CHARACTERISTICS OF RISK IN EXTREME EVENTS

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Abstract. *It is known that the environment and the human society often support the actions of some dangerous phenomena of different origins, natural or anthropogenic, that may cause destructive and brutal disturbances in some systems or default situations.*

In the following, some natural catastrophic events observed nowadays and their overall costs are presented.

In the second part of the paper hazards and their risks assessment are described and also we emphasize the types of hazard, their effects and their associated risk assessment.

The third part of the paper presents a study of portfolio risk using GARCH models (1.1), considering the daily returns of RASDAQ-C and BET indexes and the RON/EURO exchange rate, and also an analysis of the achieved results will be considered.

Keywords: *natural hazard, vulnerability, risk assessment, economic effects, social effects, environmental effects*

JEL Classification: *J17, D53, D81, C19, P28*

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1. Introduction

It is known that the environment and the human society often support the actions of some dangerous phenomena of different origins, natural or anthropogenic, that may cause destructive and brutal disturbances in some systems or default situations.

These events (earthquakes, volcanic eruptions, tsunamis, landslides, storms, floods, droughts, fires, technological accidents, conflicts, etc.) are usually unexpected and they can cause many casualties among humans and animals, a large amount of damage, ecological imbalances and even mental and moral disturbances of the impaired population affected by phenomenon.

Official statistics point out that in the last three decades, globally, various disasters have death of over 8 million people, sickness and diseases more than 1 billion people, losses and destructions of material good of hundreds of billions dollars. On average, each year, disasters are the cause of 25,0000 deaths and about $ 3 billion of economic damage.

The actual growth rate of catastrophic natural events seen today and their overall cost can be attributed to several factors: the cyclical episodes that cause different natural hazard; the increasing of the global population and its concentration in large crowds; the increasing vulnerability of human communities; the negligence in forecasting, insufficient preventive measures and activities; the increasing public awareness and requests concerning their safety and security.

In our opinion, the main responsible factor for the worsening risk is *the increasing vulnerability of the human communities*. In addition to the natural characteristics that determine the degree of vulnerability, the man creates or aggravates vulnerability in many ways: the settling in vulnerable areas, for economical reasons, increased urbanization and industrialization in areas at risk; the density and the attendance of the risk territories, the form and the type of area utilization; the nature and the quality of the constructions; the increasing dependence of urban areas on different technical networks, which are susceptible to be disrupted, either by natural or by anthropogenic cause (such as destruction of water pipes, heating pipes, electrical and telecommunication cables, etc.); the increasing mobilization of the underground space for urbanization (underground lines, tunnels, underground parking, etc.) expands the vulnerability spectrum in an worrying manner; the multiplication of the cases of subversive behaviour, acts of delinquency, etc. add an extra dimension of vulnerability.

2. Hazards and risk assessment

2.1. Classification of hazards

Hazards can be classified by various criteria: origin, mode of manifestation, frequency, damage, degree of potential damage, etc.

By origin, hazards can be classified into two major categories:

Table 1

Natural Hazards	*geological*		- earthquakes - volcanoes
		climate	- typhoons - hurricanes - cold waves - hot waves - drought - waves
	geographical	oceanographic	- tsunami
		hydrological	- El Niño - folding - fluvial processes
		geomorphological	- mass displacements (landslides, mud flow etc.) - erosion - desertification
	ecological		- species biodiversity
	biological		- epidemics - invasion of locusts
	technological		- technical progress - pollution
Anthropogenic Hazard	*social*		- radioactivity - population growth - urbanization - unemployment

By mode of manifestation and period of installation they are classified into:

Table 2

	- earthquakes
	- volcanoes
Violent hazards	- typhoons, tornadoes, etc.
	- local storms accompanied by hail, etc. - catastrophic landslides, avalanches
Progressive hazards	- Mediterranean disturbances (Mediterranean cyclones retrograde evolution)
	- phenomena fry
Slow hazards	- droughts
	- mists of radiation and evaporation

By damage (by Zavoianu, Dragomirescu, 1996):

Table 3

	casualties	at least 100 dead
by Sheehan, Hewit		at least 100 injured
	damage to the economy	at least $ 1 million
	casualties	at least 200 dead
by Swiss Re	damage to the economy	at least $16.2 million
by Gares, 1994	casualties	at least 200 dead

By surface area, active period, main effects, the classification is (by Chardon, 1990):

- Giga catastrophe (volcanic explosions);
- Mega catastrophe (big earthquakes, volcanic eruptions, tropical droughts);
- Mezzo catastrophe (smaller volcanic eruptions, earthquakes of less intensity, cold waves, thunder storms, tornadoes);
- Catastrophe (small seismic, tornadoes, rain exceptional);
- Spot localization phenomena (slope processes, muddy torrents and hail storms).

2.2. Effects of hazards

The manifestation of various hazards has effects on multiple levels, especially economic, social and environmental.

The economic effects can be best expressed by the damages caused by hazards, actual and potential:

- real damages are the actual damages that occur after a hazardous event and can be direct (destruction and deterioration of property and movables, the cost of intervention works, evacuation and relief) and indirect (loss to the national economy recorded in units unaffected by the hazard in question, but whose activity is disturbed because of the links between them and the units directly affected by hazard);
- a potential damage is the difference between the results which would run on a particular field (for example, meadow) in the conditions under which it would not be affected periodically by a hazard (for example, flood) and the results of the activities actually taking place on land in a given likelihood regime (flooding, in our example).

Among the most important ecological effects one finds: changes in the landscape, especially in terms of equilibrium and dynamic slopes, changing quality of air and surface and underground water, changing physical-chemical qualities of soil, flora and fauna zoning change, both terrestrial and aquatic, the increasing risk of production and spread of the endemic diseases, etc. Environmental effects are fully imponderables and need improvement (if possible) long periods of time.

Social effects of hazards have a much higher gravity, whose elimination is a condition with direct implications for the overall standard of living. They cannot be expressed quantitatively, only exceptionally.

2.3. Risk evaluation

Risk study and, especially, assessment proves to be a complex and difficult step having so many parameters or variables to be considered.

It must be based on an interdisciplinary approach, both by natural and by social sciences: probabilistic or deterministic approach; use of various resources and theories borrowed from mathematics (fractal geometry, chaos theory, probability calculation); development of GIS, etc.

The full control of risk is not possible, it may be streamlined by pragmatic approaches, in particular, probabilistic and normative, which are two complementary approaches, essential for this operation.

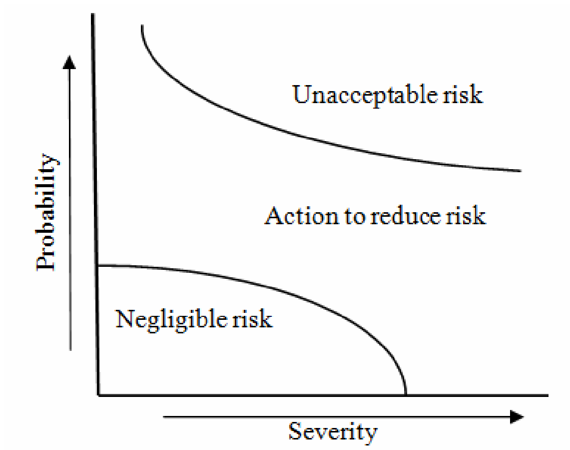
The probabilistic approach seeks to anticipate the occurrence of catastrophic events for the evolution of a system by calculating the probability discovering regularities that govern the risk and potential events. This approach highlights the extent and cyclicality of natural and socio-economic events. The main operations are finding factors involved in implementing risk and establishing correlations between events in time to seize the risky nature of some situations.

The normative approach needs to establish rules, thresholds and risk factors for certain systems. Unfortunately, in geographical systems, which are particularly complex, to establish of clear thresholds for risk factors is impossible. These thresholds should result from measurements, calculations, experiments and should obtain public or law opinion in order to be respected. Some elements, such as pollution, building resistance to earthquakes, flood embankment sizing, etc. have some well-defined thresholds, but thresholds for geographic features are complex and difficult to be established.

At present, the effort of the international community is moving from *post disaster* responses and measures, to an attitude and a *pre disaster* action, more responsible.

A risk evaluation typically consists of a graphical representation of the two main features: its probability and its severity. If the probability and the frequency are equal and the severity is given some numerical values, we obtain an F / N(frequency / number) diagram. In this way, the damage can be plotted according to its frequency and numerical coordinates (Figure 1).

Figure 1



For the planning support, the field can be divided into three action areas, according to the level of acceptability. If you graph the value of F / N area covered by "negligible", there is no question to allocate new resources to reduce risk, if it falls within the middle, resources must be directed at reducing risk; finally, if it falls within the "unacceptable", then efforts must be geared towards finding a compelling alternative. The positions of these limit area are creations of the society and are not related to the nature of risk itself. Since the process involves an estimated scale, and this is certainly a gross simplification, the accuracy of the results is limited.

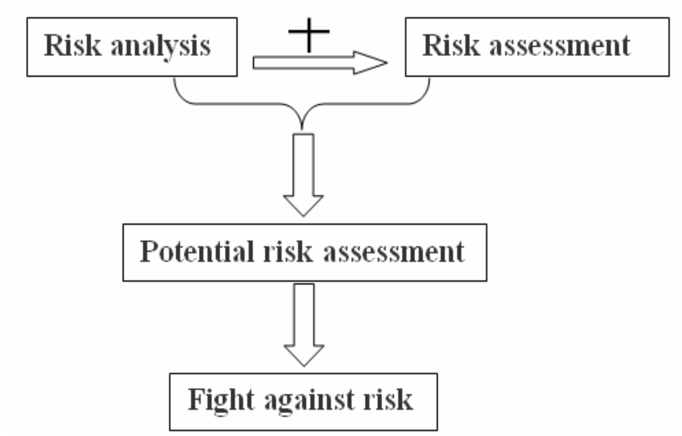
Risks induced by natural hazard study involves an entire issue which should allow an objective analysis of the phenomenon, beginning with a rigorous observation and ending in the assessment of hazards to reduce material costs and consequences of rebuilding destroyed property and the environment.

Such a study includes a laborious activity, following several aspects: the existence and analysis of statistical data over a long period of time; determining the average characteristics of each analyzed parameter; extracting extreme values representing the possible limits of variation of the phenomenon and risk thresholds; calculating the deviation from the mean parameter, considered as normal; specifying the threshold starting from which a phenomenon may be a risk; specification and analysis for genetic factors for each studied risk; how to event analysis in time and space phenomenon; establishing risk range; quantify the degree of vulnerability (damage and casualties recorded following the risks); psychological consequences and the role of education through the media; risk factor monitoring; assessment of material costs to mitigate the consequences and reconstruction of destroyed property and the environment.

For the quantification of these factors, the main criteria taken into consideration are: the potential of destruction and severity of consequences (human casualties, economic loss), the frequency of event (return period) and the difficulty of effect prevention or mitigation.

The study of the environmental risk includes, in principle, two distinct steps. First there is a location survey in order to know what environmental harm have been done or could occur (risk analysis) and secondly to know what harm can be tolerated (risk assessment).

Figure 2



So, using these two phases, we analyse risks and estimate dangerous types and their importance in present and in the future, in other words, we shall make an evaluation of *potential risk*. The purpose of this assessment of potential risks is ultimately one of whether it is urgent to do something, to deduce measures to combat the risks and, if strong contamination, to establish its mediation strategy.

Risk analysis is done beginning with a historical investigation of a potentially contaminated site (how it was used in the past, land occupation, etc.).

Technical analysis is then performed by different methods and techniques in order to review the current status of the site. Samples are collected and then analyzed in order to finally determine the type, location, quantity and concentration of any environmentally hazardous substances. It focuses on learning the actual and possible interference, their transportation and their evolution over time.

The risk assessment must be able to answer the question "What can be tolerated?", in order to assess the admissible. Therefore, the results of risk analysis will be evaluated and compared with targets for the protection of various environmental goods as a whole. They are based on scientific knowledge and social scale of values, including qualitative and quantitative criteria that define when a touch is no longer tolerable. It is necessary to have a legal basis of an appropriate legislation, which contains standard values and limits, clear and precise recommendations for the evaluation of contaminated sites.

The initiation of hazardous substances at a site contaminated in various ways (food chains, air, water, direct contact), includes several environmental risks.

Therefore, depending on the availability of hazardous substances and their different behaviour in different ways of contamination, risk analysis and assessment based on substance, the route of contamination and property protection, prove indispensable. The risk assessment will judge the interaction of different sectors on the environment as a whole.

When you know what you can tolerate, you can make an estimate of potential risks and then it is possible to take reasonable measures for the contaminated site. Such risk assessment is of course a process that touches so many areas and requires interdisciplinary participation of experts. The term *response* refers to any action when an emergency occurs, during its deployment and then to reduce its negative effects on human health, economic and environmental activities.

Responses to risk are either to prevent or to limit the consequences for the population. These fall, after varying mixtures and dosages, in the quadrilateral:

Technical responses - shows different branches of engineering sciences; intended major, if not to eliminate the risk, at least to mitigate the intensity of natural hazards and limiting the likelihood of technological risks to occur. Consist of civil engineering works, but their effectiveness remains relatively.

Spatial responses - are primarily preventive and designed to limit the vulnerability of territories under threat risk; consist in a double judicial review: one to the authorities permits and the other aimed at eliminating any new forms of vulnerability that can result from urbanization. These two types of control lead to more or less limitation of constructions, often a source of conflict between public and private interest, between state and local community.

Management responses - coming from institutions or civil protection bodies; these occur during and after an extreme event to control and eliminate its consequences; their actions put into practice the operational plans for help and intervention, which are updated based on experience, benefit from each disaster; the weak link remains the inconvenience to react to the event that any forecasts escaped, radically unpredictable.

Replies insurance - is done to repair critical damage from an event, the compensation of victims; the subject of ongoing reflection lies in the role that the insurer can exercise before the event, both in preventing and in the responsibilities (by modulating the amount of insurance premiums according to the potentiality of risk, but also from the technical requirements, contributing to the implementation of essential security rules).

3. Portfolio Risk - using GARCH (1,1) models

In practice, the financial series prove not to follow a normal distribution. The series are rather leptokurtic, meaning that there is a big deviation of their extreme values from the average. Also, financial series tend to be asymmetric. That implies that the skewness index (which captures the symmetry or asymmetry of a series) has nonzero values.

Financial series show two more particularly important problems: serial correlation recovered in residue; heteroscedasticity - uneven evolution of dispersal of that series over the analyzed time period.

GARCH models are designed to model economic series which present the characteristics listed above. GARCH means: G - generalized, AR - autoregressive, C - conditional; H - heteroscedasticity.

The first model was developed by Robert Engle in 1982. It was an ARCH model. The model includes an equation for a medium and one for dispersion, respectively:

$$\begin{aligned} y_t &= \gamma x_t + \varepsilon_t \\ \sigma_t^2 &= \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \end{aligned} \tag{1}$$

where:

y_t - dependent variable in the current period;

x_t - independent variable in the current period;

γ - is the coefficient which shows the influence of the independent variable on the dependent variable;

ε_t - the residuals in the current period;

σ_t^2 - dispersion of the dependent variable in the current period

ω - constant of the dispersion equation

α - ARCH coefficient

ε_{t-1} – the residuals of the previous period

σ_{t-1}^2 - dispersion of the dependent variable in the previous period

β - GARCH coefficient

The model described above is GARCH (1,1) where the first number shows that residual terms of the previous period act on the dispersion and the second number shows that the dispersion of the previous period has an influence on current dispersion. In fact, for very large series, GARCH (1,1) can be generalized to GARCH (p, q)1.

An interesting approach to GARCH models is the possible existence of a leverage effect. In fact, GARCH (1,1) is a symmetric model and implies that the residual terms have the same sign. In reality, the financial series often presents asymmetry. A very useful model in this case is EGARCH or otherwise called the exponential GARCH model introduced by Nelson (1991):

$$\log\sigma_t^2 = \omega + \log\left(\sigma_{t-1}^2\right) + \alpha\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \gamma\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \quad (2)$$

The leverage effect can be tested by inequality $\gamma < 0$ and $\gamma \neq 0$. We observe that this model is similar to model GARCH (1,1). However, the log term turns this model into a non-linear one. The residual terms are also reported to dispersion becoming standardized residues.

For the portfolio construction, data from 04.01.2005-22.12.2007 period were used, including about 755 observations. We used in our analysis BET and RASDAQ-C indexes and the RON/EURO exchange rate. Data on the evolution of BET index were provided by BSE, data on the evolution of the RASDAQ-C were collected from the official site of the RASDAQ Stock Market, while the evolution source of the RON/EURO exchange rate is the National Bank of Romania

In our application, we assume that an investor is willing to invest a part of his wealth in the Romanian capital market. The investor has a significant tolerance to risk, yet wishing to diversify his investment. Suppose that this investor prefers the stock market investment. More precisely, assume that 50% of his capital is invested in the first category of Bucharest Stock Exchange (to simplify the simulation we take the market index BET as financial asset), 30% in RASDAQ OTC market (i.e. the RASDAQ-C index), while for better diversification and protection against risk he will invest 20% in EURO (meaning that the investor wants a significant degree of liquidity).

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1 An interesting presentation of GARCH models is found in *The Econometrics of Financial Economics*, by John Campbell, Andrew Lo and Craig MacKinley, published in 1997 by Princeton University Press, pp. 479-490.

Our investor is interested in monitoring his investment and in this respect he wants to know how his portfolio risk evolved. Also, he would like to know what reasons have led to some peaks of volatility. Thus, he will choose the GARCH methodology to analyze volatility.

The first step will be testing the ARCH signature presence in portfolio. This will be achieved through the correlogram of efficiency radical. If the ARCH signature is present, we shall move to the conditional dispersion modeling. Thus, GARCH (1,1) will be compared with EGARCH (1,1). Finally, after choosing the most suitable model, we test for the residual terms existence by means of radical standardized residual terms correlogram and by the ARCH LM test.

Based on primary data, daily returns were calculated (of the BET and RASDAQ-C indexes and of the exchange rate). Next, based on the percentages above, the portfolio was composed and the daily returns of the portfolio were calculated. Later, the data were transferred to Eviews 7.0, where all the necessary tests were taken.

	BET	RASDAQ-C	leu/euro	Portofolio
Mean	0.001543	8.93E-05	0.001692	0.001523
Std. Deviation	0.008962	0.005539	0.002143	0.005291
Skewness	0.382	0.472	4.936	0.271
Kurtosis	7.634	52.735	82.532	7.492

4. The results study

The table indicates that the stock market was the most risky (if we refer to BET index). The lowest risk was recorded in the currency market (which was expected, by the way). The standard deviation of the portfolio was significantly reduced by balancing the portfolio with the EURO, yet another clear evidence of diversification. Also it shows that the EURO yield to a higher efficiency than that of BET index.

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