to climate change impacts.

Some examples of adaptation measures that are required in the industrial sector: energy efficiency improvements; water conservation; disaster preparedness; the development of renewable energy.

In order to mitigate and adapt *the transport sector*, it is necessary to establish the following components: assessment and management of risks related to the meteo-climate risk phenomena; investment in product design; insurance coverage; the integration of the climate strategy; new technologies.

Measures, which should be respected in the *tourism* economy for adaptation strategies to the meteo-climatic risk phenomena: the development of a National Plan for the tourism sector as part of the National Adaptation Plan (PNA); the elaboration of an economic analysis about the impact of the meteo-climate phenomena on the tourism sector; raising awareness; generating and communicating new information for climate risk management as major priorities; the rehabilitation and protection of natural resources (wetlands, biodiversity, forests, etc.) are essential adaptation strategies to the meteo-climate risk phenomena; providing financial assistance; assistance in integrating adaptation criteria and measures into sectoral plans and processes (eg investment programmes); sensitizing interested parties regarding the outcome of meteo-climatic phenomena; mediation of intersectoral dialogues.

5.2 Adaptation and mitigation measures to the meteo-climate risk phenomena regarding the natural environment

Mitigating the effects of global warming and adapting to climate change are done in synergy, with benefits for both agriculture, the economy and the environment in general (including by preserving/restoring biodiversity).

There can be identified specific categories of adaptation and mitigation to natural risk phenomena with the potential to affect the degree of environmental stability.

The soil. The main consequences of climate change at the regional level, with a major impact on soil resources, are related to the activation of extreme climatic phenomena: heat waves, periods of drought and floods, downpours (precipitation of increased intensity), which can cause the formation of local floods, increasing the intensity of the winds, increasing the frequency of droughts, etc. Some of these phenomena (showers, wind gusts) are the main causes that accelerate the soil erosion process, leading to soil degradation, increasing the clogging of water basins, where the eroded soil particles end up. This process can be stopped, or at least reduced, by expanding and correctly placing the forest strips to protect agricultural land.

The water. Climate change has a direct impact on water resources. Adaptation and mitigation measures on water resources, which aim to retain and maintain natural water, include:

Restoration of wetlands and floodplains. A wetland is an extensive flat area, completely or partially flooded, where water is the main factor controlling the natural environment and associated animal and plant life. It occurs where the water table is close to the surface. Wetlands are of dual importance in water resource management. During floods, they are able to absorb a surplus of water, and during drought they serve as the main source of the river's supply. The expansion and restoration of wetlands is required both in the meadow of the Prut and Dniester rivers, as well as on some small rivers (Răut, Cogâlnic, Botna, Camenca, Ialpug, etc.). The main conditions that must be taken into account when creating wetlands are the river meadows with an appreciable width (of 150-200 m), the presence of numerous springs or the water table near the surface, an impermeable or slightly permeable substrate (clay).

The forests. The beneficial effect of forests on water resources is very well known. These, in addition to reducing the input of pollutants and nutrients from agricultural land, also reduce the temperature of the water, thus preventing its evaporation. As a rule, degraded lands (affected by erosion and landslides), located on slopes or on interfluves, with sufficient amounts of precipitation, on forest soils (ashes, browns or clay-iluvial chernozems) are selected for afforestation.

GENERAL CONCLUSIONS AND RECOMMENDATIONS

General conclusions

Based on the research carried out in the doctoral thesis and the results obtained, the following general conclusions were formulated:

1. This paper highlights the current state of research on the impact of the meteo-climate risk phenomena from the warm period of the year on the territory of the Republic of Moldova from the beginning of the XXI century, in which the database on the meteo-climate risk phenomena for the last 22 years.

2. The synthesis of the study of the specialized literature and the research presented in the doctoral thesis demonstrates the following:

due to their origin and evolution, the meteo-climate risk phenomena are in the attention of the researches, and the impact produced by them, constitutes a basic element of the study carried out the physical-geographic space of the territory of the Republic of Moldova, during the warm period of the year, is influenced by several meteo-climate risk phenomena, which interact and are interdependent: dryness and drought, strong winds, torrential rains, floods, thunderstorms, hail, heat

waves, early autumn and late spring frosts, which sometimes, being induced by climate change, have an extreme character.

3.The meteo-climate risk phenomena represent deviations from the multi-annual norms and have a negative impact on the population, the economy and the environment, and in case of their intensification, there are announced exceptional situations. The damage caused by these phenomena is included in the category of natural disasters.

4. According to the proportions, extensions and severity of the consequences, exceptional situations are classified into local, territorial, national and cross-border, the damage caused by the meteo-climatic risk phenomena is evaluated by the commissions for exceptional district situations. The research carried out in this work on the impact of the meteo-climate risk phenomena during the warm period of the year established that the district with the highest share of damage caused by these phenomena for the last 22 years is the Cahul district with damages of over 1 billion lei, and according to the number of exceptional situations is the Soroca district with a number of 84 exceptional situations.

5. The personal research, carried out in the framework of this work, as well as the analysis of the reports and the database of the GIES for the period of 2000-2021, regarding the share of different categories of exceptional situations, produced by the meteo-climate risk phenomena from the warm period of of the year, demonstrates that torrential rains (64%), hail (20%) and strong winds (8%) have the greatest share in the establishment of exceptional situations, which does not correspond to the share of damage caused by the meteo-climate risk phenomena, where, according to the systematization of GIES data, it was deduced that the greatest share of the damage is due to dryness and drought with (62%), followed by torrential rains with (25%), followed by hail with (6%) and early frosts and the late ones with (4%).

6. The study carried out shows the fact that at the present time in the Republic of Moldova there is no public policy document in the field of managing emergency and exceptional situations, as well as lack of methodologies and specialists to assess the impact on the environment, produced by the meteo-climate risk phenomena, based on scientific research, aspect confirmed in the Program for the prevention and management of emergency and exceptional situations for the period 2022-2025 (HG no. 846/2022.).

7. The materials of the given thesis, with reference to the assessment of the impact caused by the meteo-climate risk phenomena during the warm period of the year on the territory of the Republic of Moldova, highlight a series of adaptation and mitigation measures in relation to these phenomena, but also specify the urgent need to implement adaptation and mitigation policies and measures appropriate to the weight of damage produced. These policies and measures are included in the National Climate Change Adaptation Program until 2030 and the Action Plan for its implementation, approved in the meeting of the Government of the Republic of Moldova on August 30, 2023.

8. Knowledge of the risks related to meteo-climate phenomena by the population and decision-makers in rural and urban areas, in the agricultural, industrial, energy, social and other branches of the economy offers a wider range of responses and adaptive solutions.

Practical recommendations

1. Highlighting the need to intensify research on the origin and evolution of meteo-climate phenomena with an emphasis on the risks induced by them, a deeper study of the particularities of their manifestation in the space of the Republic of Moldova with the establishment of the vulnerability of the country's territory to the respective phenomena.
2. Estimation of the exposure of the territory of the Republic of Moldova in relation to the impact produced by meteo-climate phenomena, as well as measures established for its adaptation and mitigation.

3. The results of the conducted study are proposed as support for APC, APL and GIES in developing policies based on managing risks and not crises, and the activity programs of decision-makers to contain more proactive than reactive measures.
4. It is necessary to initiate a study on the impact of the meteo-climate risk phenomena from the cold period of the year which would complete the database for the whole year, at the same time it is recommended that methodical instructions be developed and specialists trained who will intervene in the evaluation the damage caused to the natural environment by these phenomena.
5. The materials developed within the research of the given topic can serve as an informational guide for the review of GIES, APC and APL policies in taking rapid measures to prevent, reduce and mitigate the consequences of risks induced by meteo-climate phenomena.
6. The database and scientific results obtained in the conducted study are recommended and useful for the development of environmental strategies and programs, didactic materials within specialized educational institutions in the Republic of Moldova, in the process of professional training of pupils, students, master's students, etc.

Personal contributions:

In this paper, personal contributions include several aspects, the most relevant of which are the following:

- the analysis of the topic researched in the doctoral thesis through the prism of the existing publications in the field and highlighting the evolution of the impact of meteo-climate risk phenomena in the Republic of Moldova for over 20 years;
- the collection and processing of a large volume of information and data from the archives of the General Inspectorate for Emergency Situations (GIES) and the National Bureau of Statistics (NBS), for the period 2000-2021, regarding the meteo-climate risk phenomena during the warm period of the year and the impact produced by them on the population, economy and environment of the Republic of Moldova, using a calculation program in the Visual Basic programming language under the OFFICE 365 platform through EXCEL;
- analysis of the temporal evolution and spatial distribution of exceptional situations and damages caused by the meteo-climate risk phenomena during the warm period of the year on the territory of the Republic of Moldova since the beginning of the XXI century;
- the creation of cartographic material (digital maps), by using the GIS program, based on an administrative-territorial conceptual principle, which highlights the vulnerable areas to the risks produced by the presented meteo-climate phenomena.

Proposals for new directions for future research:

- The complex study of the impact produced by all phenomena of meteorological and hydrological origin, a fact that would ensure the successful implementation of the *Program for the prevention and management of emergency and exceptional situations for the years 2022-2025.*
- Carrying out research on the effects and consequences of the application of adaptation and mitigation measures in relation to the impact produced by the meteo-climate risk phenomena.

- Relevant studies on the strengthening of institutional capacities in the management of risks produced by natural phenomena through educational and training activities with the realization and implementation of pilot projects and dissemination of good practices.

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• Articles in scientific journals

1. POTOPOVA V., **CAZAC V.,** BOINCEAN B. Soukup Josef, Trnka Miroslav.Application of hydtoclimatic drought indicators in the transboundary Prut River basin. În: *Theoretical and Applied Climatology*. 2019, nr. 3-4 (137), p. 3103-3121. ISSN; 0177-798X. Disponibil: https://link.springer.com/article/10.1007/s00704-019-02789-w
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3. CODREANU I., **CAZAC V**. Ecosistemelesilvicedinbazinulrâului Bîc- oportunități de realizare a practicii de specializare și formare a competențelor profesionale la geografi. Publicat: *Acta et Commentationes, Sciences of Education,* 2023, nr. 1(31), p.93-101. ISSN;857-0623, E-ISSN 2587-3636.
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- **Articles in the proceedings of conferences and other scientific events**

4. **CAZAC V**. Evoluția cantitativă a apelor de suprafață în contextul procesului de aridizare a teritoriului Republicii Moldova. În: *Materialele conferinței naționale ,,Mediul și dezvoltarea durabilă".* Ediția aV-a, Chișinău, 30-31 octombrie 2020, p.33-38. Disponibil: https://ibn.idsi.md/sites/default/files/imag_file/33-38_16.pff
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6. **CAZAC V**. Climatic andhydrometeorologicalphenomena of risk on theterritory of the Republic of Moldova. În: *Materialele Conferinței Naționale ,,Life sciences in thedialogue of generations: connectionsbetweenuniversities, academia and business community".* vol. 2, Chişinău, 29-30 septembrie 2022, p. 161-162.
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7. **CAZAC V**. The impact anddamagecausedbytorrentialrains in the period 2000-2021 on theterritory of the Republic of Moldova. În: *The National Conferencewithinternationalparticipation*, Edition VI, Natural siences in thedialogue of generations, Chișinău, 14-15 september,2023.
   Disponibil: http://agarm.md

ADNOTARE

Cazac Valeriu *„Impactul fenomenelor meteo-climatice de risc din perioada caldă a anului de pe teritoriul Republicii Moldova la începutul secolului XXI și posibilități de atenuare”.* Teză de doctor în științe ale naturii, Chișinău, 2023.

Structura tezei. Teza este alcătuită din: introducere, cinci capitole, concluzii generale și recomandări, 177 surse bibliografice, 126 pagini de text de bază, 41 figuri, 3 tabele și 7 anexe.

Cuvintele-cheie:impact, pagube, uscăciunea și secetele, vânturile puternice, ploile torențiale, inundaţiile, orajele, grindina, valurile de căldură, înghețurile timpurii și cele tardive.

Scopul lucrării constă în evaluarea impactului fenomenelor meteo-climatice de risc din perioada caldă a anului de la începutul sec. XXI de pe teritoriul Republicii Moldova, evidențierea, argumentarea și propunerea măsurilor de adaptare și atenuare în raport cu acestea.

Obiectivele. Stabilirea variabilităţiispaţio-temporale a impactului negativ a fenomenelor meteo-climatice de risc pentru perioada 2000-2021; documentarea și analiza principalelor fenomene meteo-climatice de risc din perioada caldă a anului și impactul lor; evidențierea măsurilor de adaptare și atenuare a efectelor negative induse de acestea.

Metodologia cercetării științifice. Studiul include principii conceptual-teoretice și metode geografice de cercetare diferențiată a impactului negativ a fenomenelor meteo-climatice de risc. S-au utilizat Sistemele Informaționale Geografice (SIG) în prelucrarea datelor statistice cu privire la riscurile meteo-climatice și elaborarea hărților, care demostrează aspectele spațiale ale acestora.

Noutatea ştiinţifică a rezultatelor obţinute. În lucrarea dată sunt formulate și aplicate noi abordări de estimare ale impactului negativ al fenomenelor meteo-climatice de risc din perioada caldă a anului din Republica Moldova, pentru anii 2000-2021, prin aplicarea unui nou principiu conceptual-teoretic de estimare diferențiată a impactului negativ al fenomenelor meteo-climatice de risc, care constă *în identificarea impactului estimat prin pagubele produse de către acestea, raportate la unitate administrativ-teritorială (raion).*

Rezultatele ştiinţificepropuse spre susținere: noi estimări diferențiate ale impactului negativ al fenomenelor meteo-climatice de risc specifice perioadei calde a anului de la începutul sec. XXI de pe teritoriul Republicii Moldova, în raport cu amploarea pagubelor pe *unitate administrativ-teritorială (raion)*; noi abordări teoretice în ceea ce privește repartiția spațio-temporală a riscurilor pentru perioada caldă a anului pe durata de 22 ani, prin estimarea pagubelor induse de acestea; evidențierea măsurilor deadaptare și atenuare la aceste riscuri.

Semnificația teoretică. Au fost formulate principii conceptual-teoretice de evaluare diferențiată a impactului negativ a fenomenelor meteo-climatice de risc din perioada caldă a anului din Republica Moldova pe parcursul 2000-2021 și de aplicare a măsurilor de adaptare și atenuare a efectelor acestora.

Valoarea aplicativă a lucrării. A fost creată și sistematizată baza de date privind fenomenele meteo-climatice de risc și distribuția spațio-temporală a lor; a fost evaluat impactul riscurilor fenomenelor meteo-climatice din perioada caldă a anului; s-a estimat ponderea pagubelor produse de fenomenile meteo-climatice de risc pentru ultimii 22 ani; au fost întocmită statistica situațiilor excepționale pentru fiecare raion în raport cu fenomenele meteo-climatice de risc; au fost evedențiate măsurile de adaptare și atenuare a impactului indus de ceste fenomene.

Implementarea rezultatelor ştiinţifice. Hărțile și diagramele privind reapartiția spațio-temporală a pagubelor produse de fenomenele meteo-climatice de risc din perioada caldă a anului de la începutul sec. XXI de pe teritoriul Republicii Moldova, propuse a fi utilizate de IGSU, APC, APL și alți factori de decizie în elaborarea și implementarea politicilor de managment a riscurilor.Totodată, concluziile lucrării pot servi la realizarea proiectelor și programelor de protecție civilă a populației, de protecție și conservare a mediului, în sectorul agricol, energetic, transport, turism s.a., și în predarea cursurilor de specialitate în învățământul superior (geografie, pedologie/pedogeografie, protecția mediului, agronomie, etc.), pentru pregătirea profesională.

АННОТАЦИЯ

Казак Валериу*"Воздействие опасных метео-климатических явлений теплого периода года на территории Республики Молдова с начала 21 века и возможности его смягчения".* Докторская диссертация по естественным наукам, Кишинев, 2023.

Структура диссертации. Диссертация состоит из: введения, пяти глав, общих выводов и рекомендаций, 177 библиографических источников, 126 страниц основного текста, 41 рисунка, 3 таблиц и 7 приложений.

Ключевые слова: воздействие, ущерб, засуха, сильные ветры, проливные дожди, наводнения, грозы, град, аномальная жара, ранние и поздние заморозки.

Цель работы – оценить ущерб от воздействия влияния опасных метео-климатических явлений теплого периода года с начала XXI века на территории Республики Молдова, определяя, аргументируя и предлагая меры по адаптации и смягчению их последствий.

Задачи: установить временно-пространственную изменчивость опасных метео-климатических явлений в период 2000 – 2021 гг.; документирование и анализ основных опасных метео-климатических явлений теплого периода года и их негативных воздействий на территории РеспубликиМолдова; определение мероприятий по адаптации и смягчения негативных эффектов вызванных ими.

Методика научных исследований. Данное исследование включает в себя концептуально-теоретические принципы дифференцированной оценки (исследования) негативного воздействия явлений метео-климатического риска на территории Республики Молдова, а также использование Географических Информационных Систем (ГИС) при обработке статистических данных о метео-климатических рисках и разработке карт, демонстрирующих их пространственные аспекты.

Научная новизна полученных результатов: Данная работа представляет собой разработанные новые подходы к оценке негативного воздействия опасных метео-климатических явлений теплого периода 2000-2021 годов в Республике Молдова, был применен новый теоретико-концептуальный принцип дифференцированной оценки, который заключается в определении ущерба, относящегося к административно-территориальной единице.

Предлагаемые научные результаты: Создана и систематизирована база данных по опасным метео-климатическим явлениям и их пространственно-временному распределению за начало XXI века; оценен ущерб от влияния опасных метео-климатических явлений в теплый период за последние 22 года по каждому району; составлена статистика чрезвычайных ситуаций, связанных с метео-климатическими явлениями; были определены меры по адаптации и смягчению воздействия этих явлений.

Теоретическое значение: Сформулированы концептуально-теоретические принципы дифференциальной оценки негативного воздействия опасных метео-климатических явлений на территории РеспубликиМолдова в 2000 – 2021 гг. И определены меры по адаптации к ним и смягчению их последствий.

Прикладная ценность работы. Создана и систематизирована база данных по опасным метео-климатическим явлениям и их пространственно-временному распределению; оценено влияние рисков метео-климатических явлений за теплый период года; оценен ущерб, причиненный опасными метео-климатическимии явлениями за последние 22 года; по каждому району составлена статистика чрезвычайных ситуаций, связанными с метео-климатическими явлениями; были определены меры по адаптации и смягчению воздействия этих явлений.

Внедрение научных результатов. Представленые карты и диаграммы пространственно-временного распределения ущерба от опасных метео-климатических явлений за теплый период года с начала XXI века на территории Республики Молдова предлагается использовать Генеральной Инспекцией по Чрезвычайным Ситуациям (ГИЧС), Центральной Государственной Администрацией (ЦГА) и Местной Государственной Администрации (МГА) и другими органами власти, принимающими решения при разработке и реализации политики управления рисками. В тоже время выводы даной работы рекомендуется использовать для реализации проектов и программ гражданской защиты населения, охраны окружающейс реды, в сельскохозяйственной, энергетической, транспортной, туристической и др. отраслях, а также при преподавании специализированных курсов в высших учебных заведениях для профессиональной подготовки.

ANNOTATION

Cazac Valeriu ***"The impact of meteo-climate risk phenomena during the warm period of the year on the territory of the Republic of Moldova at the beginning of the 21st century and mitigation possibilities".*** Doctoral thesis in natural sciences, Chisinau, 2023.

The structure of the thesis. The thesis consists of an introduction, five chapters, general conclusions and recommendations, 177 bibliographic sources, 106 pages of body text, 41 figures, 3 tables, and 6 appendices.

Keywords: impact, damage, drought, strongwinds, torrentialrain, floods, thunderstorms, hail, anormal heat, early and late frosts.

The purpose of the work is to assess the impact of meteo-climate risk phenomena in the warm season on the territory of the Republic of Moldova since the beginning of the 21st century, highlighting, arguing, and proposing measures for the adaptation and mitigation of the consequences of these events.

Objectives: Determination of the spatio-temporal variability of the negative impact of meteo-climate risk phenomena in the period of 2000–2021; documentation and analysis of the main meteo-climate risk phenomena in the warm season and their impacts on the territory of the Republic of Moldova; identification of measures for the adaptation and mitigation of the adverse effects caused by these events.

Scientific research methodology. The study includes conceptual-theoretical principles and geographical methods of differentiated research on the negative impact of meteo-climate risk phenomena. Geographical Information Systems (GIS) were used in the processing of statistical data on meteo-climate risks and the development of maps, which demonstrate their spatial aspects.

Scientific novelty of theresults obtained. In this work, new approaches to estimating the negative impact of the meteo-climate risk phenomena from the warm period of the year in the Republic of Moldova, for the years 2000-2021, are formulated and applied, by applying a new conceptual-theoretical principle of differentiated estimation of the negative impact of the meteo-climate risk phenomena, which consists in identifying the estimated impact through the damage caused by them, reported to the administrative-territorial unit (district).

Research results proposed: New differentiated estimates of the negative impact of meteo-climate risk phenomena specific to the warm period of the year from the beginning of the 21st century from the territory of the Republic of Moldova, in relation to the extent of the damage per administrative-territorial unit (raion); new theoretical approaches regarding the spatio-temporal distribution of risks for the warm period of the year for 22 years, by estimating the damages induced by them; highlighting adaptation and mitigation measures to these risks.

Theoretical significance. Conceptual-theoretical principles were formulated for the differentiated assessment of the negative impact of the meteo-climate risk phenomena from the warm period of the year in the Republic of Moldova during 2000-2021 and for the application of measures to adapt and mitigate their effects.

Applied significance of the work: The database was created and systematized regarding meteo-climate risk phenomena and their spatio-temporal distribution; the impact of the of meteo-climate risk phenomena during the warm period of the year was evaluated; the weight of the damage caused by the meteo-climate risk phenomena for the last 22 years was estimated; the statistics of emergency situations were drawn up for each district in relation to meteo-climate risk phenomena; the measures to adapt and mitigate the impact induced by these phenomena were highlighted.

Implementation of scientific results. Maps and diagrams on the spatio-temporal distribution of the damage caused by meteo-climate risk phenomena of the warm period of the year from the beginning of the 21st century on the territory of the Republic of Moldova, are proposed to be used by IGSU, APC, LPA and other decision makers in the development and implementation of risk management policies. At the same time, the conclusions of the work can serve to implement projects and programs of civil protection of the population, environmental protection and conservation, in the agricultural sector, energy, transport, tourism, etc., and in teaching specialized courses in higher education (geography, pedology/pedogeography, environmental protection, agronomy, etc.), for professional training.

CAZAC VALERIU

THE IMPACT OF METEO-CLIMATE RISK PHENOMENA FROM THE WARM PERIOD OF THE YEAR ON THE TERRITORY OF THE REPUBLIC OF MOLDOVA AT THE BEGINNING OF THE XXI CENTURY AND POSSIBILITIES OF MITIGATION

166.02 - ENVIRONMENT PROTECTION AND RATIONALE USE OF NATURAL RESOURCES

SUMMARY
of the Doctoral Thesis in Natural Sciences

Approved for publishing 21.12.2023 Paper offset. Type offset Pattern printed sheets: 19	Format: 60x84 1/16. Prin run: ex. 25 Order nr. 1

CENTRUL EDITORIAL-POLIGRAFIC USM
Chișinău 2023