

Analysis of natural environmental risks occurring in the Republic of Moldova

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Abstract. Nowadays a healthy and stable environment determines the standard of living and the productivity level of the human society. To obtain an objective image and to be able to coordinate their daily activities, people must identify and evaluate the sources of natural environmental risks. The Republic of Moldova is very vulnerable to natural environmental risk, especially climatic ones. The natural environmental risks specific to the Republic of Moldova are characterised by a medium to high frequency and medium to high consequences. A large number of natural risks are affecting the country's territory, among which the following ones are especially frequent: drought, floods, frost, earthquakes, hail. According to the data provided by the Civil Protection and Emergency Situations Service of the Republic of Moldova, during the 2007-2017 period 915 emergency situations of natural origins took place, causing a total loss of over 209 million EUR. The most vulnerable to these natural phenomena are the agriculture and the industries using agricultural products as raw material, especially the food and drinks industry. For a pertinent evaluation of natural environmental risks and of the quality of the environment, this action has to be interdisciplinary, based on a complex system of investigation methods, procedures, techniques, feasible principles and instruments. The climatic risks amelioration measures often need additional funding for the construction of a proper infrastructure, for the elaboration and implementation of advanced monitoring, prevention and aftereffects diminishing technologies, spatial planning, planting risk conditions-resistant crops, erecting buildings that can withstand natural disasters, positioning at reasonable distances from the risk source, or choosing areas with a crop-favouring microclimate.

Key Words: natural risks, emergency situations of natural origins, damage, risk management.

Background. The environment was always a critical factor for human beings and is strongly influenced by human activities. This relation did constantly change its intensity and priorities, in accordance with the evolution of humankind.

At the beginning humanity being a masterpiece and integral part of nature, following the rules and restrictions, adapting their lives to it, later by humanity progress and science and technology progress, they adopted an aggressive and intensive consumption strategy extracting resources frequently in an irrational and foolish way.

In this context, the circumstances force us to realise that humankind entered, since the second half of the 20th century, in a new stage of its evolution – the era of risk. This stage is characterised not only by the dangers represented by losses or by material damages caused by natural risks, but also by the impending danger to the health and life of humans, or even to the existence of human civilisation. Finally, the stretching of the resources of the environment, the pollution beyond the environment's capacity to regenerate, the massive deforestation, the extinction of many animal and plant species, etc., effect irreversible changes in the normal development of natural processes which, ultimately, result in an increased number of cataclysms and disasters. Thus, in only a few decades, these phenomena caused numerous casualties worldwide, as well as damages worth hundreds of billions of Euros. This is exactly why, in last year's, the notion of „risk” is used with increased regularity aside those of „ecology” and „environment” in order to define environmental risks. Know these risks has become a necessity of modern society and constitutes a primary condition for the execution of impact studies, territorial planning projects and, generally, a core condition for an efficient and sustainable management (Beck 1992; Dwyer 2004; Răboșapca 2014).

The largely unpredictable character of social and economic activities requires a vast and interdisciplinary research of risk at both theoretical and practical levels. The complexity of the studied field is increased by the fact that environmental risks can be generated by human activities with impact on the environment, but also by natural risks

with impact on human activities and existence, in other words, natural phenomena can cause technogenic disasters and vice versa.

Integrating the environment variable in development strategies of different levels is a relatively new approach, brought forward by the deterioration of the environment and the obvious increase in natural disasters. Recognition of environmental problems occurred only in the 1960s, becoming wide-spread in the following decade (Varnes 1984; Răboșapca & Barta 2014).

To know and to assess properly environmental risks is not only a primal condition. It is a part of efficient economic management, meaning minimising costs and losses and maximising profit, resulting to lowering the population's vulnerability towards natural or anthropic risks and the impact of human activities on the environment, while, during a state of emergency, to offering relief aid to regions in need in order to counteract ecological, social, and economic effects.

Analysing statistical data available for the Republic of Moldova. A large number of natural risks, especially the following natural risk phenomena, affects the country's territory: drought, floods, frost, earthquakes, hail, etc.

All these natural risk phenomena, excepting earthquakes, have a progressive pattern. Agriculture and the industries using agricultural products as raw materials, namely the food and beverage industries, are the most vulnerable.

According to the data provided by the Civil Protection and Emergency Situations Service of the Republic of Moldova, during the period 2007-2017 took place 915 emergency situations of natural origins, total loss being over 209 million EUR. In 2017 there were 273 emergency situations occurred; 92, representing 33.7% of the total, had natural origins, causing 99.9% (over two million EUR) of all property damage, most of them being induced by meteorological phenomena (Figure 1).

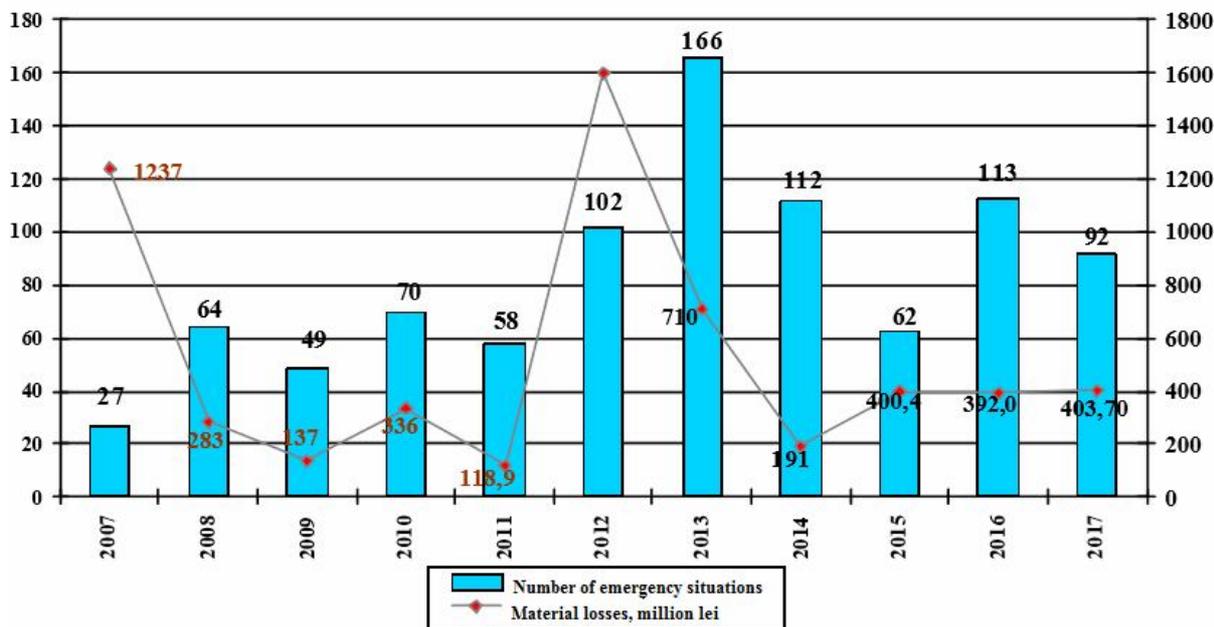


Figure 1. The number of emergency situations that took place in the Republic of Moldova, 2007-2017 (Source: Statistical indexes for the year 2017, The Civil Protection and Exceptional Situations Service of the Republic of Moldova's Ministry of Internal Affairs, <http://www.dse.md/>).

During this decade, the usual annual amount of damages ranged between 300 and 400 million Moldovian lei, or 15-20 million EUR, except for the years 2007 and 2012, when far higher values – 61,85 million EUR and 80 million EUR, respectively – were reported.

From 1990 to the present day, 9 natural disasters occurred in the Republic of Moldova, of which 5 were floodings. The most human lives were lost during the 1994 flood, when 47 people died (<http://www.dse.md/>).

The number of emergency situations of natural origin fluctuates greatly from one year to another, but this is due the occurrence of meteorological and agrometeorological extreme phenomena, that do not depend directly on the human factor.

Analysing the frequency with which emergency situations of natural origin happen, we can observe that the following phenomena have the highest – almost yearly – occurrence frequency:

- *heavy rainfall* (≥ 30 mm in ≤ 1 hour and ≥ 50 mm in ≤ 12 hours), that may be accompanied by hailstorm and/or wind. Heavy rainfall (rain showers) is being generated by strong convective air movement, especially in the warm season of the year, and constitutes a risk factor insofar it can cause certain erosional processes, or it may lead to high waters and flooding in hydrographical basins, thus having a strong impact on hillside transformation through accelerated erosion, often causing a wide range of slope processes, destroying pastures and crops. Especially intense and strong heavy rainfalls occur in the following months: July (40%), June (36,5%), and August (15,7%) (<http://www.dse.md/>). As a consequence of heavy rainfalls in July and August 2008, floods on the rivers Nistru and Prut affected 22 raions and caused major losses to farms, of over 120 million USD. Due to these events, 8473 ha of arable land and 4980 ha of pastures were flooded, over 3000 animals drowned, 3000 wells were affected, and hundreds of homes and large parts of road infrastructure were destroyed. Likewise, in 2010 the floodings in the raions Briceni, Râșcani, Ungheni, Hâncești, Nisporeni, Anenii Noi, Cantemir, and Cahul caused huge material damage, rising to some 9 million EUR.

- *hail* is a form of solid precipitation consisting of transparent or opaque ice lumps of various shapes, size, and weight, which fall during rain showers with thunders, lightning, and wind, such as thunderstorms. As a phenomenon with its highest frequency in the warm season, hail is falling on crop plants in various stages of development, affecting the proper continuation of the biological cycle and possibly compromising the entire harvest. In the last decade, heavy rainfall with hail and strong winds occurred almost every year, causing massive damage: in 2008, material losses rose to almost 17 million EUR, in 2009 – over 8 million EUR, in 2010 – approximately 20 million EUR, in 2011 – almost 7 million EUR, in 2013 – over 33 million EUR, in 2014 – 6 million EUR, and in 2016 the losses counted 9,5 million EUR.

On average, following critical risk phenomena occur every two years:

- *droughts*, which represent periods with humidity deficit, usually generated by lack of precipitations. These climatic phenomena are very complex, and their amplitude depends on: atmospheric precipitation, air humidity and temperature, soil water storage, evapotranspiration, wind speed, etc. According to data offered by the State Hydro-meteorological Service of the Republic of Moldova, droughts account for 12.5% of all hazards, and in the last 100 years, in the country there were several severe and very severe drought phenomena, namely those in 1928, 1946, 1953, 1990, 2003, 2007, 2011, 2012, 2015. The drought from 2012 affected 318 localities in 14 raions, 1068 ha of orchards, 11136 ha of vineyards, 361215 ha of seeded land, and 542 ha of young forest, with material losses summing up approx. 74 million EUR. In 2015, in the raions of Sângerei and Râșcani, following the drought there were reported material losses of over 15 million EUR (<http://dse.md/ro/date-statistic>).

- *frost (freezing)* occurs when the near-surface air temperature falls below 0°C in the warm season (the vegetation period of crops). The most dangerous risk phenomena in this category are those occurring outside the normal season, i.e. with 2-3 weeks sooner in autumn or later in spring, respectively, compared to the mean dates. In this regard, we mention that in the northern and central regions of the country, the most belated air frosts occurred in 21-24 May 1980 and 30 March 1962, and in the south of the Republic in 1-10 May 1990. Frost in the third decade of May can be observed on average every 30 years, and are a risk factor for agriculture. The probability of frost damaging the apricot

blossoms and fruits is averagely 15-40%, and for other fruits – up to 15%. If occurring after blooming, belated frosts are also a danger for grapevines, with the probability of these frosts in the country being 10-30% per year. In last year's, the agricultural sector suffered great damages cause by frost in: 15 April, 18 May, and 18 October 2001; 5-9 April and 15-17 April 2003; 15-17 April and 11 September 2004; as well as in April 2016 and 2017 (<http://www.meteo.md/index.php/researches/>). For example, due to frost in 2016, 6 raions (Briceni, Dondușeni, Drochia, Edineț, Ocnița, Râșcani) reported together material losses of approx. 4 million EUR (<http://madrm.gov.md/ro/content/rezultatele-anului-agricol-2016-2017>). In 2017, considerable material losses were reported after heavy snowfall (over 9 million EUR) and frost (over 2 million EUR) at the end of April, with 20 raions affected (Bălți, Anenii Noi, Cahul, Cantemir, Călărași, Căușeni, Criuleni, Dondușeni, Drochia, Florești, Ialoveni, Leova, Ocnița, Orhei, Sângerei, Soroca, Stefan Vodă, Telenești, Ungheni, and UTA Găgăuzia) (Figure 2A, 2B).



Figure 2. Cherry crop affected by the snow on 20-21 April 2017
(Source: <https://sanctum.md/fotografia-zilei-20-aprilie-2017.html>).

Based on the assessment of the impact of the late frost and heavy snowfall from 20-21 April 2017 on crops, made by the Monitoring Commission of the Ministry for Agriculture and Food Industry, it was shown that in the vine sector the crop damage was 43%, with approx. 1400 ha in 170 farms affected. Due to unfavourable meteorological variations, young grapevines were most affected, as it could not withstand the large mass of snow. In total, 34.4 thousand ha of farmland were affected throughout the country, according to data presented by the rational directorates for agriculture and food.

Other frequently occurring climatic risk phenomena (at least every 2-5 years) in the Republic Moldova are:

- long-lasting rainfall (≥ 120 mm in ≤ 3 days);
- heavy snow (≥ 20 mm in ≤ 12 hours);
- glaze and hard rime with a diameter of ≥ 20 mm;
- blizzards (lasting for ≥ 24 hours);
- extreme temperatures or temperatures uncharacteristic for the respective season.

Low temperatures of -25°C or below are occurring in the northern and central raions every 5-10 years, and in the southern raions every 15-60 years. Every 20 years, air temperature in the Republic of Moldova reaches extreme values of over 40°C (<http://dse.md/ro/date-statistic>, <http://www.meteo.md/index.php/researches/>).

In May 2007, the country experienced temperatures with 5°C higher than the long-term average, a phenomenon occurring for the first time in the last 100 years. The very warm and dry weather had a very negative impact on the growth and development of the crops, and the autumn harvest was very poor, with losses estimated at 2 billion lei. Concomitantly, in the same year there were downpours that caused considerable damage to plantations and crops.

From the above mentioned observations, we can conclude that the Republic of Moldova struggles every year with extreme situations caused by natural origin critical risk phenomena, especially climatic and hydrological ones.

Thus, in the first nine months of 2018, there have been 72 extreme situations, causing damages of over 14.65 million EUR. The highest losses were caused by downpours with hail and hailstorms, Table 1.

Table 1

Extreme situations of natural origins in the first 9 months of 2018

<i>Phenomenon</i>	<i>Number</i>	<i>Material loss, Euro (official exchange rate)</i>
Heavy snowfall	2	7 735
Blizzard	1	...
Flooding	1	7 590
Landslides	1	14 075
Hail	5	3 539 150
Downpour	19	1 105 750
Downpour with hail	28	8 123 570
Downpour with hail and strong winds	7	1 270 305
Downpour with strong winds	4	518 895
Frost	1	17 035
Storms	2	1 060
High water	1	51 985
Total	72	14 657 140

Source: Statistical indexes for the year 2017, The Civil Protection and Exceptional Situations Service of the Republic of Moldova's Ministry of Internal Affairs, <http://www.dse.md/>.

Based on the analysis conducted above, we can observe how vulnerable we are to natural and anthropogenic origin environmental risks. The natural environmental risks specific to the Republic of Moldova are characterised by a medium to high frequency and medium to high consequences. The most vulnerable to these natural phenomena are the agriculture and the industries using agricultural products as raw material, especially the food and drinks industry.

At the same time, we have to stress that an efficient risks management can diminish the vulnerability towards them, the probability of their occurrence and the extent of the negative effects. In this context, the main objective of the environmental risks management is to assure a sustainable development of all activities by preventing and limiting the risk factors. The natural environmental risks management can rest on one or some of the four main risk management strategies mentioned by M. Kurtz and other risk management specialists, such as:

- accepting the risk – the risk is apprehended, but there are no measures undertaken for eliminate or minimise it;
- avoiding the risk – hazardous activities are abandoned;
- minimising losses through preliminary actions or through actions undertaken immediately as the risk event started;
- transferring the risk – the risk is transmitted to an insurance company.

The set of instruments used for minimising environmental risks can be divided in four main categories, namely:

- technical instruments: technical installations for diminishing the anthropogenic impact, and for risk monitoring and prevention;
- organising instruments: operation procedures, safety measures, backup or survival plans, externalisation of some functions;
- judicial instruments: international conventions, standards, laws, rules and instructions, etc.;

- economic and financial instruments: risk provisions, credit lines, taxes, subventions, and insurance policy.

The most plausible methods of managing natural environmental risks are: insurance and minimisation of damages by performing preventive actions. The climatic risks amelioration measures often need additional costs for the construction of a proper infrastructure, for the elaboration and implementation of advanced monitoring, prevention and aftereffects diminishing technologies, spatial planning, planting risk conditions-resistant crops; erecting buildings that can withstand natural disasters, positioning at reasonable distances from the risk source, choosing areas with a crop-favouring microclimate (Raboşapca & Barta 2014). For example:

- in order to diminish the effects of drought, there are several methods that can be used: irrigations, cultivation of aridity- and drought-resistant species, applying advanced agro-technical systems, and using fertilisers. But for the implementation of these methods, additional financial sources are needed, and these are often missing. Financing can be obtained either from own sources or from external, reimbursable (credits) or not reimbursable (subventions, national and international financing programs) sources;

- minimising the negative effects of frost can be achieved by preliminary measures such as choosing the right plant species for the region's specific temperatures, and actions conducted during the frost: heating the soil through irrigation, heating with hot air, circulating the air in order to avoid thermal inversions in the air layer next to the surface, etc.;

- nowadays, there are solutions to prevent hail clouds from forming by spreading chemical substances (silver iodide) inside the cloud, thus forcing the rain to fall before ice particles can form. But these methods are very expensive and do not always work as expected. In 7 years during the last decade, this phenomenon occurred violently, causing considerable damage;

- the damages from downpours, blizzards, erosion, and earthquakes can be considerably diminished by proper technical planning.

We have to stress that risk management has to rely on special studies and has to be adapted to each object and phenomenon, as there are no universal solutions.

Conclusions. At present, the Republic of Moldova is very vulnerable to natural environmental risk, especially climatic ones. An efficient risk management increases the success probability by reducing uncertainty and decreases the risk occurrence probability and the amount of losses. We can only speak of an efficient risk management if the strategies are implemented into tactics, the objectives are operationalised, and responsibilities are allotted to each managerial link.

However, at the bottom of the definition of risk is uncertainty, and that is why, in many cases, risk can be better understood in a statistical way, but unclear at the level of single events. In this context, the difficulty resides precisely in the quantitative assessment of the occurrence possibility of special conditions with a synergic effect that may trigger various phenomena, processes or natural factors, but also the dimensioning of their consequences. Examining potential risks has to be done in a rigorous, quantitative and qualitative manner, as its role is to present veridical facts and information on the basis of which decisions can be made.

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