

## REPUBLIC OF MOLDOVA'S ZONATION BY CLIMATIC RISK LEVEL

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**Key words:** climatic risks, vulnerability, Geographical Informational System (SIG), probability, late spring frosts.

**Abstract.** Till present neither in the world nor in the Republic of Moldova is there a unanimously accepted terminology that concerns extreme natural phenomena. At the same time, UNDP experts have elaborated a unified definition of natural hazards risk (Disaster Risk Index, DRI), which mentions the *negative consequences probability and foreseen losses* that result from interaction with dangerous phenomena of natural and anthropic origin and from vulnerability conditions.

### Introduction

Vulnerabilities are *conditions* determined by natural, social, economical factors or *processes* that intensify communities' exposure to danger's influence (Reducing Disaster Risk, global report, 2005).

CRED, *the* Centre for Research on the Epidemiology of Disasters, Université Catholique de Louvain (UCL), Belgium, which is the most authoritative organization in statistics of calamities of different origin, bases its definition on criteria that include the following requirements: *10 or more human victims, not less than 100 affected, international help soliciting, declaration of national emergency* [1].

### Materials and investigation methods

The necessity of natural risks evaluation at the national level, including climatic ones, is conditioned by the significant increase in the number and

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frequency of their manifestation. In this context we should mention that using mathematical investigation methods of a phenomena or natural process needs first of all modeling, identifying particular characteristics that would describe integrally a phenomena or a random event. Their evolution is guided by *probabilistic laws* that state a certain chance for respective manifestation to lead to a predefined result. From this point of view, events or random signals are different from *deterministic* ones, the values of which can be estimated with accuracy in any moment of time. Theoretic support which allows random signals analysis is offered by the *probability theory* which is mainly analyzing medium values of physical manifestations which are produced at larger scale.

The connection point between the multitude of real physical manifestations and unified mathematical formalism is the *random variable* expressed by the function which associates a number per each possible result of a given experiment. An ensemble of random variables defines a *random process*.

A central role in the probability theory is the mathematical expectation which subscribes to a random variable a value resulted from an arithmetic mean of infinite theoretical numbers of individual realizations of considered physical manifestations. As a function of discrete or analogue experimental character it is defined as:

$$E\{\mathbf{X}\} = \sum_{i=1}^n p_i x_i$$

$$E\{\mathbf{X}\} = \int_{-\infty}^{\infty} x f_x(x) dx$$

Where X is a random value which presumably has n possible realizations with  $p_i$  probabilities in discrete cases, and in analogue cases it is *probability density*  $x f_x$  respectively. Subsequently, *climatic risk notion includes the probability of manifestation of a certain climatic extreme event within the limits of prevention* [2, 3, 4].

Thus, the territorial zoning according to climatic risk degree is normally based on verisimilar risk indexes. The quantitative evaluation of climatic extremes is based on an interaction which reflects its manifestation frequency's variability with different intensity degree.

Taking into consideration the limited number of meteorological stations as well as the relief conditions of the republic's territory, we used as initial data for spatializing, e.g. the factors that determine zonal repartition of climatic elements the geographic latitude ( $\phi$ ) and longitude ( $\lambda$ ). Azonal factors include absolute (H) and relative ( $\Delta h$ ) altitude, the coefficient of fragmentation (d), slope (k) and exposition (a). The models of physical and geographical factors influence in

climatic risk elements redistribution was executed using Statgraphics Centurion XV software and multiple regressions with stepping procedure.

### 1. Analysis of obtained results

The cartographical models that reflect the probable manifestation (once in 10 years) of climatic risk factors such as extreme seasonal temperatures and late spring and early autumn frosts were layered with the administrative regions limit, and territorial climatic risk was calculated. The proposed investigations in our opinion are extremely important taking into account the agrarian orientation of the republic's economy and the need to provide consumers with climatic information on local level.

Thus for the Republic of Moldova's agriculture late spring frosts are substantially dangerous, as they can catch agricultural plants in their first or last phases of development causing freezes sometimes substantially severe. The cartographic modeling of dangerous spring frosts layered with the administrative regions' limits (fig.1) allowed computing (tab.1) the manifestation of extreme temperatures – a necessary information for effective measures of prevention and mitigation of the given risk.

Thus in:

Briceni – once in 10 years on 70% of the region's territory are registered critical temperatures during spring within the limits of  $-4\div-5^{\circ}\text{C}$ .

Ocnita – once in 10 years on 60% of the region's territory are registered critical temperatures during spring within the limits of  $-4\div-5^{\circ}\text{C}$ .

Edinet – once in 10 years on 60% of the region's territory are registered critical temperatures during spring within the limits of  $-4\div-5^{\circ}\text{C}$ .

Donduseni – once in 10 years on 60% of the region's territory are registered critical temperatures during spring within the limits of  $-4\div-5^{\circ}\text{C}$ .

Soroca – once in 10 years on 30-40% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-5^{\circ}\text{C}$ .

Riscani – once in 10 years on 30-50% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-5^{\circ}\text{C}$ .

Drochia – once in 10 years on 30-40% of the region's territory are registered critical temperatures during spring within the limits of  $-4\div-5^{\circ}\text{C}$ .

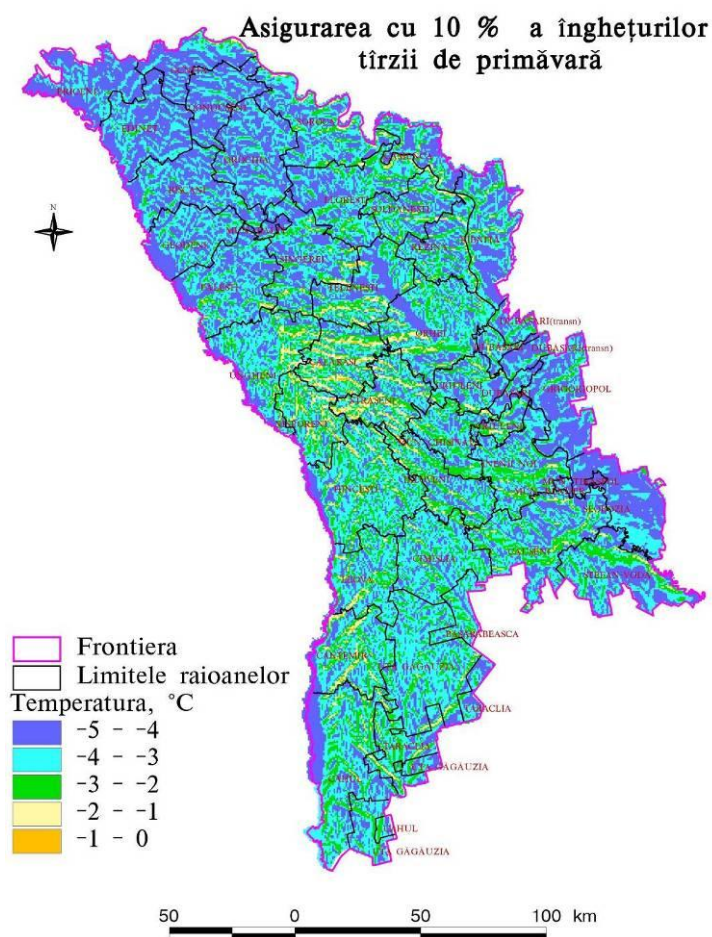
Floresti – once in 10 years on 70% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-5^{\circ}\text{C}$ .

Soldanesti – once in 10 years on 30% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-5^{\circ}\text{C}$ .

Tab. 1 - Assurance (10%) of late spring frosts on Republic of Moldova's territory

	Administrative territorial units	-5...-4	-4...-3	-3...-2	-2...-0	0...1
1	Briceni	70	25	5		
2	Ocnita	60	20	10	8	2
3	Edinet	60	30	9	1	
4	Donduseni	60	30	10		
5	Soroca	40	30	20	10	
6	Riscani	50	30	19	1	
7	Drochia	60	30	10		
8	Floresti	40	30	20	10	
9	Soldanesti	30	30	30	8	2
10	Glodeni	50	30	20		
11	Falesti	35	35	20	8	2
12	Balti Mun.	70	20	10		
13	Singerei	30	30	30	8	2
14	Telenesti	35	20	20	20	5
15	Rezina	30	30	30	10	
16	Camenca	50	25	20	5	
17	Ribnita	45	25	25	4	1
18	Ungheni	25	40	20	10	5
19	Calarasi	10	40	25	15	10
20	Orhei	25	40	25	8	2
21	Dubasari (Transnistria)	50	30	19	1	
22	Dubasari	40	30	20	10	
23	Nisporeni	15	35	30	15	5
24	Straseni	15	30	25	25	5
25	Criuleni	20	35	35	9	1
26	Grigoriopol	50	30	18	2	
27	Hincesti	20	30	30	18	2
28	Ialoveni	25	30	30	14	1
29	Chisinau Mun.	25	35	35	5	
30	Anenii Noi	25	30	30	14	1
31	Tiraspol Mun.	100				
32	Leova	20	30	30	18	2
33	Cimislia	25	35	30	9	1
34	Causeni	25	35	25	13	2
35	St. Voda	35	30	30	4	1
36	Cantemir	20	35	30	10	5
37	UTA Gagauzia	40	25	25	8	2
38	Basarabasca	20	55	20	5	
39	Taraclia	20	35	25	18	2
40	Cahul	30	35	20	14	1
41	Slobozia	50	40	5	4	1
42	Tigina Mun.	50	45	5		

Fig.1 - Late spring frosts (10% - assurance) manifested on Republic of Moldova's territory



Glodeni – once in 10 years on 30-50% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-5^{\circ}\text{C}$ .

Falesti – once in 10 years on 35% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-5^{\circ}\text{C}$ .

Mun.Balti – once in 10 years on 70% of the region's territory are registered critical temperatures during spring within the limits of  $-4\div-5^{\circ}\text{C}$ .

Singerei – once in 10 years on 30% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-5^{\circ}\text{C}$ .

- Telenesti – once in 10 years on 35% of the region's territory are registered critical temperatures during spring within the limits of  $-4\div-5^{\circ}\text{C}$ .
- Rezina – once in 10 years on 30% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-5^{\circ}\text{C}$ .
- Camena – once in 10 years on 50% of the region's territory are registered critical temperatures during spring within the limits of  $-4\div-5^{\circ}\text{C}$ .
- Ribnita – once in 10 years on 45% of the region's territory are registered critical temperatures during spring within the limits of  $-4\div-5^{\circ}\text{C}$ .
- Ungheni – once in 10 years on 40% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-4^{\circ}\text{C}$ .
- Calarasi – once in 10 years on 40% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-4^{\circ}\text{C}$ .
- Orhei – once in 10 years on 40% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-4^{\circ}\text{C}$ .
- Dubasari – once in 10 years on 30-40% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-5^{\circ}\text{C}$ .
- Nisporeni – once in 10 years on 30-35% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .
- Straseni – once in 10 years on 25-30% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .
- Criuleni- once in 10 years on 35% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .
- Grigoriopol – once in 10 years on 50% of the region's territory are registered critical temperatures during spring within the limits of  $-4\div-5^{\circ}\text{C}$ .
- Hincesti – once in 10 years on 30% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .
- Ialoveni – once in 10 years on 30% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .
- Mun. Chisinau – once in 10 years on 35% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .
- Anenii Noi – once in 10 years on 30% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .
- Mun. Tiraspol – once in 10 years on 100% of the region's territory are registered critical temperatures during spring within the limits of  $-4\div-5^{\circ}\text{C}$ .
- Leova – once in 10 years on 30% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .

- Cimislia – once in 10 years on 30-35% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .
- Causeni – once in 10 years on 25-35% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .
- Stefan-Voda – once in 10 years on 30-35% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-5^{\circ}\text{C}$ .
- Cantemir – once in 10 years on 25-40% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .
- Gagauzia – once in 10 years on 30-35% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-5^{\circ}\text{C}$ .
- Basarabeasca – once in 10 years on 55% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-4^{\circ}\text{C}$ .
- Taraclia – once in 10 years on 25-35% of the region's territory are registered critical temperatures during spring within the limits of  $-2\div-4^{\circ}\text{C}$ .
- Cahul – once in 10 years on 30-35% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-5^{\circ}\text{C}$ .
- Slobozia – once in 10 years on 40-50% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-5^{\circ}\text{C}$ .
- Mun. Tighina – once in 10 years on 45-50% of the region's territory are registered critical temperatures during spring within the limits of  $-3\div-5^{\circ}\text{C}$ .

Thus, the inhomogeneous manifestation of climatic risk phenomena on the example of late spring frosts, would allow in future elaborating adequate measures for the mitigation of climatic risk factors which can substantially decrease agricultural ecosystems productivity.

The intensity and frequency of climatic risk factors manifestation is increasing due to the global warming impact and climatic regional changes, which leads to society's increased vulnerability in general and agriculture's in particular to these unfavorable phenomena. In this context, climatic risk factors manifestation's intensity, duration and area knowledge can contribute to the mitigation of their consequences for various practical agricultural activities.

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